Synthetic biology needs robust safety mechanisms before real world application

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Targeted cancer treatments, toxicity sensors and living factories: synthetic biology has the potential to revolutionize science and medicine. But before the technology is ready for real-world applications, more attention needs to be paid to its safety and stability, say experts in a review article published in *Current Opinion in Chemical Biology*.

Synthetic biology involves engineering microbes like bacteria to program them to behave in certain ways. For example, bacteria can be engineered to glow when they detect certain molecules, and can be turned into tiny factories to produce chemicals.

Synthetic biology has now reached a stage where it's ready to move out of the lab and into the real world, to be used in patients and in the field. According to Professor Pamela Silver, one of the authors of the article from Harvard Medical School in the US, this move means researchers should increase focus on the safety of engineered microbes in biological systems like the human body.

"Historically, molecular biologists engineered microbes as industrial organisms to produce different molecules," said Professor Silver. "The more we discovered about microbes, the easier it was to program them. We've now reached a very exciting phase in synthetic biology where we're ready to apply what we've developed in the real world, and this is where safety is vital."

Microbes have an impact on health; the way they interact with animals is

being ever more revealed by microbiome research - studies on all the microbes that live in the body - and this is making them easier and faster to engineer. Scientists are now able to synthesize whole genomes, making it technically possible to build a microbe from scratch.

"Ultimately, this is the future - this will be the way we program microbes and other cell types," said Dr. Silver. "Microbes have small genomes, so they're not too complex to build from scratch. That gives us huge opportunities to design them to do specific jobs, and we can also program in safety mechanisms."

One of the big safety issues associated with engineering microbial genomes is the transfer of their genes to wild microbes. Microbes are able to transfer segments of their DNA during reproduction, which leads to genetic evolution. One key challenge associated with synthetic biology is preventing this transfer between the engineered genome and wild microbial genomes.

There are already several levels of safety infrastructure in place to ensure no unethical research is done, and the kinds of organisms that are allowed in laboratories. The focus now, according to Dr. Silver, is on technology to ensure safety. When scientists build synthetic microbes, they can program in mechanisms called kill switches that cause the microbes to self-destruct if their environment changes in certain ways.

Microbial sensors and drug delivery systems can be shown to work in the lab, but researchers are not yet sure how they will function in a human body or a large-scale bioreactor. Engineered organisms have huge potential, but they will only be useful if proven to be reliable, predictable, and cost effective. Today, engineered bacteria are already in clinical trials for cancer, and this is just the beginning, says Dr. Silver.

"The rate at which this field is moving forward is incredible. I don't

know what happened - maybe it's the media coverage, maybe the charisma - but we're on the verge of something very exciting. Once we've figured out how to make genomes more quickly and easily, synthetic biology will change the way we work as researchers, and even the way we treat diseases."

More information: "Synthetic biology expands chemical control of microorganisms" by Tyler J Ford and Pamela A Silver (DOI: 10.1016/j.cbpa.2015.05.012). The article appears in *Current Opinion in Chemical Biology*, Volume 28 (October 2015)

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