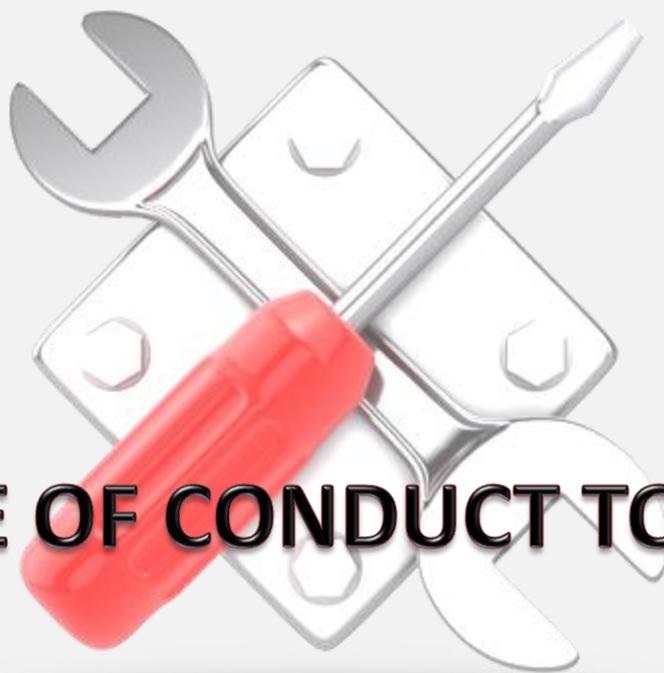


*Promoting Awareness and Responsibility in Dual Use Research*



# **A CODE OF CONDUCT TOOL KIT**

**a project of the  
NATIONAL SCIENCE ADVISORY BOARD FOR BIOSECURITY**

Dual use research of concern—**research that may be used for beneficent goals as well as malevolent purposes**—presents scientists in multiple disciplines and fields with two challenges. One is to become and remain **aware** of the dual use potential of their work. The other challenge is to become and remain **responsible** for the dual use research of concern that they themselves and their colleagues conduct.

Professional societies, academic institutions, industries, private corporations, and individual scientists can use a variety of strategies to raise awareness and to cultivate responsibility in dual use research of concern. A code of conduct for scientists engaged in dual use research is one such strategy. Here, several tools useful in contemplating and perhaps implementing this strategy are offered. This toolkit, a project of the National Science Advisory Board on Biosecurity, distills the scholarly reflections and practical experience of groups and individuals who have long wrestled with a paradox at the heart of science: that science can be used to benefit, but also to harm human and other living beings.



## *Suggestions for use*

### *Before you get started*

- Essential background on dual use research and codes of conduct

### *Tools for getting started*

- Assessing the need for a code of conduct
- Assessing feasibility and support
- Recruiting leaders and champions
- Defining the process

### *Tools for formulating a code*

- Determining the content: the key responsibilities
- Determining the content: some examples
- Navigating the extremes of generality and specificity
- Drafting, vetting and finalizing a code

### *Tools for disseminating a code*

- Developing a dissemination plan
- Utilizing existing venues
- Designing educational interventions

### *Tools for evaluating a code*

- Confronting the challenges of determining impact
- Utilizing realistic measures for code evaluations

## *Selected resources*

**ADAPTABILITY & AUDIENCE** The tools in this code of conduct tool kit have been designed and produced for adaptability to the needs of different audiences: with thought and care, they can be deployed in any one of several settings, including professional societies, academic institutions, and industry—*wherever dual use research is conducted and the researchers themselves are committed to the responsible conduct of research.*

## FIRST, EXPLORE THE ENTIRE TOOL

**KIT** The tool kit is designed for anyone interested in formulating and disseminating a code of conduct or in exploring such a possibility in a given setting. To make the best use of this tool kit, readers are encouraged to read through the entire kit before picking up any one of the tools described in the following.



**THE ULTIMATE GOAL** This tool kit offers a set of means to an end or ultimate goal: a community of researchers who are aware of—and take responsibility for—dual use research. There are other means to this end, including educational interventions targeted at graduate students, faculty, staff scientists, members of professional societies, and others. Choosing the right means is a matter of knowing your specific context and figuring out which of the available means is best for your context.

**ESSENTIAL BACKGROUND** Before embarking on the multiple steps of a code of conduct process, it is useful either to become aware of or to review key points about dual use research and codes of conduct.

**A PERENNIAL PROBLEM WORTHY OF HEIGHTENED CONCERN** Information from life sciences research is clearly vital to improving public health, agriculture, and the environment and maintaining and strengthening our national security and economy. Yet the very information and tools developed to better the health, welfare, and safety of humankind also can be misused for harmful purposes.

The development of new technologies and the generation of information with the potential for benevolent and malevolent purposes are “dual use research.” This dual use quality is inherent in a significant portion of life sciences research. In fact, it can be argued that virtually all life sciences research has dual use potential.

**CALLS TO ACTION** Over the past several years, especially following the terrorist attacks of September 11, 2001 and the subsequent anthrax attacks utilizing the U.S. Postal Service over the course of several weeks beginning on September 18, 2001, there have been increasing calls to consider the possibility that new information from life sciences research could be subverted for malevolent purposes and to institute new biosecurity measures to minimize this risk.

**CALLS TO ACTION (continued)** Concerns about the dual use potential of biotechnology research were central to the establishment of the National Science Advisory Board for Biosecurity (NSABB) in 2005. A federal advisory commission, NSABB was created to advise the US government on the formulation and implementation of appropriate policies for the oversight of dual use research. In June 2007, NSABB published its *Proposed Framework for the Oversight of Dual Use Life Sciences: Strategies for Minimizing the Potential Misuse of Research Information*.

At the center of the NSABB report is the conviction that scientists themselves are the most critical tool for oversight: through their own efforts to be aware of and responsive to the dual use potential of their own research, they are a cornerstone of any effective system of oversight.



Thus, initiatives by scientists themselves and by scientific societies and associations—initiatives designed to raise awareness and cultivate responsibility—are crucial to the effective oversight of dual use research. As voluntary, “grass roots” efforts, codes of conduct exemplify the sort of approach that the NSABB envisions as pivotal to the effective oversight of dual use research.

# BEFORE YOU START

**CODES IN GENERAL:** Asking moral questions—questions like *what should or should not be done*—is an activity that defines humankind. Ever since we, as a species, began to answer such questions, we have sought to gather the resulting insights and convictions in ways that lend themselves to remembrance and communication to others, be they contemporaries or successive generations. We have, that is, **codified** our answers to moral questions and disseminated them by word of mouth and via oral traditions, in written codes, and in oaths that are publicly sworn.

Such codifications of precepts governing moral behavior have often been the outcome of efforts (1) to form and solidify the identity of a group and (2) to address and prevent immoral behavior. The Nuremberg Code of 1947 is a good example of the latter: it was crafted with the explicit aim of preventing the unethical use of human beings in biomedical research horrifically exemplified in the infamous Nazi experiments. The Oath of Hippocrates and the 1847 Code of Ethics by the American Medical Association are statements of moral precepts that have been—and continue to be—considered central to the moral and professional identity of physicians.

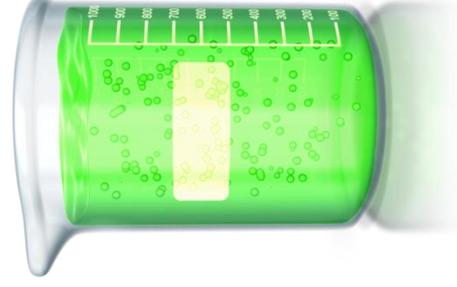
**CODES OF CONDUCT IN DUAL USE RESEARCH** A code of conduct for scientists engaged in dual use research serves both aims. Such a code makes explicit a key aspect of the social responsibilities of scientists—and it

# BEFORE YOU START

**CODES OF CONDUCT IN DUAL USE RESEARCH (cont)** does so in a way that is voluntary and, in itself, reflects an ethic of responsibility. At the same time, such a code usually seeks to identify behaviors critical to prevention of misuse.

For individuals and groups interested in codes of conduct for dual use research, this toolkit brings together various tools for use in each of several successive phases of code development. Before these phases and the relevant tools are introduced, it might be helpful to specify further the types of research that constitute what the NSABB has defined as “dual use research of concern.” In its June 2007 report, NSABB proposed a criterion for identifying dual use research of concern:

*Research that, based on current understanding, can be reasonably anticipated to provide knowledge, products, or technologies that could be directly misapplied by others to pose a threat to public health and safety, agricultural crops and other plants, animals, the environment, or materiel.*



In addition, NSABB identified seven categories of research might satisfy this criterion and thus be identified as dual use research of concern. This research could encompass knowledge, products, or technologies that would:

- 1) Enhance the harmful consequences of a biological agent or toxin.
- 2) Disrupt immunity or the effectiveness of immunization without clinical and/or agricultural justification.

# BEFORE YOU START

- 3) Confer to a biological agent or toxin, resistance to clinically and/or agriculturally useful prophylactic or therapeutic interventions against that agent or toxin or facilitate their ability to evade detection methodologies.
- 4) Increase the stability, transmissibility, or the ability to disseminate a biological agent or toxin.
- 5) Alter the host range or tropism of a biological agent or toxin.
- 6) Enhance the susceptibility of a host population.
- 7) Generate a novel pathogenic agent or toxin, or reconstitute an eradicated or extinct biological agent.



## **ASSESSING THE NEED FOR A CODE OF CONDUCT:**

A code of conduct is one of several potential means to the end or goal of a culture of responsibility in dual use research. Formal educational interventions and mindful mentoring are other means to the same end. If the aim is to create or enhance such a culture within the setting of an institution (e.g., in a research center, an academic department or division, or a specific laboratory), or to foster a sense of heightened awareness and responsibility among members of a professional society, it is important to consider the anticipated benefits *and* the associated costs of each of these various means.

### ***Potential advantages of formulating a code:***

- Undertaken as a voluntary, grass roots initiative, the process of formulating a code of conduct can be very effective in raising awareness about dual use dilemmas.
- The process of debating and reaching agreement on the content of a code—the specific responsibilities or values that will be spelled out in its provisions—can be very empowering and can inculcate a sense of “ownership,” commitment, and achievement among engaged individuals.

### ***Potential costs of formulating a code:***

- Time is money. Formulating, finalizing, communicating, and sustaining a code of conduct—as a living document—are all essential but time-consuming activities.
- Depending upon the nature and extent of dual use research underway in your institution, the effort that might be devoted to a code of conduct may be better expended on other related initiatives.

**ASSESSING THE NEED FOR A CODE OF CONDUCT, *continued*:** There are other important questions to ask and answer in assessing the need for a code of conduct, especially in the institutional setting. For example:

- What is the extent of dual use research in your institution? How many faculty are engaged in dual use research? In what departments, divisions, or centers/institutes?
- Are there are other programs or initiatives underway in your institution to promote awareness and responsibility in dual use research? Is the topic of dual use research addressed in your institution’s programs for the responsible conduct of research? How effective have these programs or initiatives been?

**ASSESSING FEASIBILITY AND SUPPORT:** If there is a clear need for a code of conduct, then the next step is to assess the feasibility of effectively meeting the need and garnering support for the requisite effort:

- Are there individuals who can be enlisted as champions, leaders, or supporters of an effort to formulate and disseminate a code of conduct?
- Is there administrative support for such an effort?
- Is there any financial support for such an effort?
- In a given institution, laboratory, or professional society, are there existing organizational venues and processes that might be utilized in formulating a code, publicizing and finalizing drafts, and disseminating an approved code?

**RECRUITING LEADERS AND CHAMPIONS** The inspiration to formulate a code of conduct for dual use research—or to incorporate dual use provisions in an existing code of conduct—may strike an individual or individuals at any “level” of an organization (e.g., rank-and-file members of a professional society) or institution (e.g., graduate students or post-doctoral fellows, younger or more senior faculty). Such an inspiration and the resolve to move forward can yield a grass-roots initiative with the promise of success, especially as a voluntary effort by group of individual scientists to define and commit themselves to a collective understanding of the responsibilities inherent in their work as scientists, an understanding that they have forged among themselves through debate and discussion.

Early on , however, it is important to identify and recruit leaders and champions—individuals who can lend the effort credibility and strategic support. Such individuals



need not occupy *formal* positions of leadership within an organization or institution, but they should be people whose reputations and influence can help to catalyze and sustain the effort through all of its phases. Almost every group has more than one individual, at multiple “levels,” whose opinions are valued and sought out: such “thought leaders” may be found among graduate students, younger faculty, as well as more

**DEFINING THE PROCESS** A code of conduct process has three phases:

1. formulating the code (or provisions regarding dual use research for an existent code);
2. disseminating the code; and
3. ensuring the ongoing vitality of the code

The activities specific to each phase will depend upon the specific circumstances, but at the outset of the effort, it is important to envision what those activities might be. And it is important, as well, to define the specifics of each activity in terms of:

- *Who* will be responsible for the activity and who, beyond those responsible, will be engaged in the activity
- *When* the activity will occur or over what time period
- *What* the anticipated outcome of the activity will be

It is likely that revisions in the process will be made in the course of each phase, but it is, nonetheless, useful to project forward and envision the process as a whole.

All phases of the process, however, should be distinguished by three traits:

- **Transparency:** Catalysts, leaders, and champions of the process should conduct their activities in a way that is public, accessible, and inclusive
- **Communication:** They should strive to ensure that all relevant stakeholders—those who will be expected to live by the code—are kept informed of the process as it moves forward
- **Engagement:** They should also ensure that all relevant stakeholders are engaged and have the opportunity to contribute their thoughts, opinions, suggestions, and recommendations to catalysts, leaders, and champions.

*What should a code of conduct say? And how? How general or how specific should its provisions be? How long or short?* These are among the questions encountered at the stage of formulating a code of conduct. To help you through this stage, several tools are presented here:



- **Some considerations in the development of codes of conduct for dual use research.** Developed by the National Science Advisory Board for Biosecurity, these considerations provide the basic “raw material” for a code of conduct and identify who is responsible for what in dual use research, from the initial stages of conceiving and designing the project or study to the publication of its results.
- **Some examples of adopted codes of conduct.** Several professional societies have developed and adopted codes of conduct with specific reference to dual use research.
- **Some thoughts on the question of how general or how specific the provisions of a code should be, along with some suggestions for how to go about the key task of formulating a code of conduct.**

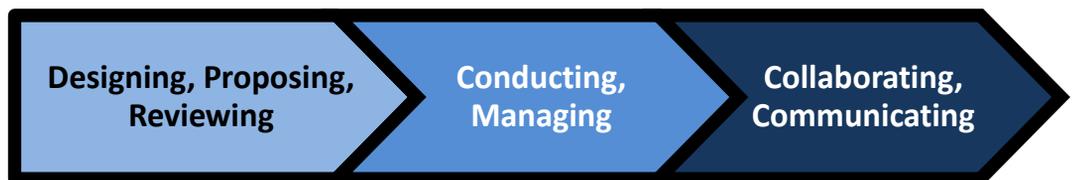
*Considerations in Developing a Code of Conduct for Dual Use Research in the Life Sciences* is Appendix 3 to the NSABB’s June 2007 report, *Proposed Oversight Framework for Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information*.



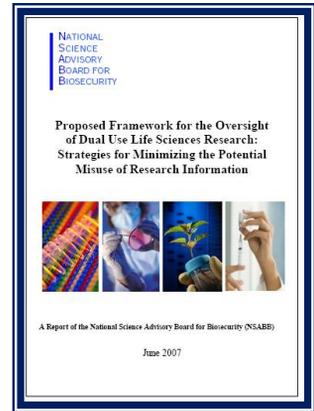
The “considerations” enunciate a basic ethical principle:

*Individuals involved in any stage of life sciences research have an ethical obligation to avoid or minimize the risks and harm that could result from malevolent use of research outcomes.*

The principle is relevant and applicable to all stages of the research process:



***Considerations in Developing a Code of Conduct for Dual Use Research in the Life Sciences, (continued)***



The basic ethical principle is “fleshed out” in 5 core responsibilities of scientists engaged in dual use research. These core responsibilities are to

1. ***Assess*** their research for dual use potential
2. ***Stay informed*** regarding relevant literature, guidance, and requirements
3. ***Train others*** to identify and appropriately manage and communicate dual use research of concern
4. ***Serve as role models*** of responsible behavior
5. ***Be alert*** to potential misuse of research

## SOME EXAMPLES OF ADOPTED CODES OF CONDUCT

Other organizations in the life (and other) sciences have adopted codes of conduct with specific provisions for dual use research. Their work is provided here, in part or whole, as examples of how such provisions might be specifically formulated.

***American Society for Microbiology (ASM) Code of Ethics.*** The following provisions are from the current version, which was reviewed and approved by the organization's Council in 2005.

***Preface:*** The American Society for Microbiology is dedicated to the utilization of microbiological sciences for the promotion of human welfare and for the accumulation of knowledge. These goals demand honesty and truthfulness in all activities sponsored or supported by the Society.

### ***Guiding Principles***

(1) ASM members aim to uphold and advance the integrity and dignity of the profession and practice of microbiology.

(2) ASM members aspire to use their knowledge and skills for the advancement of human welfare.

(6) ASM members are obligated to discourage any use of microbiology contrary to welfare of humankind, including the use of microbes as biological weapons. Bioterrorism violates the fundamental principles upon which the Society was founded and is abhorrent to the ASM and its members. ASM members will call to the attention of the public or the appropriate authorities misuses of microbiology or of information derived from microbiology.

**American Medical Association (AMA) Code of Medical Ethics:** The AMA’s Code of Ethics dates back to 1847 and has, since then, evolved in tandem with the profession of medicine and the delivery of health care. The Code enunciates eight principles of medical ethics (each beginning with the phrase “A physician shall...), but also includes a series of opinions rendered by the Association’s Council on Ethical and Judicial Affairs and providing ethical guidance on a wide range of issues, including dual use research.

**Opinion 2.078 - Guideline to Prevent Malevolent Use of Biomedical Research**

- Physicians who engage in biomedical research are bound by the ethical obligations of the medical profession and also are required to meet responsibilities of the scientific community. Beyond their commitment to the advancement of scientific knowledge and the betterment of public health, physician-researchers must strive to maintain public trust in the profession through their commitment to public welfare and safety, as demonstrated through individual responsibility, commitment to peer review, and transparency in the design, execution, and reporting of research.
- Biomedical research may generate knowledge with potential for both beneficial and harmful application. Before participating in research, physician-researchers should assess foreseeable ramifications of their research in an effort to balance the promise of benefit from biomedical innovation against potential harms from corrupt application of the findings.

***American Medical Association (AMA) Code of Medical Ethics: Opinion 2.078 - Guideline to Prevent Malevolent Use of Biomedical Research (continued)***

- In exceptional cases, assessment of the balance of future harms and benefits of research may preclude participation in the research; for instance, when the goals of research are antithetical to the foundations of the medical profession, as with the development of biological or chemical weapons. Properly designed biomedical research to develop defenses against such weapons is ethical.
- The potential harms associated with some research may warrant regulatory oversight. Physician-researchers have a responsibility not only to adhere to standards for research, but also to lend their expertise to the development of safeguards and oversight mechanisms, both nationally and internationally.
- Oversight mechanisms should balance the need to advance science with the risk of malevolent application. After research has been conducted, consideration should be given to the risk of unrestricted dissemination of the results. Only under rare circumstances should findings be withheld, and then only to the extent required to reasonably protect against dangerous misuse.
- These ethical principles should be part of the education and training of all physicians involved in biomedical research. (II, III, V, VII)

***The InterAcademic Panel (IAP) Statement on Biosecurity.*** The IAP describes itself as a global network of science academies, which are national organizations whose members are leaders in their respective disciplines and that often advise governments on issues that may be illuminated through scientific research. In November 2005, it issued this statement enunciated the obligations and responsibilities of scientists engaged in dual use research.

1. **Awareness.** Scientists have an obligation to do no harm. They should always take into consideration the reasonably foreseeable consequences of their own activities. They should therefore:

- always bear in mind the potential consequences – possibly harmful – of their research and recognize that individual good conscience does not justify ignoring the possible misuse of their scientific endeavour;
- refuse to undertake research that has only harmful consequences for humankind.

2. **Safety and Security.** Scientists working with agents such as pathogenic organisms or dangerous toxins have a responsibility to use good, safe and secure laboratory procedures, whether codified by law or common practice.

***The InterAcademic Panel (IAP) Statement on Biosecurity, continued***

3. **Education and Information.** Scientists should be aware of, disseminate information about and teach national and international laws and regulations, as well as policies and principles aimed at preventing the misuse of biological research.

4. **Accountability.** Scientists who become aware of activities that violate the Biological and Toxin Weapons Convention or international customary law should raise their concerns with appropriate people, authorities and agencies.

5. **Oversight.** Scientists with responsibility for oversight of research or for evaluation of projects or publications should promote adherence to these principles by those under their control, supervision or evaluation and act as role models in this regard.

## FORMULATING A CODE OF CONDUCT: SOME RULES OF THUMB

There is no “magic” formula that can be followed in formulating a code—some method that is *guaranteed* to have good results. Some rules of thumb, however, are useful in thinking through the process of formulating and finalizing a code of conduct:

### Rule of Thumb #1

It is useful to assign the drafting of a code to one or two individuals. The drafts, however, should be reviewed and revised by a group of individuals who represent various “constituencies” within an institution or professional society. Although the group should be populated with individuals sympathetic to the process and the anticipated outcome (a draft code of conduct), it should also include some skeptics.

### Rule of Thumb #2

In determining the specific content of a code of conduct, a careful review of the NSABB considerations and of the preceding examples would be helpful. The NSABB considerations offer examples of relatively general precepts (in the key obligations), as well as detailed descriptions of roles and responsibilities at various phases of the research process. Determining how general or specific the provisions of a code should be will depend, in large measure, on the particular aims that individuals or organizations hope to achieve: to offer general guidelines or to provide precise prescriptions of expected behaviors.

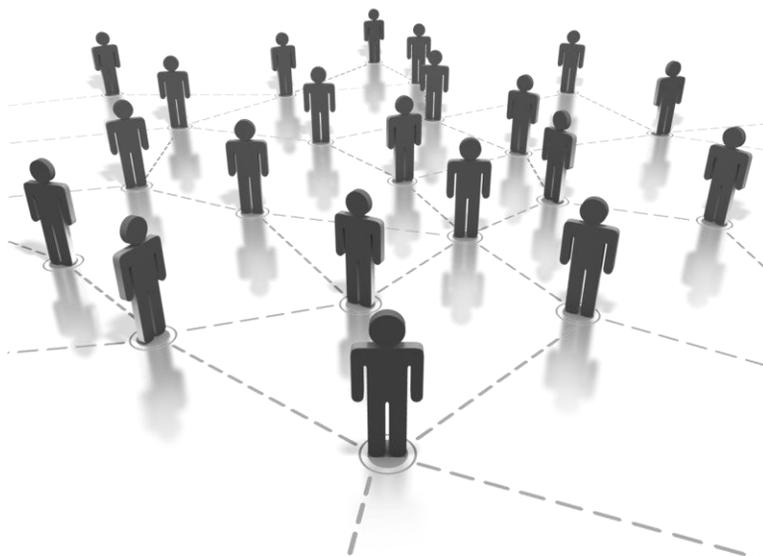
### Rule of Thumb #3

Once a draft is complete, the drafting committee should seek reactions and suggestions for revision through a broad-based consultative process.

## FORMULATING A CODE OF CONDUCT: SOME RULES OF THUMB (continued)

### Rule of Thumb #4

Before initiating the code development process, it is important to determine how a draft code will be finalized and approved. In most institutions and professional societies, there are established procedures: an academic institution may require approval by a faculty senate or a professional society may require a referendum by its membership. In finalizing a code of conduct for dual use research, however, in addition to following these established procedures, it is important to emphasize a key goal: that the code will be sustained as a living document. Thus, it is critical to underscore the need for periodic re-examinations of the code and its provisions, especially in light of developments in dual use research, both in general and within a given institution, organization, or professional society.



**DEVELOPING A DISSEMINATION PLAN** The importance of envisioning the whole process, from start to finish, has already been emphasized. If that advice is followed, then ideas for how a formulated and approved code of conduct could and perhaps should be disseminated in a given a context will already have been developed, before this phase of the process commences. Such a plan will specify the methods and venues for disseminating a finalized code:

**Methods:** Dissemination is communication and communication occurs either through the written or the spoken word. Both types of communications can and should be deployed in disseminating a code of conduct.

- **Written communications** include email, letters, newsletters, announcements and press releases, syllabi, etc.
- **Spoken communications** include speeches and addresses, informal talks, lectures, formal dialogues, and unstructured conversation and discussion

**Venues:** In disseminating a code of conduct, existing venues, as well as venues specifically designed for this purpose, can and should be used. Most organizations and institutions have vehicles for internal and external communications that might be tapped—newsletters, magazines, journals, broadcast email announcements, etc. They also have routine gatherings—annual meetings for professional societies, international and national scientific conferences and assemblies, faculty and staff meetings in academic institutions—that should be exploited for the purpose of disseminating a code of conduct.

**UTILIZING EXISTING VENUES** In fact, a case can be made for the proposition that existing venues are *critical* to this phase of the process. Using existing venues—new faculty or graduate student orientation, faculty meetings, lab meetings, professional society meetings, etc.—helps to integrate a code of conduct within the daily life and, ultimately, culture of an institution.

**DESIGNING EDUCATIONAL INTERVENTIONS**

Educational interventions—continuing educational courses for faculty, courses and seminars for graduate and undergraduate students, symposia—are ideal vehicles for disseminating a code of conduct. In designing such interventions, it is important to keep in mind some suggestions, based on well-tested principles of adult learning:

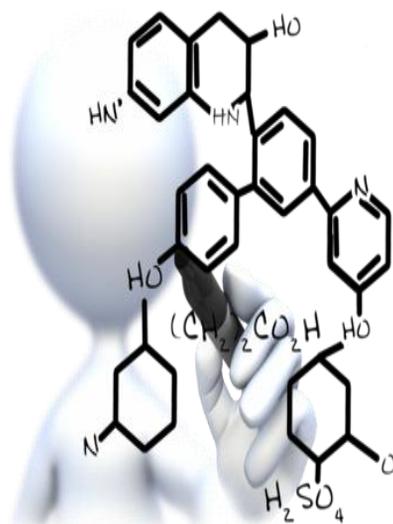
***Case-based learning engages learners immediately and vividly:*** The concrete examples of dual use research provided in the BEFORE YOU START section of this tool kit present dilemmas that challenge the moral imagination and problem solving skills of learners at all levels.

***Interactive discussion is often more effective than more didactic modes of teaching and learning:*** Learners are more apt to become immersed in the content of an educational intervention if they have the opportunity to question, discuss, and debate. Retention of material is also aided by this method.

## ENSURING THE VITALITY OF A CODE OF CONDUCT FOR DUAL USE RESEARCH

Any written statement of moral precepts is at risk of being forgotten or trivialized or of becoming irrelevant—unless steps are taken to avoid these fates and to ensure that a code remains a living document. A “living” code of conduct is one whose import and relevance is actively promoted and demonstrated by its champions, as well as renewed in light of developments in science, regulation, and the law. Here, too, a few suggestions are in order:

- In most academic institutions, scientists at all levels are required to undergo periodic education in the responsible conduct of research (RCR). RCR programs are ideal for the integration of materials about an approved (or even contemplated) code of conduct for dual use research—along with specific examples, especially if drawn from the immediate context.
- Developments in the relevant laws and regulations (e.g., the *NIH’s Guidelines for Research Using Recombinant DNA Molecules*) should be tracked and, if necessary, provide the impetus to revisions in the code. Such revisions should be widely publicized within the institution or professional society to ensure awareness.
- Developments in the life (and other) sciences should also be tracked and used to challenge, test, and illustrate the various provisions of a code of conduct.



**A FORMIDABLE CHALLENGE:** The end, the overarching goal, of a code of conduct for dual use research is a *culture of responsibility* within a particular discipline or institution or organization devoted to scientific research. A code of conduct is only one of several possible means to this end. Determining how effective a means it is or has been *in the concrete circumstances of a particular setting* is an exceptionally difficult challenge.

In part, this is due to the complexity of morally significant behavior. The “causes” of such behavior—our fidelity to, ignorance or rejection of certain norms—are very difficult to isolate and weigh. An individual’s “upbringing,”; her habitual predispositions to embrace or eschew what is good, right or just; the influences of others; the immediate circumstances: these are just a few of the factors that impinge on and shape our moral behaviors and decisions.

Because the goal of a code is a culture of responsibility, it makes sense to integrate specific measures of a code within broader attempts to assess the “state” of such a culture within a given a setting. For example, it might prove useful to ask individuals within a given setting—e.g., graduate students and faculty—whether they are aware of the dual use dilemma and, if they are, how their awareness was developed and formed: through educational interventions; engagement in specific projects with dual use potential; and/or involvement with, knowledge of or commitment to a code of conduct. Such an evaluation is an **outcomes** evaluation.

Such an evaluation is distinct from a *process* evaluation, focused on the process of formulating and disseminating a code of conduct. A process evaluation seeks “feedback” on the methods and venues utilized in the various phases of code development. Such an evaluation focuses on how well the process was conceived and executed.

**TOOLS FOR EVALUATION** Both types of evaluation—outcomes and process—make use of various tools:

- **Focus groups:** With focus groups, the aim is to gather a representative sample of individuals from a group and to solicit evaluative information of a qualitative nature from them through well designed questions. Usually, focus groups are professionally facilitated.
- **Surveys (paper-based and on-line):** Surveys utilize simple binary questions (yes/no, true/false) or questions whose answers are rendered in the form of a Likert scale.
- **Evaluations embedded within educational interventions, e.g., examinations, etc.:** Evaluations that are used to assess individuals’ understanding or knowledge may incorporate specific questions or exercises that are designed to gauge awareness of a code of conduct—of its rationale, background, and specific provisions.

**ON-LINE EDUCATIONAL RESOURCES** Tools for educating individuals and groups about dual use research can be used in lieu of or in conjunction with the development of a code of conduct for dual use research. There are several on-line educational tools available, including:

**Case Studies in Dual Use Biological Research**, an 8-module resource that has been developed by the Federation of American Scientists and that is accessible at <http://www.fas.org/biosecurity/education/dualuse/index.html>.

**Biosecurity**, a brief but useful introduction to the background, relevant regulations and guidelines, and resources on dual use research accessible at the website, Resources for Research Ethics Education: <http://research-ethics.net/topics/biosecurity>.

**Applied Dual-Use Biosecurity Education** is an on-line distance learning module that has been developed by the University of Bradford School of Social and International Studies. Only enrolled students can access the module, which provides students with 30 Masters level credits once completed. For more information, click on <http://brad.ac.uk/peace/courses/postgraduatecourses/applied-dual-usebiosecurityeducation/>.

**Dual Use Research: Promoting Understanding, Cultivating Responsibility** is an educational tool developed under the auspices of the National Science Advisory Board for Biosecurity. The tool can be accessed at <http://oba.od.nih.gov/biosecurity.biosecurity.html>.

**SCHOLARLY RESOURCES** The scholarly (and popular) literature on dual use research is growing. Some of the key resources include:

AAMC. Developing a Code of Ethics in Research: for Scientific Societies. 1997: 42 pps.

Anderson, MS. Normative orientations of university faculty and doctoral students. *Science and Engineering Ethics*, 2000; 6, 443–461. Discussion 463–465.

Atlas RM. Responsible conduct by life scientists in an age of terrorism. *Sci Eng Ethics*. 2009 Sep;15(3):293-301. Epub 2009 May 7. PubMed PMID: 19421897.

Bullock M, Panicker S. Ethics for all: differences across scientific society codes. *Sci Eng Ethics*. 2003 Apr;9(2):159-70. PubMed PMID: 12774648.

Campbell A, Glass KC. The legal status of clinical and ethics policies, codes, and guidelines in medical practice and research. *McGill Law J*. 2001 Feb;46(2):473-89. PubMed PMID: 16523580.

Cournand A. The code of the scientist and its relationship to ethics. *Science*. 1977 Nov 18;198(4318):699-705. PubMed PMID: 910153.

Davis M. What can we learn by looking for the first code of professional ethics? *Theor Med Bioeth*. 2003;24(5):433-54. Review. PubMed PMID: 14760870.

Ehni H-J. Dual use and the ethical responsibility of scientists. *Arch. Immunol. Ther. Exp*. 2008, 56:147-152.

Frankel MS. Scientific Societies as Sentinels of Responsible Research Conduct. *Proceedings of the Society for Experimental Biology and Medicine*, 2000 224: 216–219.

Frankel MS, Bird SJ. The role of scientific societies in promoting research integrity. *Sci Eng Ethics*. 2003 Apr;9(2):139-40. PubMed PMID: 12848197.

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