



Mitochondrial Training and Certification



Core Modules



Module One

How mitochondria work and their relevance to health, wellness and disease



Module Two

Basic physiology and biochemistry of mitochondria



Module Three

How practitioners are testing mitochondrial function

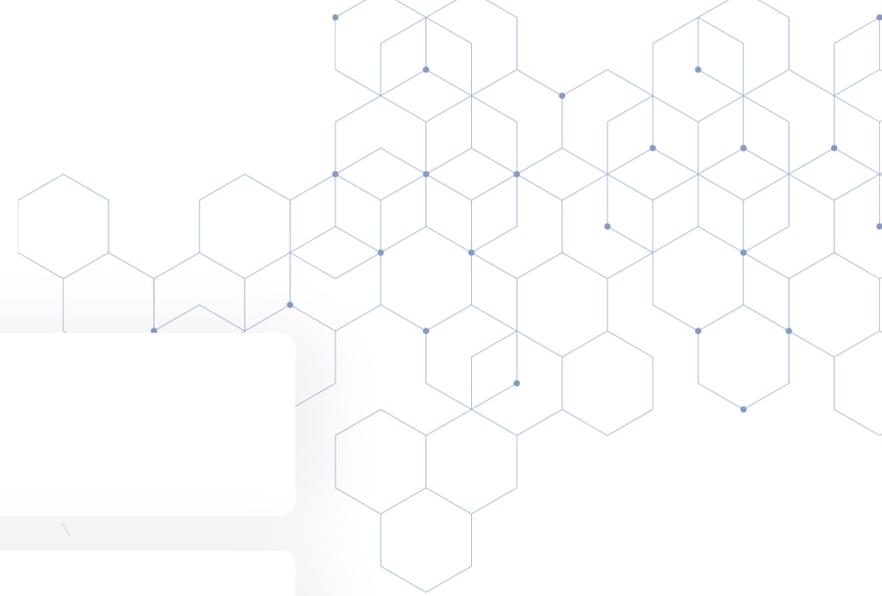


Module Four

How to explain mescreen/mitochondrial function testing to your patients



Learning Objectives of the Program



- Understand the broad role mitochondria play in physiologic processes and their relevance and connection to health and disease
- Identify the core biochemical processes involved with mitochondrial function
- Differentiate current testing approaches used to assess mitochondrial function
- Understand the limitations of testing approaches in determining primary and multifactorial mitochondrial disease and dysfunction
- Review the application of functional marker testing to aid in the assessment of mitochondrial efficiency and function





Module One

Mitochondria and their role
in health, wellness and longevity



Learning Objectives

● Review the role of mitochondria in the human body

● Understand the basic structure of mitochondria

● Describe how mitochondria are linked to health and relevant to disease



What are Mitochondria



Mitochondria (*singular: mitochondrion*) are organelles within eukaryotic cells that produce adenosine triphosphate (ATP), the primary energy molecule used by the cell.

Mitochondria produce ATP through cellular respiration—specifically, aerobic respiration, which requires oxygen.

The number of mitochondria in a cell depends on how much energy that cell needs to produce.

Muscle cells, for example, have many mitochondria because they need to produce energy to move the body. Red blood cells, which carry oxygen to other cells, have none.

Mitochondria have many other functions outside of energy production.¹

- Calcium storage and buffering
- Control cell death and survival (apoptosis)
- Regulate cell signaling
- Thermogenesis (heat production)



Endosymbiotic Theory

The Modern Cell



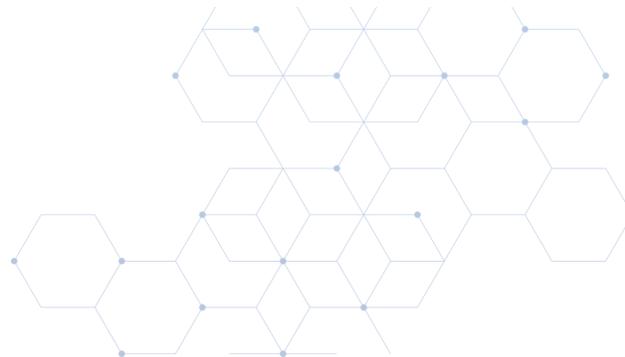
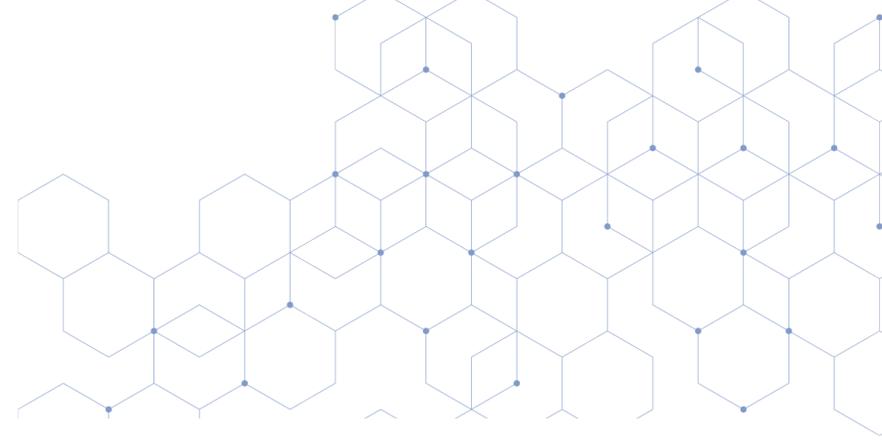
Mitochondria

Structure

Mitochondria have two membranes, an outer membrane and an inner membrane.

These membranes are made of phospholipid layers, just like the cell's outer membrane. The outer membrane covers the surface of the mitochondrion, while the inner membrane is located within and has many folds called cristae.

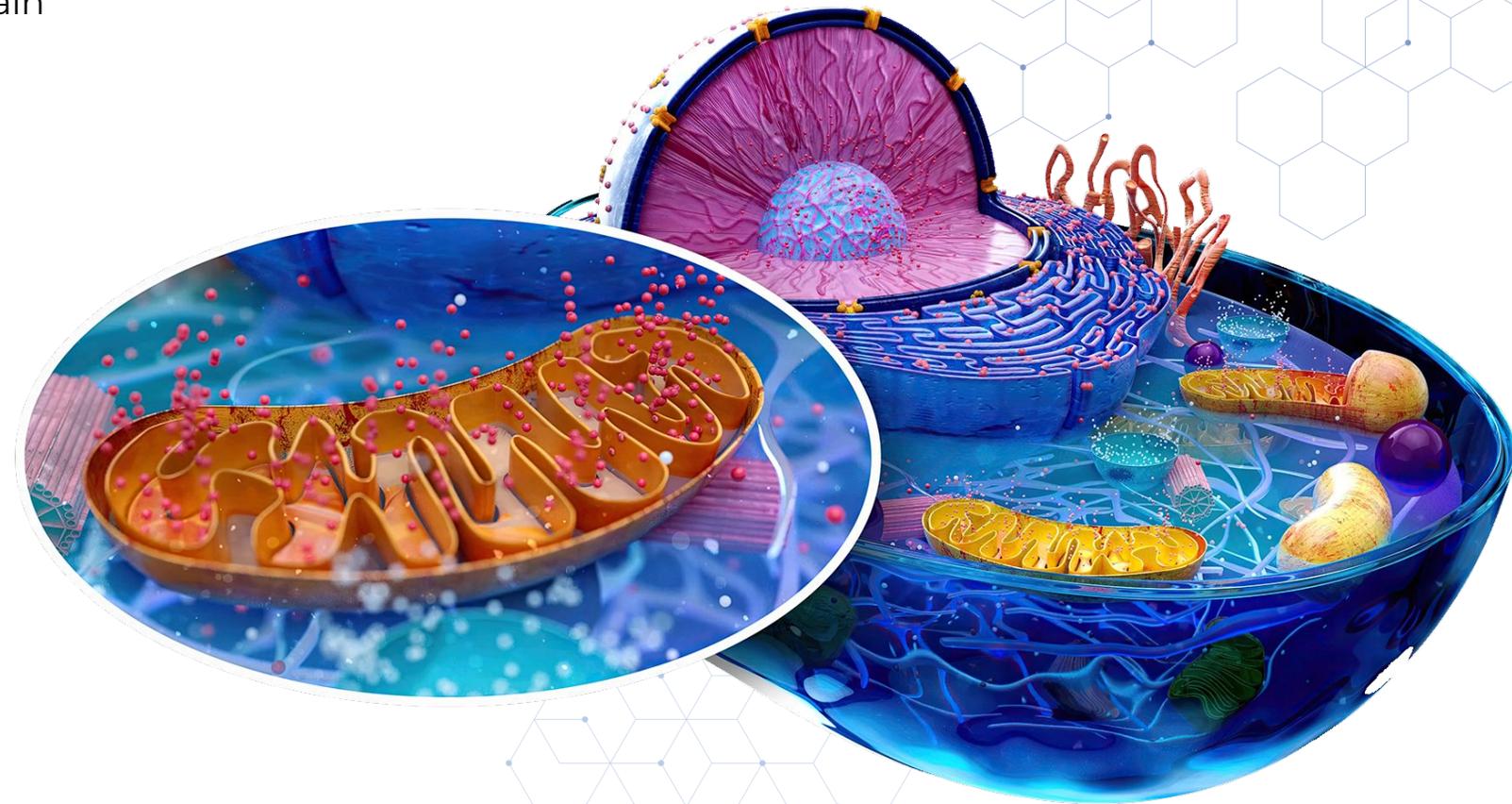
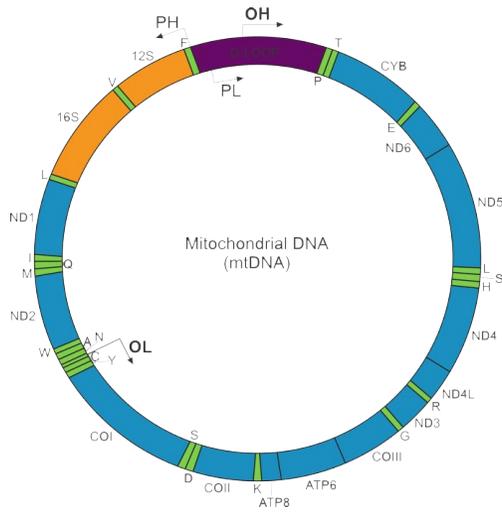
The folds increase surface area of the membrane, which is important because the inner membrane holds the proteins involved in the electron transport chain. It is also where many other chemical reactions take place to carry out the mitochondria's many functions.



Mitochondria

Genetics

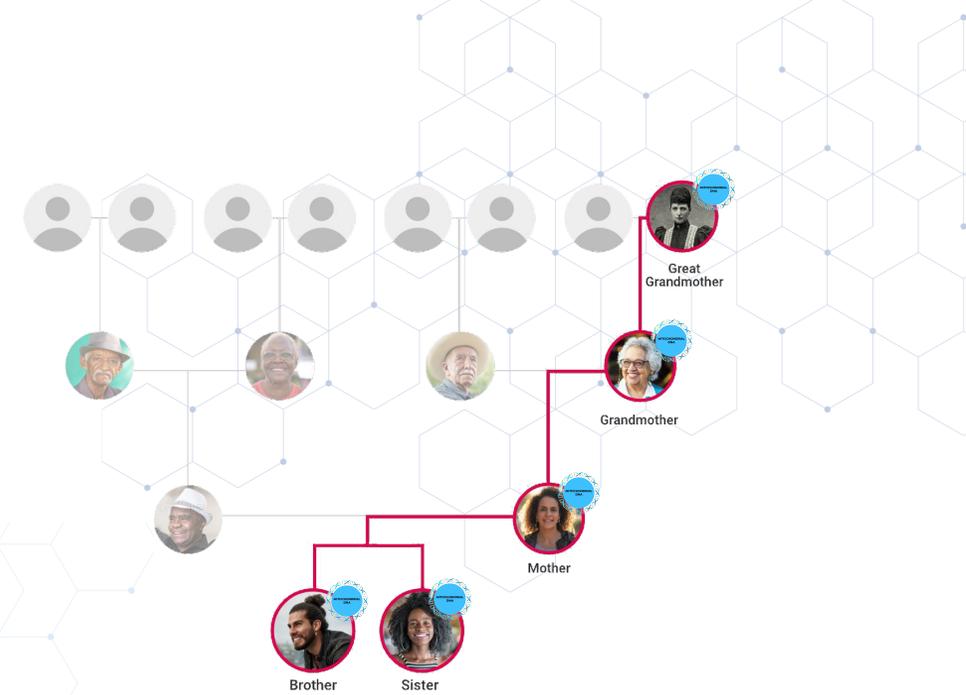
Human mitochondria contain
1100-1400 distinct proteins





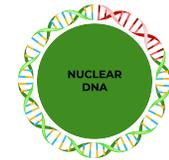
Mitochondrial DNA

Mitochondria and their unique genes are passed along by the mother



Nuclear genes are combination of maternal and paternal genes that also effect how mitochondrial genetics express

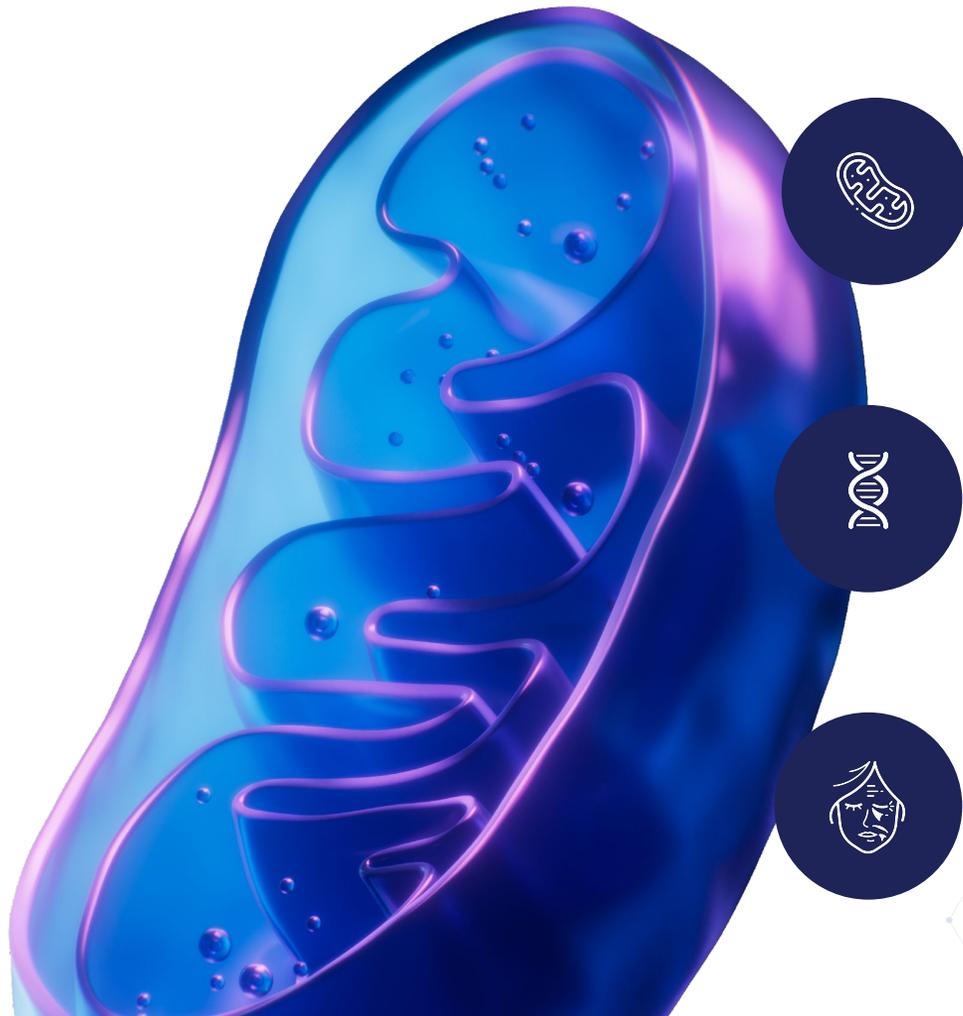
Nuclear DNA



Mitochondria in

Health and Disease

Healthy mitochondria are directly linked to wellness while dysfunctional mitochondria with disease.



Mitochondrial dysfunction is implicated in a spectrum of human diseases with dysfunction being a core feature of virtually all non-communicable chronic diseases (NCDs)

Mitochondrial dysfunction underlies >50 inborn errors of metabolism ⁴; strongly contributes to a growing list of common disorders, including type 2 diabetes, neurodegenerative diseases, and cancer

Mitochondrial impairments (known also as mitochondriopathies) can be inherited (through an autosome and/or X chromosome maternally) or developed in a multi-factorial way including but not restricted to a toxic environment, sub-optimal health conditions and collateral pathologies (such as metabolic syndrome). Mitochondriopathies carry systemic character and can be damaging for many organs .

Mitochondrial dysfunction is associated with accelerated ageing, neurodegeneration, tumorigenesis, metabolic syndromes and mood disorders, amongst others.



Mitochondria Dysfunction Link To Health and Disease



Mitochondrial injury and consequently disturbed energy homeostasis and uncontrolled ROS overproduction cause/strongly contribute to neurodegeneration, malignant cell transformation, and cardiovascular diseases.

Although the disease origin is common, individually outcomes differ from each other.

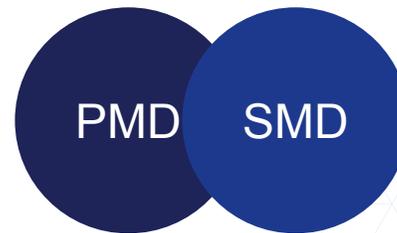
Dysfunction may occur across one or multiple mitochondrial functional outputs measured



Primary vs Secondary Mitochondrial Disease

The terms primary and secondary mitochondrial diseases are used to describe mitochondrial pathophysiology. **Each are associated with mitochondrial dysfunction**

Primary mitochondrial diseases (PMD) are mitochondrial disorders caused by germline mutations in mtDNA and/or nDNA genes that encode either OXPHOS structural proteins or mitochondrial proteins of the complex machinery needed to carry out the OXPHOS process. They are inherited

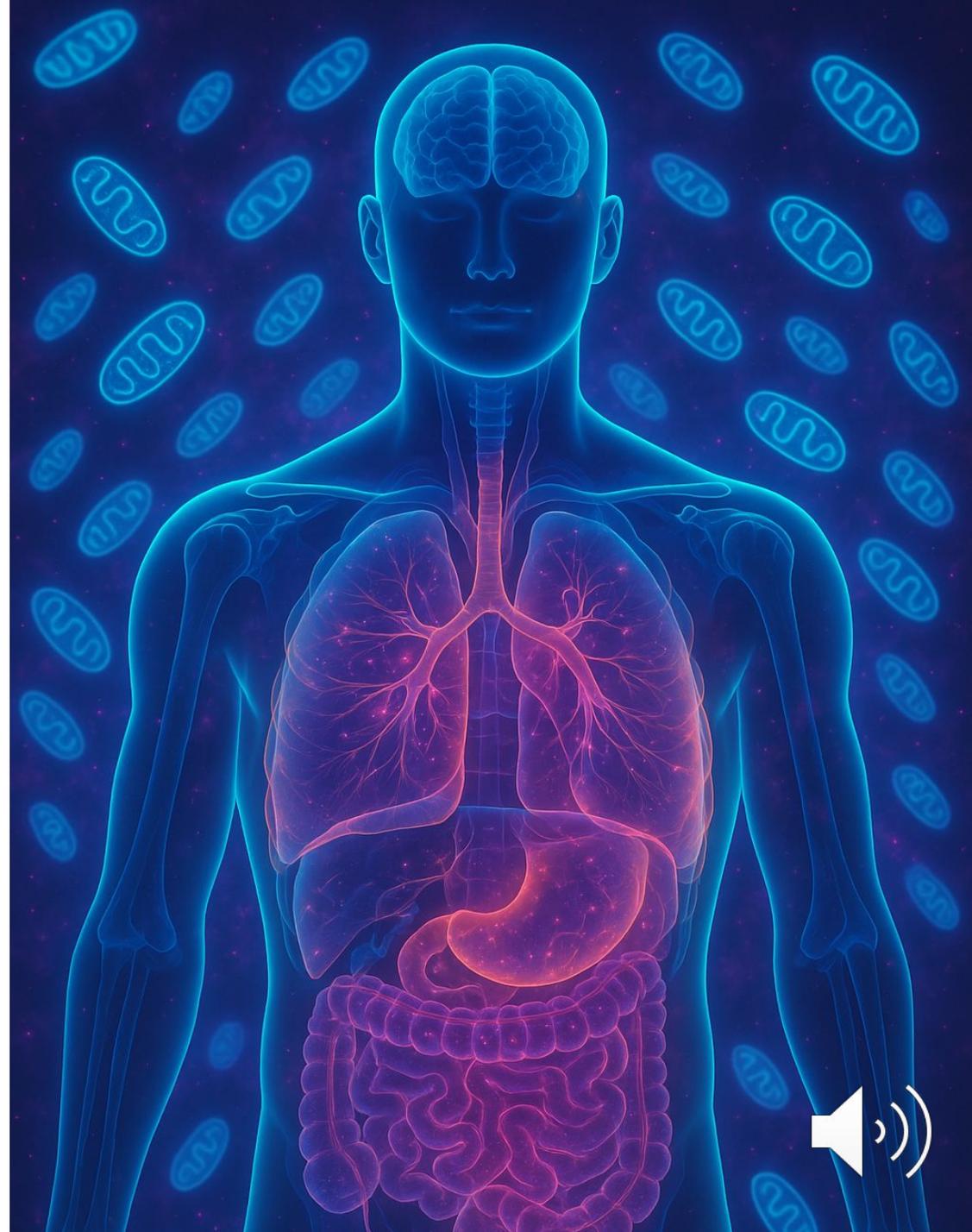


Secondary mitochondrial disorders (SMD) stem from gene defects outside the OXPHOS system or from later-life insults—anything that disturbs mitochondrial control pathways or triggers oxidative stress. These disruptions can arise in thyroid disease, diabetes, cancer, aging, and neurodegenerative conditions, where they further damage mitochondria and worsen disease. Unlike primary mitochondrial disease, which is always inherited, secondary disorders may be inherited or picked up over time.

Although there is an important distinction between PMD and SMD, they can have overlapping symptoms and signs, making a correct diagnosis difficult to obtain. There are currently no consent guidelines commonly used for the diagnosis of mitochondrial diseases distinguishing whether they are primary or secondary due to the significant variable expressivity and incomplete penetrance.



Mitochondria are everywhere and impact virtually every organ system



Summary of the role of **Mitochondria**

**Do more than
produce energy**



**Impacted by inherited,
internal and external factors**



**Play a role in the
aging process**



**Integral component of cell
signaling and survival**



**Located in every
organ system**



Function and signaling aspects of the mitochondria can be modulated/changed by general and targeted approaches



Summary

Mitochondria are organelles maternally passed along to individuals and contain a unique set of genes which along with nuclear genes express uniquely in individuals

Mitochondrial structure is unique and plays an important role in how mitochondria function and control many key processes within the human body

Mitochondria do more than produce energy and their function directly linked to health and disease



References

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