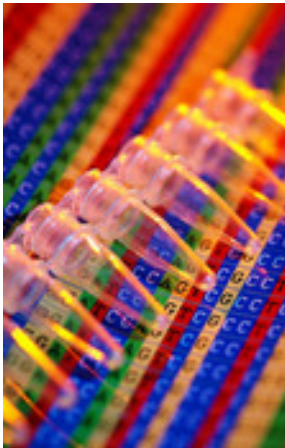


**NATIONAL
SCIENCE
ADVISORY
BOARD FOR
BIOSECURITY**

Strategies to Educate Amateur Biologists and Scientists in Non-life Science Disciplines About Dual Use Research in the Life Sciences.



**Report of the
National Science Advisory Board for Biosecurity
(NSABB)**

June 2011

Strategies to Educate Amateur Biologists and Scientists in Non-life Science Disciplines About Dual Use Research in the Life Sciences

Report of the National Science Advisory Board for Biosecurity (NSABB)

Facilitating the breadth and depth of biological research by keeping it safe and responsible

Abstract

The NSABB is charged with providing advice on strategies and tools to promote awareness of the dual use issue within the life sciences research community. The NSABB developed in December 2008, and the government has since been following, a Strategic Plan in that regard. More recently, the U.S. Government charged the NSABB with developing recommendations for promoting awareness of the dual use issue among two non-traditional audiences in particular: (1) scientists trained in non-life science fields who collaborate in the life sciences on such endeavors as synthetic biology, and (2) amateur biologists who pursue life science research as an avocation and whose activities are becoming increasingly sophisticated. Toward that end, the NSABB Working Group on Outreach and Education undertook an analysis that included interviews with members of, and experts in, these two communities. The Working Group culled out of those interviews a series of observations about both communities that point to particular outreach strategies tailored to each of these groups based on their special characteristics. This report conveys those observations and recommended strategies.

Background

The NSABB has made significant progress fulfilling a number of its charges. Specifically, the NSABB has proposed a framework for oversight of dual use research¹ that includes a criterion and guidance for the evaluation of the dual use potential of research (and, in particular, for identifying “dual use research of concern”); tools to assist assessing and managing the dual use risk associated with certain information and technologies generated by research; tools for the responsible communication of dual use research of concern; and principles to promote the development and adoption of codes of conduct addressing dual use research issues. In addition, the NSABB has developed recommendations to address dual use research issues associated with the *de novo* synthesis of select agents² and has fostered the engagement of the international community on dual use research issues. Most recently, the NSABB issued a report on biosecurity concerns related to the emerging field of synthetic biology.³

¹ National Science Advisory Board for Biosecurity, *Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information* (Washington, DC: June 2007), http://oba.od.nih.gov/biosecurity/biosecurity_documents.html.

² National Science Advisory Board for Biosecurity, *Addressing Biosecurity Concerns Related to the Synthesis of Select Agents* (Washington, DC: December 2006), http://oba.od.nih.gov/biosecurity/biosecurity_documents.html.

³ National Science Advisory Board for Biosecurity, *Addressing Biosecurity Concerns Related To Synthetic Biology* (Washington, DC: April 2007), http://oba.od.nih.gov/biosecurity/biosecurity_documents.html

Outreach and education has also been an important element of the NSABB's activities, whose original charge in this arena still stands and is being pursued to this day. Furthermore, new taskings related to outreach have been given to the NSABB, and these are discussed below, after a brief review of ongoing activities.

Original Outreach Charge to the NSABB

A key element of the NSABB's charge is to provide recommendations on the development of programs for outreach, education, and training on dual use research issues for all scientists and laboratory workers at federally funded institutions. This has been accomplished through the establishment of a Working Group on Outreach and Education⁴, whose original (and standing) charge is presented below:

The NSABB Working Group on Outreach and Education has been established to guide the Board and its staff on the development of strategies to educate the scientific community and the public at large about dual use research. The Working Group will also recommend strategies for soliciting input from key stakeholders on Federal policy proposals, as well as for disseminating new policies once adopted by the Federal government.

Specific matters on which the Working Group will advise include:

- *Message development*
- *Audiences for outreach and education*
- *Vehicles for information dissemination*
- *Solicitation of public comment and assuring public buy-in*

The NSABB Working Group on Outreach and Education will also advise, as needed, on the development of specific Outreach and Education activities. These would include, but are not be limited to, agenda for conferences and workshops to engage in a dialogue with the scientific community about dual use research issues and initiatives, as well as specific communication tools, such as electronic and print media.

In fulfillment of that charge, the Working Group developed, and the NSABB adopted in December 2008, a strategic plan on outreach to all stakeholder communities about dual use research. That plan was predicated on the observation that (1) researchers bear the primary responsibility for the integrity of their work, (2) responsible behavior with respect to dual use research issues depends on awareness of the issue, and (3) a successful system of oversight depends on the ability of researchers to recognize the dual use potential of their work and to consider options on how best to minimize the risk that their findings may be misused or misapplied toward malevolent goals.

⁴ See Working Group roster in Appendix A

The original plan included an array of message points and proposed information dissemination tools that have since been developed and utilized. Messages about the societal responsibility of scientists to recognize the dual use issue and attend to it responsibly have been incorporated into a variety of materials developed since the issuance of the plan. These include an educational video⁵ that offers a conceptual introduction to the dual use research issue (Figure 1). The video is intended as an awareness building tool that can serve as the opening chapter to an array of educational materials that will be developed in the future as Federal requirements are put in place and more specific educational content about compliance must be implemented. The video is accessible not only on the “Biosecurity” page of the Web site of the NIH Office of



Biotechnology Activities, but also on YouTube. A number of organizations have built the video into their own on-line educational offerings on the dual use research issue. It is also being distributed as a DVD playable on the most commonly used readers and computers.

Figure 1

Also developed in response to the plan was an educational brochure⁶ (Figure 2), that similarly offers a conceptual introduction to the issue and

has investigators as its target audience. Given their numbers and diversity, the investigator community has been the most challenging to reach. This brochure leverages the access that institutions and associations have to life scientists by serving as an educational tool that can be easily distributed widely in the research setting and at professional meetings.

These materials have been utilized and distributed at presentations, exhibits and poster sessions that NSABB members and staff conduct throughout the course of the year at major scientific society and professional association meetings.

Diverse groups have been reached to date, including the biosafety community (biological safety officers, members and staff of Institutional Biosafety Committees), key scientific societies (e.g., American Phytopathological Society, American Society for Cell Biology, American Society for Microbiology, etc.), pertinent professional and institutional associations (American Biological Safety Association, Association of American Medical Colleges, Council on Government Relations), and other groups (see Appendix A for a more complete listing). International audiences have been key, as well, and these materials have been disseminated at the Biological

⁵ *Dual Use Research: A Dialogue* <http://oba.od.nih.gov/biosecurity/biosecurity.html>

⁶ *“Does Your Research Have Dual Use Potential” [Brochure]*
<http://oba.od.nih.gov/biosecurity/pdf/EducationalBrochureDualUseResearch.pdf>

DOES YOUR RESEARCH HAVE DUAL USE POTENTIAL?



AN OVERVIEW FOR INVESTIGATORS

Figure 2

and Toxin Weapons Convention⁷ meeting and publicized at events organized by the NSABB Working Group on International Engagement.

These efforts notwithstanding, there remains much work to be done, particularly with respect to building awareness among the scientific community.

New Taskings to the Working Group

Science is evolving in ways that were unimaginable only a few years ago. Whereas science historically has developed in discrete disciplines of study, more recent technological advances have created opportunities that are only possible when teams of scientists across broad disciplines work together. One pertinent example is the field of synthetic

biology, where cell and molecular biologists work side by side with computer scientists, engineers, and others to fully exploit the promise of this emerging field.

Another emerging characteristic of science is the growing accessibility of technologies to practitioners working outside of the traditional institutional environment. As technologies are developed and commercialized, they typically become more affordable over time and are packaged in ways that facilitate their use. Deciphering genomes was once a multi-million dollar undertaking accomplishable only by major collaborations, including those between Federal agencies. Now, genomes are not only deciphered readily and cheaply, they are synthesized by machines obtained over the Internet for only a few thousand dollars. The capacity to reproduce and manipulate not only individual genes, but full genomes, is a development that raises a host of biosafety and biosecurity concerns as individuals undertake these kinds of experiments without the benefit of an institutional infrastructure for training and oversight.

In recognition of these developments, the U.S. Government noted that outreach efforts limited to life scientists working in the institutional setting would be insufficient. Thus, the Government tasked the NSABB, through its Working Group on Outreach and Education, to recommend strategies for reaching out to two audiences in particular: (1) amateur biologists and (2) scientists trained in non-life science fields, who nonetheless contribute to life science research. This report is the response to that tasking.

New Audiences Defined

Any strategy to reach these new audiences must clearly define who they are. Hence, after consulting with those who are members of, or knowledgeable about, these communities, the

⁷ *The United Nations Office at Geneva: The Biological Weapons Convention Website*
<http://www.unog.ch/80256EE600585943/%28httpPages%29/04FBBDD6315AC720C1257180004B1B2F?OpenDocument>

Working Group offers the following definitions of these audiences, along with some of their unique characteristics.

Amateur biologists: These are individuals who conduct biological experiments as an avocation rather than a vocation. This is a diverse community that pursues this avocation in numerous ways, but some typical characteristics include that they:

- May not be formally trained as researchers, and hence not necessarily have degrees in life science fields;
- Are often highly creative, curious, and young individuals, which is generally the basis for their interest in this field as a hobby;
- Tend to be early adopters of new technologies, including those outside the life sciences;
- Often work outside of settings with an infrastructure for oversight and training;
- May assemble into community groups (both physically and electronically) as a means of creating institutions where none are available to them;
- May not consider themselves researchers (e.g., “bioartists”)
- Have an interest in projects that generally require low levels of containment (BSL-1 or even lower - what some call “BSL-edible”)
- Often strive to promote public education about science and introduce science to those who may not have had previous exposure.

Scientists in non-life science fields: For the purpose of this report, we are focusing on researchers trained in non-life science fields who are collaborators with life scientists or who otherwise have migrated into the life science endeavors. While the dual use issue is not unique to the life sciences, and arguably the entire universe of scientists could be the focus of this section, there are pragmatic and substantive reasons to limit this report to participants in the life sciences. First, no one agency or campaign can adequately educate all scientists in a manner appropriate to their respective fields. Second, dual use is a recently heightened consideration in the life sciences, and awareness of the potential for the misuse of knowledge and technologies to do harm is much lower than in the nuclear and computer sciences, for example, whose professionals have long considered this possibility.

This, too, is a diverse community and some of its important characteristics include that they:

- Span such fields as biomedical engineering, chemistry, computer science, mathematics and physics;
- Are generally working at research institutions or government laboratories with established systems of oversight;
- Are not typically trained in such matters as biosafety and biosecurity;
- May not be subject to the oversight of such institutional committees as the Institutional Biosafety Committee, the Institutional Review Board, and the Institutional Animal Care and Use Committee; and
- May be less familiar with oversight requirements in the life sciences, if indeed they are subject to them.

Working Group's Approach to Developing Recommendations

To acquire a better understanding of these communities, the Working Group conducted interviews with individuals who are either members of or otherwise familiar with the two groups. Interviewees were provided a set of questions related to the matters that the Working Group hope to explore and participated in a conference call in which the questions served as a framework for prepared remarks. After each presentation, the Working Group probed various points of interest further. A roster of interviewees and questions addressed may be found in Appendices B and C respectively. The interviews were highly revealing and instructive.

Recommended Strategies

Presented below are some of the major observations that the interview series revealed about the characteristics of each audience. These observations led the Working Group to make particular recommendations about how the Federal government as the recipient of this report, as well as private sector groups who may also be interested in the report as equally essential players in this activity, should conduct outreach and education efforts to the two audiences that comprise the new tasking.

Amateur biologists

Observation 1

At this juncture in the development of the amateur biology field, most participants appear to be motivated by curiosity and the challenge that their projects entail. The same was true of the amateur computer science community in the 1970s, when hobbyists first entered into that field. However, at that time, there was little consideration by the government or professional community of the possible misuse of computer technologies nor of any educational interventions that would help foster responsible behavior in that community.

Recommended strategy

Because the field of amateur biology is still in its formative stages, and the current scale of the activity is much smaller than the computer hobbyist realm, the U.S. Government should capitalize on the fact that this is a unique juncture to foster education and utilize strategies that (1) promote positive motives for participation in amateur biology and stigmatize negative ones, and (2) lay the groundwork for developing a culture of responsibility in the hobbyist community.

Observation 2

To the extent that amateur biologists are organized, this occurs under such groups as DIYbio⁸, BioCurious⁹, and genSpace¹⁰. DIYbio, a national organization whose co-founders are Jason Bobe and Mackenzie Cowell, has a number of regional chapters, whose numbers are growing and

⁸ *DIYbio Website* <http://diybio.org/>

⁹ *Biocurious Website* <http://biocurious.com/>

¹⁰ *genSpace Website* <http://genspace.org/>

whose global breadth is expanding. As these groups evolve and formalize their structures, attention to matters of ethics and personal responsibility of their members tends to increase.

Recommended strategy

DIYbio, BioCurious, genSpace, and similar organizations are key conduits for reaching an important segment of this community's members. The formation of additional organizations should be monitored to identify future opportunities for outreach.

Observation 3

To the extent that this community is organized via groups such as DIYbio, there is an organizational culture that values the reputation of the organization and its perception as a “good citizen” and responsible user of research technologies.

Recommended strategy

Message points about dual use research may resonate most with this audience if embedded in broader concepts of social and personal responsibility.

Observation 4

Agencies and organizations who have organized several face-to-face meetings with the DIYbio members have found this mode of communication and interaction highly successful. Members of the community are often receptive not only to meeting and exchanging ideas with other biology enthusiasts, but also with other experts, including Federal representatives.

Recommended strategy

Federal agency representatives and members of the scientific community knowledgeable about the dual use issue should attend, and offer to participate in the programs of, meetings organized by amateur biologists. Furthermore, federal agencies working in partnership with amateur biology organizations, scientific societies and/or professional association, should organize meetings and conferences of interest to amateur biologists. These programs should include scientific and biosafety content, to attract the interest of this community, but also include content to raise awareness about dual use issues.

Observation 5

Interactions with the DIY community reveal their interest in interacting with the Federal government, to include an array of agencies with scientific and oversight responsibilities for synthetic biology and other genetically based research.

Recommended strategy

Federal agencies should find ways to collaborate on the organization of conferences and workshops designed to provide opportunities for face-to-face interaction with the DIY community and interested amateur biologists generally. These kinds of events would

provide opportunities to convey important educational content about not only dual use research issues, but also biosafety and responsible science.

Observation 6

Interviews revealed that some in the DIY biology community are skeptical of the government's interest in their activities and find that the message regarding dual use issues lacks credibility given the view of amateur practitioners that (1) their activities are relatively harmless, and (2) the government's focus and concern should be on the activities of nation-states and terrorist groups whose budgets and motives might make these latter entities more probable abusers of scientific information and technologies.

Recommended strategy

Message points should focus on the relative ease with which amateur biologists can now, and even more so in the future, develop findings and technologies that could be abused by those who would do harm. Being mindful and responding responsibly to this potential outcome is not only the responsibility of the institutionally based scientific community, but indeed all those who practice science, at whatever level and for whatever well-intended purpose.

Observation 7

Interviews revealed that, by nature, amateur biologists tend to be technology savvy, as well as early adopters of emerging technologies. To the extent that they are organized through groups such as DIYbio, various Internet groups facilitate their communications and gatherings. They are likely to access the Internet frequently (if not primarily) by mobile devices, with blogs and Wikipedia as key information sources. Other sites, such as Twitter, Facebook, MySpace, Google Groups, and other social networks are organizing tools.

Recommended strategy

This characteristic speaks to the value of electronic modes of communication. Whereas print media can be relatively effective with scientists and administrators through institutional distribution methods, those same messages are more effectively communicated electronically to this population.

Observation 8

The youth and natural curiosity possessed by many in this group leads them to migrate to novelty devices. Several interviewees reported that playing cards, trading cards, and other novelty items have been successfully used as vehicles for conveying biosafety messages, for example.

Recommended strategy

Novelty and unconventional items can serve as effective conduits of information and messages regarding responsible research conduct. Message packaging efforts should

take into account the kinds of materials that will be of interest to this group, for which conventional institutional communication tools are not likely to be effective.

Observation 9

Amateur biologists, particularly members of DIYbio, have expressed an interest in adhering to biosafety standards as a means of personal protection and social responsibility. The International Genetically Engineered Machine¹¹ competition, aimed at undergraduate students worldwide, has already incorporated biosafety competencies into its entrance criteria. Finally, SynBERC¹², as a more formal, institutionally based organization, has also expressed an interest in engaging the NIH on biosafety matters. In general, amateur biologists and others practitioners of synthetic biology have an existing interest in biosafety matters.

Recommended strategy

Message points about dual use research may be appended to information regarding biosafety practices, the latter already being a topic of expressed interest by amateur practitioners and others.

Observation 10

Looking to the future, when the dual use issue will be increasingly germane to the activities of amateur biologists, it will be the amateur biology community itself, potentially, that will be best poised to recognize the potential malevolent applications of this work and to “patch” vulnerabilities in life science endeavors (as has been true with computer hobbyists).

Recommended strategy

Part of cultivating a culture of responsibility within this community should include fostering an ethos of not only conducting amateur biology activities safely and responsibly, but also to take measures to prevent others from misusing technologies and information with dual use potential.

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Scientists in Non-life Science Fields

Observation 11

Individuals who collaborate in life science endeavors, such as synthetic biology, are extremely diverse in terms of training, scientific disciplines, and professional interests.

¹¹ *iGEM Website* http://ung.igem.org/Main_Page

¹² *SynBerc Website* <http://www.synberc.org/>

Recommended strategies

Outreach should take advantage of interdisciplinary mechanisms of communication, such as through professional associations and societies with either tailored (Biomedical Engineering Society) or broad (American Association for the Advancement of Science) memberships.

Institutional mechanisms, such as those that apply to all individuals conducting research, should be exploited, as well.

Broad reach into given disciplines might be achieved through “ambassadorships” whereby thought-leaders and influential members of the field bring the message back to their individual communities.

Observation 12

Many disciplines, such as physics and informatics, historically have had to consider the dual use implications of their research, and hence there is a greater acceptance and understanding that research results can be misused to do harm.

Recommended strategy

The experience and familiarity of many non-life scientists with the dual use research issue can be leveraged for the purpose of communicating the issue to life science colleagues.

Observation 13

Practitioners of research in life science and non-life science fields share the responsibility for the integrity and safety of their work.

Recommended strategy

Non-life scientists may be uniquely equipped (in terms of technical perspectives or understanding) to anticipate the potential malevolent applications of life science endeavors and have a special role in being vigilant over this issue.

Message points should note that non-life scientists should consider the ways in which the life science dimensions of their work could be misapplied, as their field may have already done historically for more discipline-specific activities.

Observation 14

Young people tend to be more receptive to the dual use message. In addition, educational strategies have a more lasting impact, and a true culture shift is more likely to occur, when the educational intervention comes early in the educational process and is performed repeatedly.

Recommended strategy

As is true of life scientists, sensitization to the dual use issue should occur early in the educational process. It should occur beginning at the undergraduate level or, if appropriate, in high school.

Observation 15

Many of the educational tools developed to date (brochure for investigators, educational video) have broad applicability

Recommended strategy

Existing NIH educational tools have utility with respect to all scientific disciplines and should be fully utilized. Future educational tools should be developed with a scientifically diverse audience in mind.

Conclusions

The Federal policy effort to address concerns about dual use research has been focused on the life sciences, in part because this is a community for whom dual use issues are a relatively new consideration. That said, the Federal government has tasked the NSABB with developing recommendations for outreach to two audiences in particular - amateur biologists and scientists in non-life science fields - who would be easily overlooked if efforts focused solely on formally trained life scientists.

The Working Group's research on these audiences has revealed some particular characteristics that speak to special strategies that can be useful with these groups. The Working Group also believes that its earlier strategic plan is still fully applicable to these and other audiences and should continue to be pursued.

In that regard, the opportunities for education and outreach are vast. Beyond the scientific community itself, there are still other audiences who must be reached if awareness-building efforts are to be effective. The research enterprise involves many players, all of whom may have particular insights and responsibilities in identifying and managing dual use research. These include research administrators, organizational counsel, researchers in allied fields such as public health, and young students who have yet to specialize in a field. In keeping with the spirit of the new tasking to NSABB, these groups should be included, as well, in future educational efforts.

APPENDIX A
Working Group on Outreach and Education

ROSTER

NSABB VOTING MEMBERS

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Supervisory Special Agent
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APPENDIX B

Sampling of U.S. Organizations to Whom NSABB Members and NIH Staff Have Presented or Exhibited about NSABB and Dual Use Research¹

American Association for the Advancement of Science
American Biological Safety Association
American Phytopathological Society
American Society for Cell Biology
American Society for Microbiology
Association of American Medical Colleges
Center for Strategic and International Studies
Chesapeake Area Biological Safety Association
Council on Government Relations
Global Health Security Initiative – Ministerial Meeting
Howard Hughes Medical Institute
Massachusetts Society for Medical Research
Midwest Area Biosafety Network
NAS Committee on New Government-University Partnership for Science and Security
NAS Committee on Biodefense Analysis and Countermeasures
Northeast Biological Safety Association
Princeton University – Biosciences Oversight Workshop
Public Responsibility in Medicine and Research
University of Hawaii
University of Michigan – Symposium on Academic Freedom and National Security
University of Pittsburgh Medical Center – Center on Biosecurity
University of Texas System
World Health Organization

¹Other organizations domestically and internationally have been reached as well through participation of their representatives on various roundtables, focus groups, public consultation meetings, and other activities.

APPENDIX C

Experts Interviewed by NSABB Working Group on Outreach and Education

Ann Arvin, M.D.
Vice Provost and Dean of Research
Stanford University

Kavita Berger, Ph.D.
Program Director, Center for Science, Technology and Security Policy
American Association for the Advancement of Science

Jason Bobe
Co-founder, DIYbio and Director of Community for the Personal Genome Project at Harvard
University

Rob Carlson, Ph.D.
Principal
Biodesic

Drew Endy, Ph.D.
Associate Professor, Department of Bioengineering
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Michele Garfinkel, Ph.D.
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Herbert Lin, Ph.D.
Chief Scientist, Computer Science and Telecommunications Board
National Academy of Sciences

Edward You
Supervisory Special Agent, Weapons of Mass Destruction Directorate Countermeasures
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Federal Bureau of Investigation

APPENDIX D

Discussion Questions Provided to Experts Briefing the Working Group on Outreach and Education

Appendix D lists the questions that were provided to the experts to serve as a guide for their comments. Experts were not asked to respond to every question, so individual answers are not presented here. The major points that these experts shared with the Working Group are captured in the Observations and Recommended Strategies section of this report.

1. *Ann Arvin, Ph.D., Vice Provost and Dean of Research, Stanford University*

In December 2008, the NSABB issued a report to the U.S. government proposing a [strategic plan](#) to guide activities designed to raise awareness about the issue of dual use life science research – or research done for legitimate purpose that could nonetheless yield information or technologies that could be misused by those who would want to harm national security or public health (for more information, also see the video at <http://oba.od.nih.gov/biosecurity/biosecurity.html>). While the strategic plan was aimed at all potential audiences, the U.S. government has given the NSABB a new tasking to advise on strategies to reach out to scientists in non-life science fields (e.g., computer science, mathematics, chemistry, etc.) who nonetheless collaborate in or contribute to life science research. The emerging field of synthetic biology is a case in point where practitioners involved in this field would be overlooked if outreach efforts focused only on life scientists.

A number of individuals whom the NSABB Working Group on Outreach and Education has interviewed have pointed to institutional leadership as having a critically important platform for communicating to scientists broadly. Your position as a senior institutional official at an institution that conducts a great deal of interdisciplinary work gives you insight into the community of scientists from non-life science fields who are working in life science arenas such as synthetic biology. Furthermore, as an institutional leader, you must frequently communicate and educate faculty about institutional expectations with regards to research standards. Hence the Working Group is interested in your views on the following questions:

- There has been a rapid increase in the diversity of the educational backgrounds, professional disciplines, and types of technical expertise held by researchers who are engaged in life sciences research, particularly in the arena of synthetic biology. From what types of diverse disciplines do these practitioners come? In particular, at Stanford which non-life science disciplines are routinely collaborating with or contributing to life science research?
- Much of the current NSABB and government outreach strategies on dual use research have been targeted at life scientists (given the scope of the NSABB's charge). What is your sense of the level of awareness and understanding of the dual use research issue among scientists from non-life science disciplines at Stanford? Is there a sense that this issue is something that is relevant or applicable to them?
- Should educational messages about the legitimacy and importance of the dual use issue be packaged differently for scientists from non-traditional life science disciplines? In general, are there specific message points regarding dual use research that are likely to resonate with

scientists in non-life science fields? Does the fact that engineers, computer scientists, and others in non-life science fields likely have had little exposure to issues of biosecurity and biosafety - unlike their life science counterparts - have implications for how the dual use message should be framed?

- What might be the most effective communication vehicles or strategies to reach out to scientists from non-life science disciplines who are working in the life science research arena? What mechanisms are employed at Stanford to communicate broadly to its faculty?
- Have you developed any specific mechanisms or strategies at Stanford to for reaching out across scientific disciplines (life scientists, as well as non-life scientists; trainees as well as seasoned investigators) to inform faculty and students about biosecurity-related topics that may be pertinent to their professional lives?
- Are there particular associations or other key organizations that you would recommend working with to leverage their credibility and access to the scientific community for the purposes of education and awareness building regarding the dual use issue?

2. *Kavita Berger, Ph.D., Center for Science, Technology and Security Policy, AAAS*

In December 2008, the NSABB issued a report to the U.S. government proposing a [strategic plan](#) to guide activities designed to raise awareness about the issue of dual use research. While the strategic plan was aimed at all potential audiences, the U.S. government has given the NSABB a new tasking to advise on special strategies to reach two audiences in particular: (1) amateur practitioners of biology, and (2) scientists in non-life science fields (e.g., computer science, mathematics, chemistry, etc.) who nonetheless collaborate or contribute to life science research. The emerging field of synthetic biology is a case in point. While both types of practitioners are involved in this field, they would be overlooked if outreach efforts focused only on life scientists in the institutional setting.

Your position at AAAS gives you insight into both of these communities. Hence the NSABB Working Group on Outreach and Education is interested in your views on the following questions:

Scientists in Non-Life Science Fields

- Based on your work and interactions on the topic of biosecurity policy, as well as the AAAS-NRC survey on dual use specifically, what is your sense of the level of awareness and understanding of the dual use research issue among scientists from non-life science disciplines? Is there a sense that this issue is something that is relevant or applicable to them? Are they, in fact, more receptive to the concept, given the greater experience of certain fields (chemistry, physics, computer science) with security concerns?
- What mechanisms and strategies has the AAAS found to be successful for reaching out to its broad constituency of scientist members to inform them, or receive feedback on, biosecurity-related news or events that may be pertinent to their professional lives?

- Much of the current NSABB and government outreach strategies on dual use research have been targeted at life scientists (given the scope of the NSABB's charge). Should educational messages about the legitimacy and importance of the dual use issue be packaged differently for scientists from non-traditional life science disciplines? In general, are there specific message points regarding dual use research that are likely to resonate with scientists in non-life science fields?
- Does the fact that engineers, computer scientists, and others in non-life science fields likely have had little exposure to issues of biosecurity and biosafety - unlike their life science counterparts - have implications for how the dual use message should be framed?
- Are there special communication vehicles or strategies that might be particularly effective for reaching out to scientists from non-life science disciplines who are nonetheless working in the life science research arena?
- The AAAS has a long history of fostering the responsible conduct of research through organizing conferences and developing educational resource materials, such as case study vignettes. How might education about the dual use issue fit in with other activities that AAAS has underway related to promoting the responsible conduct of research?
- Other than AAAS, are there particular associations or organizations that you would recommend working with to leverage their credibility and access to the scientists in the non-life science fields for the purposes of education and awareness building?

Amateur Practitioners of Biology

- Can you provide a brief overview of how AAAS has engaged the amateur biologist community to date?
- From your interactions with the individuals in the amateur biology community, do you have any general observations to share regarding the scope of their activities? What is your impression of the level of awareness and understanding of the dual use research issue among the amateur practitioners? To the extent awareness exists, by what means did this community become aware (e.g. meetings with FBI and others)?
- In your interactions with representatives from the DIYbio community, have there been any discussions regarding the potential biosafety and biosecurity risks associated with their work? Is there discussion about such matters as uncontrolled propagation or release of material, exposure of self or the public to materials, appropriate storage, disposal of materials, and possible elicited use of materials among members? Is the community planning any oversight for work they conduct?
- What might be the best communication vehicles to reach out to amateur biologists and others in the general public to raise awareness of the dual use issue (web, email, blogs, etc.)?
- Could you suggest who might be the leaders or credible spokespersons for the amateur biology community?

- In your experience, do DIY biologists have questions or concerns about government interest in their activities?
- What message points are likely to best resonate with amateur practitioners of synthetic biology (safety, security, responsibility, etc.)?
- Are there particular resources that would be useful for the community? Is it possible to foster engagement and buy in to the dual use message by assisting the community in other ways (e.g. development of biosafety resources)? Are you aware of other efforts to engage with the community (FBI, Woodrow Wilson etc)?

3. *Jason Bobe, Director of Community, Personal Genome Project, Harvard Medical School, and Co-founder, DIYbio*

- Who are the members of DIYbio?
 - How many people are affiliated with the group in the United States?
 - What are the demographics of the group? By academic background, training geographical location occupation or avocation? How many have some formal laboratory or life science training is there a characteristic type of person who's interested? Are there parallels with the computer hobbyists of years ago and their innovations?
 - In what settings do DIY members tend to work? To what extent are they connected to traditional university labs and/or smaller community college, smaller college labs, state or local forensic, public health agricultural, vet stations or labs, start up entrepreneurs?
 - What kinds of synthetic research do the group's members work on?
 - Is there a sense of numbers of individuals working in the amateur biologist community at large (who are not involved with a formalized group like DIYbio)? Are there nodes of activity identified outside the United States?
 - The website articles discuss the MIT challenge; is team competition a significant interest or are DIY practitioners more individualistic in nature?
- Within the DIYbio group, what is the level of awareness and understanding of the dual use research issue? Is there a sense of the level of awareness in of the issue in the amateur biologist community at large? To the extent awareness exists, by what means did this community become aware?
- Outside the formal DIYbio organization, is there a preferred nomenclature for what we might otherwise refer to as the community of "amateur biologists"?
- The DIY site mentions plans for a code of ethics. Please describe how that is being developed.
- To what extent do DIY practitioners accept the need for self regulation to prevent harm?
- Where do members tend to obtain research samples? Commercial purchase? Sharing with each other? Using materials from a work or school setting?

- What discussion has occurred of risks associated with the work? Is there discussion about uncontrolled propagation or release of material, exposure of self or colleagues to materials, appropriate storage, hacking each other's work, and disposal of materials? Possible elicited use of materials among members?
- What are the best communication vehicles to reach out to amateur practitioners of synthetic biology to raise awareness of the dual use issue (web, email, blogs, etc.)?
- The DIY site has chat sessions. Is this a good vehicle to use to communicate information from larger external groups to individual members?
- Who are credible spokespersons for the community? What popular magazines, journals, websites, chat rooms are frequented?
- Do the members have questions or concerns about government interest in the DIY activity?
- What message points are likely to best resonate with the community (safety, security, responsibility, etc.)?
- Are there particular resources that would be useful for the community? Is it possible to foster engagement and buy in to the dual use message by assisting the community in other ways?

4. ***Rob Carlson, Ph.D., Principal, Biodesic***

In December 2008, the NSABB issued a report to the U.S. government proposing a [strategic plan](#) to guide activities designed to raise awareness about the issue of dual use life science research. While the strategic plan was aimed at all potential audiences, the U.S. government has given the NSABB a new tasking to advise on special strategies to reach two audiences in particular: (1) amateur practitioners of biology, and (2) scientists in non-life science fields (e.g., computer science, mathematics, chemistry, etc.) who nonetheless collaborate or contribute to life science research. The emerging field of synthetic biology is a case in point. While both types of practitioners are involved in this field, they would be overlooked if outreach efforts focused only on life scientists in the institutional setting.

Your leadership in this field gives you insight into both of these communities. Hence the NSABB Working Group on Outreach and Education is interested in your views on the following questions:

Amateur practitioners of synthetic biology

- Describe your interactions with DIYbio and other amateur practitioners of biology. How have you become acquainted with this community? What are your typical modes of interaction with its members?
- What discussion has occurred among amateur practitioners about risks associated with the work they are conducting? Is there discussion about uncontrolled propagation or release of material, exposure of self or colleagues to materials, appropriate storage, hacking others work, and disposal of materials? Possible elicited use of materials among members?

- What is your sense of the level of awareness and understanding of the dual use issue in the community of amateur practitioners? Is there a sense that this issue is something that is relevant or applicable to them? To what extent do amateur practitioners accept the need for self regulation to prevent harm?
- Do the members have questions or concerns about government interest in their activities?
- What might be the most effective communication vehicles or strategies to reach out to amateur practitioners of biology to raise awareness of the dual use issue (web, email, blogs, internet chat sessions, face to face meetings, etc)? Are there particular message points that would be likely to best resonate with the community (safety, security, responsibility, etc)?
- Can you recommend leaders or other key individuals in the community who are credible spokespersons for the community and might serve as conduits for disseminating information to the community at large? What popular magazines journals, websites, and chat rooms are frequented?
- Are there particular resources that would be useful for the community? Is it possible to foster engagement and buy in to the dual use message by assisting the community in other ways?
- Are you aware of any other efforts by other agencies or organizations to reach out to the amateur practitioners of synthetic biology in terms of raising awareness on biosecurity and related issues (DIYBio and Woodrow Wilson, for example)?
- Should outreach efforts focus exclusively on the organized groups of amateur practitioners of biology rather than individuals who may be engaging in activities but who are not associated with formal groups? Would it even be feasible to attempt to reach such individuals?

Scientists in Non-Life Science Fields

- What is your sense of the level of awareness and understanding of the dual use research issue among scientists from non-life science disciplines? Is there a sense that this issue is something that is relevant or applicable to them? Are they, in fact, more receptive to the concept, given the greater experience of certain fields (chemistry, physics, computer science) with security concerns?
- What might be the most effective communication vehicles or strategies to reach out to scientists from non-life science disciplines who are working in the life science research arena?
- Much of the current NSABB and government outreach strategies on dual use research have been targeted at life scientists (given the scope of the NSABB's charge). Should educational messages about the legitimacy and importance of the dual use issue be packaged differently for scientists from non-traditional life science disciplines?
- Does the fact that engineers, computer scientists, and others in non-life science fields likely have had little exposure to issues of biosecurity and biosafety - unlike their life science

counterparts - have implications for packaging the dual use message? In general, are there message points regarding dual use research that are likely to resonate with scientists in non-life science fields?

- Are there particular associations or other key organizations with whom you would recommend working to leverage their credibility and access to the scientific community for the purposes of education and awareness building?

5. ***Drew Endy, Ph.D., Assistant Professor of Bioengineering, Stanford University***

In December 2008, the NSABB issued a report to the U.S. government proposing a [strategic plan](#) to guide activities designed to raise awareness about the issue of dual use research. While the strategic plan was aimed at all potential audiences, the U.S. government has given the NSABB a new tasking to advise on special strategies to reach two audiences in particular: (1) amateur practitioners of biology, and (2) scientists in non-life science fields (e.g., computer science, mathematics, chemistry, etc.) who nonetheless collaborate or contribute to life science research. The emerging field of synthetic biology is a case in point. While both types of practitioners are involved in this field, they would be overlooked if outreach efforts focused only on life scientists in the institutional setting.

Your leadership in this field gives you insight into both of these communities. Hence the NSABB Working Group on Outreach and Education is interested in your views on the following questions:

Amateur and younger practitioners of synthetic biology

- Many have recognized your mentorship of young people interested in the field of synthetic biology, through such activities as founding iGEM and your various interactions with the DIYbio community. You've also observed on a number of occasions that the techniques synthetic biology are becoming increasingly accessible to amateur practitioners in this field.
 - Where do amateur biologists tend to obtain research materials and information necessary to conduct these activities?
 - What is your current view of the degree to which the amateur biology community – either through organizations such as DIYbio or as individual hobbyists – has the resources and technical wherewithal to conduct activities that could be dual use in nature?
- Outside the formal DIYbio organization, is there a preferred nomenclature for what we might otherwise refer to as the community of “amateur biologists”?
- What discussion within iGEM or the DIYbio community has occurred regarding risks associated with their work? Is there discussion about such matters as uncontrolled propagation or release of material, exposure of self or colleagues to materials, appropriate storage, hacking each other's work, disposal of materials, and possible elicited use of materials among members?

- What is your impression of the level of awareness and understanding of the dual use research issue specifically among undergraduate students as well as amateur practitioners? To the extent awareness exists, by what means did this community become aware?
- What are the best communication vehicles to reach out to younger practitioners of synthetic biology, as well as amateur biologists, to raise awareness of the dual use issue (web, email, blogs, etc)?
- Who are credible spokespersons for the amateur biology community in particular?
- In your experience, do iGEM participants or DIY biologists have questions or concerns about government interest in their activities?
- What message points are likely to best resonate with (1) younger and (2) amateur practitioners of synthetic biology (safety, security, responsibility, etc.)?
- Are there particular resources that would be useful for the community? Is it possible to foster engagement and buy in to the dual use message by assisting the community in other ways?

Scientists in Non-Life Science Fields

- What is your sense of the level of awareness and understanding of the dual use research issue among scientists from non-life science disciplines? Is there a sense that this issue is something that is relevant or applicable to them? Are they, in fact, more receptive to the concept, given the greater experience of certain fields (chemistry, physics, computer science) with security concerns?
- To the extent that their field of science has a history of addressing security concerns, could scientists in non-life science fields be good communicators to their life science colleagues about dual use concerns?
- What might be the most effective communication vehicles or strategies to reach out to scientists from non-life science disciplines who are working in the life science research arena?
- Much of the current NSABB and government outreach strategies on dual use research have been targeted at life scientists (given the scope of the NSABB's charge). Should educational messages about the legitimacy and importance of the dual use issue be packaged differently for scientists from non-traditional life science disciplines?
- Are there particular associations or other key organizations that you would recommend working with to leverage their credibility and access to the scientific community for the purposes of education and awareness building?
- Does the fact that engineers, computer scientists, and others in non-life science fields likely have had little exposure to issues of biosecurity and biosafety - unlike their life science counterparts - have implications for packaging the dual use message?

- In general, are there message points regarding dual use research that are likely to resonate with scientists in non-life science fields?

6. Michele S. Garfinkel, Ph.D., Policy Analyst, J. Craig Venter Institute

- Your report, *Synthetic Genomics: Options for Governance*, observes that there has been “a rapid increase in the diversity of the educational backgrounds, professional disciplines, and types of technical expertise held by the users of [synthetic genomic] technologies.” From what types of diverse disciplines do these practitioners come? In particular, what are the non-life science disciplines that are key to this field?
- What is your sense of the level of awareness and understanding of the dual use research issue among scientists from non-life science disciplines? Is there a sense that this issue is something that is relevant or applicable to them?
- Many life scientists do not view the dual use issue as something about which they need to be concerned. Do you think scientists in related fields are likely to have a similar viewpoint, or might their background(s) make them more receptive to the relevance of this issue?
- What might be the most effective communication vehicles or strategies to reach out to scientists from non-life science disciplines who are working in the life science research arena?
- Much of the current NSABB and government outreach strategies on dual use research have been targeted at life scientists (given the scope of the NSABB’s charge). Should educational messages about the legitimacy and importance of the dual use issue be packaged differently for scientists from non-traditional life science disciplines?
- Your report notes the particular role that professional societies play in promoting education and standards of conduct. The report also notes that, more than 30 years after Asilomar, there is no professional society for genetic engineers or synthetic biologists.
 - Among existing societies, are there particular associations or other key organizations that you would recommend working with to leverage their credibility and access to the scientific community for the purposes of education and awareness building?
 - What might be some strategies to promote the initiation of a society for synthetic biologists in particular?
- Your report makes a number of observations about the relatedness of biosafety and biosecurity education and training. Does this observation have implications for packaging the dual use message? How do you relate this observation to the fact that engineers, computer scientists, and others in non-life science fields have likely had little exposure to biosafety training, unlike their life science counterparts?
- In general, are there message points regarding dual use research that are likely to resonate with scientists in non-life science fields?

- Another tasking to the NSABB concerns the community of amateur practitioners of synthetic biology. Did your analysis take this community into account? Do you have any observations you would make about outreach and education to that group?

7. *Herbert Lin, Ph.D., Chief Scientist, CTSB, National Academy of Sciences*

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Your understanding of the computer hacking community and your work regarding research at the “interface of biology and computing” gives you insight into both of these communities. Hence the NSABB Working Group on Outreach and Education is interested in your views on the following questions:

- What similarities, if any, do you see between the computer hacker communities and the “bio-hacker” communities? What are some of the key differences?
- What are the best vehicles for reaching out to a community of amateur practitioners or hobbyists, especially an “underground” amateur community such as computer hackers?
- What outreach or communication methods have been utilized by the established computer science community, if any, to reach computer hackers? Which methods have proven effective?
- We’ve heard from other speakers that the amateur community will respond most positively to the government when there is a collaborative, helpful, partnering approach. Have you found this to be true among the “amateur” computing community?
- Are there lessons learned from government dealings with the computer hacking community that could be applied to dealings with the amateur biologists or “bio-hacking” community?
- Are the scientists working research at the interface of computing and biology primarily from a life science or computer sciences background? Other disciplines?
- Is there much, if any, awareness of the Dual Use Research issue among collaborators in the non-life science fields? If there is awareness, is there a sense that it is relevant or applies to them? Are they, in fact, more receptive to concept, given the greater experience of computer science with security concerns?
- Much of the NSABB and government outreach strategies on dual use research have been targeted at life scientists (given the scope of the NSABB’s charge). Should educational

messages about the legitimacy and importance of the dual use issue be packaged differently for computer scientists?

- What methods of communication might be most effective for reaching out to the community of scientists working in this area? Are there particular associations or organizations that can help convey the message?
- In general, are there message points regarding dual use that are likely to resonate with computer scientists?

8. *Ed You, Supervisory Special Agent, FBI*

- What amateur biology groups has the FBI identified and interacted with (DIYBio, others)?
- What kinds of interactions has FBI had with these groups (meetings, workshops, dialogue with leadership etc)?
- What has the reception been from the groups? What accounts for this?
- What have been (or might be) the most effective communication vehicles or strategies to reach out to amateur practitioners of synthetic biology?
- Have any strategies proven **not** to be effective? What tactics should be avoided?
- How does the FBI think other Federal agencies can best complement its ongoing efforts?
- Has FBI identified leaders or other key individuals in the community who might serve as conduits for disseminating information to the community at large?
- Are you aware of any other efforts by other agencies or organizations to reach out to DIYBio or the amateur biologist community in terms of raising awareness on biosecurity and related issues (Sloan etc)?
- What is your sense of the level of awareness and understanding of the dual use research issue within the DIYBio group? Is there a sense that this issue is something that is relevant or applicable to them?
- What message points are likely to best resonate with the community (safety, security, responsibility etc)?
- Is it possible to foster engagement and buy in to the dual use message by assisting the community with respect to other topics (such as biosafety)? Are there particular resources that would be useful for the community in that regard?
- Are there effective strategies for reaching amateur practitioners of biology who may not be affiliated or involved with organized groups? Is there a “renegade” element to this community? If so, can they be reached?