
The Social Context of Scientific Research: Taking Responsibility and Engaging the Public

Ann M. Kleinschmidt¹ and David S. Koetje²

“It becomes eminently important... to examine the way we have chosen, or been taught, to grasp the world. This is the only means of establishing a conscious connection with the effects of our actions. It is the basis for *taking responsibility*.

A contextual approach is not to be looked at as yet another solidified doctrine or theory. Rather, it is a *necessary complement* to the prevailing conceptions and practices of contemporary science. It is a way of making science a healthier whole, modeled after the organisms it studies.” (Emphasis added)

- Craig Holdrege³

When research responsibility is discussed, one usually interprets this as doing research in an ethical way. In general, by “ethical research” we usually mean that its outcome does not inflict harm on an individual, and that the data accurately represents what is done in the laboratory. However, in this article, we will discuss a broader concept of ethics – extending beyond the confines of the laboratory or field to encompass the wider social contexts – and some mechanisms for teaching it in the classroom and engaging it in the research laboratory. As Holdrege states in the quote above, we are convinced that scientists must take responsibility for the action of research and understand the context into which our endeavors are placed. We need to go beyond the narrow definition of ethics and begin to understand as researchers and educators how research fits into a cultural context and how it has the potential, in turn, to shape culture.

Recognizing Reductionism’s Limitations

Both of us are molecular biologists, and teach this topic to a large number of undergraduates. Our research employs the use of molecular biological tools to investigate biological mechanisms relevant to the appropriate functioning of organisms within their environmental contexts. However, as one negotiates the particulars of molecular biology, it is clear that this discipline truly embraces a reductionistic paradigm. In textbooks used to teach molecular biology, it is impossible to escape the analogies that relate to the functioning of cells as intricate factories and the macromolecular assemblages as intricate machines. Similarly, it is rare to see an organism in the

¹ Biology Department, Allegheny College, Meadville, PA 16335; akleinsc@allegheny.edu

² Biology Department, Calvin College, Grand Rapids, MI 49546; dkoetje@calvin.edu

³ Holdrege C (1996) *Genetics and the Manipulation of Life: The Forgotten Factor of Context*. Lindisfarne Press, Hudson, NY, p. 173.

laboratory of a molecular biologist, but rather one is more likely to observe an assemblage of objects: tissue culture dishes, pipette tips, petri dishes, electrophoresis boxes, and styrofoam models of macromolecular complexes. Thus, as practitioners of molecular biology, it is quite easy to succumb to an idea that one can completely understand the working of an organism by analysis solely at the molecular level. Likewise, it is easy to forget that the outcomes of our research have the potential of being imbedded into a larger research agenda that may not necessarily be consistent with our own ideological goals.

Perhaps you object to the notion that your research is affected by ideology or larger agendas. After all, objectivity is foundational to our scientific enterprise. Pure objectivity, however, is unattainable. Each of us brings to our discipline a unique set of proclivities and mindsets from our cultural, social, and religious heritages. What we deem important is strongly influenced by these, as is our sense of right and wrong, and how we judge “good science” vs. “bad science.” Our research is also strongly affected by the larger agendas of funding agencies, which are influenced by social priorities.

Some insist that their basic research bears no social responsibility beyond their obligations to maintain high standards of scientific conduct and to publish. In reality, most of us innately sense that this is untrue. We would not sleep well at night, knowing that the fruits of our research had been exploited to commit a malicious act. Indeed, Martha Crouch of Indiana University was dismayed to discover in the 1980s that her own basic research in plant tissue culture had been exploited by the palm oil industry to develop clonal propagation of palm trees. At that time, vast monoculture plantations and corrupt business practices were threatening subsistence production of palm oil, once a mainstay for Malaysia. Rapid propagation of genetically identical palm trees enabled the development of even larger plantations, further crowding out subsistence farmers (who could not afford to buy into this system nor compete with the outcome) and encroaching upon native tropical rainforests. Concluding that her “own research [had] potentially played a real, if small, part in making this possible,”⁴ Dr. Crouch abandoned it altogether.

While this may be an extreme example, it does point out that all research has the potential to be used unintentionally to harm a large group of individuals, under the guise of economic development and/or improved efficiency. Where profit is the primary measure of success, there is great incentive for usurping even basic research for the larger profit-making machine. Similarly, in a society still in the clutches of institutionalized racism and where perfection is becoming a cultural goal it is important to keep in mind that basic research leading to genetic testing may increase the oppression of many people.

Rediscovering the Context of Our Work

People are drawn into science for a number of reasons: basic scientists tend to be fascinated with mechanisms or interactions, whereas applied scientists are usually keen on employing science to serve the human good. Regardless of the reason for entry, it is usually the wider context of the phenomenon or problem that draws us into

⁴ Crouch M (1990) Debating the responsibilities of plant scientists in the decade of the environment. *Plant Cell* 2: 176.

the science. However, in the process of becoming a scientist, both in the classroom and in the laboratory, we learn a way of knowing that in many cases takes us away from our original reasons for pursuing science. We become immersed in a scientifically acceptable culture that values focused work – work that does not require or even encourage interaction with a community beyond a scientific one. We become immersed in a culture that does not value or perhaps even remember the context of the work. We are immersed in a culture, especially if you pursue research that utilizes molecular techniques, that allows you to reduce organisms down to the level of their genes, treating them as if individual differences were insignificant or uninteresting.

These realizations lead us to a set of fundamental questions: is it possible to do socially responsible research? Are there ways that scientists can be trained that will allow them to understand that all research fits into a particular context? If so, how could science programs “fit” this type of information into our curriculum as we struggle to “cover” the material already? We would argue that it is possible to assist science students to understand how to do socially responsible research and to fit this material into our curriculum. In fact, we do our students, our scientific disciplines, and our society a great disservice if we neglect to do this.

Retooling for a More Socially Responsible Scholarship

Many of our institutions have general studies programs designed to assist students to become better communicators, both in oral and written presentations. This is one arena that science faculty have a wide latitude for exploration. One of us has chosen to teach a general studies course called the Genetic Age. In this course, students read material, including Holdrege’s book, suggesting that reductionistic thinking needs to be balanced by understanding the research context. Preparation for and teaching of these courses allows faculty to investigate topics outside their general areas of research, informing them of the context of their endeavors and the histories of their disciplines.

Faculty can also engage students in disciplinary courses, educating them about choices made for representation of science in textbooks. For example, the terms “dominant” and “recessive” as they pertain to transmission of genetic traits have come to be known as Mendelian inheritance. However, if one reads Mendel’s original paper⁵ it is clear that Mendel realized he was using a reductionist approach when selecting traits that showed dominant and recessive characteristics. His choice of these traits was deliberate, allowing him to make clear distinctions between the phenotypic outcomes. He also recognized that pea plants have traits that are not so distinct. Presenting this information to students allows for a brief conversation of the interpretation of results as they are passed through the scientific literature. Additional topics of genetics can be used as points for discussion of how language is shaped by a common culture. For example, when discussing aspects of the human genome project, students can be asked to think about why many of the genes within the database are named in accord with disease-linked mutations rather than the normal functions they encode.

⁵ English translation of Mendel’s manuscript is available on Mendel Web: <http://www.netspace.org/MendelWeb/Mendel.html>

Many of us are also beginning to appreciate the value of interdisciplinary teaching and research. For example, one of us teaches a Perspectives in Biotechnology course involving guest lectures by philosophers, theologians, economists, as well as environmental and social scientists. In this capstone course for the biotechnology major at Calvin College, students explore issues in biotechnology via readings from scientific and popular literature. Instructors from different disciplines facilitate clarification of the assumptions, values, beliefs, and ideologies underlying the arguments presented. They also infuse different elements and viewpoints from the public debate into class discussions. Most biotechnology majors strongly agree with the logic of ethicist Paul Thompson's argument for a "presumptive case in favor of biotechnology," in which the "burden of proof falls on those who would restrict, control, limit, regulate or moderate" its use.⁶ Accordingly, most discussions necessarily focus on the concerns of biotechnology's critics. Through this process students are able to map the multidimensional nature of key issues in biotechnology – identifying economic, social, cultural, political, moral, ethical, and religious aspects. Role-playing exercises (e.g., "If You Were the EPA, How Would You Handle StarLink Corn?"⁷) underscore the broader contexts of the science and provide venues for students to practice consensus building. The course culminates in each student preparing a position paper on a biotechnology-related issue of his/her choosing. These position papers integrate scientific aspects with the student's own interpretations and values.

Another way to rediscover the wider contexts of our work is to engage in multi-disciplinary and/or service-oriented research – and to involve students in this as well! Service-oriented research seems a little easier to do in some disciplines than in others. For example, ecologists may find multiple opportunities to partner with landowners, businesses, and community organizations to restore habitats and ecosystems. How might we engage in this type of research in genetics, biotechnology, or other "microscopic" disciplines? One venue would be to collaborate with colleagues in the humanities and social sciences to explore how potential applications may affect various social groups, paying particular attention to "at risk" groups and long-term sustainability issues. Ideally, this should involve dialogue with various stakeholder groups (e.g., farmers, environmentalists, medical professionals, leaders of rural or inner-city communities, local government officials), communicating to them the science and accompanying technologies, inviting their inputs and feedback, and analyzing the roots of their concerns. Publishing the results of this type of research could influence the priorities of policy-makers and granting agencies. If we truly were responsive to cultural values and concerns, such research would also generate greater public trust of the scientists involved.

In addition to individual work by faculty members, we suggest development of curricula that will be of interest to and worthwhile for the general student population at your institution. For example, at Allegheny College one of us has developed, along with faculty members in all divisions, a minor called Science, Health, and Society. This is an interdisciplinary minor that gives the students an ability to understand science and

⁶ Thompson, PB (1997) *Food Biotechnology in Ethical Perspective*, Aspen Publishers, New York, p.19.

⁷ Case study overview and background documents are available at the Project Kaleidoscope website: <http://www.pkcal.org/faculty/f21/events/2001na/koetje.html>

health from a variety of perspectives. This minor contains two elements that are common to all students, a requirement of doing 84 hours of service and shadowing and a capstone seminar course. In the capstone course students explore issues related to public health and write an extended paper reflecting on what they learned about the context of science and health in their formal coursework and their informal shadowing and service experience.

It is also important that scientist/educators learn how to discuss issues of science with others, especially with non-experts who have the greatest likelihood of benefiting or being harmed by the outcomes of scientific research. In these conversations it is imperative that we “shed” our distancing science-speak and instead be willing to discuss the issues on a basis of equality, where each party has important information to contribute. It is also important that we do not distance ourselves from the non-experts by prefacing what we say with “It is complicated, but I will attempt to explain it to you,” but rather to embrace and encourage questioning, so that all can become conversant in the issues related to the genetic age.

Finally, it is of paramount importance that we continue to educate ourselves about the histories of our disciplines and strive to understand those who criticize what we do. There is a wealth of information available related to the context of science in wider social issues. To facilitate investigation in this area, we have compiled an annotated bibliography of a few of the readings that have been instrumental to our understanding of the implications of the social context of science.

Recommended Web Sites

AgBiotech Info Net <http://www.biotech-info.net/>

AgBioForum <http://www.agbioforum.org>

Council for Responsible Genetics <http://www.gene-watch.org>

Department of Energy “To Know Ourselves” <http://www.ornl.gov/hgmis/publicat/tko/>

Genetic Engineering and its Dangers <http://online.sfsu.edu/%7Erone/GEessays/gedanger.htm>

Image Archive on the American Eugenics Movement <http://www.eugenicsarchive.org/eugenics/>

Pew Initiative on Food and Biotechnology <http://pewagbiotech.org/>

The Cost of Biotech Fever <http://www.motherjones.com/fotc/fotc17.html> by Russell Mokhiber and Robert Weissman Jan. 11, 2000

The New Eugenics: The Case Against Genetically Modified Humans, by Marcy Darnovsky
<http://www.purefood.org/Patent/genebabies.cfm>

Annotated Bibliography

Understanding Reductionism

Wendell Berry. *Life is a Miracle. Counterpoint.* Wendell Berry's writings always make us think in new ways. This set of essays contains a critique of E.O. Wilson's book, *Consilience*. This is truly a book that celebrates what it means to be human - an excellent book for junior and senior students who are interested in different perspectives on science.

Craig Holdrege. *Genetics and the Manipulation of Life: The Forgotten Factor of Context.* Lindisfarne Press. Holdrege argues that we have forgotten to look at context, what he terms fluid thinking, as we attempt to understand genes. He gives wonderful examples of how we view organisms as objects. If you would like a history of genetics in a way that is engaging and understandable, as well as a new way of viewing organisms, this would be an appropriate book for you – an excellent choice for general studies courses.

Ruth Hubbard and Elijah Wald. *Exploding the Gene Myth.* Beacon Press. This book is quite critical of the way in which genes and genetics is portrayed. It is a well-written book with a great deal of important information. We would not recommend this as the first book you read because Ruth Hubbard's tone is a little too negative and this can get rather frustrating. However, Hubbard is a person trained in the sciences, and hers is another voice of caution regarding genetic technology.

Richard Lewontin. *The Triple Helix: Gene, Organism and Environment.* Harvard University Press. Lewontin is a well-known evolutionary geneticist and critic of reductionism. Much of this book is devoted to that critique and to illustrating how metaphors guide our thinking while often limiting or misconstruing it. Lewontin rejects common alternatives of reductionism: holism (as articulated in the Gaia hypothesis) and theories of general properties (chaos theory, catastrophe theory, and complexity theory). Instead, he proposes that we think of biological organisms as "internally heterogeneous open systems," characterized by a dynamic exchange between internal processes and external factors. Much food for thought here!

Social Context of Biotechnology

Lori B. Andrews. *Future Perfect. Confronting Decisions About Genetics.* Columbia University Press. Lori Andrews is a lawyer who is interested in patient rights, especially as it applies to genetic technologies. Her writing is clear, and in this book she addresses issues such as the impact of genetic technology upon family, children, women, and the disabled. It is well researched and pulls in examples from many major studies done on the impact of genetic technology.

Gary L. Comstock. *Vexing Nature? On the Ethical Case Against Agricultural Biotechnology.* Kluwer Academic Publishers. In eight chapters Comstock chronicles how ethical considerations, which initially fueled his staunch opposition to agricultural biotechnology, gradually led him to a position of cautious support. Comstock has written an abridged version of his arguments in a recent manuscript, entitled "Ethics and Genetically Modified Foods," which is available on-line at <http://scope.educ.washington.edu/gmfood/commentary/show.php?author=Comstock> Both resources explore the deep pull of both sides of the argument over genetically modified foods.

Anne Kerr, Sarah Cunningham-Burley, and Amanda Amos. 1997. *The New Genetics: Professionals' Discursive Boundaries.* *The Sociological Review* 45(2): 279-303. This research article demonstrates that geneticists tend to think about and communicate their responsibilities within the larger social context in ways that enable them to influence policy while diverting ultimately responsibility to an abstract and amorphous 'society.' The article is accessible at many institutions via www.ingenta.com

Philip Kitcher. *The Lives to Come: The Genetic Revolution and Human Possibilities.* Touchstone Books. This book deals primarily with genetic testing. It is comprehensive and well written. It is also one

of the few books written on this subject that gives suggestions for how this technology can be used ethically and morally. It is written in understandable language. One of the most striking chapters contains arguments presented by Kitcher that address the need to discuss quality of life issues. This book is appropriate for general studies courses.

Patrick O'Mahony. *Nature, Risk and Responsibility: Discourses of Biotechnology*. Routledge.

This book contains a collection of chapters, contributed by a dozen European authors that connect biotechnology to the key question of what it means to be a responsible society in an age of increasing power to control natural organisms and processes. Major topics include human reproductive technologies, genetically modified food, and patenting.

James C. Peterson. *Genetic Turning Points: The Ethics of Human Genetic Intervention*. William B. Eerdmans Publishing.

With advanced degrees in molecular and clinical genetics and in ethics, Peterson is the CC Dickson Associate Professor of Ethics at Wingate University. In this book he explores religious arguments for and against human genetic intervention from primarily Christian faith traditions, and explaining how his own faith perspectives guide his cautious support of such technologies. He then proposes a religiously neutral ethical framework to guide decision-making concerning genetic research, genetic testing, genetic drugs, and gene therapy. This book is especially useful for courses that explore current practical issues in science and religion.

Lee M. Silver. *Remaking Eden: How Genetic Engineering and Cloning Will Transform the American Family*. Avon Books. Silver, a professor of Developmental Biology and Reproductive Biology at Princeton, is one of the experts in the field of reproductives, the combination of the fields of reproductive technology and genetics. This book articulates the zeal of those who are in favor of the new genetic technologies. It is appropriate for general studies courses.

Paul B. Thompson. *Food Biotechnology in Ethical Perspective*. Aspen Publishers. Thompson, a practical ethicist at Purdue University, is a supporter of food biotechnology. This book is an excellent, in-depth overview of its moral and social implications. It is ideal for an upper-level Science and Ethics course.

Science and Culture

Dorothy Nelkin and M. Susan Lindee. *The DNA Mystique: The Gene as a Cultural Icon*. WH Freeman & Co. This book, written by two sociologists, documents the pervasiveness of genetic imagery in popular culture and discusses topics such as genetic essentialism, the current "need" for genetic versus adopted children. It is appropriate for general studies courses.

Arnold Pacey. *The Culture of Technology*. MIT Press. Pacey was trained as an engineer and still teaches courses at one of the Open Universities in England. While this book was originally written in the mid-1980s, before a great deal of progress was made in genetic technology, his arguments are still timely today. Pacey argues that it is necessary to understand technology more broadly within the context and ideas of the time in which it was developed. Pacey writes in a way that challenges readers to think in a "circular" manner, re-integrating ideas presented previously. In contrast, most science books train us to think in a linear way. This book is appropriate for general studies courses or in courses that relate to politics and environmental science.

Arnold Pacey. *Meaning in Technology*. MIT Press. This is a more recent book by Pacey, but one where he continues the theme presented in the *Culture of Technology*.

Egbert Schuurman. *Perspectives on Technology and Culture*. Dordt College Press. Schuurman is a Dutch Christian philosopher and critic of technicism, which he identifies as the current ruling paradigm in our society. In this book he details how technicism has permeated even basic science and discusses its consequences. A manuscript outlining Schuurman's criticisms of technicism and genetic engineering is also available on-line at <http://scholar.lib.vt.edu/ejournals/SPT/v3n1/pdf/schuurma.pdf>

Richard E. Sclove. *Democracy and Technology*. Guilford Press. Richard Sclove was one of the founding members of the LOKA Institute involved in developing ways of understanding how to develop technology using the democratic process of user input. This book covers topics of how culture is “hidden” in technology and present models of how the user has been and can be engaged in conversations with the technologists (scientists). This book is an excellent starting point for anyone who wants to read more about this topic. It would be appropriate reading for junior or senior undergraduates in a course about science or health policy.

Bonnie B. Spanier. *Impartial Science*. Indiana University Press. This book critiques the way in which molecular biology textbooks are written and suggests that there is a strong gender bias in what is presented. Bonnie Spanier, trained as a Molecular Biologist and as a feminist scholar, writes this book in a way that elegantly combines the two areas. She critiques the writing without being hostile to the field or to researchers in molecular biology. This book would be an appropriate text in a Women in Science course where the students have had an undergraduate course in genetics or molecular biology.

Worldview of Biotechnology

Gerald F. Gaull. *Biotechnology Regulation in America and Europe Viewed in a Cultural Framework*. Institute of Economic Affairs. This white paper of the UK’s free-market think-tank can be purchased on-line via <http://www.iea.org.uk/record.php?type=article&ID=75> In a few brief pages this essay manages to identify key cultural differences that account for dramatic disparities in the way biotechnology is regulated in the United States and in Europe. It is suitable for courses at all levels that explore the influence of cultural contexts on science and technology.

Sandra Harding (editor). *The ‘Racial’ Economy of Science: Toward a Democratic Future*. Indiana University Press. This book is a compilation of essays written by a variety of scholars and covers a variety of topics such as non-western scientific traditions, science constructs of race, participation in science, and the concept of democratic science. Sandra Harding is a feminist scholar who has compiled in this volume a rich set of articles that analyze and critique the sense of superiority of Eurocentric science. Excerpts (individual essays) from this book are appropriate for general studies classes, but the entire book would be a good “text” for a course on scientific responsibility or for a course that focused on issues of race, gender, and ethnicity in science.

Muriel Lederman and Ingrid Bartsch (editors). *The Gender and Science Reader*. Routledge. This book is, in many ways, very similar to the one edited by Wyer, et al (see below). Some of the articles in these two “readers” are identical, but there are several essays that are unique to this reader. This reader could be used in a Women in Science course.

Mary Wyer, Mary Barbercheck, Donna Giesman, Hatice Örun Öztürk, Marta Wayne (editors). *Women, Science, and Technology*. Routledge. This is a series of essays collected by these editors and compiled in one volume to facilitate use in course related to Women in Science. This is a very rich volume that contains a large number of voices and topics, ranging from under-representation of women in science to the culture of science and technology. This books compiles work by many well-known (and lesser known) women who have written feminist critiques of science such as Evelyn Fox Keller, Helen E. Longino, and Emily Martin. Selected chapters from this book would be useful in a Women in Science course.