Mitochondrial regeneration and the relationship with NAD+

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Mitochondria are tiny structures present inside the cells that are essential for our survival. They are known as the "Power House of the Cell" because they generate energy to drive our body. Essential organs like the brain, heart, kidney, and muscles have the highest amount of mitochondria to meet their high metabolic demands. In order to generate energy from glucose, mitochondria needs a co-enzyme that can accept and donate high-energy hydrogen ions and electrons. Nicotinamide (NAD+) is the best co-enzyme that has the tendency to work with and without oxygen. A major portion of the NAD+ is located in the mitochondria to facilitate this process of ATP production.

Mitochondria experiences deterioration in their structural and functional during cellular senescence (aging). Mitochondrial damage results in impaired energy production and harmful reactive oxygen species(ROS) accumulation. Mitochondrial dysfunction is also the underlying mechanism in many neurological diseases, including Parkinson's disease and Leigh syndrome. Therefore, mitochondrial regeneration is required to maintain an appropriate high-quality mitochondrial level.

The body has a mechanism to remove these damaged mitochondria known as "Mitophagy" and replace them with the new one by "Mitochondrial Biogenesis." NAD+ is also essential for mitochondrial

regeneration as it delays mitochondrial aging, reduces oxidative stress, repairs DNA, and stimulates stem cells.

NAD+ level in the cells provides information about the nutrition status of the body. When the NAD+ level is high, a signal is sent to start the replication of cells, as nutrients are abundant. A decreased NAD+ level tells the body to stop regeneration due to low nutrients. Gregory McElroy and his colleagues conducted a study and demonstrated that improvement in NAD level decreased brain inflammation and increased lifespan of patients with mitochondrial dysfunction. (McElroy et al. 2020)

Role of NAD+ level in mitochondrial regeneration:

There are various mechanisms by which the NAD+ level is linked to Mitochondrial damage and regeneration. Some of them are discussed below:

1- Improvement in Stem Cells Function:

Stem cells are located in the bone marrow, gastrointestinal tract, and skin cells. They are essential to maintain the integrity of all cells and require NAD for their proper functioning. They continuously proliferate to make up for the damaged and aged cells. If the number of stem cells is reduced, all cells, including mitochondria, undergo progressive degeneration and atrophy.

Francisco Calderon

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