

The Natural Sciences at Princeton University

*A statement by
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July 7, 2016

Princeton University has long been known as one of the world's leading centers for teaching and research in the sciences. The report of the Task Force on the Natural Sciences builds on that tradition by specifying Princeton's distinctive strengths and laying out opportunities for the future. We are grateful to the task force for its insightful work and thoughtful recommendations. In this memorandum, we respond to the report by identifying recommendations on which we will take immediate action, those that will need further consideration and development, and those that we believe, at this time, to be of lower priority.

The sciences at Princeton

The task force described multiple factors that have contributed to the extraordinary quality and reputation of the natural sciences at Princeton, including long-standing excellence in foundational fields; an environment that fosters synthesis across disciplines and “the nimble integration of theory, computation, and experiments”; and the opportunity for close interaction with other divisions and units across the University. The task force correctly noted that in an era when government support for basic science is tightly constrained, Princeton's continued success depends on the University's ability to provide researchers in all of its departments with the support and instrumentation they require. Princeton must accordingly be judicious, as it has been in the past, about any new ventures or projects it undertakes: the University must ensure that existing departments and new initiatives alike continue to achieve the world-class quality for which Princeton is known, and the University must craft new investments in ways that capitalize on Princeton's distinctive strengths and that are sensitive to the University's special characteristics.

The task force report also emphasizes the critical importance of Princeton's Graduate School. It describes graduate students as “the lifeblood of the research endeavor” and says that they “work on the most innovative topics that cross the boundaries between research groups and disciplines, and thus are essential for establishing and maintaining close interactions across research groups.” These observations echo similar ones in reports from other task forces, including those on the Graduate School, sponsored research, and the humanities. In light of the high priority that Princeton places on ensuring the quality of graduate student support, Provost David S. Lee, working with Dean for Research Pablo Debenedetti and Dean of the Graduate School Sanjeev Kulkarni, has taken immediate steps to mitigate the dependence of graduate support on federal grants in the natural sciences and engineering by establishing a central fund that will provide research allowances to faculty to offset the cost of fourth and fifth-year graduate student tuition on eligible sponsored research grants. (Princeton will also increase the funding and professional development opportunities available to sixth-year students in the humanities and social sciences who are making timely progress toward degrees.)

Ideally, the University will in the future be able to add to the graduate student support already provided by the provost and so further reduce the dependence of graduate funding on external grants. Doing so will require the University to draw creatively on multiple funding sources. Some of the most powerful and beneficial changes will result from philanthropy, such as the visionary gift of Professor of Chemistry Emeritus Edward Taylor, whose exceptionally generous donation to Princeton created fellowships for third-year students in the chemistry department. We will continue to seek gifts to support Princeton's graduate programs.

While Princeton's science departments are superb in nearly every respect, the task force rightly notes that they need to enhance diversity and increase the number of underrepresented minorities in the natural sciences across all academic levels, including the undergraduate, graduate, postdoctoral, and faculty populations. We agree wholeheartedly. Princeton's core mission requires continued efforts to enhance the diversity and inclusivity of the entire campus community, at all levels and in all fields.

The success of these efforts will require a close partnership between the central administration and the academic departments. On the administration's side, the provost, the dean of the faculty, and the dean of the Graduate School have all initiated programs aimed at supporting diversity in the natural sciences. On the departments' side, several units have stepped up to show impressive leadership. The Department of Molecular Biology and the Lewis-Sigler Institute for Integrative Genomics, for example, have already done exemplary work to enhance both the diversity and the quality of graduate programs in the life sciences. The University is now designing a high-profile pipeline program to increase the number of doctoral candidates from underrepresented minorities, and we expect other science departments to seize this and other opportunities to follow up on the success of the biologists. We cannot achieve the excellence to which we aspire, nor can we expect the public's continued support for educational enterprise, unless we draw energetically upon the talent available from every group in our society.

Environmental institute

The first recommendation in the task force report, and its most ambitious, is that the University create an expanded and enhanced environmental institute, to be housed in an environment-themed building that would also be home to the University's departments of geosciences and ecology and evolutionary biology. We endorse this recommendation as one of the University's top priorities. The University's strategic framework recognizes that environmental issues are among the most urgent challenges facing society today. Princeton has already taken an important step to address these challenges by establishing the Andlinger Center for Energy and the Environment, a broadly interdisciplinary endeavor with strong scholarly foundations in engineering and materials science. The strategic framework calls upon Princeton to undertake a comparably bold and interdisciplinary initiative centered on the environmental sciences. This initiative would build on the important teaching and research now being done by the Princeton Environmental Institute.

The task force report persuasively characterizes environmental issues as "vexing scientific and societal challenges" that require us to "conceptualize Earth as a complex system of

interacting biological, physical, and human forces, and to subject this view to the rigor of combined mathematical, computational, and experimental analysis.” These challenges call upon the strengths of Princeton’s scientific enterprise: disciplinary rigor and excellence; an environment conducive to innovative collaboration across disciplines; nimble integration of theory, computation, and experiment; and fluid interaction between the sciences and other divisions of the University.

The success of the University’s initiatives in this area will hinge upon our ability to provide the modern teaching and research facilities that the scholars working in these areas need. We agree with the task force that Princeton’s scientists require a new building if they are to tackle these challenges as fully as they are capable of doing: at the moment, Princeton’s geoscientists, ecologists, and evolutionary biologists do brilliant work despite their location in century-old buildings ill-suited to their current function. The situation is unsustainable; the scientists must have the facilities they require to continue to do first-rate work and collaborate effectively.

We also agree with the task force that the success of this project, and hence the design for the building, will depend upon conceiving an institute that effectively integrates and leverages not only the departments located in the building but a broader array of natural scientists, engineers, humanists, and social scientists who share an interest in bringing world-class scholarship to bear on environmental questions. The task force recommends the establishment of a working group to design the institute and articulate its mission. We agree with this recommendation, and we will appoint a group to address these topics.

The task force made a number of more specific recommendations about the institute, ranging from the architectural (the institute should be located on the top floor of the new building) to the programmatic (for example, five-year rotating appointments for participating faculty members, two-year or three-year group projects, an environmental fellows program, the continuation of the Grand Challenges program, and an undergraduate educational program similar to the Program in Environmental Studies). We agree that it is desirable to continue Grand Challenges and we join the task force in anticipating that the new institute will have an important undergraduate (and graduate) teaching mission. We take the rest of the recommendations as illustrative and await more specific advice from the working group.

Perhaps the most important assignment for that working group will be to provide a more complete specification of the shared project that will constitute the scholarly spine of the new institute. The task force report lists as potential models a number of other interdisciplinary units on campus, not all of which have generated equally vibrant and sustained communities. Those that are most successful have generally maintained shared, long-term teaching initiatives or scholarly workshops that are a source of pride to all affiliated faculty members and that demand substantial commitment from them. The successful units also tend to be characterized by a self-conscious emphasis on specific scholarly or pedagogical sub-themes or approaches that distinguish their efforts from comparable centers elsewhere. While there may be exceptions to this pattern, we think that the working group will need to think carefully about the elements needed to ensure that the institute is greater than the sum of its parts.

Multi-modal imaging center and computational science

The task force report's second recommendation is for a center for multi-modal imaging of biological processes that would provide University researchers with high-resolution single particle electron cryo-microscopy (cryo-EM) imaging capability. We are fully convinced of the importance of this new form of imaging to a number of departments and units, including molecular biology, the Lewis-Sigler Institute for Integrative Genomics, and the School of Engineering and Applied Science, and to Princeton's scientific enterprise more generally. Fortunately, this recommendation requires an investment that, while certainly significant, is considerably smaller in scale than an environmental building or institute. By collaborating with several units on campus during the past spring, we established a cryo-EM imaging facility and identified suitable space for it within the Andlinger Center. The addition of this capability to the University's existing imaging facilities will provide Princeton's researchers with rare capacity to explore questions at the forefront of many fields.

The cryo-EM imaging facility is illustrative of other needs likely to arise in the future: as the task force pointed out, the University must be prepared to make periodic investments in centers and state-of-the-art research tools that are critical to Princeton's ability to remain at the most exciting frontiers of scientific inquiry. These endeavors will require the University to draw upon multiple funding sources, including central and departmentally managed funds as well as external grants and gifts.

The report's recommendations regarding the Princeton Institute for Computational Science and Engineering (PICSciE) are in many respects a variation on this theme. High performance computing has changed what is possible in scientific research, pushing back boundaries of inquiry in theoretical and empirical domains. This work is both essential and expensive; it depends, as the task force correctly said, on ensuring that Princeton continually renews its computational facilities and provides the staff to make these facilities maximally effective. PICSciE has done this very effectively by integrating the University's resources and producing strong collaboration among computational researchers; other research universities regularly visit Princeton to study how PICSciE works. However, because computational equipment becomes obsolete quickly and because federal funding for computational purchases is very limited, PICSciE's continued success will depend on sustained support from multiple sources. Ideally, the University would obtain a gift to endow PICSciE, and, indeed, there are very few gifts that would be so valuable to Princeton's research enterprise. Unless and until the University is able to secure such a gift, it will have to continue drawing creatively on multiple sources to meet PICSciE's needs. We have asked the dean for research to help us address near-term needs in this area, and we will continue to work with PICSciE's leadership and researchers to ensure that this indispensable part of Princeton's research enterprise can get the support that it requires.

Theory centers

The task force report recommends expanding the Princeton Center for Theoretical Science (PCTS) and launching a gravity initiative that leverages the strengths and synergies of Princeton faculty working in the field of general relativity. Both proposals sound attractive in

principle. The recent change to the University's spending policy may provide the PCTS, which has an endowment, with additional income that might help to support its future expansion. In any event, we will consider both initiatives as we plan the upcoming campaign. Their feasibility depends in significant part on fundraising potential. Fundraising may, of course, be easier if it is done on a term rather than an endowment basis, and we are pleased to see that the gravity initiative proposes an investment on a 10-15 year scale. Term initiatives have the benefit of allowing departments and the University to reassess priorities on a periodic basis.

Other recommendations

The task force report makes many other recommendations aimed at enhancing the University's core strengths in the natural sciences; improving undergraduate, graduate, and postdoctoral education; internationalization; and diversity. We offer a brief response to those recommendations below.

- *The task force recommends that the University make available seed funding for novel programs, matching funds, and funding for high-risk projects.* Similar recommendations came from the Committee on the Future of Sponsored Research and will be considered in the context of that task force report. Our ability to pursue this recommendation will be contingent upon fundraising.
- *The task force recommends that Princeton remain competitive in the housing and benefits programs offered to faculty.* We agree. The University's housing and benefits programs for faculty are carefully designed to support Princeton's recruitment and retention goals.
- *The task force recommends increasing resources available to support early research experiences for undergraduate students.* The research experiences we provide to undergraduates are essential to Princeton's distinctive liberal arts program. We agree that it is important to review periodically the resources that are available for undergraduate research projects and, when necessary, raise additional funds for that purpose.
- *The task force recommends that the University should increase the support and resources available for postdoctoral fellows.* The Office of the Dean of the Faculty, which oversees the University's postdocs, is currently studying ways to support better this population with additional programs and resources.
- *The task force recommends enhancing the research-based international experiences that are available to undergraduate and graduate students, and providing additional support for the growing portfolio of international research and educational opportunities.* We endorse this recommendation. As the task force report notes, the University already has some excellent programs that send students abroad to do scientific research, such as those funded by Grand Challenges and overseen by the

Program in Global Health and the Princeton Environmental Institute. We will seek opportunities to continue to expand these programs and develop new ones. The extent of our ability to do so will depend upon departmental support and fundraising success.

Conclusion

We thank the members of the Task Force on the Natural Sciences for an inspiring and thoughtful report. We look forward to pursuing its recommendations to build on the University's longstanding excellence in the sciences and seize emerging opportunities in the years ahead.