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THE SCIENCE EDUCATION OF NON-SCIENTISTS

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Numerous studies have documented the pitifully low level of scientific literacy of current college graduates in many countries. Too many college graduates—future citizens in democratic societies that are becoming increasingly dependent upon science and technology—can't understand even the simplest science-related news articles. They have difficulty distinguishing nuclear radiation from UV radiation; atoms from molecules; power from force; (nuclear) magnetic resonance from radioactivity. Clearly, if modern society is to continue to operate on the principle of an informed electorate, our educational systems must do a better job of educating that electorate. If we don't, important and far-reaching decisions will shift into the hands of a few technically competent people who will form a sort of scientific priesthood. We don't need more science majors, we need non-science majors who are better informed about science and who represent the overwhelming majority of our future citizens. Most citizens don't need to know how to synthesize a super-conductor or sequence a protein. Most citizens do need the background to understand science in its day-to-day context with technology. That kind of understanding has two basic components: an understanding of the way scientists make decisions—how science works—and a discussion of the importance of the results of scientific discoveries in our lives—the way that science has been translated into technology—as well as the importance of that technology in our modern life.

For the future of modern society, it is imperative that practicing basic scientists develop courses that will improve the scientific literacy of college graduates. Some universities already require one or two science courses (or areas of study) for non-science majors. Such requirements provide a good starting point. The central question concerns the content of the courses designed for non-science majors. Such courses could attempt to communicate either of two basic messages (*vide supra*). One approach could be to develop an appreciation for the process of science—how science works—and the elements necessary to make science work. This approach could be cast in the context of any of the basic sciences since they all work in the same way. Each depends upon the accumulation of evidence and the formulation of an internally consistent set of hypotheses, such as the particulate nature of matter, the process of evolution, or the nature of electromagnetic phenomena. Important in such approaches is the recognition of ambiguities and the way such ambiguities are resolved, that is, by the design of appropriate experiments and the evidence gathered therefrom. Such an approach could be readily formulated by practicing scientists in a variety of disciplines including chemistry. A basic science course

developed for non-scientists using this approach would tend to stress the processes of science and the idea that what we know changes in the face of new evidence.

The other approach could be the creation of courses designed to emphasize the scientific basis for solving key issues facing today's citizens, such as nuclear waste disposal and access to pure water. In a sense, this approach is the more practical of the two for the average person because it addresses subjects that are more likely to influence their lives directly and, therefore, give rise to at least a passing interest in science. This approach requires teachers to take a broader view than many (perhaps, even most) basic scientists are comfortable with; but people who have shown a capacity to learn technical subjects, as most academic scientists have, should be able to gain such perspectives. Chemistry could be the logical focus for discussions of new materials, for example, which are certainly important to our modern society. It would appear that the subject of chemistry could be a useful vehicle to help people gain an appreciation of the importance of this discipline in their lives, much in the way as we expect that the study of literature provides insights into their existence in society. This general approach to chemistry courses for non-scientists would provide students with a day-to-day context for appreciating the importance of science in their lives and a way to think about science. Hopefully, it would also ensure that these students would have a science-oriented basis for making future decisions.

The challenge is clear. Who will lead the way?