

Cambridge O Level Biology Revision Guide

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The Powerhouse of the Cell

Understanding Mitochondria

Mitochondria are often referred to as the powerhouses of the cell and for good reason. These tiny organelles are responsible for generating the majority of the energy our cells need to function. In this article, we'll delve into the fascinating world of mitochondria, exploring their structure, function, and importance in living organisms.

What are mitochondria?

Organelles: Mitochondria are tiny structures found within the cytoplasm of eukaryotic cells, cells with a nucleus.

Double membrane: Each mitochondrion is enclosed by two membranes.

- Outer membrane:** Smooth and forms the outer boundary of the organelle.
- Inner membrane:** Folded into cristae, which increase the surface area for chemical reactions.

Matrix: The space enclosed by the inner membrane is filled with a gel-like matrix containing enzymes, ribosomes, and DNA.

The Role of Mitochondria

Energy Production

Cellular respiration: The primary function of mitochondria is to carry out cellular respiration, the process of breaking down glucose to release energy in the form of ATP (adenosine triphosphate).

ATP: ATP is the energy currency of the cell, used to power various cellular processes such as muscle contraction, protein synthesis, and active transport.

Stages of cellular respiration

Glycolysis: Glucose is broken down into pyruvate in the cytoplasm.

Krebs cycle (citric acid cycle): Pyruvate is further broken down in the mitochondrial matrix, producing carbon dioxide and electron carriers (NADH and FADH₂).

Electron transport chain: Electron carriers deliver electrons to the cristae, generating a proton gradient that drives ATP synthesis.

Other Functions of Mitochondria

Apoptosis: Mitochondria play a crucial role in programmed cell death (apoptosis), releasing proteins that trigger the breakdown of the cell.

Calcium regulation: Mitochondria act as calcium stores within the cell, contributing to calcium signalling pathways.

Heat production: Some specialized mitochondria can generate heat, important for maintaining body temperature in certain animals.

Mitochondrial DNA

Circular DNA: Unlike most cellular DNA, which is linear, mitochondrial DNA is circular and located within the matrix.

Maternal inheritance: Mitochondrial DNA is inherited from the mother only, as the egg cell contributes the mitochondria to the zygote.

Mutations: Mitochondrial DNA is prone to mutations, which can lead to a range of disorders affecting

energy production and other cellular functions Importance of Mitochondria Energy supply Mitochondria are essential for providing energy to cells enabling them to perform all vital functions Cellular health Mitochondrial dysfunction can lead to a variety of health problems including neurodegenerative diseases muscle disorders and cancer Evolution Mitochondria are thought to have originated from freeliving bacteria that were engulfed by early eukaryotic cells Their presence in all eukaryotic cells is a testament to their crucial role in the evolution of life Key Points to Remember Mitochondria are the powerhouses of the cell generating energy through cellular respiration They contain their own DNA which is inherited maternally Mitochondria have a double membrane structure with the inner membrane folded into cristae They play a role in apoptosis calcium regulation and heat production Mitochondrial dysfunction can lead to various health problems Understanding the structure and function of mitochondria is essential for comprehending cellular processes and appreciating their vital role in maintaining life

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