



Mitochondria

Known as the body's "powerhouses", mitochondria are organelles or structures found inside cells that are essential for energy production. Mitochondria play a role in aerobic metabolism and the production of adenosine triphosphate (ATP), which is used as energy to drive cellular processes. With the exception of red blood cells, all human cells contain hundreds to thousands of mitochondria.

In addition to aerobic energy production, mitochondria are also involved in transcribing DNA to mRNA, which is used for protein synthesis, maintaining our innate immune system response, managing the balance of calcium in cells, and signaling for apoptosis or cellular death when necessary.

Mitochondrial Dysfunction

Mitochondrial dysfunction has been linked to chronic inflammatory diseases including cardiovascular and neurodegenerative diseases. High levels of mitochondrial damage-associated molecular patterns (DAMPs) are associated with infection, asthma, ischemic heart disease, and cancer. Primary mitochondrial disorders are characterized by impaired mitochondrial structure or function due to genetic mutations.

Mitochondrial dysfunction can occur due to the following factors:

- Aging
- Genetic susceptibility
- Toxic metal exposure
- Physical inactivity
- Exposure to persistent organic pollutants
- Certain medications
- Excess alcohol intake



Diet and Mitochondria

The table below summarizes mitochondria-supportive nutrients and the food sources in which you can find them.

| Nutrient | Function | Sources |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| B Vitamins | Act as coenzymes; necessary for the coenzyme reactions in cellular functions | Liver, eggs, tuna, lamb, legumes, brown rice, nutritional yeast, milk, and yogurt |
| Vitamin C | Acts as an antioxidant; vitamin C deficiency can lead to altered mitochondrial function | Citrus fruits, kiwi, strawberries, bell peppers, broccoli, kale |
| Vitamin E | An antioxidant that protects against oxidation of lipids in the cell; deficiency is found to affect cellular energy balance | Olive oil, nuts and seeds (almonds, hazelnuts, pecans, sunflower seeds), peanuts, leafy greens (spinach, Swiss chard, broccoli) |
| Coenzyme Q10 (CoQ10) | Component of the electron transport chain in the inner mitochondrial membrane | Organ meats (heart, liver, kidney), beef, pork, oily fish (trout, herring, sardines), spinach, cauliflower, broccoli, oranges |
| N-acetyl-cysteine (NAC) | Can help with dysfunction by improving markers of oxidative damage in mitochondria | Food sources of cysteine: chicken, turkey, yogurt, cheese, eggs, sunflower seeds, garlic, and legumes |
| Magnesium | Required for cellular energy production; mitochondria store high levels of magnesium | Nuts and seeds, soy (tofu, tempeh, etc.), green leafy vegetables (spinach, Swiss chard) |

Lifestyle and Mitochondria

Lifestyle factors that improve mitochondrial function include exercise, calorie restriction (CR), and reducing alcohol consumption. Adopting a regular sleep schedule can also help your mitochondria, as cellular energy metabolism follows the circadian rhythm.

Physical activity offers a number of benefits, including increased mitochondrial enzyme activity, mitochondrial density, mitochondrial quantity, and muscle mitochondrial respiration. Studies have shown that combined training, including aerobic exercises, such as cycling or treadmill walking, and resistance exercise, such as weight training, improves aerobic capacity and mitochondrial respiration.

New research has demonstrated that a calorie-restricted (CR) diet that meets nutritional demands can contribute to “longevity”, in part by supporting mitochondrial health and function. With CR, the caloric intake is low enough to achieve a body mass index (BMI) below 21 kg/m². This means eating approximately 30% fewer calories per day from nutrient-dense foods. CR has been shown to prolong lifespan and prevent age-related metabolic disorders. Some of the benefits include improvements in insulin sensitivity, reduction of oxidative damage, and inhibition of certain inflammatory pathways. This type of lifestyle change should be guided and supported by your integrative healthcare provider.