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Researchers creating life from scratch

'Synthetic biologists' build with one genetic molecule at a time

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BERKELEY, Calif. - They're called "synthetic biologists" and they boldly claim the ability to make never-before-seen living things, one genetic molecule at a time.

They're mixing, matching and stacking DNA's chemical components like microscopic Lego blocks in an effort to make biologically based computers, medicines and alternative energy sources. The rapidly expanding field is confounding the taxonomists' centuries-old system of classifying species and raising concerns about the new technology's potential for misuse.

Though scientists have been combining the genetic material of two species for 30 years now, their work has remained relatively simplistic.

Scientists might add one foreign gene to an organism to produce a drug like insulin. The technique is more art than science given the brute trial-and-error it takes to create cells that make drugs.

So a new breed of biologists is attempting to bring order to the hit-and-miss chaos of genetic engineering by bringing to biotechnology the same engineering strategies used to build computers, bridges and buildings.

The idea is to separate cells into their fundamental components and then rebuild new organisms, a much more complex way of genetic engineering.

The burgeoning movement is attracting big money and some of the biggest names in biology, many of whom are attending the "Life Engineering Symposium" that begins Friday in San Francisco.

"Synthetic biology is genetic engineering rethought," said Harvard Medical Center researcher George Church, a leader in the field. "It challenges the notion of what's natural and what's synthetic."

Already, synthetic biologists have created a polio virus and another smaller virus by stitching together individual genes purchased from biotechnology companies.

Now, researchers are getting closer to creating more complex living things with actual utility.

In Israel, scientists have created the world's smallest computer by engineering DNA to carry out mathematical functions.

J. Craig Venter, the entrepreneurial scientist who mapped the human genome, announced last month that he intends to string together genes to create from scratch novel organisms that can produce alternative fuels such as hydrogen and ethanol.

With a $42.6 million grant that originated at the Bill and Melinda Gates Foundation, Berkeley researchers are creating a new malaria drug by removing genetic material of the E. coli bacterium

and replacing it with genes from wormwood and yeast.

"We're building parts that can be assembled into devices and devices that can be turned into systems," said Jay Keasling, head of the Lawrence Berkeley National Laboratory's Berkeley synthetic biology department, which was created last year.

Keasling, who doubles as a chemical engineering professor at the University of California, Berkeley, hopes to create never-before-seen living molecules by fusing genes from the three species — a new breed of bacteria capable of spitting out malaria-fighting artemisinin, a chemical now found only in small traces in the wormwood plant.

Artemisinin has been extracted from finely ground sweet wormwood for more than 2,000 years as a treatment for a variety of ailments, but the method is expensive, time consuming and limited by access to wormwood, which is found mainly in China and Vietnam.

Keasling has a similar project in the works to synthetically create a compound now found in Samoan trees, one that shows promise in fighting AIDS.

Such efforts are attracting more than grant money.

A group of topflight venture capitalists led by Vinod Khosla of the Menlo Park-based Perkins, Caufield & Byers invested $13 million in Codon Devices of Cambridge, Mass., which was co-founded by Keasling and Church. Keasling also co-founded Amyris Biotechnologies of Emeryville to build microbes that will produce novel or rare drugs.

Venter, meanwhile, has launched Synthetic Genomics Inc. with Nobel laureate Hamilton Smith and will compete with Codon and several other recent startups to commercialize the technology.

Ethical questions

But with success also comes ethical questions. For example, national security experts and even synthetic biologists themselves fret that rogue scientists or "biohackers" could create new biological weapons — like deadly viruses that lack natural foes. They also worry about innocent mistakes — organisms that could potentially create havoc if allowed to reproduce outside the lab.

"There are certainly a lot of national security implications with synthetic biology," said Gigi Kwik Gronvall, a researcher at the University of Pittsburgh's Center for Biosecurity.

Researchers are casting about for ways to self-police the field before it really takes off. One solution could be to require the few companies that sell genetic material to register with some official entity and report biologists who order DNA strains with weapons potential.

The Arthur P. Sloan Foundation in June awarded the Venter Institute, the Massachusetts Institute of Technology and the Center for Strategic and International Studies a $570,000 grant to study the social implications of the new field.

"There are a cascade of ecological issues," said Laurie Zoloth, a bioethics professor at Northwestern University. "Synthetic biology is like iron: You can make sewing needles and you can make spears. Of course, there is going to be dual use."

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