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"Big science" and interdisciplinary science

The paper by Humphrey et al. (this volume) describes an innovative graduate program that seeks to foster interdisciplinary thinking and research in biomedical sciences and engineering. In reflecting on the manuscript, two observations about wider issues suggested themselves.

First, the authors cite several recent examples of advances made by "team science" as opposed to previous advances made by individual scientists. However, I would argue that they have confused technology with science and "big science" with interdisciplinary science.

The fundamental understanding underlying the atomic bomb had been achieved before the Manhattan Project began. This is not to suggest that there weren't scientific problems to be solved, but the Manhattan Project was overwhelmingly about finding engineering solutions that would make possible a deliverable bomb. Similarly, the Apollo Project was a mammoth engineering effort that basically applied Newtonian mechanics, chemistry, materials science, and computer science to the task of getting a manned vehicle to the moon and back. Even the Human Genome Project quickly became an engineering project to find ways of obtaining the enormous amount of information being sought in finite time.

"Big science," however interdisciplinary it may be, whether in high energy physics, molecular biology, or physiological genomics, is more about how laboratories are run and how work is accomplished than it is about where the breakthrough ideas come from.

Future scientific advances in physiology (however the discipline comes to be defined) will undoubtedly be increasingly interdisciplinary. And the practicalities of doing science these days suggests that "big science" is likely to become the norm, not the exception. But whether these advances will arise out of a group effort or from the mind of a single individual able to synthesize ideas from different fields remains to be seen.

Second, scientific disciplines are constantly reinventing themselves. That is to say, they are constantly redefining what it means to be a biomedical engineer (or neuroscientist or physiologist), what kinds of questions the discipline will and can ask of nature, and how one should be educated and trained to pursue work in that discipline. The proposed new curriculum for biomedical engineering is only the latest attempt since the late 1960s to redefine what that discipline is all about. Neuroscience too has expanded its purview and become even more interdisciplinary since its birth in the 1970s as it has come to recognize the importance of other disciplines to its mission.

Similarly, physiology is now facing a need to redefine what it is to be in the age of the human genome. We know it must become an even more interdisciplinary science than it has been in the past. We know that it must embrace molecular biology and the advances that are occurring there as it continues to stress the importance of looking at the tissue, organ, or whole organism in an attempt to understand function. What we don't yet know is how to train physiologists for productive work in this new era, how to assemble research teams that can work together to enhance the productivity of each member of the team, how to organize an academic department of physiology, and finally how the American Physiological Society ought to be contributing to these developments.

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