Research in the Life Sciences with Dual Use Potential: An International Faculty Development Project on Education About the Responsible Conduct of Science

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Research in the Life Sciences with Dual Use Potential

An International Faculty Development Project on Education About the Responsible Conduct of Science

Committee on Developing a Framework for an International Faculty Development Project on Education about Research in the Life Sciences with Dual Use Potential

Board on Life Sciences
Division on Earth and Life Studies

NATIONAL RESEARCH COUNCIL
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COMMITTEE ON DEVELOPING A FRAMEWORK FOR AN INTERNATIONAL FACULTY DEVELOPMENT PROJECT ON EDUCATION ABOUT RESEARCH IN THE LIFE SCIENCES WITH DUAL USE POTENTIAL

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This report has been reviewed in draft form by persons chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of the independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards of objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We thank the following for their review of this report:

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Acronyms

BEP	Biosecurity Engagement Program, U.S. Department of State
BWC	Biological and Toxin Weapons Convention
EPI	Egyptian Prototype Institute
HHMI	Howard Hughes Medical Institute
MENA	Middle East and North Africa
NASI	National Academies Summer Institute
NRC	National Research Council, U.S. National Academies
RCR	Responsible conduct of research
RI	Research integrity
TWAS	The Academy of Sciences for the Developing World

Contents

1
Background

THE CONTEXT

The initial impetus for the project described in this report was rising concern that the knowledge, tools, and techniques resulting from research in the life sciences, while offering great potential benefits for human health, the economy, and the environment, could also be misused for bioterrorism or the creation of biological weapons. Research intended for beneficial purposes that nonetheless presents the risks of potential misuse is sometimes referred to as "dual use."[1]

The speed of research advances and the global diffusion of academic and industrial research capabilities, led to recognition of the importance of engaging scientists in efforts both to recognize and to mitigate the risks and consequences of misuse. Raising awareness across the life sciences community about risks and ways to address them through education is a fundamental component of engagement. In many countries, colleges and universities are where the majority of innovative research is done; in all cases, they are where future scientists receive both their initial training and their initial introduction to the norms of scientific conduct regardless of their eventual career paths. Thus, institutions of higher education are particularly relevant to the tasks of education on research with dual use potential, whether for faculty, postdoctoral researchers, graduate and undergraduate students, or technical staff.

Although traditional dual use issues are focused on security, the role of scientists in recognizing and addressing them fits well within broader concepts of responsible conduct of research (RCR), research integrity (RI), and the social responsibility of science. Biosafety education and the teaching of science ethics that already address responsible conduct provide vehicles and educational templates into which these new concerns could be incorporated. Growing attention to the benefits of investing in research and the importance of inculcating responsible conduct/research integrity as

[1] The traditional definition of "dual use" related to technology developed for civilian purposes that also had potential military applications; light aircraft, helicopters, and computers are frequently cited examples. Using the term to refer to research intended for beneficial purposes that could be misused dates from the early 2000s (NRC 2004; NSABB 2007).

part of building research capacity may expand these opportunities. Although research integrity traditionally has been considered as a set of ethical guidelines of concern to developed countries, the globalization of science and the resulting concerns about dual use now transcend national borders.

In addition to growing interest in research integrity, the lessons from research on adult learning methods (more below) may be able to contribute both a lens and focus for developing strategies to address dual use issues. The potential audiences include a broad array of current and future scientists and the policymakers who develop laws and regulations around issues of dual use. As with research integrity, improving the quality of science teaching can be considered part of broader efforts to build the capacity to conduct research according to world-class standards.

INTERNATIONAL COOPERATION ON DUAL USE: ROLES OF THE NATIONAL RESEARCH COUNCIL

The core international agreement devoted to ensuring peaceful applications of biological research is the Biological and Toxin Weapons Convention (BWC).[2] The BWC is both a legal instrument and the embodiment of the global norm against the use of infectious and toxic agents as a weapon. BWC member states increasingly have recognized the importance of education and engagement as part of a mix of policies designed to create a "web of prevention" (Rappert and McLeish 2007). Over the past decade, this has led to a growing relationship between the BWC and a number of national and international scientific organizations through annual meetings of experts that address topics directly relevant to the conduct of science and policy issues where scientific expertise is essential. In 2008, for example, the focus was "Oversight, education, awareness raising, and adoption and/or development of codes of conduct."[3] At that meeting the U.S. Government announced that the U.S. Department of State would sponsor a workshop, to be organized by the National Research Council (NRC) of the U.S. National Academies in cooperation with a group of international scientific organizations, to: (1) survey existing courses and resources; (2) identify gaps and needs; and (3) suggest potential remedies. The NRC appointed an international Committee to oversee the workshop and prepare a report on these issues.

The workshop *Promoting Education about Dual Use Issues in the Life Sciences* was hosted by the Polish Academy of Sciences in Warsaw, Poland in November 2009 (NRC 2010). The full list of findings and recommendations of this report may be found in Appendix A; one key finding, however, was the lack of faculty able to teach on

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[2] The text of the treaty may be found at *http://unhq-appspub-01.un.org/UNODA/TreatyStatus.nsf/44e6eeabc9436b78852568770078d9c0/ffa7842e7fd1d0078525688f0070b82d?OpenDocument*.

[3] For further information see *http://www.unog.ch/80256EE600585943/(httpPages)/8C24E93C19BDC8C4C12574F60031809F?OpenDocument*.

responsible conduct of research and dual use issues given the diversity of scientific fields, interests and experiences involved. The report made two recommendations to address this need:

- Build networks of trained faculty as networks can help sustain teaching efforts on these topics.
- Take advantage of and incorporate the growing body of research on the "science of learning" as part of the education on dual use issues of faculty-teachers.

The second recommendation fits with the recommendation made in another NRC report, *BIO2010: Transforming Undergraduate Education for Future Research Biologists* (NRC 2003), which identified faculty education in new pedagogical approaches as a crucial component in improving [undergraduate biology] education. A condensed summary of these new approaches is presented in the next section.

THE "SCIENCE OF LEARNING"[4]

Applying relevant findings from the science of learning to curriculum and materials development will enhance the likelihood of achieving desired outcomes. There is strong evidence that "active learning" approaches enhance learning generally (NRC 2000; Handelsman et al. 2006; Knight and Wood 2005; NRC 2011a). A critical component of active learning is that the learner, rather than the instructor, is at the center and focus of all activities in the classroom, laboratory, or field. Learner-centered environments are more likely to be collaborative, inquiry-based, and relevant (Brewer and Smith 2011). There is still a place for shorter, carefully structured lectures, but the instructor becomes primarily a guide providing effective learning materials and expertise as needed. Michael (2006) summarizes several characteristics of active learning processes:

- Having students engage in some activity that forces them to reflect upon ideas and how they are using those ideas.
- Requiring students to regularly assess their own degree of understanding and skill at handling concepts or problems in a particular discipline (this process is also called "metacognition"; NRC 2000).
- Attaining knowledge by participating or contributing.

[4] The text in this section is modified and updated from *Challenges and Opportunities for Education about Dual Use Issues in the Life Sciences* (NRC 2010, pp. 37-42).

- Keeping students mentally, and often physically, active in their learning through activities that involve them in gathering information, thinking, and problem solving.

As this list suggests, there are numerous teaching strategies to support active learning, ranging from in-class problem solving to case studies to learning from original investigations which they design in whole or in part. The variety of strategies enable active learning approaches that can be implemented in classes of any size, including large, lecture-based introductory courses.

Several findings from the learning sciences can inform education about dual use issues. For example, to be well understood, factual knowledge must be placed in a conceptual framework. Framing learning in the sciences as four intertwined strands of proficiency provides a sound basis for creating effective teaching and learning experiences across all levels of education, including the primary grades (NRC 2007, 2011b):

- Understanding scientific explanations;
- Generating scientific evidence;
- Reflecting on scientific knowledge; and
- Participating productively in science.

This model emphasizes the integration of learning about process and content in effective instruction. There are many opportunities for learners to engage with conceptual material, while being deeply involved in laboratory work. Thus laboratory work is not an add-on or distraction from content mastery, but rather one of many pathways to both factual knowledge and deeper conceptual understanding (NRC 2005). Social and ethical responsibility, as well as biological content, can readily be integrated in laboratory learning, whether it is a formal undergraduate laboratory experience or graduate-level research (NRC 2009a; NAE 2009).

Building in time for reflection, as called out in the third strand above, is an essential component of effective approaches to learning. To date, this is the only practice that has been demonstrated to result in student gains in understanding the nature of science (NRC 2005, 2008). Reflection involves the opportunity to engage in the exploration of understandings with other learners and a teacher, and in giving students opportunities to become more aware of their own levels of learning. Numerous studies have demonstrated the value of "metacognition" or self-monitoring in learning. Many effective teaching and learning strategies engage the learner in metacognitive practice. As discussed below, active learning, properly implemented, encourages metacognition. Given the complexities of the social and ethical dimensions of dual use and other issues in the responsible conduct of science, it would be important to include time throughout a course for various forms of reflection—ranging from deliberate breaks in lectures that

provide such opportunities to exercises both in and outside of class or laboratory that structure and guide reflection—in new curricula.

Understanding is constructed on a foundation of existing conceptual frameworks and experiences. Prior understanding can support further learning. In some cases, however, it can also lead to the development of pre- or misconceptions that may act as barriers to learning. Prior understandings also can be influenced by culture, which has implications for the development of dual use curricular materials for an international audience (NRC 2008). The importance of engaging learners' prior understanding as they encounter new material is another key insight from the science of learning (summarized in NRC 2000) with direct implications for education about dual use and related issues.

Conceptual change often requires explicit instruction and takes time. In many current education systems, learners are often faced with too many disconnected ideas too quickly to be able to take meaning from them and change a previously held conception. And the literature on learning suggests that humans are not adept at making connections between disparate fields or types of knowledge unless they are specifically helped to do so through education (NRC 2000).

Curricula can be designed to engage students in key scientific practices: talk and argument, modeling and representation, and learning from investigations (NRC 2008). Designing a course or module in order to achieve specific learning goals and measurable outcomes is the first step in designing a curriculum with the techniques of active learning in mind. In contrast, the current system practiced by many faculty consists of first selecting a textbook, followed by compiling the course syllabus and assignments, constructing exams, and finally describing learning goals and outcomes based on the earlier steps. This "reverse design" process (i.e., first set the desired goals and outcomes of the educational module and then design a syllabus; Wiggins and McTighe 2005) is intended to ensure that learning outcomes inform instructional and also assessment strategies both by explicitly articulating and then integrating them into curriculum development at the outset. Assessment can be both formative and summative. Formative assessment is usually informal and low stakes (i.e., assessment exercises either do not count or comprise only a small percentage of students' grades) and is offered regularly throughout the learning process, providing feedback for both the teacher and learner on progress achieved. In contrast, summative assessment, conducted at the end of a learning and teaching experience, provides information to students about their learning gains and to faculty and programs about the overall success of the effort. Both formative and summative assessments can be used to inform subsequent restructuring of the curriculum. Concept inventories, critical thinking rubrics, and curriculum-specific, pre- and posttests are examples of summative assessment tools. Without assessment that is closely aligned to learning outcomes, it is difficult to gather evidence about the effectiveness of curriculum.

In addition to considering ethical and intellectual development, attention to the learners' culture and environment is also important for effective curriculum development. As discussed above, prior understandings will affect how an individual interacts with the materials, and learning is enhanced when the learner perceives its relevance to them. The need for relevance underscores the importance of making materials adaptable to local settings and individual circumstances, for example by providing instructors with a range of suggestions for adapting a common curriculum to their own settings.

2
The NRC's MENA Project

Based on the recommendations from the Warsaw workshop, the U.S. State Department's Biosecurity Engagement Program (BEP) agreed to support a two-year pilot project aimed at developing a network of faculty in the Middle East/North Africa (MENA) region able to teach on dual use issues through exposure to and incorporation of tenets of responsible conduct of research[5] (for the Statement of Task see Appendix B). Briefly, the project is being implemented in phases, with a planning meeting that was held in late spring 2011 (see next section) to design a general framework for faculty development workshops based on the successful model of the Summer Institute organized by the National Academies and the Howard Hughes Medical Institute for undergraduate biology faculty (The National Academies Summer Institute [NASI]; next page).[6] In contrast to the Summer Institute, however, which is designed for undergraduate faculty-educators, the participants in these workshops will be faculty who teach graduate students, post-docs and other laboratory personnel. The participants at the planning meeting also began to prepare for a pilot test of the Egyptian Prototype Institute (EPI), the first faculty workshop in early 2012. In the final phase of the project the participants will implement some of the methods learned at the EPI at their home institutions and a final report will be produced that will assess the initial outcomes and draw lessons for future efforts. This report serves as a summary of the outcomes of the planning meeting.

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[5] The mission of BEP is to "develop cooperative international programs that promote the safe, secure and responsible use of biological materials that are at risk of accidental release or intentional misuse" (see *http://www.bepstate.net/*). BEP provides funding for such programs in certain high priority regions, including the MENA, South East Asia, the former Soviet Union, and sub-Saharan and East Africa. As discussed above, the finding of the Warsaw workshop (also a BEP project) "…the lack of faculty able to teach on responsible conduct of research and dual use issues given the diversity of scientific fields, interests and experiences involved…"(page 3) supports using the concept of responsible conduct of research as an educational vehicle for dual use issues. The MENA was chosen to pilot this project in part because there are fewer BEP-funded activities in these countries as opposed to the other regions of interest to the BEP and this project has the potential to grow into a major regional activity. The project has also become more interesting in the wake of the Arab Spring because the emphasis on responsible conduct and improved teaching techniques is potentially attractive to countries with increased emphasis on expanding their science capacity as part of the newly instituted reforms.

[6] In the context of this report, the terms "workshop" and "faculty (development) workshop" are interchangeable.

THE NATIONAL ACADEMIES SUMMER INSTITUTES FOR UNDERGRADUATE EDUCATION IN BIOLOGY

Introductory science courses at large universities in the United States serve as the portals that connect undergraduates to frontiers in research and scientific ways of thinking. An introductory undergraduate biology class might be the only exposure many students have to the life sciences, or to any of the sciences. It often serves as the best opportunity to interest students in a biomedical research or other life science career.

However, according to the 2003 NRC report, *BIO2010*: *Transforming Undergraduate Education for Future Research Biologists*, teaching practices have not kept pace with advances in scientific research. Consequently, the gateway through which most students pass is antiquated, misrepresents the interdisciplinary, collaborative, evidence-based culture of science, and fails to implement current knowledge about how people learn. *Bio2010* identified faculty development as a crucial component in improving undergraduate biology education. Therefore, the authoring Committee suggested the creation of a Summer Institute during which life sciences faculty would work to improve their educational skills by integrating current scientific research with new pedagogical approaches to create courses that actively engage students in the ways that scientists think.

One substantive result of this recommendation has been the development of the annual National Academies Summer Institute for Undergraduate Education in Biology.[7] This unique Institute is designed to model the scientific teaching principles on which it is founded and draws on the expertise of both participants and presenters.

The Summer Institute has provided a venue each year for teams of faculty from primarily research-intensive universities to meet for five days of in-depth discussions, demonstrations, and working sessions on research-based approaches to undergraduate biology education. The idea is to generate the same atmosphere as a Cold Spring Harbor research course, but with the topic being issues in education rather than, for instance, phage genetics. Current research in effective practices in undergraduate science education, active learning, assessment, and diversity are woven through the week, creating a forum for participants to share ideas with each other and develop innovative instructional materials that they are expected to implement when they return to their own campuses.

Initiated with a pilot institute in 2003, the Summer Institute has convened each year during the last week of June on the campus of the University of Wisconsin, Madison. The current target audiences have been faculty and academic leaders from universities where large classes, especially at the beginners' level for both life sciences majors and for students with other career goals, provide significant impediments to reform. Some universities have sent a team of 2-3 people to one Institute. Others have sent multiple teams (consisting of different people each year) over two or more years. The Institute has been supported primarily through funding from the Howard Hughes Medical Institute (through summer 2011) with additional support from Research Corporation for Scientific Advancement and the Burroughs-Wellcome Fund.

Participants are selected based upon a rigorous application process that is overseen by an NRC Committee. There is a particular emphasis on including pre-tenured as well as more

[7] For additional information see http://academiessummerinstitute.org and Pfund et al. 2009 available at *http://www.sciencemag.org/cgi/content/full/324/5926/470.*

senior faculty as members of the team. The Institute also trains a cadre of mentor/facilitators who work with participating teams each summer. Many of these facilitators are alumni from Summer Institutes in previous years, selected for this honor based upon observations of their performance during the Institute they attended.

Each annual session consists of a series of plenary sessions in the mornings and facilitated small group activities during the afternoons. All plenary sessions model the kinds of evidence-based active teaching and learning that the Institute stresses for improving undergraduate education. Topics include subjects such as active teaching, how people learn, formative and summative assessment, teaching to diverse student populations, mentoring, and working with colleagues to improve teaching and learning.

Each small group consists of participants from three university teams and focuses on producing a "teachable tidbit" within some broad area of biology or interconnected disciplines (e.g. biology/chemistry, biology/mathematics). A tidbit is an integrated module that combines aspects of classroom, laboratory or field experiences, assessment, and techniques to help diverse student populations learn more effectively. Small groups are given time to interact with each other during the week to critique each other's tidbits as they are developed. Each team then presents its "tidbit" on the next-to-last day. Each tidbit is peer-reviewed by other participants, facilitators, and members of the organizing Committee.

All resources and products of each Institute are collected on a National Academies portal and made available to all participants, current and previous.

At the recently completed 2011 Summer Institute 39 participants from 16 universities participated. Over the course of the Institute (2004-2010) 342 people have participated from 110 institutions in 41 states. Because so many of these participants serve as instructors in large lecture-style courses, collectively they have taught more than 250,000 undergraduates.

The National Academies recognizes the commitment of these participants by naming each as an "Education Fellow in the Life Sciences" for the year following their attendance at the Summer Institute and by notifying key academic leaders on their campuses about this honor.

From its inception, the Summer Institute has been a research project. Data from participants are collected and analyzed regularly to determine the impact of this initiative. In addition, HHMI sponsors a mid-year meeting for one representative from each university team approximately 6 months after their participation in an institute to measure success, challenges, and new activities that have emerged from their participation.

Because of its success to date, HHMI recently provided a new award to the Summer Institute that will enable its expansion to several institutes each year in various regions across the United States. Four of these regional institutes were organized in 2011.[8] It is envisioned that up to 8 regional institutes will be held each year over the next four years of the grant. These new institutes will adhere to the structure and emphasis of the Madison session but will also expand the pool of educators beyond faculty in research-intensive universities. Data about the participants in these institutes and how they change their approaches to teaching and student learning will continue to be collected and analyzed.

[8] Links to information about the four regional institutes that were held in 2011 are available at *http://nasummerinstitutes.org/*.

THE PLANNING MEETING

The NRC appointed a Committee (see Appendix C) to oversee the project; its first task was to organize the planning meeting to bring together life science educators from the MENA region and experts and leaders in dual use issues and science education from other parts of the worlds. Although the original plan called for taking a broad regional focus, it was decided that concentrating on a single country offered the best opportunity to carry out the test of a pilot workshop and to assess the implementation of the results. Egypt was chosen[9] and initial contacts were made with the Bibliotheca Alexandrina (*www.bibalex.org*) because of its commitment to education and extensive ties to the international scientific community. Political conditions in Egypt caused the meeting to be moved to the academy of sciences for the developing world (TWAS[10]; *www.twas.org*), in Trieste, Italy, which has close ties to the Library.[11] The meeting was held from May 30 — June 1, 2011. In addition to the members of the Committee and NRC staff, experts from Egypt, Europe and the United States took part in the meeting. The meeting agenda and list of participants may be found in Appendix D.

As with the earlier workshop in Warsaw, a key emphasis of the Trieste meeting was the prominent role for experts in active learning methods of teaching. After an initial discussion of the project's goals and some of the fundamental concepts around dual use and responsible conduct of research, the meeting focused on examples of education and "train-the-trainer" programs that employ active learning methods. The organizers gave participants a chance to experience the methods for themselves, using the techniques featured in the NASI. As described in Box 1, participants were divided into small groups tasked with developing broad goals and concrete learning objectives for the EPI. This set of activities provided the basis for a general discussion on the final day on the next steps. These conversations and the Committee's subsequent deliberations provided the basis for the remainder of this report. This document is intended to serve as global guidelines applicable not only to Egypt but to any country wishing to adopt this educational model that combines principles of active learning and training with attention to norms of responsible science. It aims to address the unmet need of respectfully incorporating into existing science teaching and research (especially in the field of emerging infectious diseases) the ideas of conducting science responsibly, of cultivating a culture of laboratory safety, and of raising awareness within the local

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[9] The choice of the country was influenced by the Arab Spring events and the need to avoid duplication of efforts by other educational projects in the region also funded by the U.S. Government.

[10] The acronym TWAS reflects the old name "Third World Academy of Sciences" that has been replaced with the name "the academy of sciences for the developing world"

[11] The TWAS regional office for Africa is at the Bibliotheca.

scientific community of the consequences of misusing research with dual use potential (NSABB 2008; NRC 2009b).

3
Framework for a Faculty Development Program

PLANNING MEETING OUTCOMES: GENERAL CONSIDERATIONS

Responsible conduct of research/Research integrity as core themes. Building on a prominent theme from the Warsaw workshop and other NRC reports about education related to dual use issues (NRC 2004, 2009b, 2010), broader principles of responsible conduct and research integrity rather than the "dual use" theme were chosen as the foundation for faculty development. By embedding the EPI in general discussions on professional conduct, participants accepted the idea that this more general approach would likely be more enduring and sustainable than focusing only on dual use issues. It also resonated with the participants from Egypt for whom a more comprehensive framework beyond research with dangerous pathogens is a more realistic educational opportunity. Such an inclusive approach would also enable future workshops to take advantage of other initiatives such as those mentioned in pages 1-2.

Importance of respecting and adapting to the national context of workshop host countries. One of the insights from earlier efforts to develop education programs on responsible conduct of science and dual use issues is the wide variation in higher education structure and process, and national education policy and how those differences could affect the design and implementation of programs (NRC 2010; Rappert 2010).

- The difficulty of introducing new material, especially beyond core science topics, into crowded curricula is a common concern among nations. In some countries introducing entire new courses into existing curricula can have a direct impact on the development and implementation of faculty networks both at an institutional and national level and efforts to develop nationwide approaches may be difficult. In some countries where institutions of higher education are largely autonomous (e.g., the United States), development of new courses can essentially result from an instructor's initiative, with only limited approval needed from immediate supervisors. In nations with a centralized ministry of higher education (e.g., Egypt) a new course could require approval by national authorities, an often lengthy process.

- One of the most sensitive areas for teaching about dual use and related issues is the political and historical context of different countries, under which certain words have additional underlying connotations. The word "security" is such a word and its use may make faculty reluctant to become involved in anything that may be associated with "security" even if far removed from politics. This supports the point already made above about the advantages of embedding dual use issues within the broader framework of responsible conduct. It also may affect the choice of the local partners, for example, understanding whether formal or informal endorsement by certain government or education officials is essential or how important it might be to work with an institution that by virtue of its prestige or connections can provide flexibility for teaching new courses for its faculty.
- The importance of local context for the successful design of a faculty development program underscores the need of a preparatory site visit(s) as part of the planning process. One outcome of the Trieste workshop was the decision to send a small team of staff and Committee members to Egypt to meet with local faculty, university officials, and government administrators in Fall 2011. The purpose of these meetings is to inform university and government leaders about the planned workshop, and acquire their active support for its successful execution, for the participation of junior faculty, for any follow-on activities originating from the participants, and for the initiation of a network of faculty-workshop participants who will subsequently become trainers for other faculty and their students. An important point to discuss will be the mechanism by which the participants will be chosen so that local mechanisms will be considered. As mentioned in the previous bullet, the advice of well-chosen local partners is invaluable in understanding the political sensitivities and planning a successful visit.

Advantages of a "science of learning" approach. The enthusiasm among participants for their experience with active learning reinforced the message from the Warsaw workshop about the value of such approaches in education about dual use and related, broader issues. The relevance of adopting such methods for classrooms and laboratories across the world is supported by the decision by the World Health Organization to revamp its biosafety train-the-trainer programs to adopt similar active learning methods (WHO 2006, 2010; for more details see Appendix E).

Sustainability of efforts: Value of a network approach and institutional support. As already mentioned, a continuing challenge for efforts to promote new concepts, materials, and pedagogical approaches is the competition for space in a crowded curriculum. It is essential that, from the beginning, the planning for any such effort include a focus on strategies to make the project sustainable. The lessons from efforts in many other areas reinforce the value of building networks of faculty who can share experiences and provide mutual reinforcement (NRC 2010). Follow-up meetings and

strong networks can more effectively facilitate true transformation in faculty teaching behaviors (Ebert-May et al. 2011). For example, creating opportunities for participants in a faculty development workshop to get together after their initial experience in implementing what they have learned has proved extremely valuable to sustaining commitment and momentum (Pfund et al. 2009). In a broader context, building institutional support for sustaining not only the network but the faculty's ability to introduce others to these concepts as well as support for both teaching and research would help foster the culture of responsible science.

Assessment and evaluation. The "science of learning" approach emphasizes concrete goals and continual, measurable outcomes of student performance, whether qualitative or quantitative. Effective evaluation depends on incorporating assessment as an integral part of the follow-on activities and as such would inform any strategies to sustain these educational efforts.

GENERAL CHARACTERISTICS OF THE EGYPTIAN PROTOTYPE INSTITUTE

Advance planning. Since this is a new endeavor for the NRC, the preparations for the first workshop included the formal planning meeting and a site visit. If the program is successful, it is assumed that other countries in the MENA region will be able to participate in workshops hosted by the Egyptian network as the basis for launching their own projects. The NRC may have a supporting role but there will be less hands-on involvement as countries gain experience and take "ownership." This is the model that the NASI program has adopted as it expands from a single national institute to multiple regional ones (see Box 2). There may still be cases where an initial site visit would be helpful, for example when the program begins in a new region, but the intent is to build a largely self-sustaining endeavor.

The workshop itself. The success of the NASI program (Pfund et al. 2009), as well as of other programs for faculty development, have suggested some basic features for a workshop:

- In person. Although it is becoming increasingly feasible to create and sustain virtual networks using resources such as videoconferencing and web 2.0 communications, there is still substantial value in bringing people together to be immersed in a common experience. Personal interactions also allow for informal communication outside the defined schedule that can be valuable to the network-building process.
- Duration. Experience from 8 years of NASIs suggests that 4 to 5 day long workshops would be optimal, given the amount of new material that participants would be expected to absorb and the value of cumulative learning-by-doing (see Box 2). Participants would be expected to do some advance

preparation, but the main experiences would be obtained during the meeting itself.

- Team-based. A key element for ensuring success and enhancing sustainability in the NASIs is the participation of teams from institutions, preferably including a range of junior to senior members on each team. Gaining buy-in from administrators is critical and it has proved useful to have them among the participants. The NASI model has shown added success and commitment by participants if their home institute provides at least modest resources to help implement what faculty learn.
- Hands-on. As the design of the planning meeting suggested, the workshop would be built around extensive, direct participation. Participants would have the opportunity to be both "students" and "teachers," to practice the methods they are learning, and to develop "teachable tidbits" and other materials (e.g., appropriate assessments) to help them implement their new courses or modules at their home institutions.
- Implementation and Assessment. An important feature of the workshop's hands-on approach is the commitment to assist participants in implementing what they have learned. In addition to implementing new ideas or courses, they will acquire experience and resources to plan and carry out effective assessments of whether the learning goals of their new activities are being met. As already mentioned in the context of sustainability, thinking about assessment from the outset is helpful on multiple levels. Examples of useful assessment techniques include observation of the participants, collecting and analyzing work samples, introducing checklists of skills, use of quizzes and/or self-assessment tools, interviews, etc.

The Network. Fostering successful and sustainable networks of faculty able to teach about dual use issues and broader problems of responsible conduct in science and research depends on several key elements, some of which have already been discussed earlier in this report.

- From the beginning. Given the emphasis on forward planning, strategies for building and sustaining the network of faculty will be part of the earliest discussions of the workshop. As previously presented, networks will be influenced by the local/national context, for example with regard to the degree of faculty autonomy in course design.
- Resources. As mentioned above, whenever possible participants in the workshop will be provided with materials and other resources to help them implement what they have learned. Modest resources from their home institution to show its commitment and obligation may be particularly desirable in the project's initial stages. It is the existence and ready availability of these resources rather

than their amount that matters most; in many situations modest resources can have a significant impact.

- Continuing connections. Another way to help build a network is to have project staff from the sponsoring organization available for consultation to participants after the workshop as they implement their new ideas (courses, modules, etc.). These connections would reinforce rather than substitute for local commitment.
- Appraisal. The NASI arranges for at least some of the team members to get together approximately six months after the Institute to share experiences and challenges, reinforce ties, and make plans and adjustments. This is always important but is particularly critical in the early days of a long-term project, i.e., the first years of implementation. The anticipation of a reunion may also encourage participants to persevere with applying their new skills, since it should be expected that, in spite of resources and support, at least some of them would encounter barriers or become discouraged.

DETAILS OF THE EGYPTIAN PROTOTYPE INSTITUTE: GOALS AND LEARNING OBJECTIVES

The syllabus (e.g., content and pedagogy) of the institute is developed in close consultation with the faculty in whose country it will take place. The elements described below have been adapted to the needs identified by the faculty from research institutions in Egypt. Consequently, these may have to be modified to best fit the characteristics of each country.

During the planning meeting in Trieste, the general themes of the EPI were identified (listed on page 18) but the detailed content was not discussed. This is one of the tasks that the Committee overseeing this project is working on in close collaboration with the experts from Egypt who took part in the planning meeting.

The importance of the workshop's title. In the planning meeting a substantial amount of time was devoted to selecting an appropriate title for the future Institute. While the chosen title reflects the core interests of the planners, it was mostly shaped by the Egyptian experts. It is aspirational and evokes the notions of education; responsible research; infectious diseases (or other life science); and safety in science: *Education in responsible research with infectious diseases: Ensuring safe science in the 21st century*. It also reflects the sensitivities to potential implications of such words and concepts as dual use and biosecurity under current conditions in Egypt; it is unclear whether other workshops in other settings would experience the same concerns as strongly.[12] It is possible that further consultations during the site visit might led to modification of the title, for example if it seems desirable to broaden the focus beyond infectious disease.

[12] See NRC (2010) and Rappert (2010) for accounts of the experiences of programs on dual use issues in other countries.

Goals of the EPI. Expanding on the themes previously discussed, the following three are the goals to achieve by the faculty workshop:

1. *Understand the ethical and legal responsibilities of physical and life scientists*. The existence of multinational and multidisciplinary perspectives, guidelines and legal frameworks on what constitutes responsible life sciences research makes a discussion on the various norms and cultures of the practice of science very valuable. It would also foster the idea of a global science and research community, although the amount of legal information necessary is a matter of discussion. At the end of the workshop the participants will have a clearer appreciation of responsible conduct in research and science.
2. *Educate participants in the conduct of responsible science*. The workshop will foster good practice in teaching life and physical sciences and teach participants to adapt these to their own subject matters. At the end of the workshop the participants will have an appreciation for active learning techniques as these apply to responsible scientific practices, they will be able to utilize the teaching methods of the workshop, and to incorporate the workshop materials into existing programs in their own institutions.
3. *Cultivate future leaders in responsible science and research integrity*. In order to sustain the impetus for this project and foster a sense of achievement and dignity the workshop participants will be encouraged to not only develop good research practices but to identify the necessary support system to facilitate such changes. In the formative years of the project, the accomplishments of the site visit and the guidance of the NRC Committee members will be crucial to identify champions and to foster the exchange of scientists around the world to sustain this effort. An example of how to structure the activities at the institute using a learning outcomes approach is shown in Table 1.

Activities and Assessments. There are numerous activities to choose from to implement what was learned at the EPI at each participant's home institution. The choices could be influenced by what integrates well within a laboratory, a department or an institution and what is commonly used and accepted in a country's educational system. Pfund and colleagues have described a number of activities originating from the 6 years of Summer Institutes (Pfund et al. 2009), and below are some additional examples:

- Brown bag seminars.
- A new course on responsible conduct of research (this may take a long time for approval, depending on the national structure of education curricula in a country).

TABLE 1 Example of a "Learning Outcomes" approach.

General goals addressed	Specific learning objectives/outcomes	Types of assessments that measure objective	Activity that accomplishes that specific objective
Participants will be advocates for teaching responsible conduct of research and practice of science.	Develop a teaching module to illustrate the use of the concepts of responsible conduct of research.	Develop an assessment instrument that will demonstrate the student's ability to use the concepts you have discussed to solve practical problems. Use a historical case study to engage students and deepen their awareness of the various issues.	Present your approach to your colleagues in the Institute and obtain their feedback.
Participants will have an awareness of hazards in the laboratory and know how to bring that awareness to others.	Identify the difference between chemical and biological hazards. Be able to describe biosafety guidelines and standards of practice to prospective trainees	Tested knowledge; pre- and post- assessment. Offer a problem and ask students to describe any obvious hazardous situations.	Group activities, small group discussions, clicker questions. Expertise sharing (own experiences of best practice; own stories of not-so-best practices).
Appreciate the ethical, legal, and social responsibilities of life scientists.	Indentify policies and guidelines and regulatory statements of both international and local bodies and critique the applicability of these statements. Able to write standards of practice for their own institution, department, or laboratory.	Convey these policies to the workers/students in their native language. Critique and discuss how these apply to participants' own experience, laboratory, institution, or country.	Locate and read/discuss these guidelines with the group. Discuss cases from historical examples (e.g., Thomas Butler). Discuss case studies specific to the group itself, e.g., based on personal experience.

- Incorporation of new teaching methods within existing courses in the life sciences adding the elements of RCR/RI teaching.

At the end of the project a meeting of the EPI participants, Committee members and project staff will take place to measure success, discuss challenges and new activities to be undertaken (this also happens with the NASI). While no specific assessment tool has been designed, oral deliberations –especially during the formative years of the project- between participants are thought to be the most helpful assessment tool. It is possible that, following the completion of the EPI and the debriefing meeting a few months later, the Committee will formulate guidelines on data to be collected from participants and analyzed in the footsteps of the NASI.

Costs and Implementation Issues. Although these are important issues, they can only be addressed after the EPI has taken place.

4
Summary

This report describes the outcomes of the planning meeting for a two-year project to develop a network of faculty who will be able to teach the challenges of research in the life sciences with dual use potential. These faculty will be able to incorporate such concepts into their teaching and research through exposure to the tenets of responsible conduct of research in active learning teaching methods. The first network will be developed as a pilot project in Egypt. This document is intended to provide guidelines for that effort and to be applicable to any country wishing to adopt this educational model that combines principles of active learning and training with attention to norms of responsible science.

The main findings of the planning meeting are:

- It is important to respect and adapt to the national context of workshop host countries to facilitate the introduction of new materials into preexisting curricular frameworks.
- Active learning approaches, including assessment strategies, can be effectively used to teach dual issue issues.
- Building faculty networks is key to sustain momentum and commitment to this effort.

References

Brewer, C., and D. Smith, eds. 2011. *Vision and Change in Undergraduate Biology Education*. Washington, DC: American Association for the Advancement of Science.

Ebert-May, D., T. L. Derting, J. Hodder, J. L. Momsen, T. M. Long, and S. E. Jardeleza. 2011. What we say is not what we do: Effective evaluation of faculty professional development programs, *BioScience* 61(7):550-558.

Handelsman, J., S. Miller, and C. Pfund. 2006. *Scientific Teaching*. San Francisco: Freeman and Sons.

Knight, J.K., and W. B. Wood. 2005. Teaching more by lecturing less. *Cell Biol Educ* 4:298-310.

Michael, J. 2006. Where's the evidence that active learning works? *Adv Physiol Educ* 30:159-167.

NAE (National Academy of Engineering). 2009. *Ethics Education and Scientific and Engineering Research: What's Been Learned? What Should Be Done?* Washington, DC: National Academies Press.

NRC (National Research Council). 2000. *How People Learn: Brain, Mind, Experience, and School (Expanded Edition)*. Washington, DC: National Academy Press.

NRC. 2003. *BIO2010: Transforming Undergraduate Education for Future Research Biologists*. Washington, DC: National Academies Press.

NRC. 2004. *Biotechnology Research in an Age of Terrorism*. Washington, DC: National Academies Press.

NRC. 2005. *America's Lab Report: Investigations in High School Science*. Washington, DC: National Academies Press.

NRC. 2007. *Taking Science to School*. Washington, DC: National Academies Press.

NRC. 2008. *Ready, Set, Science!* Washington, DC: National Academies Press

NRC. 2009a. *On Being A Scientist.* Washington, DC: National Academies Press.

NRC. 2009b. *Responsible Research with Biological Select Agents and Toxins*. Washington, DC: National Academies Press.

NRC. 2010. *Challenges and Opportunities for Education about Dual Use Issues in the Life Sciences*. Washington, DC: National Academies Press.

NRC. 2011a. *Promising Practices in Undergraduate Science, Technology, Engineering, and Mathematics Education: Summary of Two Workshops*. Washington, DC: National Academies Press.

NRC. 2011b. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: National Academies Press.

NSABB (National Science Advisory Board for Biosecurity). 2007. Proposed framework for the oversight of dual use life sciences research: Strategies for minimizing the potential misuse of research information. Available at *http://www.biosecurityboard.gov/news.asp*.

NSABB. 2008. Strategic plan for outreach and education on dual use research issues. Available at *http://oba.od.nih.gov/biosecurity/biosecurity_documents.html*.

Pfund, C., S. Miller, K. Brenner, P. Bruns, A. Chang, D. Ebert-May, A. F. Fagen, J. Gentile, S. Gossens, I. M. Khan, J. B. Labov, C. Mail Pribbenow, M. Susman, L. Tong, R. Wright, R. T. Yuan, W. B. Wood, and J. Handelsman. 2009. Summer institute to improve university science teaching. *Science* 324:470.

Rappert, B., ed. 2010. *Education and Ethics in the Life Sciences: Strengthening the Prohibition of Biological Weapons.* Canberra: Australian National University E Press.

Rappert, B., and C. McLeish, eds. 2007. *A Web of Prevention: Biological Weapons, Life Sciences and the Governance of Research*. London: Earthscan.

Wiggins, G, and J. McTighe. 2005. *Understanding by Design*, Expanded 2nd ed. Alexandria, VA: Association for Supervision and Curriculum Development.

WHO (World Health Organization). 2006. Biorisk Management: Laboratory Biosecurity Guidance.

WHO. 2010. WHO Biorisk Management Advanced Trainer Programme: Concept Sheet. Photocopy.

Appendix A

Recommendations from the NRC report Challenges and Opportunities for Education about Dual Use Issues in the Life Sciences

GENERAL APPROACH

An introduction to dual use issues should be part of the education of every life scientist.

- **Except in specialized cases (particular research or policy interests), this education should be incorporated within broader coursework and training rather than via stand-alone courses. Appropriate channels include biosafety, bioethics and research ethics, and professional standards (i.e., RCR), as well as inclusion of examples of research with dual use potential in general life sciences courses.**
- **Insights from research on learning and effective teaching should inform development of materials, and approaches to teaching students and preparing faculty.**

SPECIFIC ACTIONS

Achieving the broad goal of making dual use issues part of broader education will require a number of specific actions. They may be undertaken separately by different organizations but there will be substantial benefit if there is an effort to coordinate across the initiatives and share successful practices and lessons learned. Resources will be needed to ensure that the initiatives are carried out at an appropriate scale and scope.

The workshop participants and the committee did not explore the implementation of any specific recommendations in sufficient depth to prescribe a particular mechanism or path forward. Instead, reflecting the diversity and variety of situations in which education about dual use issues will be carried out, the final chapter lays out a number of options that could be used to implement each of the recommendations below.

- **Develop an international open access repository of materials that can be tailored to and adapted for the local context, perhaps as a network of national or regional repositories.**
  - **The repository should be under the auspices of the scientific community rather than governments, although support and resources from governments will be needed to implement the education locally.**
  - **Materials should be available in a range of languages.**
  - **Materials should interface with existing databases and repositories of educational materials dedicated to science education.**
  - **Additional case studies to address broader segments of the life sciences community should be developed, with a focus on making the case studies relevant to the student/researcher.**
- **Design methods for commenting and vetting of materials by the community (such as an appropriately monitored Wikipedia model) so they can be improved by faculty, instructors and experts in science education.**
- **Build networks of faculty and instructors through train-the-trainer programs, undertaking this effort if possible in cooperation with scientific unions and professional societies and associations.**
- **Develop a range of methods to assess outcomes and, where possible, impact. These should include qualitative approaches as well as quantitative measures, for example, of learning outcomes.**

Appendix B
Statement of Task

An ad hoc Committee appointed by the National Research Council will develop a framework for an international series of faculty development workshops with the goal of promoting and enhancing education about issues related to research in the life sciences with dual use potential in key regions around the world.

The workshops will bring together higher education faculty in the life sciences as well as experts in related areas to teach and learn about methods for effective teaching and learning, develop curricular materials to facilitate education about dual use issues that they will use in their classes, and become prepared to be leaders in their communities on these topics.

The project will be conducted in three phases:

- **Phase I: Planning (Year 1).** The Committee will organize and hold a planning meeting, tentatively scheduled at the Bibliotheca Alexandrina in Alexandria, Egypt in late May, which will bring together life science educators from the MENA region with leaders in dual use issues and science education. The planning meeting will help to answer substantive and logistical questions that will guide the organization of Phase II, including issues such as scheduling, language, target audience, and evaluation, outreach and dissemination strategies. A consensus letter report will be prepared to guide the organization of Phase II and to serve as a model for organizing similar meetings in the MENA or other regions. In its report, the Committee may offer guidance on the distribution of resources to support implementation and follow-up activities.
- **Phase II: First Faculty Development Workshop (Year 1).** The Committee will organize a first workshop focused on Egypt that will feature several invited presentations in addition to workgroups and hands-on exercises. The Committee will identify the topics, select and invite speakers and other participants, and work with regional hosts in organizing the session.
- **Phase III: Implementation and Additional Activities (Year 2; NEW).** The Committee will work with participants from the first institute to help them implement what they have learned at their home institutions. Small amounts of funding to support implementation, such as the development of new materials, brown bag seminars, or other activities will be made available to at least some of

the participating faculty. A follow-up meeting for workshop alumni will take place in Egypt at the end of the academic year 2011-2012, which staff and 2-3 Committee members will attend. The Committee will also oversee the preparation of a final consensus report that would provide an account of the first workshop, the activities initiated by the participants at their home institutions, the presentations at the follow-on meeting of the alumni, and an evaluation of the outcomes. It will also offer further conclusions about successful practices for preparing faculty to teach about research with dual use potential.

Appendix C
About the Authors

COMMITTEE MEMBERS

Dr. Rita Colwell (Chair) is Chairman of Canon US Life Sciences, Inc. and Distinguished University Professor both at the University of Maryland at College Park and at Johns Hopkins University Bloomberg School of Public Health. Her interests are focused on global infectious diseases, water, and health, and she is currently developing an international network to address emerging infectious diseases and water issues, including safe drinking water for both the developed and developing world. Dr. Colwell has held many advisory positions in the U.S. Government, nonprofit science policy organizations, and private foundations, as well as in the international scientific research community. Dr. Colwell is a member of the National Academy of Sciences, the Royal Swedish Academy of Sciences, Stockholm, the American Academy of Arts and Sciences, and the American Philosophical Society. Dr. Colwell holds a B.S. in Bacteriology and an M.S. in Genetics, from Purdue University, and a Ph.D. in Oceanography from the University of Washington.

Dr. Enriqueta Bond served, from 1994 to 2008, as the first full time President of the Burroughs Wellcome Fund (BWF), a private, independent foundation dedicated to advancing the medical sciences by supporting research and other scientific and educational activities. During her presidency Dr. Bond guided BWF in its transition from a corporate to a private independent foundation. Prior to joining the BWF, Dr. Bond served as the Chief Executive Officer for the Institute of Medicine. In 1997, Dr. Bond was elected as a full member to the Institute of Medicine. In 2004, she was elected as a fellow to the American Association for the Advancement of Science for her distinguished contributions to the study and analysis of policy for the advancement of the health sciences. Dr. Bond is Chairman of the NRC's Board on African Science Academy Development and a member of the Forum on Microbial Threats. She is a past member of the Report Review Committee as well as numerous other study committees. Dr. Bond is the recipient of numerous honors, including the 2008 Order of the Long Leaf Pine award from the state of North Carolina. This is the highest honor the governor can bestow on a citizen and was awarded to Dr. Bond for her efforts to improve science education for children of North Carolina. She has also received the Institute of Medicine Walsh McDermott Medal, in recognition of distinguished service to the National

Academies, and the National Academy of Sciences Professional Staff Award. She received her bachelor's degree from Wellesley College, her M.A. from the University of Virginia, and her Ph.D. in molecular biology and biochemical genetics from Georgetown University.

Dr. John Clements is a Professor of Microbiology and Immunology at Tulane University School of Medicine. After receiving his doctorate in 1979 from the University of Texas Health Science Center at Dallas, Dr. Clements completed a National Research Council Associateship at Walter Reed Army Institute of Research in Washington, DC. In 1980, Dr. Clements was appointed as Assistant Professor in the Departments of Microbiology and Medicine at the University of Rochester School of Medicine in Rochester, NY. In 1982, Dr. Clements joined the faculty at Tulane University. Dr. Clements has served as Professor and Chair of the Department of Microbiology and Immunology since 1999. Dr. Clements served as Vice Dean for Research from 2006 to 2009 and in 2009 was appointed as Director of the Tulane Center for Infectious Diseases. Dr. Clements's research has been continuously funded from a variety of Public Health Service and Department of Defense. He is currently Director of the *Tulane/Xavier Vaccine Development/Engineering Project* supported by the Department of Defense. Dr. Clements is also Co-Director of the South Louisiana Institute for Infectious Disease Research and Co-Director of the Louisiana Vaccine Center, both collaborative projects between Tulane University and Louisiana State University Health sciences Center in New Orleans. Research in Dr. Clements's laboratory has resulted in more than 100 peer reviewed publications and book chapters, and thirteen issued patents.

Dr. Clements has served on numerous scientific panels and Editorial Boards. He currently serves on the Infectious Disease Subcommittee of the Defense Health Board (a Federal Advisory Committee) and is a member of the National Vaccine Advisory Committee (NVAC) H1N1 Vaccine Safety Risk Assessment Working Group (VSRAWG). Dr. Clements also serves on the Scientific Advisory Board of PATH-EVI, an international non-profit organization whose primary goal is to develop vaccines against enteric diseases for children in developing countries, and on the Steering Committee of the Western Regional Center for Excellence in Biodefense Research. In 2003, Dr. Clements was trained as a U.N. Weapons Inspector (Biologic) in the 7th United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) training program in Vienna. In 2003, and again in 2004, Dr. Clements was a member of the Iraq Survey Group in Baghdad as a Subject Matter Expert in Weapons of Mass Destruction and dual use equipment and programs. In 2009, Dr. Clements served on a National Academy of Sciences committee on biosafety and personnel reliability in laboratories that conduct research of biological select agents and toxins (resulting in publication of the National Research Council policy for Responsible Research with Biological Select Agents and Toxins).Dr. Clements served on active duty with the US Marine Corps from 1966-1972 and was a member of the USMC Individual Ready Reserves from 1972-1991. He was Honorably Discharged at the rank of LTCOL from the US Marine Corps Reserves in 1991.

Dr. Nancy Connell is professor of medicine at the University of Medicine and Dentistry of New Jersey (UMDNJ) -New Jersey Medical School. She is also director of the UMDNJ Center for BioDefense, which was established in 1999 and is the recipient of $11.5 million in congressional recommendations (2000-2006) for research into the detection and diagnosis of biological warfare agents and biodefense preparedness. Dr. Connell also is director of the Biosafety Level 3 Facility of UMDNJ's Center for the Study of Emerging and Re-emerging Pathogens and chairs the Recombinant DNA Subcommittee of the university's Institutional Biosafety Committee and she has worked with several international programs on dual use issues. She is past chair of the National Institutes of Health's Center for Scientific Review Study Section HIBP (Host Interactions with Bacterial Pathogens, which reviews bacterial-pathogenesis submissions to the National Institute of Allergy and Infectious Diseases. She is current chair of the F13 infectious diseases and microbiology fellowship panel. Dr. Connell's involvement in biological weapons control began in 1984, when she was chair of the Committee on the Military Use of Biological Research, a subcommittee of the Council for Responsible Genetics, based in Cambridge, Massachusetts. Dr. Connell received her Ph.D. in microbial genetics from Harvard University. Her major research focus is the interaction between Mycobacterium tuberculosis and the macrophage.

Dr. Clarissa Dirks has just begun a faculty position at The Evergreen State College in Olympia, Washington. Clarissa earned her B.S. in Microbiology from Arizona State University and Ph.D. in Molecular and Cellular Biology from the University of Washington. She was a postdoctoral fellow at the Fred Hutchinson Cancer Research Center in Seattle, WA. In her previous position at the University of Washington, she oversaw undergraduate programs funded by the Howard Hughes Medical Institute, taught undergraduate courses in biology, and led professional development seminars for graduate students. As part of her science education research endeavors, she created educational materials that aim to engage students in active learning and develop their metacognitive skills. Her primary focus was to assist incoming freshman, particularly underrepresented minorities and those who are economically disadvantaged. She serves on local and national committees to enhance diversity in the sciences. As a faculty member at Evergreen, she is continuing this work in partnership with the Evergreen Native American Research Institute. Her scientific research aims to better understand the evolutionary principles that underlie the emergence, spread, and containment of infectious disease by studying the co-evolution of retroviruses and their primate hosts.

Dr. Mohamed El-Faham is Director of the Center for Special Studies and Programs (CSSP), Bibliotheca Alexandrina, Egypt. His is also a Professor and Director of Power Systems Group at the Department of Electrical and Computer Control Engineering, Faculty of Engineering and Technology, Arab Academy for Science and Technology and Maritime Transport in Alexandria. He received his B.Sc. in Electrical Engineering from the University of Alexandria and his M.Sc. and D.Sc. in Electrical Engineering from the George Washington University, Washington D.C., USA. He is a Senior Member of the Institute of Electrical and Electronic Engineering (IEEE). Dr. El-Faham is

author/co-author of a number of publications. As director of the CSSP, he organizes, each year, a number of major conferences in the fields of science technology and education.

Dr. Elizabeth Heitman received her PhD from Rice University in 1988. She has extensive expertise in biomedical ethics, responsible conduct of research, and ethics in public health, as well as experience with biodefense-related ethical decision-making as member of the Policy, Ethics, and Law Core of the Southeast Regional Center of Excellence for Emerging Infections and Biodefense (SERCEB). Her primary research addresses the evaluation of education in the responsible conduct of research, and the cultural awareness and professional socialization of students and researchers. Dr. Heitman is the Director of a four-year, research ethics education program for Costa Rican biomedical researchers and research ethics review committees sponsored by the NIH's Fogarty International Center and a member of the Clinical Research Ethics Key Function Committee of the Clinical and Translational Science Award (CTSA) Consortium. She is the coauthor of The Ethical Dimensions of the Biological and Health Sciences (with Drs. Ruth Ellen Bulger and Stanley Joel Reiser).

Dr. Adel A. F. Mahmoud is a professor at the Woodrow Wilson School of Public and International Affairs and in the Department of Molecular Biology at Princeton University. He has recently retired as president of Merck Vaccines of Merck & Company, Inc. Before that, Dr. Mahmoud served at Case Western Reserve University and University Hospitals as Chairman of Medicine and Physician-in-Chief. Dr. Mahmoud's academic pursuits focused on investigations of the determinants of infection and disease in human schistosomiasis and helminthic infections He has led the effort to develop new vaccines for measles, mumps, rubella, varicella, rotavirus, shingles, and human papillomavirus. Dr. Mahmoud's leadership in setting global health strategies shaped the agenda of the Forum on Microbial Threats of the Institute of Medicine in recent years by tackling such topical issues as biological threats and bioterrorism; SARS; and Pandemic Flu. He is a member of the Expert Advisory Panel on Parasitic Diseases of the World Health Organization (WHO). He was elected to the Institute of Medicine (IOM) of the National Academy of Sciences (NAS) in 1987, and he is a member of the NAS National Science Advisory Board for Biosecurity and Committee on Scientific Communications and National Security (CSCANS). Dr. Mahmoud received an M.D. from the University of Cairo and a Ph.D. from the University of London, School of Hygiene and Tropical Medicine.

Dr. James H. Stith is Vice President Emeritus for the American Institute of Physics (AIP). While an officer of the Institute, he had oversight responsibilities for AIP's Magazine Division, the Media and Government Relations Division, the Education Division, the Center for the History of Physics, the Statistical Research Division and the Careers Division. Throughout his career, he has been an advocate for programs that ensure ethnic and gender diversity in the sciences. His doctorate in physics was earned from The Pennsylvania State University, and his masters and bachelors in physics were received from Virginia State University. A physics education researcher, his primary interests are in Program Evaluation, and Teacher Preparation and Enhancement. He

was formerly a Professor of Physics at The Ohio State University and Professor of Physics at the United States Military Academy. He has also been a Visiting Associate Professor at the United Air Force Academy, a Visiting Scientist at the Lawrence Livermore National Laboratory, a Visiting Scientist at the University of Washington, and an Associate Engineer at the Radio Corporation of America. He is a past president of the American Association of Physics Teachers, past president of the National Society of Black Physicists, a Fellow of the American Association for the Advancement of Science, a Fellow of the American Physical Society, a Chartered Fellow of the National Society of Black Physicists, and a member of the Ohio Academy of Science. He was named a Distinguished Alumni of Penn State, an Honorary Member of Sigma Pi Sigma the physics honor society, a National Academies Education Mentor in the Life Sciences and a ScienceMaker (by HistoryMakers). Stith was chosen as one of the "50 Most Important Blacks in Research Science" by the magazines Science Spectrum and US Black Engineer & Information Technology for his "lifelong work in making science part of global society." Additionally, he has been awarded a Doctor of Humane Letters by his alma mater, Virginia State University. He is married and has three adult daughters and two grandchildren.

NATIONAL ACADEMIES STAFF

Dr. Lida Anestidou is Senior Program Officer at the Institute for Laboratory Animal Research of the U.S. National Academy of Sciences, where she directs a diverse portfolio of studies on the use of laboratory animals; biodefense and biosecurity; and research integrity/responsible conduct of research. Prior to this position she was faculty at the Center for Biomedical Ethics and Society, Vanderbilt University Medical Center. She earned her doctorate in biomedical sciences from the University of Texas at Houston. Working with physiologist Norman Weisbrodt, she explored the effects of nitric oxide on the motility of the gastrointestinal musculature. Working with research integrity expert and biomedical ethics educator Elizabeth Heitman, she concurrently pursued her interests in biomedical ethics, scientific integrity and science policy. Dr. Anestidou also holds a Doctor of Veterinary Medicine degree from Greece (her home country) and an M.S. in Veterinary Sciences from the University of Florida. She is an editorial board member of Science and Engineering Ethics, Lab Animal, and SciTech Lawyer and an ad hoc reviewer for the American Journal of Bioethics. She is a member of the National Conference of Lawyers and Scientists. Dr. Anestidou serves as an expert reviewer in the Ethics Evaluation of grant applications to the 7th Framework Program of the European Research Council and the European Commission Directorate General Research.

Dr. Jo L. Husbands is a Scholar/Senior Project Director with the Board on Life Sciences of the U.S. National Academies. Dr. Husbands managed the project that produced the 2004 report, Biotechnology Research in an Age of Terrorism, and directs the international activities following up on its recommendations, including the 2nd

International Forum on Biosecurity held in Budapest in March 2008 and an international workshop on biosecurity education to be held in the fall of 2009. She represents the National Academy of Sciences on the Biosecurity Working Group of the InterAcademy Panel on International Issues, which also includes the academies of China, Cuba, the Netherlands (chair), Nigeria, and the United Kingdom. She managed a joint project with AAAS that has carried out a survey of AAAS members in the life sciences to provide some of the first empirical data about scientists' knowledge of dual use issues and their attitudes toward their responsibilities to help mitigate the risks of misuse of scientific research.

From 2005-2008 Dr. Husbands was a senior project director with the Academies' Program on Development, Security, and Cooperation where, along with her work on international security, she was staff director for a USAID-sponsored report, Improving Democracy Assistance: Building Knowledge through Evaluations and Research (2008). From 1991-2005 she was the Director of the Committee on International Security and Arms Control (CISAC) of the National Academy of Sciences and its Working Group on Biological Weapons Control. In 1998-99 she also served as the first Director of the Program on Development, Security, and Cooperation in the Academies' Office of International Affairs. From 1986-91 she was Director of the Academies' Project on Democratization and a Senior Research Associate for its Committee on International Conflict and Cooperation. Before joining the National Academies, she worked for several Washington, DC-based nongovernmental organizations focused on international security.

Dr. Husbands is currently an adjunct professor in the Security Studies Program at Georgetown University, where she teaches a course on the International Arms Trade. She is a member of the Advisory Council of Women in International Security, the International Institute for Strategic Studies, the Global Agenda Council on Illicit Trade of the World Economic Forum, and the editorial board of International Studies Perspectives. She is also a Fellow of the International Union of Pure and Applied Chemistry. She holds a Ph.D. in Political Science from the University of Minnesota and a Masters in International Public Policy (International Economics) from the Johns Hopkins University School of Advanced International Studies.

Dr. Jay B. Labov is senior staff member of the National Research Council's Center for Education. In this capacity, Dr. Labov leads an institution-wide effort to leverage the National Academies' work in education by helping to make more deliberate connections between the work of the Center for Education, the National Academy of Sciences, National Academy of Engineering, and the program units of the National Research Council. He is the principal liaison on education activities between the program units of the National Academies and its Office of Communications, with the goal of enhancing communication with outside stakeholders about the Academies' work in education and the public's understanding of science and technology. He also has been the study director for several NRC reports, Evaluating and Improving Undergraduate Teaching in Science, Mathematics, Engineering, and Technology (2003); Learning and Understanding: Improving Advanced Study of Mathematics and Science

in U.S. High Schools (2002); Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium (2000); Transforming Undergraduate Education in Science, Mathematics, Engineering, and Technology (1999); Serving the Needs of Pre-College Science and Mathematics Education: Impact of a Digital National Library on Teacher Education and Practice (1999); and Developing a Digital National Library for Undergraduate Science, Mathematics, Engineering, and Technology Education (1998). He has been Director of the Center's Committee on Undergraduate Science Education and oversees the National Academy of Science's efforts to improve the teaching of evolution in the public schools. Prior to assuming his position at the NRC Dr. Labov was a member of the biology faculty for 18 years at Colby College in Waterville Maine.

Mr. Carl-Gustav Anderson is a Program Associate with the Board on Life Sciences of the National Research Council. He received a B.A. in philosophy from American University in 2009. He is currently completing his M.A. in Philosophy at American University. He has worked closely with the All Women's Action Society (Malaysia), helping to engage young men in feminist dialogue and to present a feminist response to the unique identity politics of contemporary Malaysia. His current research focuses on Buddhist encounters with the West, with particular emphasis on syncretic responses to western feminism, communism, transcendental philosophy, and existentialism in the early 20th Century.

Since joining the Board on Life Sciences in 2009, he has served as Program Associate for variety of projects including, among others, R*esponsible Research with Biological Select Agents and Toxins* (2009), *Challenges and Opportunities for Education about Dual Use Issues in Life Sciences Research* (2010), and *Sequence-Based Classification of Select Agents: A Brighter Line* (2010). In addition to several ongoing studies, he also serves as Program Associate for the United States-Canada Regional Committee to the International Brain Research Organization.

Appendix D
Planning Meeting Agenda and Participant List

DEVELOPING A FRAMEWORK FOR AN INTERNATIONAL FACULTY DEVELOPMENT PROJECT ON EDUCATION ABOUT RESEARCH IN THE LIFE SCIENCES WITH DUAL USE POTENTIAL

May 30-June 1, 2011

TWAS, the academy of sciences for the developing world

Trieste, Italy

AGENDA

May 29: Informal reception/dinner

May 30: Relevant topics to the Education Institute and the report

The day will begin with an overview of the topics of the meeting through a series of presentations and discussions and will move on to focus on educational models of active learning. After the afternoon break, we will switch to modeling active participation techniques by engaging with an actual case study.

Open Data-Gathering Session

9:15-10:00: Breakfast

10:00: Opening Plenary

- Welcome and Introduction of Participants
- Welcome from Dr. Romain Murenzi, Executive Director, TWAS
- Introduction to the National Research Council process - Lida Anestidou (NRC staff)
- Charge to the Committee and outcomes of the planning meeting - Rita Colwell (Committee Chair)
- Words from the sponsor: Putting the project in context - Jacqueline Smith (US Department of State)

11:15: Break

11:30: Culture of responsibility in science

- Ethics of science and integrity in research - Elizabeth Heitman (Committee member)

- The development of biosafety in the context of responsible research – John Clements (Committee member)
- Biosecurity and research with *dual use* potential – Nancy Connell and Adel Mahmoud (Committee members)

13:30: Lunch

14:30: Plenary – The Bibliotheca Alexandrina and its role in supporting the life sciences and Education. A talk by Ismail Serageldin

15:30: Break

15:45: Overview of active learning educational models

- How People Learn - Jay Labov (NRC staff)
- Train the trainers [in-person] - Nicoletta Previsani (WHO)
- Train the trainers [online] - Simon Whitby (University of Bradford)

18:00: Adjourn

Tuesday May 31: Biosecurity and Education: Pedagogy of the Education Institute

Open Data-Gathering Session

8:30-9:15: Breakfast

9:15: The experience of a case study - Alastair Hay (U Leeds)

10:30: Break

10:45: The educational and research context in Egypt/MENA: the lay of the land

- Regulations, government oversight, curriculum development and approval, responsibilities in grants and in higher education. This discussion will begin with facts about Egypt, but if time permits would be expanded to higher education in other countries of the MENA region: Mohamed El-Faham (Committee member) and Alaa Ibrahim (American U Cairo)
- Biomedical ethics/RCR: Eiman Aleem (U Alexandria)
- Teaching life sciences research in Egypt: Mona Mostafa Mohamed (Cairo University)

The rest of this day will be devoted to engaging with active learning exercises guided by Jim Stith and Clarissa Dirks (Committee members) and Jay Labov. The group will be split into smaller groups that will be working both collectively and in these smaller groups on the following topics:

12:00: Lunch

12:30: Backward Design: what it is; the development of topics; how to develop and use assessment methods (summative assessments, formative assessment using measurable verbs: "What do I want my students to do in this class, what message do I want them to take home, and how do I assess the impact of the class)" - Clarissa Dirks

13:30: Modeling of Backward Design through a Physics case study - Jim Stith

15:00: break

15:15: Applying backward design in education on science with dual-use potential: identify the major topics in research with dual use potential amenable to this approach; identify the outcomes of the educational institute in relation to d-u research; discuss summative assessments - Jay Labov

16:00: Break into smaller group to discuss specific dual-use topics with set learning goals in mind (i.e., set the goals up front)

17:15: Expand on the relevant topics of dual use in biological sciences relevant to Egypt (and the MENA more broadly)

18:00: Adjourn

Wednesday June 1: Practical matters

Open Data-Gathering Session

8:30-9:30: Breakfast

9:30: Designing the Institute. The group will discuss the general educational approach to be employed in the first Institute.

- A consistent message that the Education Institute should impart to the faculty/students during the event
- Syllabus content and reading materials
- Faculty of the Institute and assignments
- Logistics of the Education Institute, including methods to select participants for the Institute
- The Education Institute students

10:30: The participants will break into small groups; each group will be assigned one of the previous topics. The groups will think conceptually about the topics and will present their findings and recommendations to the plenary that follows [NOTE: rapporteurs will be assigned; there will be coffee and refreshments so that groups may take a break].

12:00: Plenary - reports from working groups on the five topics

13:30: Lunch

14:15: Plenary session-continued

15:45: Break

16:00: Final Plenary - Summing up and additional assignments

17:00: Adjourn

PARTICIPANTS

COMMITTEE MEMBERS

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Appendix E
Examples of Other Networks or Train-the-Trainers Programs[13]

WORLD HEALTH ORGANIZATION

In 2009 the World Health Organization revamped its Biorisk Management Advanced Training Course to align with a new focus that encompasses both biosafety and laboratory biosecurity (WHO 2006). The new program reflects concepts based on the latest science and theory behind accelerated and adult learning. This highly interactive workshop builds the knowledge and skills of individuals who train and educate others in the biorisk management community. The workshop is intended to increase the number of qualified trainers able to support biorisk management globally (WHO 2010).

Participants in the workshop are expected to have some prior teaching/training experience and to be prepared to carry out at least two training sessions a year in their regions or countries. The first seminar was held in Amman, Jordan, in April 2010, and five more throughout 2010 covered all six of the WHO regions.

BRADFORD DISARMAMENT RESEARCH CENTRE

Another approach to faculty development has been created by the staff of the Disarmament Research Centre of the University of Bradford as part of a broader project on "Dual Use Bioethics."[14] This train-the-trainer program takes advantage of distance learning techniques and advanced videoconferencing capabilities at the university take relatively small groups of faculty through a series of lectures as well as a set of interactive scenarios designed to explore ethical dilemmas related to dual use research.

Working in a fully supported online learning community, participants will be able to communicate and interact with peers, developing their practice through sustained reflection and participation in a range of activities and scenarios. Participants

[13] The contents of this appendix are largely excerpted from NRC 2010.

[14] An overview of the larger project may be found at its website: *http://www.dual-usebioethics.net/*.

will be encouraged to bring their own personal ideas and experiences to the course, sharing these with peers in order to contextualise their knowledge and understanding in ways that will help them meet the ethical challenges thrown up by dual-use (Bradford Disarmament Research Centre website 2011).

The program will begin its third cycle in Fall 2011, and has added a shorter course.