Unlike any other organelle, except for chloroplasts, mitochondria appear to originate only from other mitochondria. They contain their own DNA, which is circular as is true with bacteria, along with their own transcriptional and translational machinery. Mitochondrial ribosomes and transfer RNA molecules are similar to those of bacteria, as are components of their membrane. These and related observations led Dr. Lynn Margulis, in the 1970s, to propose an extracellular origin for mitochondria.

Some species of present-day protists contain living organisms within their cytoplasm. For example, *Paramecium bursaria* are hosts for zoochlorellae, photosynthetic protists, that reside within the cytoplasm. The relationship appears to be symbiotic. The endosymbiont gains protection and possibly some essential nutrients from the host cytoplasm. The host has a readily available food source when its usual food source is depleted. If you have the opportunity to observe *P. bursaria*, note that the endosymbionts are not incorporated into food vacuoles. They are residents within the cytoplasm itself, and either are descended from organisms that survived endocytosis or have some mechanism for escaping food vacuoles once they are ingested.

Protists are eukaryotes, of course, meaning that their genetic material is organized into a compartment, the nucleus, that is surrounded by membrane, and that they have membrane-delineated organelles. In the warm seas of the ancient earth, the first living things would have been prokaryotes. The endosymbiotic hypothesis for the origin of mitochondria (and chloroplasts) suggests that mitochondria are descended from specialized bacteria (probably purple nonsulfur bacteria) that somehow survived endocytosis by another species of prokaryote or some other cell type, and became incorporated into the cytoplasm. The ability of symbiont bacteria to conduct cellular respiration in host cells that relied on glycosis and fermentation would have provided a considerable evolutionary advantage. Similarly, host cells with symbiont bacteria capable of photosynthesis would also have an advantage. In both cases, the number of environments in which the cells could survive would have been greatly expanded.

Mitochondria do not contain anywhere near the amount of DNA needed to code for all mitochondria-specific proteins, however, a billion or so years of evolution could account for a progressive loss of independence. The endosymbiotic hypothesis might be called a theory, but experimental evidence can't be provided to test it. Only circumstantial evidence is available in support of the proposal, which is the most likely explanation for the origin of mitochondria. The evidence needed to change the model from hypothesis to theory is likely forever lost in antiquity.