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Teaching the Ethics of Biology

David Harris Ph.D.
University of Southern Maine, deharris@usm.maine.edu

Carol K. Johansen
University of Southern Maine

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We live in an age where the social implications of scientific experimentation and discovery are openly debated at all levels of society. While all areas of science are being subjected to increased levels of social scrutiny, biology seems to get a particularly close examination. This is, perhaps, only reasonable. Important areas of biology, from genetic information gathering and technology (Venter & Cohen 1997; Wadman 1997a; Wadman 1997b) to animal dissection and experimentation (Gilmore 1991; Flannery 1997) to the assessment of environmental threats (Bicak 1997) have recognized ethical considerations. As biologists, it may be comforting and convenient for us to argue that science is the search for objective truth, and therefore ethically neutral. However, most socially reflective scientists recognize that those who make discoveries have an ethical responsibility for the uses to which those discoveries are put (Reiser & Heitman 1993). Biologists who are also educators face a double challenge. We must both confront the ethical issues of our own professional lives and also instill a framework for ethical decision making in our students. This is obviously vital for our students who plan to pursue careers in science themselves. It is no less important for students oriented toward other disciplines because, as citizens, they will be called upon to make decisions about how society will control and/or support biology.

Educating students about bioethics presents a variety of challenges. Some of the most nettlesome and important ethical issues in biology are broad—even interdisciplinary—in scope, and thus may not fit comfortably into a standard science curriculum. For example, the need for a sustainable environmental policy must be addressed from the perspectives of biology, chemistry and political science, among others (Bybee 1991). By contrast, graduate education in biology is increasingly focused; and biologists, who generally prefer to discuss their own research, are often reluctant to speak outside their specific area of expertise (Greene 1997).

To further complicate matters, many biologists have only limited training in ethics. Pressed by the explosion of scientific discovery, many precollege and undergraduate biology courses concentrate on science facts and virtually ignore the social consequences of biological discoveries (McInerney 1995; Lindell & Milczarek 1997). The National Institutes of Health (NIH) requires education in science ethics for all graduate students supported by federal grants. But these courses may focus on the ethical conduct of research (i.e. preventing research fraud) and give less consideration to the basic principles of ethical decision making or the social implications of biological and medical research (Reiser & Heitman 1993; Deutch 1996). As a result, biologists have an acutely developed sense of what constitutes data fabrication or the misappropriation of ideas (Korenman et al. 1998) but may not have been trained to automatically consider the consequences of scientific discoveries to the public (Lindell & Milczarek 1997).

Despite this lack of preparation, biologists are under a variety of pressures to consider the ethical implications of their work. Precollege biology teachers may have to confront both students who are outspoken opponents of animal dissection (Watt 1995) and undergraduate faculty who prefer that students entering their classes have experience in dissection (Gilmore 1991). Undergraduate faculty may teach a curriculum that includes topics that have obvious ethical implications, such as the Human Genome Project (Lindell & Milczarek 1997) and the relationship between humans and the environment (Bicak 1997). Research scientists may be called upon to consider voluntarily forgoing experimentation with human cloning to forestall sweeping legislative bans (Wadman 1997b). Whatever decisions biologists make in these matters, they will need to articulate the ethical principles underlying their positions to their students, their colleagues and, increasingly, to an interested but cautious public.

Part of the practical challenge for scientists dealing with ethical issues is that they are trained in an intellectual paradigm that can make them appear to be at odds with the public. Indeed, the tendency of scientists to view arguments as intellectual pursuit can confuse the public. "The public tends to see things as 'black or white' while we scientists readily acknowledge that science involves a continual evolution of understanding" (Lindel & Milczarek 1997). To facilitate the process of explaining their work, many science teachers and students want a common-

Carol K. Johansen, Ph.D., is Associate Professor of Leadership and Organizational Studies and **David E. Harris**, Ph.D., is Assistant Professor of Natural and Applied Sciences at Lewiston-Auburn College, University of Southern Maine, Lewiston, ME 04240; e-mail: Cjohan@usm.maine.edu.

sense practical decision-making "model" or strategy to use when making ethical decisions about technical scientific issues. They seek a process of ethical decision making that will help them to "analyze problems in a logical manner with the ability to articulate multiple viewpoints and to defend on" (Lindell & Milczarek 1997).

There is a rich literature discussing courses that deal with the social and ethical consequences of specific areas of scientific advancement (Armstrong & Weber 1991; Baker 1993; Markham & McKone 1993; Reiser & Heitman 1993; McInerney 1995; Lindell & Milczarek 1997; Anderson 1998). This work is invaluable because it provides educators with specific examples of ethically important issues in biology that they can raise in their own classrooms. These articles commonly indicate that the courses they describe devote at least some class time to the delineation of ethical principles, but spend little or no space discussing what these principles are or how they are applied in the practical process of ethical decision making.

In this paper, we discuss the basic principles of ethics and ethical decision making as they apply to biology. We then compare three practical methods for ethical decision making. Two of these methods have previously been described and are widely used (O'Morrow & Carter 1997; Pfeiffer & Forsberg 1997). The third method was developed by one of this paper's authors and is employed in an undergraduate ethics course that confronts the ethical implications of biomedicine. All three methods could be adapted for use over a large variety of educational levels from precollege classes to graduate programs. Our intention is to provide an understandable and useable framework that biologists in general and biology teachers in particular can employ themselves and teach to their students to facilitate the process of ethical decision making in all relevant areas of biology.

Theoretical Basis of Ethical Decision Making

One of the first problems ethics teachers encounter in a classroom is that students (and in our experience at least, particularly students who are majoring in the sciences) want to know both the correct "way to solve" ethical dilemmas and the "right answer" to any and all ethical dilemmas. Only with considerable discussion can students understand that the study of ethics does include "guidelines" for making ethical decisions but does not provide them with either the perfect solution method or the concrete correct answer to every ethical conflict. This realization can cause considerable discomfort for students. This discomfort may be particularly intense for students of science who have experience with the ideas that: 1) the scientific method is the "method of choice" for answering questions in the sciences, and 2) complex questions have answers that are both correct and scientifically verifiable. Problems with the discussion of ethical dilemmas in the science arena are further intensified by the fact that each of us brings to the ethical decision-making process a personal, cultural and often religious background of values that we have developed without questioning other sides of ethical dilemmas.

Cognizant of these challenges, we begin our discussion of ethical decision making by exploring the two basic types of theories upon which ethical decision-making paradigms are based: teleological (consequentialist) and deontological (rules or principles) theory. As Hugh LaFollette explained in *Ethics in Practice*, "Consequentialist theory states that we should choose the available action with the best overall consequences, while deontology states that we should act in ways circumscribed by moral rules or rights, and that these rules or rights are defined (at least partly) independently of consequences" (pp. 8–9). In this usage, the word "rights" indicates a value opinion (i.e. rights vs. wrongs) rather than a statement of an individual's moral worth (i.e. human rights vs. animal rights). We discourage student arguments based on this second meaning of "rights" because these arguments tend to produce absolutist, polarized positions and discourage communication among people with different viewpoints.

Others who have introduced this material into ethics courses, even at the graduate level, have found that students struggled with primary literature readings on these subjects and had difficulty relating these theories to specific practical examples (Deutch 1996). We have found that some background in ethics theory is vital for students, even if readings in the primary ethics literature are not appropriate for students at all levels. For students to thoroughly employ a specific model of ethical decision making, they must consciously utilize one or more theories of ethical reasoning.

To provide students with the tools they will need to use models of ethical decision making, we explain that teleological theory (utilitarianism) is based on the concept that moral judgments have consequences, and that these consequences determine if an action is right or wrong. Teleological (from the Greek root *telos* meaning "goal" or "end") moral theory is, therefore, results oriented. We judge whether an action is better than alternatives by analyzing its expected results or consequences. For instance, the use of animals in science experiments might be ethically justified if: 1) the experiments were designed to discover a cure for human cancer, and 2) there were no alternatives that did not use animals. However, if an alternative experimental approach that did not

use animals existed or if the goal of the experiments were less laudable (developing cosmetics, perhaps) the use of animals in experiments might not be justified. In teleological theory the motivation of the operator is not at issue. The scientist developing the cosmetics may honestly believe that cosmetics improve peoples' lives while the cancer researcher may be motivated by an interest in fame and fortune. We judge the ethics of the action based solely on its outcome. Utilitarianism is sometimes called "end-result ethics" and is further described as an approach in which "the end justifies the means," or one that provides the greatest good for the greatest number of people (MacKinnon 1998, p. 82).

By contrast, deontological (Kantian) theory is based on the idea that actions may be right or wrong regardless of their consequences. Deontological (from the Greek root *deon* meaning "duty") theory is concerned with the motive behind the action rather than the eventual outcome. In this nonconsequential theory, an act has moral worth when the operator is motivated by a sense of duty or concern, that is, when the operator has the "right intention." An act is right if it is consistent with the demands of reason and human dignity. In a Kantian analysis of the morality of animal experimentation, a single experiment could be ethically defensible if it is conducted with altruistic motivation but nondefensible if it is conducted for the self-aggrandizement of the experimenter.

In our experience, students fully grasp the complexity of ethical theories best by practicing their use in an ethical decision-making model, such as the models described in this paper. Scientific discoveries including cloning and new reproductive technologies provide some interesting opportunities for students to use one or more ethics theories within the framework of an ethical decision-making model. For instance, many scientific discoveries are commonly justified via utilitarian theory. However, it is also interesting for students to analyze these discoveries using a deontological approach that focuses on the duties and obligations of the individual and holds that the features of actions themselves determine whether they are right or wrong.

There are other classical theories in ethics, including the Natural Law theory—the belief that morality is based on human nature and is thus accessible to human reason. This is an important idea, but we have found that it can often confuse students studying science because they have trouble separating Natural Law theory from "laws of nature" or generalizations of natural science. According to Natural Law theory, the approach to determining what we ought to do is written into nature, specifically, into human nature. A great difficulty of Natural Law theory is separating an "ought" from an "is." John Locke argued that people are all equally human, therefore they ought to be treated equally. Rather than involve students in complex discussions of consequences, duties, and the essence of human nature, it is more productive to discuss the benefits of arguments that generate multiple different points of view.

Importance of Scientific Understanding to Ethical Decision Making

While an understanding of ethical principles is necessary, it is not by itself sufficient to allow students to engage in reasoned ethical decision making. One reason for this is that students too often make their ethical decisions based on value judgments without examining the basis of those values. All of us believe what we believe based on what we have learned from our parents, schools, churches, influential friends, what we have read, and what we just "feel" is right. Few of us are comfortable questioning how we developed these beliefs. This can make even the most tolerant individual very sure that he/she is right in an ethical belief and that all those who disagree are wrong. Students need to be encouraged to listen to others, to hear other points of view, and to discriminate between conflicting claims that something may or may not be ethically correct. To facilitate this, we use readings that present ethical dilemmas from multiple points of view and then ask students to begin their discussion by outlining what the competing points of view are. Even this basic task can be a difficult process for a student who begins without an understanding of why an individual might even choose to view an idea from multiple ethical perspectives.

Students also need a firm grasp of the basic biology of a new discovery or technology before they can make intelligent ethical decisions about it. For instance, the slowly subsiding controversy around cloning that was ignited by Dolly the sheep (Krauthammer 1997) appears to have been fueled as much by popular ignorance about what cloning technology can (and cannot) do as by reasoned ethical considerations. This is not to say that only scientists can understand the ethical implications of science. Quite the contrary. In our experience students from all disciplines can grasp enough of the biological basis of controversial advancements to make well-reasoned ethical decisions about them. However, to do so they must be presented with simple yet factually correct scientific information.

A variety of popular scientific journals publish articles about ethical controversies in science oriented toward a nontechnical audience (Gould 1997; Barnard & Kaufman 1997; Botting & Morrison 1997). We have used articles such as these with success in undergraduate classes of nonscience majors. One of

this paper's authors is a biologist who has also developed and taught interdisciplinary courses for nonscientists that examine controversial topics such as race and HIV/AIDS from social and biological perspectives (Harris & Raimon 1998). True interdisciplinary courses such as these are difficult to arrange and are expensive to offer because they require the presence in the classroom of two instructors from different disciplines. However, a biologist can be a valuable technical resource for an ethics class in other ways such as by suggesting appropriate readings and coming to a class as a guest to facilitate discussion of technical material. To be effective in this role, the biologist must grasp the basic process of ethical decision making. To fully utilize the expertise of the biologist, instructors in ethics must also expand their own understanding of basic biology.

Eventually, students must go well beyond a technical understanding of controversial scientific discoveries and an acceptance of the idea that individuals have different values. Students need to practice ethical decision-making inquiries so that they can solve a conflict or dilemma by using a logical questioning process. The following section offers some simple models of decision making that will aid science teachers in the presentation of material that is "ethically loaded."

Models of Ethical Decision Making

Using Classical Theory as Questioning

Students are often unsure how to begin when analyzing an ethical conflict or dilemma. They may not know what questions to ask and how to proceed to arrive at a decision. To explain why reaching a reasoned ethical decision is important, we can impress upon students that making no final decision is a decision in itself. At the most basic level, we can ask questions in any ethical conflict that focus on the motive, the act and the consequences. In our class, we introduce a technical scientific problem and ask students to enunciate as many ethical viewpoints as they can. For example, we ask students to consider whether animal experimentation for scientific discovery is ethically correct and to defend their position. We group responses according to whether they question the consequences (Utilitarian theory) or the motive and act independently of the consequences (Kantian theory). The Natural Law theory may also be used as it will lead students to question what the laws of human nature are, but they will want to look at the consequences as well. The point of such a discussion is to get students to realize there are many different points of view on a subject that they may have previously viewed as having only one "correct" conclusion. The limit of this simple model is that students may easily arrive at a number of very different conclusions and may not be able to offer any decision or "solution" to the conflict or dilemma.

RESOLVEDD

Another useful model of decision making is the RESOLVEDD strategy, introduced in *Ethics on the Job* (Pfeiffer & Forsberg 1993). This strategy allows the students to make a decision after having analyzed and evaluated both main sources of ethical justification: consequences and principles. It helps students survey the possible solutions to a given conflict by identifying the significant consequences of each main solution, stating the debated ethical principle and evaluating each before making a decision. The RESOLVEDD strategy includes the following steps:

R. *Review* the history.
E. *Estimate* the conflict or problem.
S. List the main possible *solutions*.
O. State the important *outcomes* or consequences of each main solution.
L. Describe the *likely* impact of each main solution.
V. Explain the *values* upheld and those violated by each solution.
E. *Evaluate* each main solution and its outcomes, likely impact, and the values upheld and violated by it.
D1. *Decide* which solution is the best, state it, clarify its details, and justify it.
D2. *Defend* the decision against objections to its main weaknesses. (p. 36).

To apply RESOLVEDD, students must have a firm grasp of the basic biology of the problem they wish to address, as well as an understanding of both teleological and deontological ethical theory. One of the benefits of using RESOLVEDD is that it prevents students from looking for the "one" correct answer to an ethical conflict because RESOLVEDD often generates many solutions or final decisions. For instance, this model might work very well if the ethical issue for debate concerned access to medical history versus personal privacy of medical information. People die in emergency situations when information about their current medications and past medical treatments is not available. This argues for making medical information about individuals more readily available. On the other hand, the more available this personal information is, the greater the potential for discrimination in job hiring, job advancement, social acceptance, and educational opportunities and training. Using the RESOLVEDD method, students would be able to generate numerous solutions, describe the impact of each main solution, evaluate the likely impact, describe the best solution, and defend their decision.

The benefit of using this model is the numerous solutions it generates when it is applied to a technical scientific question. The limitation to using this model is that it tends to generate so many solutions and outcomes that it can become both tedious and time-consuming. This is a shortcoming RESOLVEDD shares with the direct application of classical ethical theory to an ethical dilemma (see above). Students often find it difficult to explain the ethical values upheld and those violated by each main solution. While this step may not be critically important in a science class, it is the vital teaching piece of ethical reasoning. When applying RESOLVEDD, students may also get so involved in the process that they do not ever reach a conclusion or come to a decision about the conflict. When this occurs, RESOLVEDD can fail because students are unable to decide what they believe is the best course of action for themselves or for society. That is, they are not able to complete the final two steps of the RESOLVEDD process.

The Ten-Step Model of Moral Reasoning

The Ten-Step Model (O'Morrow & Carter 1997, p. 98) is based on moral reasoning, decision theory, moral development, values and valuing, and evaluation. Students work through the process and eventually decide on a morally acceptable action appropriate for a given situation. As is the case for all good ethical decision-making models, the students' knowledge of ethical theories helps them to identify the ethical issues and provides the moral justification for whatever action they decide is correct. These are the steps of the Ten-Step Model:

1. Isolate the problem, identify the decisions needed, including the ethical components, and specify the key individuals.
2. Clarify the situation; gather additional information.
3. Identify the ethical issues or ethical dilemmas of the situation.
4. Examine the problem for personal and professional moral positions.
5. Clarify the moral positions of key individuals involved.
6. Identify value conflicts of the individuals.
7. Decide who should make the decision.
8. Develop the range of actions with anticipated outcomes.
9. Reach a decision on a course of action and carry it out.
10. Evaluate and review the results of the decision. Monitor this evaluation over time. (O'Morrow & Carter 1997, p. 98).

One of the benefits of using this model of ethical decision making is that it identifies the key individuals involved in the situation and determines who should make the decision. This will generate some interesting results if a class is dealing with the ethical issue of using animals for scientific experimentation because it forces students to consider the very different perspectives of research scientists, animal rights advocates, and the public at large. By considering both the individuals involved in the situation and those who make the key decisions, students will gain a realistic appreciation for how ethical decisions are actually made. This method also generates a range of outcomes that have great potential for class discussions based on the scientific impact of each decision. Perhaps the most relevant step in the Ten-Step Model is the process of monitoring the decision over time (Step 10). Because many scientific experiments do not return immediate results, students must understand this step if they wish to gain a realistic perspective on this process.

One limitation of this model is that it works best for people in management or controlling positions while many ethical conflicts and dilemmas must be addressed by scientists and technicians who work alone, or members of the public who may believe themselves to be relatively powerless. This model also does not allow for scientific mistakes or unprofessionalism or even apathy by those who are the key individuals doing the actual scientific work. It also does not account for the possibility that the ethical decision makers are individuals far removed from the scientists involved with the experiments.

Where the RESOLVEDD model may take too much time and may generate too many alternatives without coming to a solution, the Ten-Step Model relies a great deal on key individuals who may not be directly involved with the scientific process. Most ethical decisions are made by individuals who bring personal, and frequently unquestioned, beliefs to the ethical decision-making process. The next model was designed by one of the authors of this paper to provide people with a self-examination process that they can apply to many ethical dilemmas that occur in the scientific or technical settings.

The ABCDE Method

This method of ethical decision making is one that the authors have developed to allow a group or individual to reach a final decision in an ethical conflict. The ABCDE model of decision making asks students to think about opposing arguments, costs and benefits, and to reach a final decision based on personal fairness.

The model is explained as follows:

A. *Argument.* Insist that students put forth short simple arguments for and against each side of an ethical conflict. One of the most effective

ways to do this is to ask students who hold the strongest positions before the discussion to take the "other side of the argument." Though it is hard at first, students will often put forth arguments with clarity when they are arguing for an opposing side.

B. *Both Sides.* Make sure that an argument has two or more sides. The "other side" can be approached from the perspective of consequences. Remind students that to make no decision is a decision with consequences. It is important to encourage students to see that there are other sides to any dilemma even though they may protest that they can only see one side.

C. *Costs and Benefits.* Using the information they have developed thus far in the process, have students prepare longer and more far-reaching statements about the costs and benefits of each argument. This does not mean that students must generate dollar figures: it simply means that they should make realistic statements based on their research of the topic. This can be difficult in science. The development of a new methodology may both represent a technical breakthrough and give rise to social ethical dilemmas that were unintended (and perhaps unrecognized) by the scientists. Students should analyze who benefits and who pays when determining the success or failure of a scientific discovery.

D. *Decision.* Using open discussion and debate, students should reach a conclusion or decision. This does not mean that an entire class will necessarily agree. However, it is worth the time to attempt to reach a final decision because this accurately reflects the process in society at large. The decision might be agreed upon by majority vote or by consensus. Not everyone will agree but it is important that students be a part of a process that reaches a decision that is agreed upon by most of the group. Students should leave this process with a deeper understanding of their own moral values and the moral values of others.

E. *Evaluate.* Given all the arguments, costs and benefits, and final decision, did the process seem fair? While fair is not a simplistic term, most students can understand fairness. Students may need to evaluate and discuss the criteria for defining fairness.

This model clearly requires that students have a grasp of classical ethical theory because it allows arguments to be put forward using either teleological or deontological theory. It also requires that students have a working knowledge of the basic biology behind the subject under discussion. The model has several advantages. It is easy to explain and offers a straightforward decision-making process. It also provides a forum in which each individual must explain his/her own values and understand those of others. Through this process, students will discover new information, explore points of view opposed to theirs, and develop increasingly sound arguments for their own points of view. Understanding the costs and benefits of each decision provides students insight into the practical results of scientific endeavor—something the public believes scientists need to know more about. The decision part of this process gives students experience with socially and morally acceptable compromise. Finally, the evaluation stage highlights for students the consequences of their decisions. Using this model will not make everyone happy but it will offer most students an opportunity to examine their ethical decision-making processes by exploring beyond their individual values. It may also encourage students to learn more about the biology of the subject they are considering.

Conclusion

Using the ABCDE model, we have had substantial success in teaching ethics to undergraduate students. However, ultimately, the best model of ethical decision making is the one that a group or individual finds most helpful in the solution of the practical problems they face. In addition, few biology teachers have the formal training in ethics to put any of these decision-making models into use without some practice. For these reasons we encourage those who confront the ethical implications of biology in the classroom and in their professional lives to experiment with a variety of ethical decision-making models and adopt the one they find most useful.

Public debates on areas of biology from global warming to gene cloning suggest that some members of our society have arrived at strongly held ethical positions even if they have put little effort into understanding the basis of their beliefs. Learning about the views of "the other side" forces each of us to think through the assumptions and consequences of our beliefs. Discussing our ideas with those who disagree may be particularly valuable for scientists, because it forces us to defend and explain our actions to the public. Through the process of ethical decision making, scientists can come to realize that they must defend the process of their work as well as its outcomes.

It is vital that we, as a society, learn how to reach decisions on the ethical implications of scientific matters because many of the scientific subjects that generate ethical dilemmas are both constantly changing from a technical perspective and are attached to deep-seated cultural values. For instance, consider

the subject of global warming. This is a subject that was of virtually no interest to the public only a few decades ago. Now it is widely recognized as a potentially serious (if poorly understood) problem. If we fail to make ethically based decisions about global warming now, future generations may pay dearly for our cowardice. However, before we can hope to reach a social consensus about the proper response to global warming, we must confront and understand both a changing set of technical information on this subject and widely varied beliefs about the proper relationship between humans and the rest of nature. The challenges of ethical decision making around biological issues are great. However, teaching the process of ethical decision making in the classroom and employing it in our professional lives provides members of the scientific community and general society experience with this important process.

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