POLICY FORUM

Scientists and the Integrity of Research

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The scientific research enterprise is built on a foundation of trust: trust that the results reported by others are valid and trust that the source of novel ideas will be appropriately acknowledged in the scientific literature. To maintain this trust in the current climate of research, we believe that more attention must be given by the scientific community to the mechanisms that sustain and transmit the values that are associated with ethical scientific conduct.

The responsibility for scientific conduct falls on all parts of the research community, including administrators, the leaders of scientific societies, journal editors, and government officials. In this article we will concentrate on the group that must bear the greatest responsibility for maintaining high standards of conduct—the working scientists themselves.

In the past, scientists learned the ethics of research largely through informal means—by working with senior scientists and watching how they dealt with ethical questions. That tradition, while important, is no longer sufficient to meet the needs of the scientific community and the expectations of society.

Most scientists are already consumed with the tasks of doing research, teaching, mentoring, and administration, and have found little time to devote to formal consideration of research ethics. But we must find the time, if the public is going to maintain confidence in the integrity of the scientific enterprise. Unless the trust that scientists traditionally extend to each other also characterizes the relationship between science and the public, the research enterprise is likely to become much more encumbered by counterproductive regulation and oversight.

External and Internal Pressures

What has changed about the research environment that makes it important for scientists to take action? The factors are both external and internal.

The external forces originate in the high standards of accountability now being applied to the scientific community. U.S. citizens make a heavy investment in science. The federal government now spends about $25 billion per year on basic and applied scientific research, or about $100 annually for every person in the country. American taxpayers have a right to insist that these funds are well spent.

The internal forces come partly from the greatly intensified competition for research positions, resources, and recognition in many areas of science. This competition puts a great deal of stress on all researchers. For some, it promotes undesirable behavior or even dangerous shortcuts.

Public attention tends to focus on dramatic instances of misconduct—the occasional cases of fabrication, falsification, and plagiarism that all agree violate the ethical norms of science. But even more damaging to the integrity of science are those behaviors that do not rise to the level of misconduct but nevertheless violate values held in common by the scientific community. These questionable research practices arise in areas such as allocation of credit, the treatment of research data, respect for intellectual property, and mentorship responsibilities. By eroding the ethical foundations of research, the questionable behaviors can create an environment in which blatant misconduct in science becomes more likely.

Last June the National Academy complex held a convocation to examine issues relating to scientific conduct and to identify key next steps that need to be taken. Though scientific misconduct was extensively discussed, convocation participants focused even more attention on questionable research practices. They agreed that these behaviors must be defined and discouraged without constraining the creativity and initiative that have made American science so productive. Because questionable research practices are generally not appropriate targets for governmental or legal investigations, the scientific community itself must take responsibility for determining which practices are serious enough to warrant institutional or professional responses and what forms these responses should take.

A second topic discussed concerned the best ways to integrate consideration of ethical issues into the research enterprise. Some universities and other research institutions have developed educational programs to inform and sensitize students and faculty about ethical issues. But many of these programs seem to be poorly integrated into the research and educational missions of the institutions.

Our experience has been that appropriately designed educational programs can be extremely useful for students and faculty alike. Such instruction can explicitly raise issues that might otherwise be handled using implicit or incompletely articulated principles. It also establishes a clear public commitment to high standards of ethical behavior that can permeate effectively throughout the entire institution.

These educational programs can take many different forms. At the University of California, San Francisco, questions of scientific ethics occupy one of four sessions held on consecutive Saturdays each spring. These optional daylong sessions deal with such subjects as directing a laboratory, teaching undergraduates, and getting and staying funded; they attract a large number of participants, including students, postdoctoral researchers, and faculty. The session on ethics, entitled "Etiquette and Ethics in Science," is organized largely around real cases of ethically difficult situations that researchers have encountered in the course of a scientific career. Especially popular are cases presented by faculty that incorporate actual correspondence and other details, with only the names of the individuals obscured. The course is presented as a problem-solving exercise, in which students and faculty join together to discuss and analyze situations involving conflicts of interest, authorship practices, responses to suspicions of misconduct, and other complex issues.

At the University of California, Los Angeles, interest in issues of scientific misconduct have led to the creation of a Center on Scientific Ethics. Central to the work of the center has been the preparation of an extensive bibliography and the collection of case studies (*1*).

The University of Pittsburgh has found that many ethical issues are best addressed within the core curriculum rather than in a stand-alone course. In courses in basic biomedical science, students, using a case-study approach, examine issues such as genetic engineering, the use of animals in research, and university-industry relations.

Other research institutions, professional societies, and journals have developed policies and educational materials that can be used in courses or seminars on ethical issues. The experiences of the last 10 years have generated a wealth of case materials and analyses that can inform students' and faculties' consideration of these issues (*2*).

Many of the issues that scientists deal with daily have ethical implications but no clear answers. It is in these gray areas that it is easiest to engage the attention and energies of those attending sessions designed to promote ethical behavior. Preaching

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against blatantly destructive behaviors is unnecessary in such a context, and it is unlikely to engage the audience in any case. Some examples of topics of great interest include:

1) A scientist makes a series of measurements. A few of the measurements are grossly out of line with all the others. Under what conditions, if any, is the scientist justified in omitting these measurements from a publication that contains the rest of the data?

2) A young scientist arranges a collaboration with the distinguished head of a second laboratory. In the end, the collaborating laboratory contributes nothing, and all of the work is completed by two students in the first scientist's laboratory. When a preprint of the publication is mailed to the intended collaborator, this individual claims the right to be an author, based on the initial discussions. How should the young scientist respond?

3) A laboratory publishes a revolutionary finding that is based on experiments that require a special chemical reagent that had to be synthesized by a student, in an effort that required several years. A competing laboratory whose original model is challenged by this experiment writes to request a small sample of the reagent so that the second laboratory can attempt to reproduce the new finding. The amount of reagent available could be limiting to the further experiments of the student trying to complete his or her thesis, and there is also a concern that supplying the reagent to the second laboratory might enable them to compete directly with the student's current experiments. How should the laboratory head respond?

A third major topic discussed at the June convocation concerned the best way for institutions to respond to allegations of ethical transgressions. Many institutions have set up procedures for evaluating allegations of misbehavior, but many of these procedures remain vague and ambiguous. Students and faculty also tend to be unfamiliar with the procedures that are in place. When faced with an allegation, they often use intuition in deciding on a response, when experience shows that such an approach can lead to disaster.

Recent federal rulings have made it clear that transgressions of ethical standards in science will most often be investigated and adjudicated at the level of the research institution. Institutions are therefore going to have to become much more adept at establishing policies, making procedures known to faculty, students, and staff, and handling cases in a manner that is fair to both accuser and accused. There is much to be learned from past experience, and we need better mechanisms to promote the sharing of information and expertise among institutions.

Protecting the Scientific Enterprise

At the convocation, Harold Varmus, director of the National Institutes of Health, said:

> [T]here are a lot of problems, but it seems to me that we have come a long way in the past decade. Certainly my own attitudes have shifted considerably from the time when I would have said that science is simply self-correcting and society should leave us alone, to a time like the present when we all recognize that scientific misconduct is a real issue and deserves the current attention that it is getting.

Despite the progress of the past decade, much remains to be done, and the involvement of our most outstanding scientists is critical. They play key roles in departmental and university governance and serve as the role models for students and young scientists. If we are to be effective in maintaining high standards for the scientific community, this issue cannot be left to deans and administrators alone.

The involvement of the most respected scientists at an institution is necessary for setting standards of conduct, designing educational programs, and responding to alleged violations of ethical norms. In meeting such responsibilities, these scientists should be continually asking themselves: (i) Are we setting a good example? Do we go out of our way to give credit to others on whose findings and ideas we build? Are we explicit about the contributions to our own work by students? (ii) Do we reward the scientific quality rather than the quantity of publications? Do we reward faculty who contribute to the scientific community through outstanding public service, teaching, and mentoring? (iii) When allegations of misconduct arise, are they scrupulously examined regardless of the rank or status of the scientist in question or the financial implications for the scientist or the institution? (iv) Are we contributing to the mechanisms that spread appropriate values? Do we support educational efforts that promote the high ethical standards of science?

In addition, national organizations should provide a framework for grass roots efforts and facilitate the spread of model programs designed elsewhere. They can also help define standards for educational programs and methods to evaluate the effectiveness of such programs. Building on the June convocation, the Academy complex is working with other organizations to organize a series of regional projects designed to help local institutions and departments improve how they handle allegations of misconduct, address questionable research practices, educate their communities about research ethics, and share resources.

Every scientist has a stake in contributing to the ethical standards of scientific conduct. If we do not police ourselves, others may step in to do so. The result could be a scientific enterprise that is increasingly constrained by legal strictures, financial oversight, and bureaucratic provisions. We must recognize that good science resembles art more than it resembles the law, accounting, or government. If scientific research is beset with paperwork and regulation, much of the joy and creativity in doing science could disappear. Such a cultural change would not only impede scientific progress, it would also make our field much less attractive to the dedicated and talented young researchers who represent the future. It is incumbent upon all of us in the scientific community to help provide a research environment that, through its adherence to high ethical standards and creative productivity, will attract and retain individuals of outstanding intellect and character to one of society's most important professions.

REFERENCES

1. Association of American Medical Colleges, *Teaching the Responsible Conduct of Research Through a Case Study Approach: A Handbook for Instructors* (Association of American Medical Colleges, Washington, DC, 1994).
2. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, Committee on Science, Engineering, and Public Policy, Panel on Scientific Responsibility and the Conduct of Research, *Responsible Science: Ensuring the Integrity of the Research Process* (National Academy Press, Washington, DC 1992); Institute of Medicine, Committee on the Responsible Conduct of Research, *The Responsible Conduct of Research in the Health Sciences* (National Academy Press, Washington, DC, 1989); National Academy of Sciences, Committee on the Conduct of Science, *On Being a Scientist* (National Academy Press, Washington, DC, 1989); B. Alberts, R. W. White, K. Shine, "Scientific conduct," *Proc. Natl. Acad. Sci. U.S.A.* **91**, 3479 (1994). The National Academy complex also is compiling many of the educational materials that have been used in various programs on research ethics. This resource material will be made available to institutions, scientists, and educators who are involved with developing and implementing educational programs in scientific conduct. For further information, contact Eric Fischer at (202) 334-2215.