Researchers Resurrect Four-Billion-Year-Old Enzymes, Reveal Conditions of Early Life on Earth

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Newswise — New York, New York – A team of scientists from Columbia University, Georgia Institute of Technology and the University of Granada in Spain have successfully reconstructed active enzymes from four-billion-year-old extinct organisms. By measuring the properties of these enzymes, they could examine the conditions in which the extinct organisms lived. The results shed new light on how life has adapted to changes in the environment from ancient to modern Earth.

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Description

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Citations

Nature Structural and Molecular Biology (April 3, 2011)

In their study, published in the journal *Nature Structural & Molecular Biology*, the researchers used vast amounts of genetic data to computationally reconstruct the genes of extinct species, a technique known as ancestral sequence reconstruction. The researchers then went a step further and synthesized the proteins encoded by these genes. They focused their efforts on a specific protein, thioredoxin, which is a vital enzyme found in all living cells.

Dr. Julio Fernandez, professor in Columbia's Department of Biological Sciences, and his team conducted a detailed biophysical analysis of the reconstructed thioredoxin enzymes, using ultra-high resolution atomic force microscopy methods. "Given the ancient origin of the reconstructed thioredoxin enzymes, with some of them predating the buildup of atmospheric oxygen, we expected their catalytic chemistry to be simple," said Dr. Fernandez, "Instead, we found that enzymes that existed in the Precambrian era up to four billion years ago possessed many of the same chemical mechanisms observed in their modern day relatives."

Further examination of the ancient enzymes by Dr. Jose Sanchez-Ruiz' group at the University of Granada in Spain revealed some striking features; the enzymes were highly resistant to temperature and were active in more acidic conditions. The findings suggest that the species hosting these ancient enzymes thrived in very hot environments that since then have progressively cooled down, and that they lived in oceans that were more acidic than today.

"By resurrecting proteins, we are able to gather valuable information about the adaptation of extinct forms of life to environmental alterations that cannot be uncovered through fossil record examinations," said Dr. Eric Gaucher, an expert in ancestral sequence reconstruction at the Georgia Institute of Technology.

The researchers are now looking to apply their strategy to other enzymes to get a clearer picture of what life was like on early earth.

The work could have applications in biotechnology, where enzymes are playing an increasing role in many industrial processes. “The unique features we observe in the ancestral enzymes show that our technique could be adapted to generate enhanced enzymes for a wide range of applications,” remarked Pallav Kosuri, a graduate student and part of the team at Columbia University. “If we learn to harness these extinct features, we could potentially improve the efficiency of important processes such as the generation of biofuels,” he added. Columbia Technology Ventures, the technology transfer office at Columbia University, is working with the scientific team to explore commercial applications of the discoveries.

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