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Commentary

Organelle Inheritance and Cellular Dynamics: A Eukaryotic Study

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DESCRIPTION

The process of organelle inheritance is important for eukaryotic cells during division, ensuring the retention of functional cytoplasmic organelles. Translocases in the outer membranes serve as entry gates for proteins imported into mitochondria and chloroplasts, navigating them through two membranes. Despite commonalities, the modes of translocation differ between the two organelles. In mitochondria, pre-protein transit is triggered by increasing affinity for translocase subunits, while in chloroplasts, transport relies on GTP-binding and hydrolysis by receptors. This intricate mechanism underscores the necessity for precise organelle inheritance patterns, safeguarding the functionality of cytoplasmic organelles during cell division in eukaryotic cells.

The mechanism by which cellular organelles generate chemical energy is called oxidative phosphorylation. Using specialized mitochondrial transcription and translation machinery that is different from that employed for nuclear gene expression, they are descended from bacteria and they are neverthless able to express their own genome. In particular, the structure and function of the machinery governing eukaryotic, cytosolic translation are very different from those governing mitochondrial protein synthesis. Mitochondria are not completely isolated from the rest of the cell, while having their own genetic material, and their activity is closely linked to cellular fitness. Mitochondria mostly depend on nuclear-encoded proteins for gene expression and function; thus, they interact with other compartments to regulate their proteome.

This connection allows mitochondria to adjust to changes in cellular conditions in addition to mediating responses to stress and mitochondrial dysfunction. With an emphasis on yeast and mammals, significant advancements in their understanding of the biogenesis, structure, and functions of the mitochondrial translation apparatus have been accomplished in recent years. A substantial amount of biological study as well as the advent of several near-atomic structures have made these findings conceivable. Auxiliary factors such as translation regulators that alter the rate of mitochondrial translation are also covered, along with the significance of inter compartmental crosstalk with nuclear gene expression and cytosolic translation and how it promotes the integration of mitochondrial translation into the cellular context.

Translocases of the outer membrane act as an entry gate for the bulk of the proteins that are imported into mitochondria and chloroplasts. These translocases interact with the incoming precursor protein and directing factors. An important component of the translocon, which enables both transfer *via* a cation-selective channel and initial sorting towards internal sub compartments, is bound by precursor-protein receptors. The two organelles' modes of translocation differ despite these commonalities. Whereas in mitochondria, the pre-protein transit is triggered by its increasing affinity for the translocase subunits, in chloroplasts, transport requires the receptors' GTP-binding and hydrolysis. For eukaryotic cells to retain a functional set of cytoplasmic organelles during cell division, a precise process of organelle inheritance is required.

The outer membrane's translocases act as entryways for mitochondria and chloroplasts, which bring most of their proteins through two membranes. These translocases interact with both the guiding chaperone components and the incoming precursor protein. Translocon precursor-protein receptors bind to a core element that facilitates early sorting towards interior sub compartments as well as transfer *via* a cation-selective channel. Despite these parallels, the two organelles' ways of translocation are distinct. In mitochondria, pre-protein transit is mediated by increasing affinity for the translocase subunits, whereas in chloroplasts, transport is mediated by GTP-binding and hydrolysis by the receptors. Eukaryotic cells need to adhere to a specific organelle inheritance pattern in order to preserve a functional set of cytoplasmic organelles during cell division.

However, knowledge of the role of mitochondria in cell biology has recently expanded as a result of the discovery that these organelles are essential hubs for a variety of cell signaling cascades. The dynamic reorganization of the cellular mitochondrial network, referred to as mitochondrial membrane dynamics, is closely associated with the cellular flexibility and includes various mechanisms such as organelle division and fusion

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(combination) and ultrastructural membrane remodeling. Thus, mitochondrial dynamics influence and are often responsible for the orchestration of complex cell signaling events, such as those governing cell pluripotency, division, differentiation, senescence, and death.