

PRESS RELEASE

SCIENTISTS ANNOUNCE AN ARTIFICIAL CHEMICAL SYSTEM CAPABLE OF DARWINIAN EVOLUTION

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Scientists from the Foundation for Applied Molecular Evolution (FfAME) and the Westheimer Institute for Science and Technology in Gainesville Florida announced today that they have taken the next steps towards a synthetic biology. Presenting their work at the annual meeting of the American Association for the Advancement of Science in Chicago, Dr. Steven Benner described the first example of artificial genetic system was capable of supporting Darwinian evolution. The presentation occurred at a session covering "Weird Life", which refers to life different from what we might know already on Earth. The symposium marked the 200th anniversary of the birth of Charles Darwin.

Natural DNA (deoxyribonucleic acid) is the molecule that supports life on Earth. That molecule is built from four building blocks, or "nucleotides". These nucleotides are represented by four letters, A, T, G, and C, where the sequence of those letters in a gene determines what that gene means. When we inherit that information from our parents, DNA is copied according to simple rule (A pairs with T in the double helix, while G pairs with C).

"Darwinian evolution occurs only because natural copies of DNA are imperfect, and because those imperfections themselves can be copied," explained Dr. Benner. "Sometimes the mutations arising from imperfect copying make the child less fit to survive. Sometimes, however, those mutations make the child *more* fit to survive, especially when the environment is changing. In this case, natural processes select the mutation, and the species as a whole can improve itself to meet new challenges to its survival."

For twenty years now it has been possible to get DNA to evolve in a test tube, Dr. Benner explained. A process known as the "polymerase chain reaction" (of PCR) allows DNA to make copies of itself, and then to have the copies copied, and then to have the copies of the copies copied, and so on. The copying in a PCR is imperfect, and the mistakes cause mutations that themselves can be copied. Therefore, DNA can evolve in a test tube.

The advance reported by FfAME scientists in Chicago involves the application of PCR technology to an artificial synthetic genetic system. The synthetic genetic system was built from six different nucleotides, two more genetic letters than are found in natural DNA. While artificial genetic systems have been described by these scientists previously, the new results showed for the first time that PCR can be done with an indefinite number of unnatural synthetic nucleotides, various mutation processes can occur in the PCR at a low, but significant rate, the artificial genetic alphabet could support replications over dozens of copying cycles, and the reasons for mutations interconverting standard and synthetic nucleotides are understood.

"Scientists are excited about incremental advances," said Dr. Benner. "While genetic alphabets have been examined in the past as binding molecules, and single artificial nucleotides have been incorporated into synthetic genetic systems that have been copied, this is the first time where multiple artificial nucleotides have been so incorporated, where repeated copying with mutation does not lose the artificial nucleotides, and where we understand how we get the mutations that we observe."

Dr. Benner cautioned that this does not mean that synthetic life had been created. Referring to his upcoming book entitled *Life, the Universe and the Scientific Method*, Dr. Benner listed alternative theories of life, including cell theory, gene theory, and evolutionary theory that underlie the thinking of current biologists about what makes life life. In addition to these, the use of carbon compounds in water, the ability to metabolize those compounds, and the ability to be self sustaining are also considered important or essential to life by many in the biological community.

"There is a sliding scale of criteria that will be applied by the community to decide when synthetic biology has been achieved. A NASA panel recently defined 'life' to be a self-sustaining chemical system capable of Darwinian evolution. While the chemical system that we have synthesized is certainly capable of Darwinian evolution, it is not self-sustaining. Further, it is not encapsulated by a cell and does not do its own metabolism. We would certainly not talk about synthetic biology until the system is self-sustaining and does not rely on as many proteins from the natural world to work. Some in the community would set the bar higher, requiring the system also to have a cell, make its own food from simpler organic molecules, and to evolve in response to natural challenges. If all of these properties were present, however, this would be widely regarded as a synthetic life form. But we are far from that point."

Nevertheless, this system is presently being incorporated into diagnostics tools to detect infectious diseases, cancers, and mutations that cause cystic fibrosis, as well as to support high throughput sequencing of genes. This work was supported by NASA, the National Institutes of Health, and private donors.

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