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Information Bulletin

Synthetic Biology

What is synthetic biology?

Synthetic biology is a relatively new and rapidly evolving interdisciplinary area of scientific research that focuses on the design and fabrication of biological organisms that don't already exist in the natural world. Synthetic biology may also be applied to the re-design and fabrication of existing biological organisms.

Why use synthetic biology?

Synthetic biology can be used to better understand complex biological processes involving DNA, cells, organisms, and biological systems. Recent technological advances in reading, writing and editing genomes have provided synthetic biologists the necessary tools to engineer or re-engineer living organisms and answer research questions that are challenging to address using conventional methods and techniques.

Synthetic biology is used to create and produce organisms that can help produce energy sources, clean up the environment and find new ways to manufacture medicine. Synthetic biology can also be used to recreate existing products such as milk and meat in cleaner, faster, less expensive and more environmentally sustainable ways.

What products are made today using synthetic biology?

Insulin
Arguably, the best example of synthetic biology is the production of synthetic insulin, which started in 1978. Produced predominantly using bacteria and yeast for therapeutic use in human, synthetic insulin has immensely benefited the diabetic population around the world.

Artemisinin
Another success story for synthetic biology is the large-scale production of artemisinin, the key ingredient in the most effective anti-malaria drugs. *Artemisinin* was first isolated from the sweet wormwood plant. However, the supply is limited due to difficulties in cultivating sweet wormwood. Synthetic biologists were able to engineer a yeast that produced artemisinin at a much lower cost and in greater volume.

Biofuels
Scientists have also engineered yeast to produce the biofuel *farnesene*. This hydrocarbon is energy dense enough to be used as aviation fuel and does not emit particulates and sulfur when burned.

Other synthetic biologists are attempting to engineer algae to be a cheaper and environmentally friendly method to produce biofuels. Algae would only require the use of briny water and sunshine to produce biofuel.

Cosmetics
In addition to its use as a biofuel, *farnesene* produced by yeast can be used to make personal-care products such as vitamin E, patchouli oil and squalene, a naturally occurring chemical compound that is a major component of skin moisturizers. *Farnesene* and other similar chemicals are also used to create popular natural smells and fragrances.

Environmental Sensors and Bioremediation
It is estimated that more than 200 million people drink water from wells contaminated with arsenic. Scientists are engineering bacteria that can sense trace amounts of arsenic in well water with the aim of producing safe, precise, easy-to-use test kits to detect arsenic in the field.

Other microorganisms are being developed to help clean up radioactive soil and oils spills, absorb heavy metals from contaminated ground and digest plastics.

Synthetic Food and Materials
Scientists have engineered yeast to produce all the components necessary to create synthetic milk and are also beginning to grow synthetic meat. These products could help alleviate animal welfare issues, address concerns about the impact of farm animals on the environment while providing meat and dairy products to areas that can't support the raising of farm animals. Other materials produced through synthetic biology include spider silk, non-animal leather, and particle board.

Is synthetic biology safe?

The ability of scientists to modify or engineer genes and genomes to create synthetic or engineered organisms and products has raised several societal concerns. Despite the success and public acceptance of life-saving synthetic drugs to fight diseases, such as diabetes, malaria and cancer, there remains concerns and skepticism about the broader use and impact of synthetic biology — particularly, around synthetic organisms.

Some groups believe that there should be a moratorium on the release and commercial use of synthetic organisms and stronger regulation on the tools used in synthetic biology research.

Others, including researchers, companies and regulators, believe that the current regulatory framework in place for other areas of biotechnology such as genetically engineered organisms can serve as a basis for the regulation of synthetic biology.

However, recognizing that potential synthetic biology products may have both positive and negative impacts, synthetic biologists have developed a series of guidelines for ethical and self-regulated research.

Societal concerns with synthetic biology

Synthetic biology has raised several societal, ethical and environmental concerns. These range from: the impact of synthetic organisms on humans and environment; biocontainment of engineered organisms; and the use a bioweapons.

In addition, concerns have been raised about how synthetic biology could harm or contradict deeply held beliefs and worldviews about what is right or good with respect to conceptions of fairness, equity, progress and our relationship with the natural world.

Some of these ethical questions are:

- Who will control the synthetic organisms?
- Is it appropriate to own a patent on a living organism?
- Will everyone have equal access to the benefits if synthetic biology produces cures for diseases or chronic health issues?
- Should synthetic biology be used to enhance human traits and capabilities?
- What would happen to farmers, and other producers whose natural products are replaced by synthetic organisms?
- Are humans crossing some type of moral barrier when redesigning organisms with synthetic biology techniques?

Synthetic biology researchers, social scientists, policy makers and regulators have come to understand that society needs to participate in the discussion regarding the use of synthetic biology to understand the tradeoffs between the potential benefits and harms.

Resources

https://www.youtube.com/watch?time_continue=126&v=mlOFE9-3CN0

http://buildingwithbiology.org/about-syn-bio

https://cosmosmagazine.com/biology/life-2-0-inside-the-synthetic-biology-revolution

https://www.genome.gov/27571877/synthetic-biology/

http://engineeringbiologyresearchconsortium.org/what-is-synthetic-engineering-biology/

http://www.synbioproject.org/

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