

FACT SHEET

Discussions on the Ethical and Societal Implications of Synthetic Genomics Research at JCVI

The J. Craig Venter Institute (JCVI) considers the ethical and societal implications of its work to be as important as the scientific research. To this end, JCVI has since the earliest days of the research considered the ethical questions and today continues this work to understand societal implications even before beginning scientific experiments.

1995-1999: Exploring the ethical implications of constructing a bacterium with the minimal set of genes capable of sustaining life.

When research on a project to understand the minimal set of genes capable of sustaining life started in 1995 at JCVI legacy organization TIGR, the idea of constructing a bacterium with a minimal genome underwent a thorough ethical review by a panel of experts at the University of Pennsylvania. The panel's independent deliberations, published along with the scientific minimal genome research findings, concluded that there were no strong ethical reasons that should prevent the team from continuing research in this field as long as they continued to engage in public discussions.

2003: The first synthesis of a non-pathogenic virus phi X174

In 2003, before publishing their results on generating a synthetic genome of the phi X174 bacteriophage, a team of scientists from JCVI contacted several Government agencies, including the US Department of Energy (DOE), the White House Office of Science and Technology Policy (OSTP), the National Institutes of Health (NIH), and the Department of Homeland Security (DHS) to discuss any potential repercussions of their findings. After a series of meetings, the findings were released at a press conference hosted by the Secretary of Energy.

2010: The first synthetic cell and the Presidential Commission for the Study of Bioethical Issues

JCVI published the creation of the first cell controlled by a synthetically created genome in 2010. Ahead of its publication, Dr. Venter and others met with OSTP, DHS, the National Science Adviso-

ry Board for Biosecurity (NSABB) and other government agencies. In response, President Obama directed his Presidential Commission for the Study of Bioethical Issues to look at the implications of synthetic biology. The JCVI team welcomed the process and the conclusions of the report, which was released in December, 2010.

2004-Ongoing: JCVI studies on the Policy and Ethical Implications of Synthetic Genomics

In 2004, the JCVI's Policy team, along with the Center for Strategic & International Studies (CSIS) and the Massachusetts Institute of Technology (MIT), were funded by the Alfred P. Sloan Foundation to conduct a series of workshops and an invitational public session over a 20-month period to discuss the ethical and societal implications of synthetic genomics. In 2007, the group published *Synthetic Genomics: Options for Governance*, which focuses on options for policy makers to address biosecurity and biosafety concerns. A modified version of one of those options was later issued as *Guidance for DNA synthesis companies* by the US Department of Health and Human Services (HHS). In 2010, HHS released its "Screening Framework Guidance for Providers of Synthetic Double-stranded DNA," which called on providers of double-stranded DNA to screen both customers and the DNA sequences ordered by those customers for potential biosecurity concerns.

"DNA Synthesis and Biosecurity: Lessons Learned and Options for the Future", released in 2015, examined two questions: 1) how well has the HHS Screening Guidance worked during its first five years, and 2) are changes to the Guidance needed to keep pace with anticipated developments in the field of DNA synthesis over the next five years? The team concluded that the Guidance has been reasonably successful in its first five years with a large majority of the industry in voluntary compliance. However, over the next five years, with changes in the technology and the industry, it will become more difficult for companies to adhere to the Guidance and more challenging for U.S. policy makers to maintain a high level of biosecurity screening.

In 2014, the JCVI Policy Center team, along with researchers at the University of Virginia and EMBO, examined how well the current U.S. regulatory system for genetically engineered products will handle the near-term introduction of organisms engineered using synthetic biology. "Synthetic Biology and the US Biotechnology Regulatory System" focused on those organisms intended to be used or grown directly in the environment, outside of a contained facility. The study concluded that the U.S. regulatory agencies have adequate legal authority to address most, but not all, potential environmental, health and safety concerns posed by these organisms. Such near-term products are likely to represent incremental changes rather than a marked departure from previous genetically engineered organisms. However, the study also identified several key challenges for the regulatory system, which are detailed in the report.

Ongoing Activities: Lectures, Media, Congressional Education, Briefings to Executive Branch Agencies

Dr. Venter and the JCVI team routinely give public lectures and presentations around the globe to both scientific and lay audiences, members of congress, schools, and other organizations. Realizing that most people get their information from the media, Dr. Venter and the team also conduct many interviews with global media (online, print, video, radio, etc.) about their work and the implica-

tions and applications. Dr. Venter has testified to Congressional Committees about various aspects of synthetic biology on three separate occasions. The JCVI team helped organize and briefed the Congressional Caucus on Synthetic Biology.

The JCVI Policy Center team has presented and discussed the conclusions of its various studies to numerous Executive Branch Agencies, including OSTP, HHS, NIH, DHS, DOE, US Department of Agriculture (USDA), US Food and Drug Administration (FDA), US Environmental Protection Agency (EPA), among others.

Team members have also briefed Committees of the National Academy of Sciences and served on advisory committees such as the UN Convention on Biology Diversity Technical Experts Group on Synthetic Biology.

Overview of Selected Studies of the Societal, Ethical, and Policy Considerations Associated with Synthetic Genomics and Synthetic Biology

US Government Actions Specific to Synthetic Biology

- NIH Guidelines for Research Involving Recombinant DNA Molecules` was updated to include synthetic DNA in 2013. (<http://osp.od.nih.gov/office-biotechnology-activities/biosafety/nih-guidelines>)
- HHS developed guidance to firms that supply synthetic DNA with respect to screening orders and customers for malicious intent; action was undertaken in response to the 2006 report from the National Science Advisory Board for Biosecurity (NSABB; below). (Federal register notice, Oct 13, 2010: <http://www.gpo.gov/fdsys/pkg/FR-2010-10-13/pdf/2010-25728.pdf>)
- The White House OSTP released a “Bioeconomy Blueprint” in 2012, which prioritized development of a “21st century bioeconomy” and listed synthetic biology as a “foundational technology.” (https://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf)

US Government Advisory Committees and Related Projects

- New Directions: the Ethics of Synthetic Biology and Emerging Technologies (2010): Presidential Commission for the Study of Bioethical Issues. (<http://bioethics.gov/cms/synthetic-biology-report>) Report concluded that synthetic biology research should continue under a “prudent vigilance” framework that does not require broad additional oversight.
- Addressing Biosecurity Concerns Related to Synthetic Biology (2010): National Science Advisory Board for Biosecurity (NSABB). (http://oba.od.nih.gov/biosecurity/pdf/NSABB%20SynBio%20DRAFT%20Report-FINAL%20%28%29_6-7-10.pdf) Considered whether synthetic biology risks were captured under existing NIH guidelines and “dual-use” technology oversight paradigms.
- Addressing Biosecurity Concerns Related to the Synthesis of Select Agents (2006): NSABB. (http://oba.od.nih.gov/biosecurity/pdf/Final_NSABB_Report_on_Synthetic_Genomics.pdf) Considered options for addressing risks created by easy synthesis and purchase of DNA sequences; HHS developed guidelines in response (above).

Selected Activities of the US National Academies of Sciences

- National Academy of Engineering and National Research Council. Positioning Synthetic Biology to Meet the Challenges of the 21st Century: Summary Report of a Six Academies Symposium Series. Washington, DC: The National Academies Press, 2013. <http://www.nap.edu/catalog/13316/positioning-synthetic-biology-to-meet-the-challenges-of-the-21st-century>
- National Academies/OECD/Royal Society: Opportunities and Challenges in the Emerging Field of Synthetic Biology: A Symposium (2010). (http://sites.nationalacademies.org/PGA/stl/PGA_050738) Report from a two-day symposium that brought together biologists, social scientists, and policy
- A range of ongoing activities address implications of new genetic engineering advances, including studies on the use of CRISPR-based gene editing techniques in humans (<http://www.nationalacademies.org/gene-editing/index.htm>) and the development of gene drive technologies in non-human organisms (<http://dels.nas.edu/Study-In-Progress/Gene-Drive-Research-Human/DELS-BLS-15-06>).