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Endosymbiotic Hypothesis: Origin of Mitochondria and Chloroplast

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SUMMARY

Endosymbiotic theory is the unified and widely accepted theory of how organelles arose in organism, differing prokaryotic organisms from eukaryotic organism. In endosymbiotic theory, consistent with general evolutionary theory, all organism arose from single common ancestor. This ancestor probably resembled a bacteria or prokaryote with single strand of DNA surrounded by plasma membrane.

INTRODUCTION

Evolution from Simple Prokaryotes to Complex Eukaryotes? Now that we have examined both the Prokaryotic and Eukaryotic cells, we can see that the cell has sustained very dynamic changes over time. Specifically, we have seen the appearance of numerous cell organelles as well as the implementation of a more organized cell structure. The question is how did these changes occur? A fundamental concept of evolution is the belief in the natural progression *from the simple, to the more complex.* For the evolution of the eukaryotic cell, the predominating theory is known as the Endosymbiotic Theory.

Endosymbiotic Theory

The Endosymbiotic Theory of Eukaryote Evolution **(Symboitic Theory)** was first proposed by former Boston University Biologist Lynn Margulis in the 1960's and officially in her 1981 book *"Symbiosis in Cell Evolution"*.

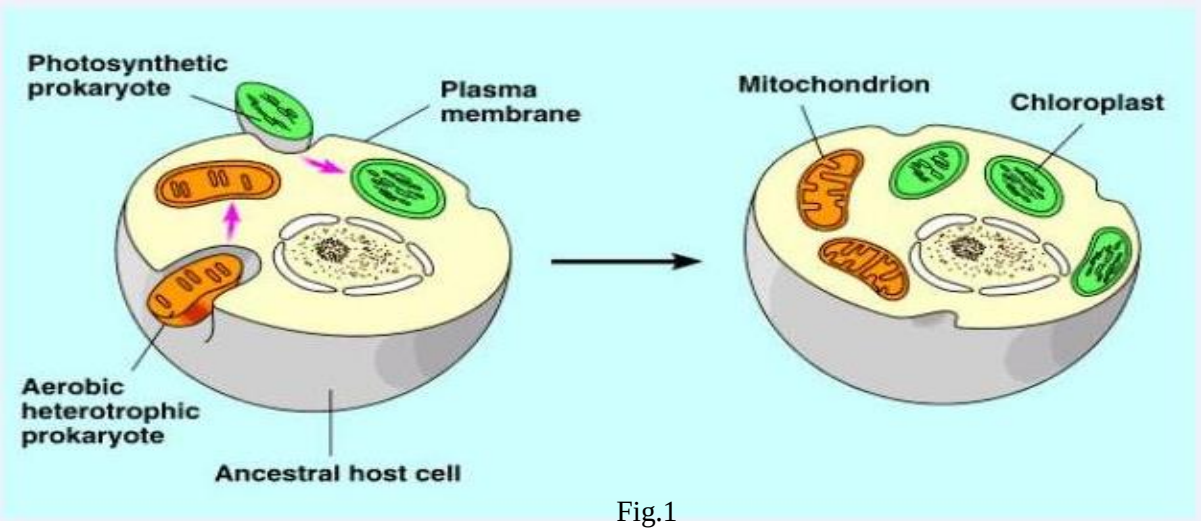

Fig.1

The most important mechanism behind the Endosymbiotic Theory involves the process of phagocytosis. Phagocytosis involves the ability of one cell to engulf another cell, which likely initially evolved as a feeding mechanism. Before this process evolved, material (e.g., food) was transported through the cell membrane molecule by molecule. The evolution of phagocytosis gave cells the ability to engulf entire cells, setting the foundation for the endosymbiotic theory.

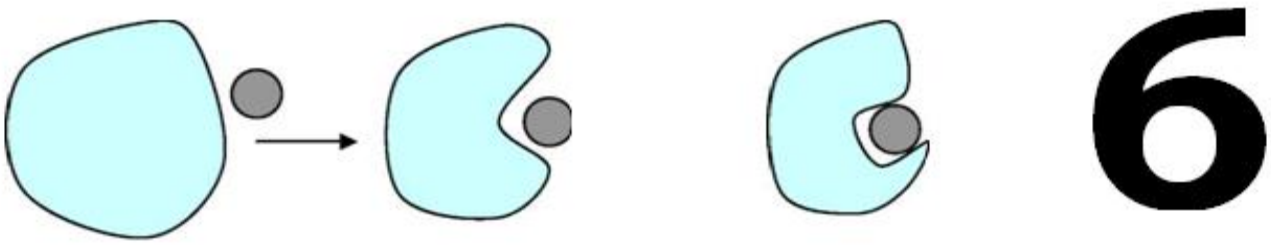

Fig.2

According to Margulis, the pre-eukaryotic cell engulfed an aerobic bacterium (through phagocytosis), but rather than digest and destroy the bacterium, a symbiotic relationship was born. In this relationship, the aerobic bacterium provided

energy through ATP (adenosine triphosphate) and the eukaryotic cell provided an environment to live while protecting the new symbiont from harmful environmental factors such as oxygen. Because almost all living eukaryotes have a mitochondrion, it is safe to assume that this event happened before plants and animals split in the evolutionary lineage. After this first evolutionary leap came a second that would separate the plant and animal lineages forever. Through a second symbiotic event that involved the eukaryotic cell engulfing a cyanobacteria, the plants would gain the ability to photosynthesize and make their own food. This would categorize them into the autotrophs and secure their position at the bottom of the food chain, regardless of how many evolutionary events would take place from that point on evidence to support Margulis's Endosymbiotic Theory has grown over the years.

This evidence includes (but is not limited to) the following

- A double membrane surrounding the organelles with an inner layer that retains the bacteria's characteristics and an outer layer that retains characteristics of the cell that engulfed it.
- Mitochondria and chloroplasts are similar in size to prokaryotes.
- Mitochondria and chloroplasts have their own DNA and lack histone proteins, the DNA is circular, and it is attached to the inner membrane just like in prokaryotes.
- Mitochondria and chloroplasts divide by fission, not mitosis.
- The mitochondria, chloroplasts, and prokaryotes make proteins by similar biochemical pathways that differ from those in eukaryotes.

CONCLUSION

The endosymbiotic theory is currently the most commonly accepted and renowned explanation for the evolution of mitochondria and chloroplast. As discussed above there is evidence that endosymbiotic relationship between cells can be as well as other evidence including cell structure and function and characteristics that propose xenogeonous origin.

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