

## The Origin of Eukaryotic Cells

The first cells were most likely very simple prokaryotic forms. Radiometric dating indicates that the earth is 4 to 5 billion years old and that prokaryotes may have arisen more than 3.5 billion years ago. Eukaryotes are thought to have first appeared about 1.5 billion years ago.

The eukaryotic cell might have evolved when a large anaerobic amoeboid prokaryote ingested small aerobic bacteria and stabilized them instead of digesting them. This idea is known as the endosymbiont hypothesis and was first proposed by Lynn Margulis, a biologist at Boston University. (Symbiosis is an intimate association between two organisms of different species.) According to this hypothesis, the aerobic bacteria developed into mitochondria, which are the sites of aerobic respiration and most energy conversion in eukaryotic cells. The possession of these mitochondria-like endosymbionts conferred the advantage of aerobic respiration on the host.

Flagella may have arisen through the ingestion of prokaryotes similar to spiral-shaped bacteria called spirochetes. Ingestion of prokaryotes that resembled present-day cyanobacteria could have led to the endosymbiotic development of chloroplasts in plants.

Another hypothesis for the evolution of eukaryotic cells proposes that the prokaryotic cell membrane folded inward (invaginated) to enclose copies of its genetic material. This invagination resulted in the formation of several double-membrane-bound entities (organelles) in a single cell. These entities could then have evolved into the eukaryotic mitochondrion, nucleus and chloroplasts.

Although the exact mechanism for the evolution of the eukaryotic cell will never be known with certainty, the emergence of the eukaryotic cell led to a dramatic increase in the complexity and diversity of life forms on the earth. At first, these newly formed eukaryotic cells existed only by themselves. Later, however, some probably evolved into multicellular organisms in which various cells became specialized into tissues, which, in turn, led to the potential for many different functions. These multicellular forms then adapted to life in a great variety of environments.