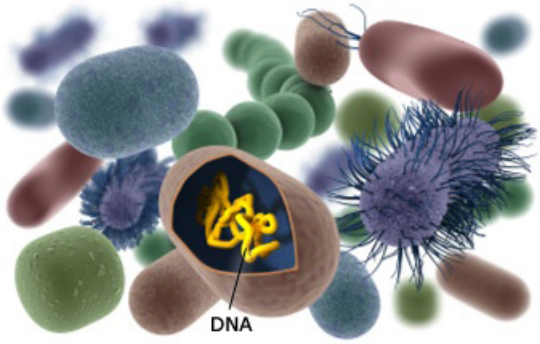
The Evolution of the Cell

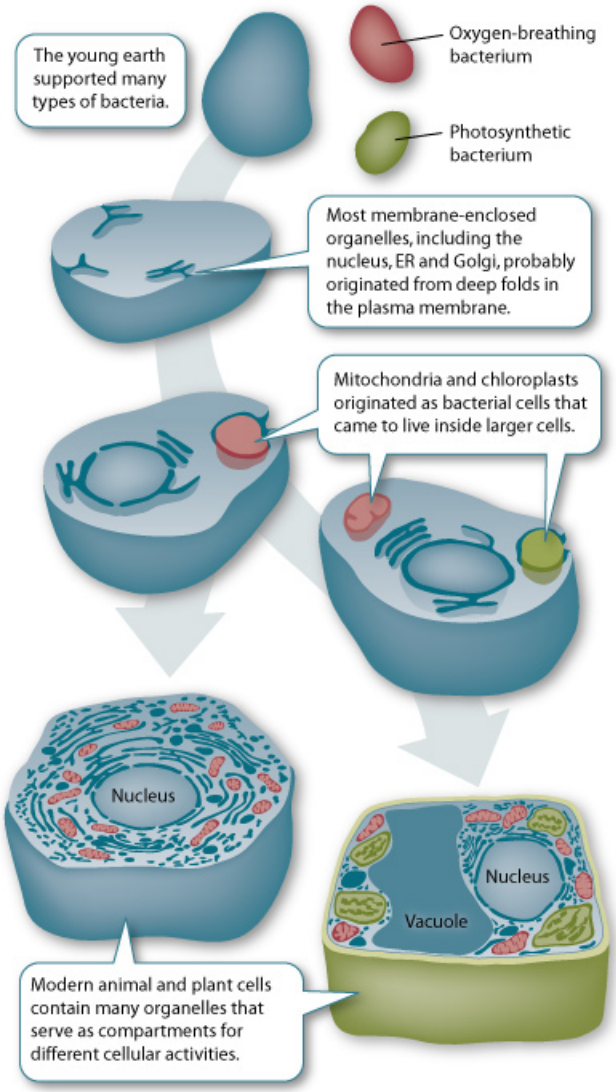
The Cells That Changed the Earth

Some of the oldest cells on Earth are single-cell organisms called bacteria. Fossil records indicate that mounds of bacteria once covered young Earth. Some began making their own food using carbon dioxide in the atmosphere and energy they harvested from the sun. This process (called photosynthesis) produced enough oxygen to change Earth's atmosphere. Soon afterward, new oxygen-breathing life forms came onto the scene. With a population of increasingly diverse bacterial life, the stage was set for some amazing things to happen.



Bacteria are single-celled organisms with a circular DNA molecule and no organelles.

The Endosymbiotic Theory



There is compelling evidence that mitochondria and chloroplasts were once primitive bacterial cells. This evidence is described in the endosymbiotic theory. How did this theory get its name? Symbiosis occurs when two different species benefit from living and working together. When one organism actually lives inside the other it's called endosymbiosis. The endosymbiotic theory describes how a large host cell and ingested bacteria could easily become dependent on one another for survival, resulting in a permanent relationship. Over millions of years of evolution, mitochondria and chloroplasts have become more specialized and today they cannot live outside the cell.

It's Just a Theory

In everyday speech, people use the word theory to mean an opinion or speculation not necessarily based on facts. But in the field of science, a theory is a well established explanation based on extensive experimentation and observation. Scientific theories are developed and verified by the scientific community and are generally accepted as fact.

Mitochondria Have DNA

Mitochondria and chloroplasts have striking similarities to bacteria cells. They have their own DNA, which is separate from the DNA found in the nucleus of the cell. And both organelles use their DNA to produce many proteins and enzymes required for their function. A double membrane surrounds both mitochondria and chloroplasts, further evidence that each was ingested by a primitive host. The two organelles also reproduce like bacteria, replicating their own DNA and directing their own division.

Drawing the History of Evolution

Mitochondrial DNA (mtDNA) has a unique pattern of inheritance. It is passed down directly from mother to child, and it accumulates changes much more slowly than other types of DNA. Because of its unique characteristics, mtDNA has provided important clues about evolutionary history. For example, differences in mtDNA are examined to estimate how closely related one species is to another.

Analysis of mitochondrial DNA from people around the world has revealed many clues about ancient human migration patterns.

Archaea: Models for Astrobiology

Archaea survive today in extremely harsh environments, such as evaporative salt ponds on the edge of Great Salt Lake (above) and the boiling hot springs of Yellowstone National Park (right).

Conditions on Earth 4 billion years ago were very different than they are today. The atmosphere lacked oxygen, and an ozone layer did not yet protect Earth from harmful radiation. Heavy rains, lightening and volcanic activity were common. Yet the earliest cells originated in this extreme environment. Today, a group of single-celled organisms called archaeabacteria, or archaea, still thrive in extreme habitats.

Astrobiologists are now using archaea to study the origins of life on Earth and other planets. Because archaea inhabit places previously considered incompatible with life, they may provide clues that will improve our ability to detect extraterrestrial life. Interestingly, current research suggests archaea may be capable of space travel by meteorite. Such an event could have seeded life on Earth or elsewhere.