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Regenesis

Matthew Herper, 04.18.06, 6:00 PM ET NEW YORK

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Four billion years ago, the first simple life emerged in Earth's oceans, setting in motion a process driven by Darwinian competition and pure dumb luck that resulted in everything from E. coli to oak trees, from tyrannosaurs to people.

What if we could just yell "do-over"?

There are literally trillions of ways evolution could have gone differently. Some dinosaurs were pretty smart, evolving pack behavior and caring for their young. If every triceratops and velociraptor had not been wiped out 65 million years ago, would a civilization of sauropods walk the earth? It's certainly possible but the potential for change goes back further, to the very structure of DNA. The very make-up of the cell is malleable.

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Synthetic Biology
A Better Plan For Man
Poll: What adaptation would you most like to have?

In fact, many other types of life might exist. Robert Hazen, a geologist at George Mason University and author of *Gen-e-sis: The Scientific Search for Life's Origins*, points out that an estimated hundred billion trillion (that's a one with 22 zeroes) planets may support life in the universe. "Is it not possible," Hazen asks, "that every possible outcome is out there?"

Questions about how much biology can be tweaked are neither merely academic nor just fodder for science fiction. Researchers are now working to re-build DNA, proteins and even cells in a new field called synthetic biology. It's a vein of science potentially as exciting as the recombinant DNA technology that led to the founding of biotech giants such as **Amgen** (nasdaq: AMGN - news - people) and **Genentech** (nyse: DNA - news - people).

Already, privately held companies are being founded with lofty goals. **Codon Devices** of Cambridge, Mass., hopes to play **Intel** (nasdaq: INTC - news - people) to the field, making the basic tools that will be used by a whole generation of synthetic biologists. **Amarys Biotechnologies** of Emeryville, Calif., is engineering cells that

could help produce cheap anti-malaria drugs. **Synthetic Genomics**, a Rockville, Md., firm founded by J. Craig Venter, best known for mapping the human genome at **Celera**, is looking to use the technology for environmentally friendly manufacturing. The only limits of this new technology, in a sense, were established 3.8 billion years ago when the first one-celled life came into being.

Exactly what happened then, of course, is still an open question. In 1953, chemist Stanley Miller showed that just running electricity through a soup of basic chemicals created the kinds of complex proteins needed for life. But assembling these proteins into an actual living thing is apparently no easy task. Certainly, no one has done it in the lab.

But there is a theory on how it could have happened. To get things started, a single molecule just has to start copying itself. Slowly, it will crowd out molecules that are just being created randomly. Any slight change that makes the self-copier better at replicating itself will have a similar effect. Fairly soon, geologically speaking, this original molecule would have turned itself into something that's really good at copying itself--a bubble of self-replicating biological material, otherwise known as a cell. At that point, evolution had begun.

There is even a likely candidate for the molecule that could have set things in motion: ribonucleic acid, or RNA. In our cells, RNA is used to ferry information between DNA, which contains the genetic code, and machines called ribosomes that make proteins. But it is possible that RNA once did the work of genes and proteins, too--that first living things were made only of RNA. In 1983, Thomas Cech, now president of the Howard Hughes Medical Institute, created an RNA that could copy itself if given raw material--a feat that won him the Nobel Prize.

Cech's discovery led support to the idea that the first life form was RNA. Walter "Wally" Gilbert, a Harvard biologist and the first chairman of **Biogen** (nasdaq: BGEN - news - people), coined the term "RNA world" to describe the theory. "It doesn't prove that's the way life originated," says Cech, "but if you could get something to work in the laboratory, it's at least plausible."

Everything after that point may be up for grabs--even the structure of DNA. Synthetic biologists have created DNA chains that function, but are made of different sugars and acids than the stuff in our cells. It's even possible that DNA-like molecules could work in ammonia, not water. The number of basic amino acids used to make proteins may also be flexible--just because we're stuck with 20 doesn't mean that's how it has to be. From there on out, there's no reason tons of things couldn't have happened differently.

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