

Debating a Proposed Moratorium on Synthetic Biology Research

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Abstract

This essay explores the ethical issues surrounding the public policy debate of imposing a moratorium on synthetic biology research. In particular, this article explores the risks of synthetic biology research, including those of safety, intellectual property rights, and a shift in the global economy, while assessing whether these risks are dangerous enough to call for a moratorium.

Introduction

For centuries, mankind has been manipulating the genetics of organisms through artificial selection, or selective breeding. The concept of selective breeding relies on the heritability of genetics, and the aim of such breeding is to maintain and select for certain desirable traits in a species, from crops like corn to animals like horses or dogs. In 1973, biochemists began directly manipulating genes through the development of recombinant DNA technology, in which enzymes splice together particular gene sequences.

Recombinant DNA technology proved to be an incredibly powerful tool with a wide variety of applications from agriculture to biomedical research to pharmaceuticals and gene therapy. In light of the vast array of applications and enormous promise of the technology as well as the corresponding potential dangers and hazards, scientists called for a voluntary moratorium on recombinant DNA research until they had assessed the risks. Eight months later, in February of 1975, biologists, lawyers, and physicians participated in the Asilomar Conference on Recombinant DNA to discuss those risks. The Conference established several guiding principles regarding containment and safety (biological, physical, accessibility, and training). Furthermore, some experiments, such as cloning of DNA from pathogenic organisms and large-scale experiments that could make potentially harmful products, were altogether prohibited (Berg, Baltimore, Brenner, Roblin, & Singer 1975). The Asilomar Conference was significant as it set the precedent for developing precautionary guidelines to govern regulation of new technology, and that

it brought biomedical research and engineering into the public eye. Coverage sparked interest and learning, which, in turn, led to knowledgeable public discussion of the social, political, environmental, and ethical aspects of recombinant technology (Berg & Singer 1995).

Synthetic biology is amongst the more recent and rapidly growing fields within biotechnology. While artificial selection and recombinant DNA technologies modify and manipulate genes, synthetic biology takes genetic engineering to a new level by exploring the design and construction of novel biological functions and systems. Looking to recombinant technology as precedent, we can explore the ethical and public policy expectations for synthetic biology much in the same way. The idea behind synthetic biology is that rather than splicing genes from known genomes together as in recombinant DNA, one could instead construct an original sequence of DNA and “program” a living organism the way one might program a computer.

In May 2010, a research group led by Craig Venter was the first to successfully reconstruct a known bacterium genome, over one million base pairs long, and introduce it into another cell (Gibson 2010). This feat was described as the first “synthetic cell” and prompted President Obama to convene his Bioethics Commission, which recommended self-regulation by the synthetic biology community rather than a moratorium on research or complete lack of regulation (Presidential Commission for the Study of Bioethical Issues 2010).

Justification for a Moratorium

Many groups have called for a moratorium on synthetic biology research until environmental and socioeconomic risks are thoroughly studied. Main arguments cited in favor of a moratorium include consequentialist concerns about safety, intellectual property, and the economy, as well as the need for a more democratic, global consensus approving the research. Some have also argued for a permanent ban, rather than a moratorium, based on a deontological repulsion for the idea of “playing God,” reminiscent of Mary Shelley’s *Frankenstein*.

Safety concerns over synthetic biology are two-fold: inadvertent harm introduced to the environment and society as well as the deliberate abuse of new biotechnology by terrorists, governments, and corporations. A subcommittee of the United Nations Convention on Biological Diversity stressed a precautionary approach to synthetic biology, in which proof of no harm must precede research rather than proof of harm ceasing research. This priority of proof of no harm is especially appropriate for living organisms, which could mutate to survive and flourish unexpectedly in natural environments and perhaps even evolve pathogenic properties (Humane Biotech 2010). Furthermore, the current safety measures in place rely heavily on the implementation of “suicide genes” and “terminator technologies”, which trigger cell death under certain conditions in order to mitigate

potential environmental harm. Scientific studies have found that these processes are not completely effective: genetic use restriction technologies (GURTs) like suicide genes provide an evolutionary disadvantage. Thus, strains with mutations that overcome intended sterilization or death could reproduce and thrive (Steinbrecher 2005). In addition to these outlined concerns, there is reason to fear intentional abuse by bioterrorists, given the growing accessibility and open source culture of synthetic biology. Moreover, corporations like Monsanto have exhibited arguably questionable moral behavior in their use of genetic technologies, as revealed by studying their many legal battles. Finally, some might even be hesitant to trust governments to act ethically regarding scientific experimentation, especially in light of controversial government research such as the United States' human radiation experiments from 1944 to 1973.

Not only does synthetic biology research call into question ethical and safety concerns, but a whole host of issues that will result as a consequence of this research, such as intellectual property rights and economic impacts. The advent of synthetic biology raises one of the biggest questions surrounding intellectual property rights in the life sciences: Can one patent a living organism? Is it comparable to patenting a gene? Would patenting in this context create a monopoly on a living organism or treatment for a disease, or does it incentivize important biomedical research? These questions need well-thought out answers before synthetic biology research continues freely.

Synthetic biology research, like all technological developments, will also undoubtedly have enormous economic implications. As Jim Thomas of the ETC group, a Canadian environmental organization, speculates, if a synthetic biology technology made it possible to grow an organic product in a vat at a lower cost than by farming, the livelihood of thousands of farmers would be threatened (Rugnetta 2010). There is conjecture that the global economy is not currently prepared for such a shift in labor needs and job opportunities.

Based on the outlined reasoning, proponents of a moratorium argue that a global democratic consensus seems necessary before allowing scientists to continue synthetic biology research. This new technology will undoubtedly have a global impact, and as discussed earlier, has severe potential harms especially because it is, at this time, poorly understood. Moratorium proponents therefore require that all stakeholder interests be accounted for and that stakeholders consent to the associated risks before synthetic biology research can proceed.

Argument Against a Moratorium, Supporting Self-Regulation
Synthetic biology enthusiasts point to the endless possibilities synthetic biology research will yield: applications include pharmaceutical discovery and production, energy innovation, bacterial computing, and much more. With these tremendous benefits at hand, a

moratorium on synthetic biology research would therefore be unwise. The Bioethics Commission's recommendation for self-regulation is the most sensible course of action at this point.

Synthetic biology is not a radical departure from the current state of biotechnology; it is instead a step forward for science and genetic engineering. The scientific community and society have dealt with the possible risks associated with recombinant DNA technology; they can handle the associated risks of synthetic biology research, especially considering the potential benefits.

Others have criticized the accessibility of synthetic biology to the general public, especially bioterrorists who could abuse the technology. The current open-source quality of synthetic biology is an advantage over these potential harms. If software, owned by a particular company, had a bug that threatened a computer's safety and security, only that company which owned the software would be able to access the code and make adjustments to solve the problem. However, with open source, a vast number of technically skilled people around the world have the ability to work together to find a solution to potential threats. This situation is analogous to synthetic biology.

Critics of synthetic biology have argued that manipulating nature will undoubtedly lead to negative, perhaps irreversible, consequences that mankind could not possibly foresee. Nature is not stable and harmonious, but constantly changing and imperfect (Rugnetta 2010). Furthermore, the very existence of human beings changes nature as well. Risks will undoubtedly accompany the enormous potential synthetic biology holds. However, this pursuit of science and technology is not an unreasonable risk. The risks we are facing with synthetic biology are not risks that we can eliminate before pursuing research. Rather, the scientific process is one that involves trial and error in order to understand and confront problems (Specter 2010). The scientific community must act with forethought and caution, but a moratorium on synthetic biology would be counterproductive to both science and society.

Conclusion

After careful consideration of both sides of the debate over synthetic biology research, I advocate self-regulation of the field, as recommended by the Presidential Commission on Bioethics, rather than a moratorium.

One of the most convincing arguments of those opposed to the moratorium is that synthetic biology, though novel, is not a radically different technology at its fundamentals: it is a new form of genetic engineering. As such, we can subject it to the same regulations and caution that we exercise on other forms of genetic engineering. That is not to say that the technology should go unchecked, but that there are

already precedents set to follow. The regulations will, of course, require some differences in policies because of the novelty of certain aspects of the technology, such as the open source foundation; however, a complete moratorium on synthetic biology is unreasonable if other forms of biological research, like recombinant DNA, continue. Concerns about safety risks, possible abuse, economic implications, and controversy over intellectual property rights are, after all, associated with other types of bioengineering research as well.

Furthermore, some of the concerns voiced by supporters of a moratorium are somewhat unfounded. While safety risks are a valid concern, the argument that the global economy is unprepared to handle the economic implications lacks evidence. The technology is indeed likely to have a profound impact on the economy, but this is not necessarily a negative consequence nor is it exclusive to synthetic biology. Any novel technology will alter the state of the economy and availability of specific job opportunities. This is not grounds for a moratorium: technology and society evolve together and adapt to suit new needs. Even so, while jobs in one industry are eliminated, job opportunities in the biotechnology industry might grow. These jobs could even offer higher pay and require more technical skills, which is a potentially positive consequence.

Another concern, which does not warrant a moratorium, is the destructive capacity of synthetic biology. Necessary precautions to limit the potential harm facilitated by synthetic biology are sufficient for dealing with this possible threat. After all, those intending harm will find a way to do so regardless of the available technology. One could compare this situation to nuclear technology: while splitting the atom was an important scientific pursuit, it yielded the atomic bomb. Ultimately, however, those who use the bomb are responsible for their actions, not the scientists who intended to further human understanding. The potential for abuse of synthetic biology is a reason for scientists and engineers to research ethically and carefully, rather than stop altogether. Moreover, if those who would use this technology for harm were to continue their research in order to do so, it would be best if well-intentioned people had the skills and knowledge to combat those goals.

Proponents of the moratorium have also put forward the argument that because synthetic biology has the potential to impact the entire world, then the world is made up of stakeholders who must consent to allowing this research. This is an unreasonable demand, as so many things- technology, laws, publications- affect the world in a profound manner. Insisting on a democratic consensus before pursuing this research is a gross limitation on liberty.

The most legitimate concern of this debate is whether synthetic biology is unsafe. In the end, this fundamentally boils down to an argument over John Mill's harm principle, articulated in his essay *On*

Liberty, which argues that “the only purpose for which power can be rightfully exercised over any member of a civilized community, against his will, is to prevent harm to others” (Mill 1869). Thus, in a society that values liberty, Mill essentially defines liberty to be freedom to do anything, so long as it does not interfere with another person’s freedoms. Most relevant in the context of this debate is prospective harm to the public, which Robert McGinn, Stanford STS scholar, articulates as: “the liberty of an agent may (possibly) be coercively restricted/limited if doing so is reasonably necessary to prevent injury or harm to institutions or ‘common goods’ putatively in the public interest, or to prevent situations from occurring that would pose an unreasonable risk of such harm’s being done” (McGinn 2011). Does synthetic biology research pose an unreasonable risk of harm, and if so, is a moratorium reasonably necessary to prevent those risks? Synthetic biology may pose an unreasonable risk if we consider the release of synthetic organisms into the environment. However, if we were to pursue only contained research while simultaneously investigating the possible risks and solutions associated with releasing novel organisms into the environment, then a moratorium would not be necessary, as containment would minimize risks. The growing field of synthetic biology has not yet reached a stage of uncontained research, and containment problems with synthetic biology are no worse than with other forms of biological research that, for example, investigate deadly viruses.

At this point, the potential benefits of synthetic biology research far outweigh the associated risks, and the exploration of this field of research is not radically different from past or current genetic engineering research. Until evidence arises that synthetic biology poses a real harm to society, I oppose a moratorium on synthetic biology research, in favor of self-regulation of the field.

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