Molecular Biologists Uproot the Tree of Life

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One of science's most popular metaphors — the "tree of life," with its evolutionary branches and roots, showing groups of bacteria on the bottom and multicellular animals on the higher branches — turns out to be a misnomer, UCLA molecular biologists report in the Sept. 9 issue of the journal Nature. "It's not a tree; it's actually a ring of life," said James A. Lake, UCLA professsor of molecular biology. "A ring explains the data far better." Lake initially titled the Nature article, "One Ring to Rule Them All." The ring of life has significant implications for eukaryotes (cells with nuclei), the group that includes all multicellular forms of life, such as humans, animals and plants.

"Through the use of genomics, we show that the fusion of two prokaryotes — a life form that does not have a cellular nucleus — created the first eukaryote," Lake said. "There have been theories, but we have never known where eukaryotes came from before. Eukaryotes inherited two sets of genomes from very different prokaryotes."

One prokaryote ancestor branches from deep within an ancient photosynthetic group of microscopic single-celled bacteria called the proteobacteria. The group is primarily photosynthetic, but today also includes non-photosynthetic E. coli and human pathogens. The other group is related to the archaeal prokaryotes, some members of which today can live at temperatures hot enough to boil water (160–230 degrees Fahrenheit) and can be found in hot sulfur springs and geothermal ocean vents worldwide.

"At least 2 billion years ago, ancestors of these two diverse prokaryotic

groups fused their genomes to form the first eukaryote, and in the processes two different branches of the tree of life were fused to form the ring of life," Lake said. "A major unsolved question in biology has been where eukaryotes came from, where we came from. The answer is that we have two parents, and we now know who those parents were.

"If we go back a hundred billion generations, our ancestor was not a human, and wasn't even a primate," Lake added. "But we are distantly related to archaeal eocyte- and proteobacterial-ancestors, just as we are related to our parents and grandparents."

The research, based on an analysis of more than 30 genomes, was federally funded by the National Science Foundation, the Department of Energy, the National Institutes of Health and NASA's Astrobiology Institute.

Lake conducted the research with Maria C. Rivera, a research scientist in UCLA's department of molecular, cell, and developmental biology, and UCLA's astrobiology program. They made new algorithms, conducted a detailed mathematical analysis and studied the evolution of genomes.

"We followed the genes that make up organisms through time, and saw the fusion of organisms," Lake said. "As we learn more about the organisms that came together, we will learn more about their genetic background. The ring will lead to a better understanding of eukaryotes."

Source: UCLA