CHAPTER 12

Science and Social Responsibility

Scientists have ethical obligations to benefit society and avoid causing harm. Scientists can benefit society by conducting research that advances human knowledge or produces useful results (or both); educating the public about their research through lectures, media interviews, websites, and popular books; developing nutritional or health guidelines; providing expert testimony in legal proceedings or on government committees; or contributing informed opinions to public policy debates. Though social responsibility is an important principle for scientific research, it can lead to some ethical dilemmas, because it may conflict with other principles, such as openness and freedom. Conflicts may also arise within the principle itself when scientists consider how best to balance benefits and risks to society.

INTRODUCTION

Scientists have ethical responsibilities not only to each other but also to other members of society. Scientists who work with human subjects, for example, have an obligation to respect their rights and dignity and protect them from harm and exploitation. Social responsibilities may also arise even when scientists do not work with human subjects. All scientists have ethical obligations to benefit society and avoid causing harm. Scientists can benefit society by conducting research that advances human knowledge or produces useful results (or both); educating the public about their research through lectures, media interviews, websites, and popular books; developing nutritional or health guidelines; providing expert testimony in legal proceedings or on government committees; or contributing informed opinions to public policy debates. Scientists can avoid causing harm by refraining from publishing or conducting research that may be

used to harm the environment, the economy, species, or society (Committee on Science 2009; Forge 2008; Kitcher 2001; Pielke 2007; Resnik 1998a, 2009a; Shrader-Frechette 1994; Weed and McKeown 2003).

The basis for social responsibilities in science is twofold.

First, like other members of society, scientists have a moral obligation to avoid causing harm and to benefit the others. Most moral theories support a general duty to avoid causing harm (nonmaleficence), which manifests itself in prohibitions against murder, manslaughter, rape, assault, theft, fraud, and so on. Most moral theories also support an obligation to do good when one can be reasonably expected to do so. For example, most people would agree that if you see a person drowning in a pool you should take some action to save that person, such as throwing that person a life preserver or calling a lifeguard. Scientists should benefit society by conducting research that contributes to human health, happiness, liberty, and reducing disease, injustice, and psychosocial distress. Scientists should treat all human beings as having equal worth, regardless of gender, sexual orientation, nationality, religion, and economic status (Shamoo 2012). Scientists' obligations related to benefits and harms extend beyond human society and include other species, habitats, and ecosystems. Scientists have obligations to avoid causing environmental damage (Resnik 2012b).

Second, scientists receive various forms of support from society. Even those scientists who are not directly funded by government agencies usually take advantage of publicly owned or supported laboratories, offices, universities, computers, research sites, and so on. Scientists who work for private companies have usually benefited from public support during their education. Scientists have an obligation to provide public benefits in return for the support they receive (Resnik 1998a; Shrader-Frechette 1994). If scientists cause harm to society, mismanage funds or resources, or fail to produce social benefits, they may endanger their public support.

In 1945, Vannevar Bush, who was a science advisor for Presidents Roosevelt and Truman, wrote an influential report, *Science: The Endless Frontier*, which laid the foundation for U.S. science policy since then. At that time, there was a dispute about how the government should invest money in scientific research and development (R&D). Some argued that government R&D funding should focus on projects with clear and definite practical applications that could be expected to provide immediate benefits to society. Bush argued that focusing on applied R&D was short-sighted and that the government should also fund basic research because basic research has significant long-term impacts on science, technology, private

industry, and society. For example, basic research in subatomic physics during the late 19th and early 20th centuries laid the foundations for nuclear power, radar, x-ray imaging, radio, television, and many other technologies. Moreover, private industry is not likely to fund basic research, even though it benefits from it. Basic research can be considered a public good similar to infrastructure (e.g., roads, bridges), the police, firefighters, and the military.

For many years scientists have recognized that they have social responsibilities. The imminent English scientist and philosopher Francis Bacon (1561–1626), who inspired the first scientific association, the Royal Society of London, argued that the goal of science was to produce knowledge that would have practical value and would benefit humankind (Bacon 2000). Though Bacon believed that scientific knowledge should be sought for its own sake, he was confident that knowledge would benefit society by giving people control over nature. The father of microbiology, the French scientist Louis Pasteur (1822–1895), made many important discoveries that helped prevent disease and saved thousands of human lives. Pasteur helped found the germ theory of disease and developed vaccinations against rabies and anthrax (Robbins 2001). The physicist and philosopher Albert Einstein (1879–1955) believed that he had a responsibility to help the Allied forces stop the threat posed by Germany, Japan, and Italy in World War II. Einstein, whose special theory of relativity ($E = MC^2$) provided evidence of the tremendous power represented by nuclear fission, wrote several letters to President Roosevelt urging the United States to take steps to develop an atomic bomb before the Germans did. Roosevelt heeded Einstein's advice and initiated the top-secret Manhattan Project, which led to the development of atomic bombs that were dropped on Japan in 1945 (Isaacson 2007). The marine biologist Rachel Carson (1907–1964) published an influential book, *Silent Spring* (1962), which warned the public about the dangers of DDT (dichlorodiphenyltrichloroethane) and other pesticides for wildlife and human beings. Carson's work helped launch the modern environmental movement and led to increased government regulation of pesticides (Resnik 2012b).

Though social responsibility is an important principle for scientific research, it can lead to some ethical dilemmas, because it may conflict with other principles, such as openness and freedom. Conflicts may also arise within the principle itself when scientists consider how best to balance the inherent benefits and risks to society of their research. The remainder of this chapter will discuss some common ethical dilemmas related to social responsibility.

COMMUNICATING WITH THE PUBLIC AND THE MEDIA

Communicating with the public and the media about one's research raises ethical issues because the public and media may misunderstand and misinterpret scientific information. Laypeople and reporters may misunderstand or misinterpret scientific evidence, concepts, theories, and recommendations. For example, if a study shows that a gene increases the chances of homosexuality in males by 10%, a reporter may write a headline saying "Scientists Discover Gay Gene." If a small but vocal minority of the scientific community does not accept the hypothesis that human activities that produce greenhouse gases are causing the Earth to warm, the public may interpret this as showing that there is no evidence for human-caused global warming. If a study shows that having a glass of red wine a day can reduce the risk of heart disease, some people may conclude that having three or more glasses of wine a day would be even better at preventing heart disease (Resnik 2001c).

Some scientists are so concerned about being misunderstood, misinterpreted, or misquoted that they decide not to communicate with the public or the media about their research. Others decide to oversimplify or "dumb down" their research to avoid misunderstandings or misinterpretations. While these reactions are understandable, one could argue that they are not socially responsible. Scientists who refuse to communicate with the public or the media about their research ignore their obligation to benefit society. People can benefit in many ways from learning about science. Scientific knowledge can help people learn how to take care of their health and the environment, as well as understand the world and their place in it.

Oversimplification of scientific information can be problematic when it undermines the public's understanding of research and interferes with informed decision making (Elliott 2006; Resnik 2001a). For example, since the 1980s, there has been an ongoing controversy concerning the recommended daily intake of sodium (Kolata 2013; Taubes 1998). Evidence shows that reducing sodium intake can lower blood pressure. High blood pressure is a risk factor for stroke and heart disease (Aburto et al. 2013). A severely restricted sodium diet (less than 500 mg per day) can lead to a dangerous condition known as hyponatremia (Goh 2004). Public health officials recommend that healthy individuals should not consume more than 2,300 mg of sodium per day and that individuals with risk factors, such as hypertension or kidney disease, should not exceed 1,500 daily (Centers for Disease Control and Prevention 2013; Institute of Medicine 2009). However, most people consume much more than 2,300 mg of sodium per day in the form of sodium chloride (salt). Salt is used widely to

enhance the flavor of food and as a preservative. Thus, it is difficult for most people to avoid exceeding the recommended daily sodium allowance. Moreover, the evidence has not shown that reducing sodium intake has a significant impact on mortality or morbidity in healthy adults (Aburto et al. 2013; Graudal et al. 1998). Adults without risk factors may derive no significant health benefits from a restricted sodium diet, other than lowering their blood pressure marginally. If your blood pressure is normal and you have no risk factors, then reducing sodium intake to 2,300 mg daily or less may offer you no benefits (Graudal et al. 1998).

Even though the evidence does not show, conclusively, that all healthy adults should consume no more than 2,300 mg of sodium daily, most public health researchers and officials have stuck by the 2,300-mg recommendation, because they want to promote public health and they don't want to confuse people by giving them conflicting evidence (Kolata 2013; Resnik 2001c; Taubes 1998). It is better to give the public a simple recommendation that is not completely accurate, according to this line of reasoning, than to disclose the whole truth, which may be complex and difficult to understand. Enacting policies that help to lower blood pressure in the population will have a beneficial impact on public health by lowering the incidence of stroke and heart disease even if these policies oversimplify the scientific debate somewhat (Taubes 1998). One might argue, however, that withholding or distorting information in order to ensure that people make the "correct" decisions is paternalistic interference in the public's right to make informed choices (Resnik 2001c). The appropriate response to concerns that the public will misunderstand or misinterpret scientific information is to enhance the public's understanding by explaining scientific ideas in lay language and discussing the implications of conflicting evidence.

EXPERT TESTIMONY

Scientists are often asked to provide expert testimony in court cases, including criminal prosecutions and medical malpractice and products liability litigation. Scientists are also asked to provide expert opinions for government committees dealing with such issues as chemical regulation, pollution, food and drug safety, water quality, electric power generation, and highway and airline safety (Elliott 2006; Resnik 2004c). When scientists serve as experts they are usually asked to provide testimony concerning knowledge within their area of expertise, including their own research and scientific evidence, theories, concepts, methods, or principles. Expert

witnesses in legal cases can answer questions concerning facts (e.g., "is asbestos listed as a known human carcinogen?") and opinions (e.g., "in your judgment, did exposure to asbestos cause cancer in these workers?"). Attorneys on opposing sides of legal cases are allowed to call their own expert witnesses and challenge the testimony of experts. Experts in legal cases are usually paid for their time (ranging from $200 to $2,000 per hour) and compensated for travel. Some experts, known as "hired guns," make over $100,000 dollars per year from providing testimony (Resnik 2007).

In several high-profile legal cases, such as the Dow Chemical breast implant case, there have been legal and political controversies about the validity of expert testimony. Many writers have argued that the courts have been far too liberal in admitting expert testimony in that they have allowed people to testify who lack legitimate qualifications, valid data, or sound theories. In a key U.S. Supreme Court case, *Daubert v. Merrell Dow Pharmaceuticals* (1993), the Court ruled that judges must be the gatekeepers for admitting expert testimony and that they can use a variety of criteria for determining who qualifies as an expert. Prior to this case, judges could admit expert testimony only if it was based on generally accepted ideas, theories, or methods. The practical effect of the general acceptance standard was that it was often used to exclude "junk" or "fringe" science as well as novel or untested science from the courtroom. Some commentators have argued that the pendulum has swung too far in the other direction and that scientists should reassert some control over expert testimony in the courtroom. Some have suggested that scientists could establish panels or boards of independent experts to provide testimony or that they could certify or license experts (Angell 1997b; Huber 1991). In addition to the issue of expertise in the courtroom, commentators have made similar arguments regarding the approval of new drugs, claiming that the Food and Drug Administration (FDA) should not bow to public demands to approve drugs.

Expert testimony raises at least two ethical issues. The first issue is financial conflict of interest (COI). Because experts in legal cases are paid by a particular party, they may have a financial interest in promoting the interests of that party, which could bias their testimony. Although attorneys' ethical rules forbid quid-pro-quo arrangements (i.e., an agreement to provide a particular kind of testimony for money), as well as contingency fees (i.e., payment based on the outcome of the case), financial interests can still influence how experts testify (Resnik 2007). For example, if a forensic science expert provides convincing testimony that helps prevent a defendant from being convicted in a criminal case, then other

attorneys may seek the expert's assistance on their cases. The scientist could develop a reputation and a career based on his or her talent as an expert witness. Experts in medicine, product liability, automobile safety, and other areas of science and engineering could have similar motivations. Fortunately, the legal system has effective methods of dealing with COIs related to expert testimony. Attorneys can hire their own experts and cross-examine the opponent's experts. During cross-examination, an attorney can ask an expert to disclose his or her financial interests (i.e., who is paying for the testimony and how much). Thus, the legal system involves COI disclosure and management (Resnik 2007). Prohibiting experts from testifying based on their financial interests would not be a good idea, because this could interfere with the right to legal due process. Opposing parties have the right to call witnesses, including experts (Resnik 2007).

Experts testifying on government committees may also have financial interests that could bias their testimony. The FDA uses expert panels composed of scientists, physicians, pharmacists, and biostatisticians to provide recommendations concerning the approval and oversight of drugs, biologics, and medical devices. The opinions of these boards are nonbinding but very influential. In 1998, the FDA approved a rotavirus vaccine manufactured by Wyeth Lederle. The company took the vaccine off the market in 1999 when researchers discovered that it caused bowel obstruction in children. A congressional investigation of COIs at the FDA found that three out of the five committee members who voted to approve the vaccine had financial ties to rotavirus vaccine manufacturers. One committee member had $33,800 worth of stock from Merck, and another shared a patent on a rotavirus vaccine developed by Merck (Krimsky 2003). The congressional investigation of 177 FDA committee meetings found that in 88 meetings (49.7%) half of the committee members had a financial interest related to the topic being addressed.

Fortunately, the FDA has enacted what appear to be stringent rules concerning financial COIs on expert panels in response to criticism from Congress and others. FDA panel members and consultants must disclose their financial relationships and are not allowed to have financial interests related to the particular matter in question, unless they have been granted a waiver. Members may not participate on the panel if their total financial interests are $50,000 or more for the previous 12 months. The FDA may grant a waiver if "the need for the individual's services outweighs the potential for a conflict of interest" (Food and Drug Administration 2013). A waiver may be granted based on several factors, including the nature of the person's financial interest (e.g., stock or consulting arrangements and the

amount of money involved) and the importance of their participation on the committee. Some commentators have criticized the use of waivers to include individuals on panels with COIs. Wood and Mador (2013) describe the effect of waivers on the FDA's advisory panel's decision and its threat to the integrity of FDA decisions. They cite a 2009 Institute of Medicine report stating that COIs on FDA advisory boards threaten the integrity of science.

The second issue is nonfinancial COIs. An expert may have a personal, professional, or political interest in the outcome of a court case or committee hearing. For example, a medical expert for the prosecution in a rape case, who is the mother of a daughter who was raped, would be strongly tempted to bias her testimony in favor of the prosecution. An ecologist, who is also a member of an organization that seeks to preserve wilderness, might bias his testimony in a committee hearing concerning the environmental impact of building a new electric power plant. While it may be difficult for scientists to set aside their personal, professional, or political interests when offering expert testimony, they have an obligation to do so, because the public expects that scientists will strive for objectivity when testifying in court or on government committees. Scientists who intentionally bias their testimony to promote their personal, professional, or political interests violate the public's trust. Scientists should disclose relevant personal, political, or professional interests when offering testimony and should be aware of how those interests may impact their thinking at a conscious or subconscious level.

Some might argue that, while they should not intentionally bias their testimony, scientists should be free to offer their personal or political opinions when they testify because complete objectivity is unattainable (Pielke 2007). Everyone is influenced by political, religious, economic, or other biases in some way. A scientist who claims to provide an objective presentation of the facts may actually present testimony that has been impacted by subconscious biases. For example, a scientist may omit some important evidence that impacts his conclusions, or he may use a method of data analysis that skews the results in a particular direction. While it is true that no one is perfectly objective, this is not a good reason for injecting personal or political opinions into expert testimony. Scientists who provide expert testimony should refrain from rendering opinions unless they are specifically asked to do so (Resnik 2004c).

PARTICIPATION IN POLICY DEBATES

Scientists, as informed experts and concerned citizens, can make important contributions to public policy debates on issues ranging from nuclear

energy to environmental regulation to gun control. After World War II, Robert Oppenheimer and other scientists involved in the Manhattan Project sought to stop the proliferation of nuclear weapons and promoted peaceful uses of nuclear energy (Monk 2013). The pediatrician and child psychiatrist Herbert Needleman, who conducted important research demonstrating the adverse impacts of lead on human development in the 1970s, informed the public about the dangers of lead and pushed for regulations to ban lead as an ingredient in household paint and gasoline. As noted earlier, Rachel Carson advocated for additional pesticide regulations (Resnik 2012b).

There are several different ways in which scientists may participate in public policy debates (Pielke 2007; Resnik 2009a):

- Conducting research relevant to policy debates and publishing results in the open literature
- Educating the public about the relevance of their research for policy debates
- Advocating for regulations, policies, or political viewpoints

The first two ways of participating in public policy debates reinforce the image of the scientist as objective and impartial: The scientist conducts research and describes and explains facts. The third way, however, has the potential to impact the scientist's objectivity. As we have stressed several times in this book, objectivity is one of science's most important values. The public's trust in science is based, in part, on the expectation that scientists will strive to be objective. People look to scientists to provide objective information and facts. When people want opinions, they turn to political leaders, interest groups, religious organizations, newspaper columnists, bloggers, and so on (Resnik 2009a). Scientists who advocate for particular policy positions risk compromising their own objectivity and losing the public's trust. However, scientists have a right and a duty to express their opinions and participate in the political process, especially since they often have well-informed perspectives on policy issues. Because the public can benefit greatly from having scientists take an active role in policy debates, scientists who refuse to participate in policy debates in order to safeguard their objectivity may be neglecting their social responsibilities. It is worthy to note that scientists are citizens first and scientists second. To avoid compromising their objectivity or creating the impression in the public's mind that they are biased, scientists should exercise prudence and good judgment when participating in policy debates. A scientist who writes an opinion piece for a newspaper by definition is

expressing his or her opinion. For example, a scientist should carefully distinguish between facts and opinions in his or her analysis.

MILITARY RESEARCH

Since ancient times, scientists have assisted with military efforts. Archimedes (287–212 B.C.E.) developed weapons to help the Greeks defend against Roman invasions, including a giant crane that could drop heavy weights on ships. The English physicist Isaac Newton (1642–1727) did research on ballistics that helped the military improve its aiming of cannons. The German chemist Fritz Haber (1868–1934), who won the Nobel Prize in 1918 for synthesizing ammonia, developed chemical weapons that were used in World War I. The American physicist Robert Oppenheimer (1904–1967) oversaw scientific research for the Manhattan Project. Other notable physicists, such as Enrico Fermi (1901–1954) and Richard Feynman (1918–1988), also worked on the project. The computer scientist Alan Turing (1912–1954) helped the British military break Germany's codes during World War II (Forge 2013).

Today, the U.S. Department of Defense (DOD) spends billions of dollars per year on military research and employs thousands of scientists. Although most people equate military research with research on weapons, strategies, and tactics, military research encompasses many different fields of science, including medicine, physiology, chemistry, physics, electronics, engineering, aeronautics, computer science, and psychology. Some of the world's most important inventions, including radar, satellites, computers, and the global positioning system, have their origins in military research (Resnik 2009a).

The primary ethical issue concerning military research is whether scientists should do it at all. Many people oppose the military on philosophical or religious grounds. Some are pacifists and oppose the use of violence for any reason. Others accept the limited use of violence (or the threat of violence) for police purposes but object to the use of violence for military goals. Still others accept the necessity of having a military but oppose specific military actions, such as the Vietnam War. Also, many people are deeply skeptical of the confluence of political and economic interests that influences the military, or what President Eisenhower referred to as the military–industrial complex. Those who have substantial qualms about the military will naturally object to military research (Forge 2013).

The justification for military research hinges on the rationale for having a military. The argument for having a military is that nations need to be able to defend themselves against threats from other nations as well as terrorism. In a utopia, there would be no need for a military because nations would coexist in peace. The real world, however, is a dangerous place. Hence, having a military is a necessary evil (Resnik 1998a). If having a military can be justified, then military research can be justified on the grounds that it is necessary for the military to achieve its goals.

While this argument for military research has considerable merit, it is important to be mindful of its limitations. The argument only shows that military research, in general, can be justified. It does not show that all types of military research are justified. One could coherently maintain that many types of military research, such as research on biological weapons or using torture as an interrogation technique, are unethical, while maintaining that other types, such as research on bulletproof vests or treatments for traumatic brain injuries resulting from battle, are ethical. Questions concerning the ethics of different types of military research are beyond the scope of this book and will not be explored here.

A secondary ethical issue concerning military research is whether it should be conducted on academic campuses. Some military research is kept secret (or classified) to protect national security interests. Access to classified information is granted on a need-to-know basis. To obtain access to classified information, one must undergo a thorough background check. There are different categories of classified information, including "top secret" (the most restricted), "secret," and "confidential" (the least restricted). For a research project to be classified, it must be funded by a government agency, such as the Department of Defense, the National Security Agency, the Department of Homeland Security, the Department of Energy, the Department of Health and Human Services, or the Federal Bureau of Investigation, that has the authority to classify research. Research that has not been explicitly classified remains open, except research on nuclear weapons, which is automatically classified (Resnik 2009a).

Some object to conducting classified military research on university or college campuses because it violates the ethical principle of openness, which is essential to academic research. Professors, students, and staff who work on classified projects must keep their work secret and not discuss it with their peers. They may also need to establish secure workspaces to prevent unauthorized access to data or materials. Although the sharing of information and ideas is vital to the academic ethos and scientific progress, military research is not the only type of secret research conducted on

college or university campuses. Many academic institutions conduct research for private corporations, such as pharmaceutical, biotechnology, or computer technology companies, which treat the research they sponsor as confidential and proprietary information. If conducting secret research for private companies on campus is acceptable, then conducting secret military research should also be acceptable. Of course, one might object to all types of secret research conducted on academic campuses. However, it would be logically inconsistent to reject secret military research without rejecting secret corporate research.

DUAL USE RESEARCH

Scientific research conducted with the goal of benefiting society may yield results that can be misused by others (such as criminals or terrorists) to cause significant harm to national security, public health, society, the economy, or the environment. For example, knowledge of chemical explosives can be used to excavate land or to make bombs. Studies about the genetic makeup of human populations may be used to understand diseases or to perpetuate racist ideologies or to create a deadly gene-specific virus. The term "dual use research" was coined at the beginning of the 21st century to refer to research that may be used for either good or bad purposes (National Research Council 2004). Since 2001, the dual use research that has generated the most controversy has involved experiments involving dangerous pathogens and toxins. Some of these published studies include the following:

- Research that could be used to develop smallpox viruses that can overcome the human immune system's defenses (Rosengard et al 2002)
- A paper describing how to infect the U.S. milk supply with botulinum toxin (Wein and Liu 2005)
- A study demonstrating how to reconstruct the extinct 1918 Spanish influenza virus, which caused over 50 million deaths worldwide, from published sequence data (Tumpey et al. 2005)
- Research on genetically engineering the H5N1 avian flu virus so that it can be transmissible by air between mammals, including humans (Imai et al. 2012; Russell et al. 2012) (H5N1 has an estimated 60% mortality rate; fortunately, humans can only contract the virus by direct contact with infected birds [Resnik 2013])

In 2004, the U.S. government created the National Science Advisory Board for Biosecurity (NSABB) to provide government and institutional officials, journal editors, and scientists with advice on how to handle the findings from dual use research (Resnik 2013). The NSABB focused its attention on experiments of concern involving dangerous biological pathogens and toxins, known as select agents and toxins. Some select agents include the avian influenza virus, the 1918 Spanish influenza virus, the Marburg virus, the Ebola virus, variola viruses (animal and human pox viruses), botulinum neurotoxins, ricin, and saxitoxin (Health and Human Services and U.S. Department of Agriculture 2013). The U.S. government adopted a policy in 2012 that requires risk mitigation for government-funded experiments of concern involving select agents and toxins, including studies that

a. Enhance the harmful consequences of the agent or toxin;
b. Disrupt immunity or the effectiveness of an immunization against the agent or toxin without clinical or agricultural justification;
c. Confer to the agent or toxin resistance to clinically or agriculturally useful prophylactic or therapeutic interventions against that agent or toxin or facilitates their ability to evade detection methodologies;
d. Increase the stability, transmissibility, or the ability to disseminate the agent or toxin;
e. Alter the host range or tropism of the agent or toxin;
f. Enhance the susceptibility of a host population to the agent or toxin; or
g. Generate or reconstitute an eradicated or extinct agent or toxin. (U.S. Government 2012)

Risk mitigation could include modifying experimental protocols to reduce the risks of accidental contamination or misuse of results; enhancing biosafety measures; regularly reviewing experiments; and reviewing evidence of medical countermeasures for agents or toxins (such as treatments or vaccines). If risks cannot be adequately mitigated, options include not providing or terminating funding; redacting key information from publications and communications; or seeking classification of the research (U.S. Government 2012).

Some scientific journals have also adopted policies for reviewing dual use research. These policies involve additional review of submitted manuscripts identified by reviewers or editors as raising dual use issues. Additional review may involve gathering more information about the benefits and risks of the research (Resnik 2012c). *Science* and *Nature* conducted a dual use review of articles reporting the results of experiments that modified the H5N1 virus (Imai et al. 2012; Russell et al. 2012). The NSABB also

reviewed this research. The NSABB initially concluded in December 2011 that one of the papers (Russell et al. 2012) should be published in redacted form, but it later decided in March 2012 that both papers should be published in full, after it received more information about the benefits and risks of the research. The journals published the papers shortly after the NSABB made its final determination (Resnik 2013).

Dual use research raises difficult ethical issues for scientists, funding agencies, journal editors, and society. On the one hand, the principles of openness and freedom favor no restrictions on publication or funding. Additionally, the results of research often have the potential to benefit society. For example, one of the objectives of the controversial H5N1 experiments was to determine whether this virus was capable of mutating in the wild so that it would be transmissible between mammals via respiratory water droplets. If the virus were to acquire this capacity, it could cause a global pandemic because human beings have no natural immunity to the virus. Information about potentially dangerous mutations of the virus could be useful to public health officials monitoring bird populations. If public health officials are able to detect forms of the virus with these dangerous mutations in the wild, they could take appropriate steps to try to stop the spread of the pathogen (Resnik 2013). On the other hand, social responsibility may favor restrictions on funding, publication, or both, if the results of research could be used to cause significant harm. Many scientists were concerned that terrorists, or other people with nefarious motives, could use the information produced by the controversial H5N1 studies to produce a bioweapon that could cause a global pandemic if deployed. Scientists were also concerned about the public health threats of accidental contamination of researchers working with the virus.

Dual use research can be difficult to evaluate not only because fundamental values may be at stake but also because there is usually a great deal of uncertainty concerning the risks of the research (Resnik 2013). While it may be possible to identify the risks of research, it may not be possible to quantify these risks (i.e., assign them an objective probability, such as 0.01, 0.10, 0.50, etc.). Traditional risk/benefit assessment performed by regulatory agencies, such as the FDA or the Environmental Protection Agency, usually involves weighing and comparing quantitative risks and benefits. For example, when the FDA approves a new drug, it bases its decision on scientific evidence concerning the likely effects of the drug on health outcomes in the population, such as morbidity and mortality. Traditional approaches to risk/benefit assessment may not apply to decisions concerning dual use research, due to lack of scientific evidence concerning risks. When traditional risk/benefit approaches to decision making break

down, another strategy, known as the precautionary principle (PP), may apply. According to one version of the PP, one should take reasonable measures to prevent, minimize, or mitigate risks that are plausible and significant (Resnik 2012c, 2013). A measure is "reasonable" if it is effective and balances competing values appropriately. In the H5N1 example, competing values include openness, freedom, and social responsibility (i.e., the obligation to maximize benefits and minimize harms).

Publishing the H5N1 papers in full did little to prevent, minimize, or mitigate the risks of the research. Enhancing biosafety pertaining to H5N1 genetic engineering research, which was recommended by the NSABB, helped to mitigate risks, but biosafety enhancements would have been indicated even if the research had not been published. One could argue that a reasonable measure in the H5N1 case would have been to publish the research in redacted form, because this would balance competing values fairly. Although this option would limit scientific openness and freedom, it still would have alerted scientists and public health officials to H5N1's potential to mutate dangerously. Moreover, some responsible researchers working in the area could have been granted access to the full papers, with the understanding that the full papers would not be distributed. This option would also have helped to prevent or minimize potential harm to society. One problem with redacted publication, however, is that it might not be very effective, because the Freedom of Information Act (FOIA) allows the public to obtain access to nonclassified research supported by the federal government. If the research had been published in redacted form, someone probably could have gotten the result through an FOIA request and distributed them widely. Scientists would need to develop a system for making full copies of redacted papers available to responsible scientists. Scientists who receive these papers would need to undergo a background check to verify their trustworthiness and would need to agree to keep information confidential. The option of classifying the research would not have balanced competing values fairly because this would significantly restrict openness and freedom and would not alert scientists and public health officials to H5N1's potential threat (Resnik 2013).

QUESTIONS FOR DISCUSSION

1. What does it mean for a scientist to be socially responsible?
2. Why is social responsibility important in science?
3. What are some of scientists' social responsibilities?

4. Do you think scientists should conduct research sponsored by the military? Why or why not?
5. What is dual use research?
6. Can you think of any examples of dual use research from your discipline?
7. Do you think restrictions on scientific publication are warranted in some circumstances? Why or why not?
8. Should government funding organizations judge research proposals according to their potential to contribute to society? Why or why not?
9. Is it important to fund research projects that may have any practical applications?
10. Why is it important for scientists to communicate with the public and the media?
11. Should scientists take any steps to ensure that their research is not misunderstood or misinterpreted when communicating with the public or the media?
12. How should scientists participate in public policy debates? Should they offer opinions? Should they advocate for particular positions?
13. Are scientists inherently biased? How should they deal with their own biases when conducting research or communication with the media or the public?

CASES FOR DISCUSSION

CASE 1

The National Security Agency (NSA) has negotiated a $20 million contract with a large, public university to establish a research center on campus. The research conducted at the center would help the NSA mine data from emails, websites, and phone records for patterns that may indicate terrorist activity. The NSA would not access the content of particular emails or phone calls but will collect data on the locations of senders and recipients. The center would conduct basic research on statistical and analytical methods and will not access any data from emails or phone calls. The center would employ faculty, graduate students, postdoctoral students, and research staff. All of the research would be classified. A group of faculty and students who have learned about the negotiations with the NSA have begun protesting. They strongly object to the NSA's monitoring of electronic communications, which they regard as an invasion of privacy. They also object to conducting classified research on campus. They want the university to reject the contract. What should the university do? How should the university respond to the protesters?

CASE 2

A group of researchers have studied the vulnerability of the U.S. milk supply to attacks. They have identified weak (unsecure) points in the milk supply and have developed a mathematical model that predicts how many people will be killed when different amounts of the toxin are dumped into the supply at different points. They have submitted their work for publication in a top-tier journal. The National Institutes of Health (NIH), which funded the research, has contacted the editors and asked them to stop the publication. The agency is concerned that the publication will provide information that terrorists can use for an attack. The editors of the journal want to go ahead with publishing the article, because they feel that the benefits of the research will outweigh the risks. The editors believe that publishing the research will alert milk suppliers and public health officials to the significance of the problem and motivate them to take effective action to secure the milk supply. The editors and officials from NIH have a meeting to discuss these issues. Should this research be published in full, in redacted form, or not published at all? Was it appropriate for the NIH officials to inform the journal about their concerns with this research?

CASE 3

Marci Poirot, a doctoral student at a French university, has discovered a new species of truffle growing in a location near the Alps. This is an important discovery that will help biologists have a better understanding of the evolution, genetics, and ecology of this species and related ones. This discovery is important to her as well, because she will get to name the new species. Her dissertation will focus on a description of this new species. The new species is very rare, however, and could become extinct if people harvest the truffle. Truffles are a much sought-after delicacy, and truffle suppliers are always looking for new sources. Ms. Poirot is concerned that if she names the exact location of the new species that it could become extinct. Should she publish her finding in full or in redacted form?

CASE 4

Brent Barry is an anthropology professor who has studied a Native American community in Canada for several years. Dr. Barry has developed a good working relationship with members of the community and they trust him. The community is having a dispute with the Canadian government concerning ownership of some land. Tribal leaders claim that the land belongs to the tribe, based on their historical connection to the land. They claim that they have been occupying the land for more than

a thousand years and should be granted ownership. Dr. Barry has learned through interviews with members of the tribe that ownership claims made by the tribal leaders cannot be substantiated. According to these members, the tribe has no historical connection to the land and has only been occupying it for a few decades. Dr. Barry is preparing to publish a paper on the tribe's history and customs. Should he mention anything about occupation of the land in the paper? Should he present evidence in the paper that contradicts the claims made by the tribal leaders? If the Canadian government asks him to testify about this issue in court, should he comply?

CASE 5

Doreen Wilkins has studied the physical and mental health of a community affected by Hurricane Katrina. She is attempting to understand how the community has been affected by the disaster and how it is recovering. She has worked closely with community leaders from the beginning of her project. A community advisory board has provided valuable input into the project and has helped with recruitment. Dr. Wilkins has given the board regular updates about the progress of her study and has shared her findings with the board prior to publication. Dr. Wilkins discovered that the community has significantly higher rates of human immunodeficiency virus (HIV) infection, hepatitis C, and drug and alcohol abuse, compared to the rest of the U.S. population. She shares this information with the board. The board asks her to not publish these results, because they are concerned that it could result in discrimination and bias against the community. What should Dr. Wilkins do? How could this predicament have been avoided?

CASE 6

Jack Johnson, a criminologist at a private university in Chicago, has been an advocate for gun control ever since his father was shot and killed 10 years ago when a person suffering from mental illness fired an assault rifle randomly into a crowded street. Six other people died in the incident. Dr. Johnson's research has focused on the effectiveness of gun control legislation. He has examined the effects of gun control laws in different nations and states. Dr. Johnson has been asked to give testimony about his research to a congressional committee considering gun control legislation, which will meet in two weeks. He has also been asked to write an opinion piece about gun control for a prominent Chicago newspaper. A student political group at his university has asked him to sign and help circulate a petition in favor of increased gun control. They have also invited him to speak at a downtown rally against gun violence. How should Dr. Johnson manage his social responsibilities related to gun control? Should

he testify before the committee? How should he testify? Should he let the committee know about his personal connection to this issue? Should he write an opinion piece, circulate the petition, and speak at the rally?

CASE 7

Sophie Seymour is a pharmacologist at a medical school associated with a large university and hospital. She has conducted research on interactions between hypertension drugs and antidepressants. She has discovered a potentially dangerous interaction between a common hypertension drug and a new antidepressant medication. The interaction can lead to itching, a generalized rash, swelling, nausea, respiratory failure, and death. One person has died and several have been hospitalized. Individuals with asthma or other respiratory diseases are most at risk. The evidence she has for this interaction is based on her analysis of 82 medical records kept at the hospital during the past year for patients who have been treated for possible adverse drug reactions. Dr. Seymour has already informed the FDA about the interaction, but she believes that lives can be saved if she also warns the public immediately about this drug interaction, and she wants to call a press conference to announce her findings. Her research has not yet been submitted for peer review. Should she hold a press conference or wait until her research is published in a peer-reviewed journal? Would holding a press conference prevent her from publishing in a peer-reviewed journal?

CASE 8

Dr. Peter Protkin is a cancer epidemiologist who has studied a possible link between cell phone use and brain cancer. Several published studies have demonstrated no connection between cell phone use and brain cancer, but the studies were not very large and did distinguish between different types of phones used or methods of use (e.g., handheld, headset, etc.). Dr. Protkin's study collects data on patients with one of three types of brain cancer—glioma, meningioma, or acoustic neuroma—and compares the cases to a control group. Cases and controls are both asked questions about their cell phone use. Dr. Protkin has found evidence that the use of a particular type of cell phone that is no longer in use increases the risk of acoustic neuroma by 24%. However, the P-value for this study is 0.059, just above the accepted threshold for statistical significance (0.05). Dr. Protkin is therefore not very confident about this result, but he thinks it is interesting and warrants further study. Dr. Protkin publishes his findings in a public health journal. Shortly after his results are published, a reporter from the *Daily Planet*, a popular online publication managed by an environmental and public health interest group with over one million followers,

wants to interview Dr. Protkin. During the interview, Dr. Protkin stresses that this study does not prove anything and that any possible relationship between cell phone use and brain cancer needs further study. The reporter asks Dr. Protkin if he uses a cell phone. He tells the reporter that he does, but he says he tries to minimize his use and he does not hold his phone near his head. He has the reporter's assurance that these comments are "off the record." The next day Dr. Protkin becomes very angry when he reads a story posted on the *Daily Planet*'s website. The headline says "Study Links Cell Phone Use to Brain Cancer." The article includes several other inaccuracies and Dr. Protkin's off-the-record comments. How should Dr. Protkin respond to the reporter's misrepresentation of his research? How could he have avoided this problem?