The Effects of Synthetic Biology

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Abstract

This paper explores the concept of synthetic biology and the potential effects it can have on the world. While it talks about some of the associated benefits, it mainly goes into discussion on the negative effects and harmful consequences that synthetic biology may possess on our society, health, and the health of our environment. Specifically, this paper goes over how synthetic biology can negatively affect small farmers, the unpredictable health and environmental health concerns, and the idea of "playing God".

Introduction

Synthetic biology is a growing scientific process that refers to both the design and fabrication of biological systems and components that do not already exist in the natural world and the re-design and fabrication of existing biological systems. There are two types of synthetic biologists that perform different tasks; the first group uses unnatural molecules to mimic natural ones with the ultimate goal of creating artificial life, while the second group uses natural molecules and assembles them into a system that acts unnaturally. The ultimate goal of synthetic biology is to solve problems that are not easily understood through simple analysis and observation alone; these problems can only be solved through the manifestation of new models (syntheticbiology.org, par 1). Synthetic biology can work to potentially solve many problems, one of these being the ability to feed people more easily with the creation of artificial lifeforms, and making food more accessible to those who can't easily access it. The promise of this technology is that scientists will be able to employ this type of genome synthesis to create these artificial lifeforms that can provide a wide variety of functions. However, the promises that come with synthetic biology have the same effect as the perils and problems that can be presented with this form of technology. Synthetic biology is an extreme form of genetic engineering that is developing rapidly and entering the marketplace. Like traditional GMOs, the products of synthetic biology are virtually unregulated, have not been assessed adequately for impacts on our health or environment, and are not required to be labeled (Friends of the Earth, par 1). This leads many skeptics to question whether or not the benefits of synthetic biology are really worth all of the associated risks. If synthetic biology becomes more accepted, we could see many problems, some of which include disrupting the livelihood and business of thousands of small farmers, unknown and unexpected health and environmental consequences, and the tale as old as time concept of "playing God".

Case Study: Artemesinin and Synthetic Biology

In a case study done in July of 2014, researchers studied the certain developments in synthetic biology that could potentially disrupt the livelihood of thousands of small farmers who cultivate Artemisia. These developments have a great impact on the sustainable use of biodiversity and equitable sharing of benefits from these such genetic resources that produce natural plant products. If biosynthesis of artemisinin can successfully be scaled up, in the future, pharmaceutical companies will source their supply of artemisinin from microbial cell factories rather than the farmers in Asia and Africa. This will obviously possess a huge threat on these farmers, as their small Artemisia farms are their sole source of income. Artemisinin is just one example of a raw material that could potentially be developed with the use of synthetic biology. It has been estimated that at least 50% of today's commercial pharmaceutical compounds are derived from certain plants, animals and other microorganims. As of now, seven of the ten largest pharmaceutical companies have created partnerships with synthetic biology companies to develop synthetic biology production routes for pharmaceuticals which were previously obtained through botanicals produced by the Asian and African farmers. Artemisia, as well as other products produced by these farmers such as vanilla, when produced via synthetic biology is able to be sold to pharmaceutical companies at a lower price, which many of the farmers see as unfair (Case Study: Artemisinin and synthetic biology). If synthetic biology ends up taking over, this will put thousands of small farmers out of business and create many economic difficulties.

Unknown Health Consequences

Synthetic biology could potentially pose serious health effects not only on people and ecosystems, but also on our planet's biodiversity and communities that sit on the front lines of

corporations' plans to enforce these new technologies and created organisms for profit. According to Friends of Earth, the U.S. government as well as many major oil and chemical companies have already begun making big donations towards synthetic biology research, which has provided millions of dollars to start-up these synthetic biology companies. Supporters of this technology maintain hope that this emerging field will create a new "bioeconomy" in just about every type of plant matter that can feed synthetic organisms that will be "living factories" which could produce fuels, industrial chemicals, bio-plastics, certain medications and even food (par 4). However, while all of this sounds great and can obviously lead to a big impact in these fields, there are many problems that are posed with this science, especially with regards to the creation of “artificial life”, or synthetic organisms that are in talks of being produced. The potential interactions of synthetic organisms with the natural environment are extremely unpredictable and can lead to adverse effects that can pose permanent and devastating outcomes on our environment. While other types of pollution can be cleaned up and do not breed, synthetic biological creations are designed to self-replicate and, once they are released into the environment, they will be impossible to recall. A synthetic organism designed for a specific task, such as eating up oil spills in the ocean, could in theory swap genes with naturally occurring organisms and overpower them (this is a survival of the fittest type effect), which could lead to a disruption of the entire ecosystem with the addition of a new class of species (Friends of Earth, par 7). Before synthetic biology is fully employed, scientists need to study these harmful effects that can damage our environment and society. Extreme precautions must be taken place before scientists decide to make such a drastic decision that could have major impacts on the world as we know it.

The Future of Food: Science Fiction or Nature?

In Wenonah Hauter's book, *Foodopoly: The Battle Over the Future of Food and Farming in America*, she explores many different factors that influence the way our food is grown in America, and the health impacts and consequences they can have on us. One of the topics she explores later in her book is the idea of synthetic biology; she has a very strong opinion on this type of technology, which is a strong opposition to synthetic biology, especially with regards to "artificial life". Hauter describes the scientists behind the idea of creating artificial lifeforms as "a new breed that believes so deeply in his own abilities that he is willing to make humankind a guinea pig as he seeks to outdo nature in producing synthetic organisms for food" (page 264). There are many scientists like this who are interested in synthetic biology, apparently for the sake of solving many problems such as world hunger, however, Hauter makes it clear in her book that these scientists are merely seeking out a profit for themselves, rather than seeking to make a positive impact in the world. The Synthetic Biology Project is an emerging field of study which takes science and combines it with engineering with the hopes to redesign living organisms for food and industrial uses. The proponents of this study believe that man-made genetic codes are the next step that goes above and beyond selectively breeding animals to increase their productivity for basic human needs. And because most people are unaware of this growing technology, it seems that the future of the world is being decided for us (Hauter, page 265). Because of the unknown consequences of this technology and the fact that most people don't even know of its existence, Wenonah Hauter believes that the idea of using synthetic biology to create artificial lifeforms is unethical and can produce many damaging consequences.

Unpredictable Environmental Consequences

Wenonah Hauter also goes on to describe that because synthetic biology is unregulated and self-governing, nobody really has a clear understanding of what could potentially occur

when these synthetic organisms are released intentionally and unintentionally in the environment. The creation of genes that are nonexistent in nature is extremely dangerous and there is no way to predict how these organisms will behave in these new living systems. Intentionally meddling with genetic material can have unpredictable and unintended major consequences in both our ecosystem and the natural environment alike (Hauter, page 266). Wenonah Hauter explains the potential affects these instances of manmade genetic material being released into the environment can have by using an example of GE salmon. Just a small number of GE salmon could cause the extinction of wild populations because of their competitive advantage as big and powerful fish. These GE salmon could easily out-compete with other wild fish for habitat and food. They could also spread disease to wild populations because of the hostile environment in which they were raised in. In March 2010, nearly one hundred thousand farmed Atlantic salmon escaped into the wild through a hole in a fishing net at a UK fishing farm; and this is not the only instance of these types of events; millions of farmed salmon escape into North Atlantic waters every year, endangering species such as wild Atlantic salmon (Hauter, page 272-273). It is clear that there are real hazards involved with synthetic biology. These hazards must be addressed and fixed before these farmed organisms are released in the environment, if they should even be released at all.

Playing God? Synthetic Biology as a theological and ethical challenge

The idea of "playing God" has accompanied basically every advancement that has been made in biotechnology since its beginnings. Almost every step forward in research has provoked some type of extreme protest against the disregarding of creation. Just some of these protests and disapprovals have been against anesthesia against pain, birth control, transplantation, stem cell research, genetic engineering, and now synthetic engineering. Religious groups often have a

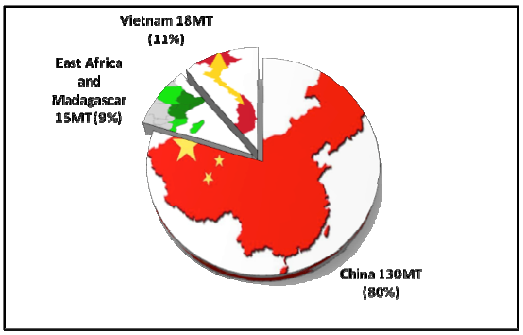
hard time grasping the idea of biotechnology because they see it as sinful for man to create or destroy lifeforms, as they see this as the job of God, and God alone. It is unlikely that a proponent of synthetic biology would be unable to change the beliefs of a hardcore Christian, as they seem to be set in stone with what they choose to believe in (Dabrok, par 2). Synthetic biology, should not be seen as sinful, and probably to a large amount of people is not seen as that way. Research and applications in this field have obviously become misled by the power of sin and thus have resulted in failure for the admiration of synthetic biologists from this group (Dabrok, par 29). Religion is a very important aspect in society, so it is important that religious concerns are also addressed with the ideas of synthetic biology. In order for an idea to take off, everyone needs to be on board, and to get everyone on board, it is important that the scientists behind synthetic biology present the benefits that this technology can provide. However, before this technology can be applied to society, it is extremely crucial that all of the problems that can arise from synthetic biology be addressed and solved through continued research.

Conclusion

Synthetic biology can be seen as a great alternative to solving many problems in our world. By analyzing and observing new concepts, synthetic biology has the potential to give us a better understanding in ways in which we may solve global concerns such as world hunger. However, before this technology can be applied fully, scientists must continually research and fix the potential adverse effects that may arise from the creation of these organisms. Specifically, scientists must address the threats that this technology can pose on small farmers, the unexpected health and environmental consequences that may arise, and the idea that synthetic biology is nothing more than scientists simply “playing God”. If these problems can be

addressed and improved upon, then synthetic biology could become an extremely influential factor in dealing with many problems we face in this world.

Pictures



Above are the countries of small farmers that produce Artemisia crops; these countries will be affected by the takeover of synthetic engineering in producing these crops.
http://www.etcgroup.org/sites/www.etcgroup.org/files/case1.png

Man-made DNA strands are the result of synthetic biology, and are used in the creation of artificial life.
http://www.foe.org/system/storage/877/2e/4/328/DNA_Lab_website.jpg

Many people view the creation of man-made DNA strands as simply "playing God".
http://www.dailygalaxy.com/photos/uncategorized/2007/06/21/2407ld1.jpg

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