Ethical and Policy Problems in Synthetic Biology: Emergent Behaviors of Integrated Cellular Systems (EBICS)

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Description

This problem was given to students as part of a [course on problem based learning (PBL) using fractious problems.](#) It asked them to consider the ethical and policy issues surrounding developments in synthetic biology. Students were asked to apply six skills in analyzing and devising policy resolutions for the problems and to apply PBL skills in doing so.

Body

The rapidly advancing field of synthetic biology seeks novel solutions to old problems in environment, energy, and health through the integration of biology and engineering knowledge and know-how. The goal is to engineer biological machines — biological systems that do not occur in nature — to perform human-directed functions.

The potential range of applications for these systems is vast, and the potential value of these applications — in effectively and efficiently addressing environmental problems, energy needs, and therapeutic goals in health — is enormous. The potential of synthetic biology is well known to policymakers and governmental

agencies, including the National Science Foundation (NSF), which is funding research in the field. But policymakers and governmental agencies are also concerned about the ethical and policy problems that may be associated with the development and application of these machines — and about our capacity to identify, understand, and address them.

NSF recently funded the synthetic biology research project of researchers spanning Massachusetts Institute of Technology, University of Illinois at Urbana-Champaign, and Georgia Institute of Technology (Georgia Tech). The research team was awarded $25 million for a 5-year Science and Technology Center (STC) in Emergent Behaviors of Integrated Cellular Systems (EBICS). This NSF-funded EBICS STC will perform research in the following three areas:

1. Cellular systems that sense the level of substances, such as glucose, in the human blood stream, and then instruct other cellular systems to produce and secrete drugs, such as insulin.
2. Test-bed cellular systems that mimic the behavior of human organs, such as the heart or liver, to be used in screening drugs for safety and efficacy, reducing or eliminating the need for animal testing in drug development.
3. Cellular systems that sense the level of neurotoxins in water and signal other cellular systems to produce substances that eliminate the neurotoxins.

The cellular machines described above might be produced by one of two methods under investigation by EBICS researchers: either as engineered systems or as emergent systems. Engineered systems are produced by inducing stem cells to differentiate into particular cell types, such as nerve cells or muscle cells, which are then assembled into machines to perform a desired function. Emergent systems are produced by interventions to steer the differentiation and evolution of stem cells into different components that interact naturally to perform a desired function. This method mimics the way in which, for example, embryos develop into adults in nature: by interactions and communication among stem cells that result in differentiation into interacting clusters of cell types.

You are a diverse group of graduate and professional students drawn from Georgia Tech, Emory University, Georgia State University College of Law, and Morehouse School of Medicine. You are participating in an experimental ethics course funded by NSF and designed by diverse researchers spanning these and additional institutions; the NSF-funded project of which you are a part reflects the broad

concern of NSF that the next generation of science and engineering professionals, aided by colleagues with expertise spanning multiple disciplines, develop competency in understanding and addressing challenging ethical and policy issues associated with the science and engineering enterprise.

The NSF-funded course in which you are enrolled is collaborating with the NSF-funded EBICS STC. This collaboration aims to serve both the broad concern of NSF to build capacity in the next generation of professionals to address ethical and policy issues in science and engineering and the particular concern of NSF regarding identifying, understanding, and addressing the ethical and policy problems that may be associated with the field of synthetic biology.

You are charged with investigating and providing real-time ethical and policy analysis and recommendations to the EBICS STC. Select one of the three areas listed above and one of the above methods (engineered or emergent systems) as your focus of study. In performing your analysis and arriving at your recommendations, you will have access to members of the EBICS research team, including faculty and graduate student researchers, and the opportunity both to learn from them and engage with them on the ethical and policy issues associated with their work. You will deliver your presentation and your report with analysis and applications to the EBICS STC in December, 2010.

Notes

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Use of Materials on the OEC

Resource Type

Open-ended scenario

Parent Collection

Problem Based Learning (PBL) Fractious Problem Case Assignments

Topics

Communicating Science and Engineering
Emerging Technologies
Ethics and Society
Governance
Responsible Innovation
Risk
Social Responsibility

Discipline(s)

Biomedical Engineering and Bioengineering
Engineering
Life and Environmental Sciences
Public Policy and Public Administration
Social and Behavioral Sciences
Synthetic Biology