Key points that need to be taken into account when considering models of eukaryogenesis

All extant eukaryotes have mitochondria or related organelles, so endosymbiosis must predate LECA.

- LECA was a highly complex organism that already had all signature functional systems of eukaryotes and was probably a typical eukaryotic cell, so all key innovations of eukaryogenesis must have occurred at the stem phase of evolution before LECA.
- Highly conserved genes of eukaryotes are a chimeric set: a minority of genes encoding information transmission systems and some other key molecular machines, such as the cell division apparatus, are of archaeal origin, whereas the majority of metabolic enzyme genes originate from bacteria.
- Some of the key functional systems of the eukaryotic cell, such as RNA interference or repair pathways, are archaeo-bacterial chimeras.
- Other essential molecular machines of the eukaryotic cell, such as the nuclear pore complex, seem to be primarily of bacterial provenance.
- Likely ancestors of eukaryotic genes are scattered among archaeal and bacterial lineages.

The archezoan scenario

The host of the proto-mitochondrial endosymbiont was a hypothetical primitive amitochondrial eukaryote, termed archezoan. Figure 5a shows the origin of the archezoan from an archaeal ancestor; however, under this scenario, the possibility also exists that the putative archezoa and archaea evolved from a more primitive common ancestor.

This scenario is, at least historically, associated with a 'crown group' phylogeny, in which some groups of eukaryotes are thought to primitively lack mitochondria and to have branched early in eukaryotic evolution, whereas the crown group of mitochondria-containing eukaryotes evolved later.

The symbiogenesis scenario

A single endosymbiotic event involving the uptake of an α-proteobacterium by an archaeal cell led to the generation of the mitochondria. This was followed by the evolution of the nucleus and the compartmentalization of the eukaryotic cell (Figure 5b).

This scenario is associated with a star-like phylogeny, in which several 'supergroups' radiated at (almost) the same time (as shown in Figure 1).