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Scientists and Citizens: Different Roles?

1. Introduction

Not long ago, Robert Oppenheimer, Albert Einstein, and other scientists seemed comfortable distinguishing the role of the scientist from that of the citizen along these lines: that it was the role and responsibility of the scientist to pursue and acquire knowledge, and the responsibility of the citizen to wrestle with the social, political, and/or moral implications or consequences of the knowledge and technologies the sciences generated. This was not a distinction invented by scientists in the twentieth century; as we will see, its roots can be traced to the Scientific Revolution. But this distinction was reaffirmed in the context of debates following World War II concerning whether scientists should pursue any knowledge that could be pursued -- debates prompted by the development and use of the atomic bomb.

I hope to encourage you to critically re-evaluate this traditional division of labor and responsibility between scientists and citizens, but also to convince you that there are complex issues with which we will need to contend should we come to think it needs refinement or abandonment. I have chosen this topic for the keynote address of this conference as much in anticipation of your future role as citizens as in anticipation of your future career as scientists.

Within our broader social community, scientists as a group exercise a special kind of authority. This is not an authority to command obedience.[1] Rather, it is what Kathryn Pyne Addelson refers to as an "epistemological or cognitive authority". As Addelson notes, "we take [scientists'] understanding of factual matters and the nature of the world within their sphere of expertise as knowledge, or as the definitive understanding".[2] As students, we learn these understandings in textbooks; as public or private officials, and professionals in a wide range of fields, we use these understandings to solve social, medical, and environmental problems; and as ordinary citizens, we rely on what scientists tell us about the natural world—its objects, events, and processes—in a multitude of ways.

These observations are familiar. But consider how deep the divide in "cognitive labor" between contemporary scientists and non-scientists. There was a time when an educated person (and, we should add, one with the financial resources to permit lots of

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[1] We should note, however, that on the basis of their cognitive authority within their fields of expertise, scientists are often granted an "external" authority: i.e., they are frequently asked for and at times offer recommendations about social policy -- sometimes with disastrous consequences. I discuss this and related issues in detail in *Who Knows* (Temple University Press, 1990, Chapter Four).

[2] K.P. Addelson, "The Man of Professional Wisdom" in S. Harding and M. Hintikka (Eds.) *Discovering Reality* (Kluwer 1983), p. 165.

free time) could read and understand the major scientific treatises of the day, and if she or he chose, correspond with their authors—offering criticism or additional evidence to support a scientist's hypothesis or theory. Indeed, throughout the 18th and 19th centuries (i.e., before science became professionalized[3]) lay persons often undertook experiments to see if they could reproduce the results scientists reported. Darwin's correspondence with animal breeders and botanists, as well as with naturalists interested in identifying new species, was extensive. So, too, in the nineteenth century, geologists and biologists could correspond and understand each other's theories sufficiently well to offer useful criticism or propose additional experiments or applications (Lyell and Darwin, for example, engaged in such correspondence).

But a number of developments—including the professionalization of science, the proliferation of scientific disciplines and specialties, and the virtual explosion in the details and scope of scientific research and knowledge—make such understanding virtually impossible today for the lay person and often for scientists in other disciplines. The late Richard Feynman, one of the founders of quantum electrodynamics, displayed an almost insatiable interest in keeping up with developments in other specialities in physics and in other sciences. In his delightful autobiography, *Surely You're Joking, Mr. Feynman*, Feynman chronicled the difficulties he encountered crossing disciplinary boundaries, noting that he found the best way to deal with an equation or scholarly article he didn't understand, including in his own field of physics, was to "hum through it" and move on.

I have so far stressed ways in which our broader social community relies on science, not only in terms of the technological advances so often cited, but in the at least as important sense that non-specialists are typically not in a position to evaluate (or, in some cases, even understand) the details of scientific research in many areas. But science also relies on our broader social community; that is, there is an interdependence between the two.

As we earlier noted, the intellectual or cognitive authority scientists exercise is not one they do or could command; authority, unlike power, requires the consent of both parties. And although many of us believe that the authority granted to scientists within their fields of expertise is warranted by their education, their success in explaining and predicting features of the world, and the norms that govern scientific practice, this authority is not inevitable -- as indicated by the various points in history in which large segments of a larger social community rejected a theory that scientists advocated (for example, evolutionary theory).

And, today at least, there are quite tangible ways in which science depends on the broader social community. The vast majority of the funding for scientific research, and not just for so-called big science projects like the Human Genome Project, is

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[3] *I.e.*, Before there were degree programs, professional journals, peer review mechanisms, journals, etc.

provided by private enterprise and public monies (i.e., tax dollars) -- the latter through institutions such as the National Science Foundation and the National Institutes of Health, state and federal legislatures, and, of course, the military. Public interest in, say, a cure for cancer or for AIDS—or lack of interest in, say, a supercollider to identify what high-energy physicists tell us are the ultimate constituents of the universe—has an impact on what research gets funded, thus what research gets undertaken and, ultimately, what we come to know about or do not. For example, Congress's decision several years ago not to fund the supercollider project brought research in some areas of physics to a halt and caused many graduate programs in high-energy physics to shut down completely or become much smaller. And in terms of private funding, research projects are typically funded on the basis of their potential for technological application; private funding of "pure research" is relatively rare. For these several reasons, a new Ph.D. in physics, chemistry, biology, anthropology, sociology, or psychology quickly learns that her or his research career will depend, in fundamental ways, on the interests of those in a position to fund research.

As my discussion unfolds, the relationships between science and its social context that I have mentioned will prove relevant to the traditional division of labor between scientists and citizens, and it is to this division that I next turn.

Recall that what I am calling "the traditional division of labor" is the view that it is the responsibility of the scientists to pursue and acquire knowledge, and that of the citizen to wrestle with the social, political, and/or moral implications of the knowledge that results. This division has, I think, two sources. One source is the longstanding assumption that knowledge is a good in itself. The other is an assumption, more recent but also longstanding, that in its pursuit of knowledge science should not be interfered with on the basis of non-scientific beliefs or values (at least when scientific research is devoted to the acquisition of knowledge for its own sake). We'll consider each of these sources of the division of labor between scientists and citizens, beginning with the assumption that the knowledge scientists pursue is a good in itself. While I have suggested that the realities of funding have an impact on what knowledge gets pursued, this assumption continues to motivate many scientists, to shape public perceptions of science, and to channel public funds—for example, through the funding of universities—into "pure research".

Knowledge as a good in itself

At least since the Enlightenment, many have been comfortable with the view that knowledge is a good in itself, and prior to this century, many if not most viewed the goal of science to be the acquisition of knowledge for its own sake. But prior to this century, less of the research undertaken by, say, physicists or biologists was funded by private enterprise or the government and, arguably, what we came to know about (or not know about) -- what Harvard biologist Richard Levins calls "the distribution of knowledge and ignorance" -- was more obviously a function of a deep commitment to understand nature for the sake of understanding, than it was a function of potential technological applications.

As importantly, while some in the nineteenth century expressed concerns about the potential impact of science—such concerns are clear, for example, in Mary Shelley's *Frankenstein*—it was not until our own century that science's pursuit of knowledge came to show the potential for producing results that might threaten the continued existence of our own as well as numerous other species. I am thinking, of course, of the development of the atomic and hydrogen bombs, of nuclear weapons, and of chemical and biological weapons.

Not surprisingly, there was considerable debate concerning both the directions and the applications of scientific knowledge in the period following World War II. Oppenheimer, one of the major figures in the development of the atomic bomb, defended his participation in the project by appealing to the assumption that knowledge is good for its own sake and also to the view that it is the scientist's responsibility to pursue knowledge:

> ... the reason we did this job is because it was an organic necessity. If you are a scientist you cannot stop such a thing. If you are a scientist you believe that it is good to find out how the world works, that it is good to turn over to mankind at large the greatest possible power to control the world and to deal with it according to its lights and values.[4]

The view Oppenheimer expresses here is complex. Part of it is that "finding out how the world works" is a good in itself. On the other hand, this passage suggests that accumulating more and more knowledge is good *because* it gives "mankind" [sic] the "power to control the world and to deal with it". These are not incompatible assumptions, but they are different.

In any event, of most relevance to the topic at hand is Oppenheimer's claim that once a scientist recognizes the potential of gaining knowledge in some area, there is, for that scientist, what he calls an "organic necessity" to pursue it. A researcher can choose, on the basis of the potential use of some piece of knowledge, not to engage in further research to acquire it — but the phrase "organic necessity" is intended to underscore that if a scientist did so decide, he or she would cease *to be a scientist* (or, at least, would not be acting as a scientist). If this is the case, then responsibility for deciding how, if at all, to use the knowledge that results, must rest with the non-scientist or citizen. And the last sentence of the passage suggests that Oppenheimer does maintain this division of responsibility. It is, he states, the scientist's responsibility to turn over to "mankind at large" the greatest possible power to control the world, and it is up to "mankind at large" to deal with that power according, as he puts it, to "its" -- and 'its' here refers to 'mankind's' -- "own lights and values".

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[4] Kunetka, James W. *Oppenheimer, The Years of Risk*. Prentice Hall, 1982, p. 120.

Edward Teller seemed to hold a view similar to Oppenheimer's concerning the necessity for the scientist *qua* scientist to pursue knowledge that is deemed possible. In a passage quoted in Richard Rhodes' *The Making of the Atomic Bomb*,[5] Teller states that "the important thing in any science is to do the things that can be done". And Teller is even more explicit that it is not the scientist who should decide, or who might even be in a position to decide, how to use the knowledge produced within science. "[While] scientists naturally have a right and a duty to have opinions... ", Teller argued, "their science gives them no special insight into public affairs. There is a time for scientists... to restrain their opinions lest they be taken more seriously than they should be" (32).

It was also in the context of the debates following World War II that Einstein considered whether the role of the scientist was different from that of the citizen. (Let's remember that, contrary to popular mythology, Einstein was not involved in the project to develop the atomic bomb.) Apparently at one point Einstein entertained the view that as a scientist, a researcher has an obligation to do good science, but neither the obligation nor the right to make recommendations about how the results of her or his research should be used. However, as a citizen, Einstein seemed to think, the scientist does have such a right and obligation—but no more so than any other citizen.[6]

I think Einstein's recognition that the scientist is *also* a citizen represents an advance over the views expressed by Oppenheimer and Teller. And while Einstein at least entertained the view that the scientist had no *special* responsibilities in her or his role as citizen, perhaps given the potential technological applications of scientific research in many areas, we should ask whether this really *is* obvious.

Is it obvious, for example, that a scientist engaging in research that is both esoteric and carries the potential to significantly impact on the human or other species, has no "special responsibility" relative to those of her fellow citizens? Might the scientist in such a situation have an obligation to consider its potential implications before engaging in such research because she, unlike the majority of citizens, is in a position to recognize and understand these implications? Or might she have a responsibility to engage some group in a discussion as to whether to pursue the research in question -- particularly if, unlike the atomic bomb, the research she is contemplating does not involve national security?

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[5] Simon and Schuster, 1986, pp. 31.

[6] See Virgil Hinshaw Jr., "Einstein's Social Philosophy", in *Albert Einstein: Philosopher Scientist*, ed. Paul Arthur Schlipp (The Library of Living Philosophers Inc., 1949), p. 652. But these views are in tension with Einstein's own actions. In 1939, other physicists convinced him to write to President Roosevelt to warn him that it was likely that Germany would come to be in possession of atomic power in the near future so as to prompt Roosevelt to organize and fund research into atomic power. In other words, Einstein used his knowledge and credibility as a physicist to get the attention of the President -- and, of course, succeeded.

I want to be clear that I don't think there are anything like easy answers to these questions. For example, if our hypothetical scientist did think it appropriate to engage some larger group in the decision, who might or should that group include? Her scientific colleagues? The broader social community? Congress? The President? A special presidential or congressional committee?

These questions suggest how complicated the issues are that we are considering. As we have already noted, intellectual labor is now fundamentally divided between scientists and the lay public, and there is an abundance of evidence to suggest an alarming level of science illiteracy among the latter. Given this, it is not obvious that the general public would be in a position to consider the pros and cons of pursuing the knowledge that our hypothetical scientist is contemplating. Moreover, even a superficial exploration of recent debates concerning whether evolution should be taught in public schools, about fetal tissue research, and about cloning, suggest that scientific illiteracy is not the only problem; these public debates are often characterized by circular reasoning, dogmatism, and deep, if not irreconcilable differences.

And what of our scientist and her colleagues? The demands of specialization that characterize contemporary science, and the traditional understanding that it is the citizen rather than the scientist who is responsible for deciding how knowledge is to be applied, have resulted in the vast majority of undergraduate and graduate programs in science neither including nor requiring that students study social issues or ethics. In other words, and here I am echoing Teller, there seems little reason to think that scientific expertise translates into wisdom concerning social policy, morality, etc.

I'll leave it to you to come up with reasons why it might not be wise to rely on our politicians to make the decision our hypothetical scientist is faced with.

The situation just outlined is not, in fact, hypothetical. The question of whether knowledge is an end in itself, and whether science should pursue any and all knowledge it is possible to attain, re-emerged in the 1970s within the context of debates concerning recombinant DNA research. We will consider this debate after we explore the assumption that science's autonomy must be maintained. As I earlier suggested, this assumption— what I will call the ideal of the autonomy of science—is a second source of the division of roles and responsibilities between scientists and citizens.

The ideal of an autonomous science

The ideal of the autonomy of science prescribes that the broader social community not dictate or limit what research scientists undertake: what questions they ask, what knowledge they pursue or acquire. According to this ideal, non-scientific beliefs and values might have a legitimate role in determining the *application* of the knowledge scientists acquire, but not in limiting their ability to pursue or produce it. This ideal did not emerge at a time when it was virtually impossible for the lay person or scientist in another discipline to master the esoteric details of some body of research or theory. That is to say, it was not motivated by the assumption that non-scientists couldn't understand science. The origins of the ideal of an autonomous science lie in the very origins of modern science and in events in which non-scientists well understood the theories scientists were proposing.

Recall that in the beginnings of the era we have come to call "the Scientific Revolution", a newly emerging science was competing with religious and other intellectual traditions for the intellectual authority to explain the natural world. For example, some of the strongest opposition to the hypothesis that the sun, rather than the earth, was the center of the then known universe, opposition with which its advocates Copernicus and Galileo had to contend, had its sources in religious belief. [We should note here that not all of the opposition to the heliocentric theory was religious in nature; there were also scientific objections.[7]] More specifically, there was at least the perception that the heliocentric hypothesis Copernicus and Galileo advocated conflicted with religious doctrine that the earth was the center of creation, and the perception that the geocentric (earth centered) hypothesis of the Ptolemaic model of the universe was in keeping with that doctrine.[8]

At the time, the Catholic Church, whose clergy included scientists who supported the geocentric hypothesis, was a formidable opponent. And aware that his hypothesis that the sun was at the center of the universe could be viewed as constituting heresy, a charge serious enough to be punished by death, Copernicus' editor used the preface to *On the Revolutions of the Heavenly Spheres* to assure readers that Copernicus was not maintaining the hypothesis was true but only that it would prove a useful tool to astronomers attempting to predict planetary motion.

Galileo, of course, did claim that the heliocentric hypothesis was true, with the result that he was tried for heresy by the Inquisition, ordered to not pursue or advocate the hypothesis and threatened with torture if he did, and ultimately placed under house arrest. (Indeed, it was only in the twentieth century that Galileo, who died in 1642, was "pardoned.")

Were this the only case in the history of science in which scientific hypotheses and theories were condemned on the grounds that they conflicted with the beliefs and values of the broader social community, the ideal that science be allowed to pursue knowledge without interference might not have come to have the deep significance it currently has. But, of course, it is not. More recent examples include the condemnation of Darwin and evolutionary theorists in the nineteenth century; laws banning the

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[7] See, e.g., Galileo, *Dialogue on the Two Chief World* Systems and *Two New Sciences*; and Thomas Kuhn, *The Copernican Revolution* (Harvard University Press, 1957) and *The Structure of Scientific Revolutions* (University of Chicago Press, 1970).

[8] Why geocentrism gained the status of dogma in Christianity is far from clear. With the exception of a story in which Joshua is said to have stopped the sun from moving, there is nothing in the Hebrew or Christian testaments about geocentrism.

teaching of evolution in public schools which resulted in the Scopes trial earlier in this century; the continuing efforts by some religious groups to keep evolutionary theory out of the high school science curriculum; the ban in the 1980's of any federal funding for research into Alzheimer' Disease which made use of fetal tissue even if that tissue became available because of spontaneous abortions (i.e., miscarriages); and the efforts lawmakers of various states and at the federal level are currently engaged in to write legislation to regulate, or ban, cloning.

These episodes and others like them lead many to maintain that the autonomy of science — science's ability to pursue knowledge without interference based on the nonscientific beliefs or values of the broader social community—must be sustained. And viewing the history of science from hindsight, it would seem that this ideal is indeed important. The beliefs and values of the broad social community change -- witness the universal acceptance of the heliocentric hypothesis today, and the substantial, though not yet universal, acceptance of evolution and the "Big Bang" theory of the origins of the universe. In addition, it is not clear (or at least so I would argue) that the public is in a position to effectively wrestle with moral and social issues attendant to areas of scientific research; for example, the role of religious positions in shaping and polarizing the debates mentioned above should give us pause.

<u>A more recent case</u>

We have considered two sources for the traditional division of responsibility between scientist and citizen: the assumption that the pursuit of knowledge is a good in itself and the goal of science, and the ideal of the autonomy of science. With this background, I want to turn to a more recent debate concerning recombinant DNA research. Like those occurring in the period immediately following World War II, this debate involved the questions of whether any and all knowledge scientists can pursue should be pursued, and of whether decisions about which knowledge should be pursued should be made solely by scientists and made on scientific, rather than ethical or moral, grounds -- *i.e.*, made on the basis of whether the knowledge can indeed be acquired.

What distinguishes this debate from the others I have mentioned, and why it is particularly relevant to the question of whether the roles of the scientist and citizen are distinct, is that it originated *within* the scientific community. It was scientists who first asked and debated whether research which promised an enormous advance in our understandings of life, as well as in our ability to identify the causes and perhaps develop effective treatments for a host of diseases and disabilities, should be pursued. It is not my intention to convince you that one or the other side in this debate was correct. I use the debate to further illustrate the complex and significant issues surrounding the traditional division of responsibilities between scientists and citizens.

The debate, again, concerned recombinant DNA research. Science writer Nicholas Wade began his book, *The Ultimate Experiment: Man-Made Evolution*, in which he chronicled the major issues, events, and figures of the debate, this way:[9]

> A turning point has been reached in the study of life. A turning point of such consequence that it may make its mark not just in the history of science but perhaps even in the evolution of life itself.
> The turning point is the discovery in 1973 of a technique for manipulating the stuff of life. Known at present by the awkward name of recombinant DNA research, the technique is in essence a method of chemically cutting and splicing DNA, the molecular material which the genes of living organisms are made of (3).

As Wade goes on to explain, recombinant DNA research enables biologists to transfer genes from one organism to another, including from one species to another. A biologist today cannot design entirely new genes, but the ability to transfer genes from one species to another in effect overrides the reproductive barriers nature has built to isolate the two species -- and in this way allows for the creation of new life forms (Wade, 3-7). Prior to the development of recombinant DNA technology, research into DNA focused, in the main, on identifying what specific genes or clusters of genes do, the processes through which they produce proteins, and so on. In other words, the twenty five years which preceded the new technology result in a body of knowledge about the genes of various species -- as Wade describes it, "a storehouse of knowledge that, given the new technology, could be used".

> Everything biologists have learned in their attempt to understand nature now becomes a means to change it... It is now becoming technically possible (even if practically fruitless) to intermingle the genes of man and fungus, ant and elephant, oak and cabbage. The whole gene pool of the planet, the product of three billion years of evolution, is at our disposal. The key to the living kingdom has been put into our hands (3).

And like others whose views we will consider, Wade was impressed with the magnitude of the potential consequences of our holding this key. Writing in 1977, he noted

> Some thirty-five years ago, physicists learned how to manipulate the forces in the nucleus of the atom, and the world has been struggling to cope with the results of that discovery every since. The ability to penetrate the nucleus of the living cell, to rearrange and transplant the nucleic acids that constitute the genetic material of all forms of life, seems a more beneficent power but one that is likely to prove at least as profound in its consequences (5).

Despite the potential benefits of the research techniques in terms both of pure knowledge and applications, there were scientists in the 1970s who argued that

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[9] Walker and Company 1979.

research utilizing techniques to transfer genes from one species to another and to create new forms of life should be abandoned. In an unprecedented move, some of the most well known and respected biologists and biophysicists, many of them members of the prestigious National Academy of Science (including James Watson, who together with Francis Crick, had discovered the structure of DNA), called for a self-imposed moratorium on recombinant DNA research until a conference could be convened to discuss the hazards and dangers it posed.

The call for the moratorium came in the form of a letter, signed by Watson and others, that was published in the July 1974 issues of both *Science* and *Nature*, both prestigious science journals. The moratorium was observed from mid 1974 to early February 1975, when a conference to consider the potential benefits and potential dangers of recombinant DNA technology was convened. By the end of the conference, participants had agreed that strict controls should be placed on experiments utilizing gene splicing but that the moratorium itself should be called off. After considerable dispute and compromise, the principles adopted at the conference were transformed into guidelines for research undertaken under the auspices of the National Institutes for Health, or NIH (Wade 1977, 3-10; 150-170).

What led scientists to propose a moratorium on an area of research? And how was it eventually decided that strict controls, but not a moratorium, were appropriate? The moratorium was motivated by two general concerns, although those who proposed it did not always agree about which reflected the more real or significant danger. One general concern was that recombinant DNA technology would result in the production and perhaps accidental release of pathogens more virulent than those previously encountered (Wade, 5). The second was the impossibility of predicting the long term evolutionary consequences of overcoming the reproductive barriers that isolated species.

In terms of the first issue, some were concerned about the use of bacteria in recombinant DNA research, and specifically with the transference of animal or plant genes into bacteria. The concern was that introducing the genetic signals of higher cells into bacteria might threaten animals and plants with new forms of bacterial attack. In addition, much of the research undertaken used of E.coli as the host for foreign genes; because E coli is a normally peaceful guest in the human gut, introducing such genetic signals to it seemed particularly dangerous to some (ibid., 3).

The second general concern motivating the moratorium was the inability to predict the long term evolutionary consequences. This concern is clear in a letter published in *Science* by Erwin Chargaff, a well known molecular biologist. Here is an excerpt from Chargaff's letter, entitled "On the Dangers of Genetic Meddling".

> You can stop splitting the atom; you can stop visiting the moon; you can stop using aerosols; you may even decide not to kill entire populations by the use of a few bombs. But you cannot recall a new form of life. Once

> you have constructed a viable E coli cell carrying a plasmid DNA into which a piece of eukaryotic DNA has been spliced, it will survive you and your children and your children's children (quoted in Wade 1977, 104).

"Have we", Chargaff asked his scientific colleagues, "the right to counteract, irreversibly, the evolutionary wisdom of millions of years, in order to satisfy the ambition and curiosity of a few scientists? An irreversible attack on the biosphere is something so unheard of, so unthinkable to previous generations, that I could only wish that mine had not been guilty of it" (ibid., 105).

Robert Sinsheimer, another scientist who advocated a moratorium, was more explicit in rejecting the view that all knowledge that could be pursued, should be. In a lecture entitled "On Coupling Inquiry and Wisdom", which he gave after the moratorium was lifted, Sinsheimer reminded his listeners that the maxim "Know the truth and the truth shall made you free" is a credo carved on the walls of laboratories and libraries across the land". But, he maintained,

> We begin to see that the truth is not enough, that the truth is necessary but not sufficient, that scientific inquiry, the revealer of truth, needs to be coupled with wisdom if our object is to advance the human condition.
> Two scientific discoveries have extended our powers far beyond prior human scale and experience. In the nucleus of the atom we have penetrated to the core of matter and energy. In the nucleic acids of the cell we have penetrated to the core of life.
> When we are armed with such powers I think there are limits to the extent to which we can continue to rely upon the resilience of nature or of social institutions to protect us from our own follies and finite wisdom. Our thrusts of inquiry should not too far exceed our perception of their consequences. We need to recognize that the great forces we now wield might — just might — drive us too swiftly toward some unseen chasm (quoted in Wade 1977, 107).

I have already noted that the moratorium was lifted. Despite their prestige as biologists, Chargaff, Sinsheimer, and others who wanted the moratorium to continue, did not win the day, and had to settle for the list of controls that won consensus at the conference in February 1975. These guidelines, adopted by the NIH, were subsequently weakened in 1979.

The arguments in support of lifting the moratorium included arguments that the specific dangers cited by those who called for the moratorium were either manageable or exaggerated; and arguments to the effect, as Wade himself made the argument, that the "abnegation of intellectual curiosity" called for by a moratorium on scientific research "is not in human nature" (ibid., 5). Moreover, in arguments that echoed Oppenheimer's, such abnegation was seen by some to be fundamentally incompatible with what it is to be a scientist.

James Watson, who signed the original call for the moratorium, came to think both it and the NIH guidelines which resulted from it were largely unneeded. In response to both the specific and more general risks that concerned Chargaff and Sinsheimer, Watson maintained, "But you can't measure the risk. So they want to put me out of business for something you can't measure" (quoted in Wade, 48). And concerning his own signing of the call for the moratorium, remarks Watson later made appeal to the norm of the autonomy of science, for the debate had by then expanded into the broader community:

> As one of the signers of the original moratorium, I apologize to society... the question now is, what is the best way to get out of this political mess? Science is good for society. We are just being attacked by everyone who doesn't have the guts to go ahead (quoted in Wade, 165).

Twenty years later, the horse is out of the barn and there is no reason to think that a moratorium on recombinant DNA research will be reinstated. But the debate remains worthy of attention. In an unprecedented move, a number of scientists at least considered, and some called for, a halt to pursuing knowledge when they could not predict its consequences. They spoke as individuals who recognized that the citizen who is a scientist might have special responsibilities in both capacities: that such responsibilities might be attendant to the pursuit of knowledge that carries the potential for enormous consequences, not all of which are predictable, and to being a citizen of a world community with obligations to its current and future inhabitants, and that these responsibilities might override their responsibility *qua* scientists to pursue and acquire knowledge.

In the letter to *Science* from which I quoted earlier, Chargaff seems to be acknowledging and shouldering just this sort of special responsibility. He concluded his letter this way:

> This world is given to us on loan. We come and we go, and after a time we leave earth and air and water to others who come after us. My generation, or perhaps the one preceding mine, has been the first to engage, under the leadership of the exact sciences, in a destructive colonial war against nature. The future will curse us for it (quoted in Wade 1977, 104).

<u>Conclusion</u>

I hope the issues we have considered have given you food for thought. I suspect that no individual, indeed no one generation, will have all the answers to the questions we've considered this evening; nor do I think that there is some uniquely correct way for the sciences and the broader social community to shoulder and share the responsibilities for determining what knowledge should be pursued and how it should be used.

In the debate just considered, some scientists took it upon themselves to shoulder the responsibility of considering the moral implications of the knowledge they might acquire, but for reasons we earlier considered in terms of the scope of science education and the potential impact of research in some arenas, it is not clear that the responsibility should be the scientist's alone. On the other hand, extending such decision making to the broader social community would require a more science literate population, and I suspect at least two things more: that lay persons themselves be in a position to wrestle with the ethical issues involved -- and, given the history of the battles between science and segments of the lay public, that something like the autonomy of science be preserved until such time as we can be confident that it is no longer needed. It is perhaps obvious by now that I don't think this is the time to abandon that ideal.

Let me conclude by noting that I have not devoted much time to the question of whether we should continue to assume that knowledge *is* good for its own sake or continue to assume that the goal of science is the pursuit of knowledge for its own sake. But these questions are being raised by scientists and science scholars, and it is perhaps obvious that how we answer them will have some bearing on how much importance we attribute to maintaining science's autonomy and how we think about the traditional division of labor between scientists and citizens. In "Knowledge for Whose Sake?", for example, Jack Nelson argues that there are reasons to rethink both assumptions – as well, in some ways, as the ideal of an autonomous science:[11]

> The question I am asking is not whether the epistemic endeavor should seek or settle for something less than or different from the truth, the question is rather whether *every* truth is *worth finding*. Is the likelihood of adding to our stockpile of truths always, or ever, *itself a justification* for undertaking a scholarly endeavor or research project?[12]

Nelson went on to identify issues that, at least today, challenge the long-standing assumptions that knowledge is a good in itself and that gaining it should be the over-riding goal of science.

> There are two fundamental problems with the [traditional] position... First, no current society has the economic resources to support all proposed pure research. Second, it is not clear, as I think the gene splicing case shows, that pure research should be presumed to be good in the sense of being likely to produce beneficial consequences. In this case, and retrospectively in the case of atomic research, it may be that before the programs were undertaken, the research communities [should have

[11] Presented at Umeä University, Umeä, Sweden in November 1994.

[12] Ibid., emphasis added.

> asked] if the dangers of the research outweighed the possible benefits (20).

In his conclusion, Nelson recommended what he took to be a “plausible” position and identified the difficult questions it would raise.

> It is not, I think, difficult to state a plausible view about the value of pure research. We should not presume that all pure research will lead to socially beneficial results, nor even that all such research will be at worst harmless. We must attempt to foresee the results of research programs, and to make judgments as to whether, given those judgments, the programs are worth pursuing or too dangerous to pursue. We must realize that pure research is only one area which demands resources, and that we will have to weigh the likely benefits of specific pure research projects against the need, e.g., to provide quality and affordable health care for all citizens.
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> The difficult issue is not whether we should have some sort of general, entirely defeasible, presumption that research or knowledge is a good, but rather how we are to make decisions about what portion of our resources should be devoted to pure research and which research projects should be pursued and which left un-pursued (21-22).

It is my hope that, as future scientists, who are *also* citizens, you will bring your knowledge and experience, and a willingness to consider issues without easy answers, to bear on the issues we have considered, and to make the work and its potential implications accessible to the broader community within which you practice. If you make an effort in terms of these things, I think both science and our broader social community will be better for it.

Lynn Hankinson Nelson