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The Magic of Micronutrients

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4 MIN READ

Metabolism refers to the incredible set of processes through which our mitochondria turn glucose (sugar) into energy—in the form of ATP, the main energetic currency in the human body—to power our cells.



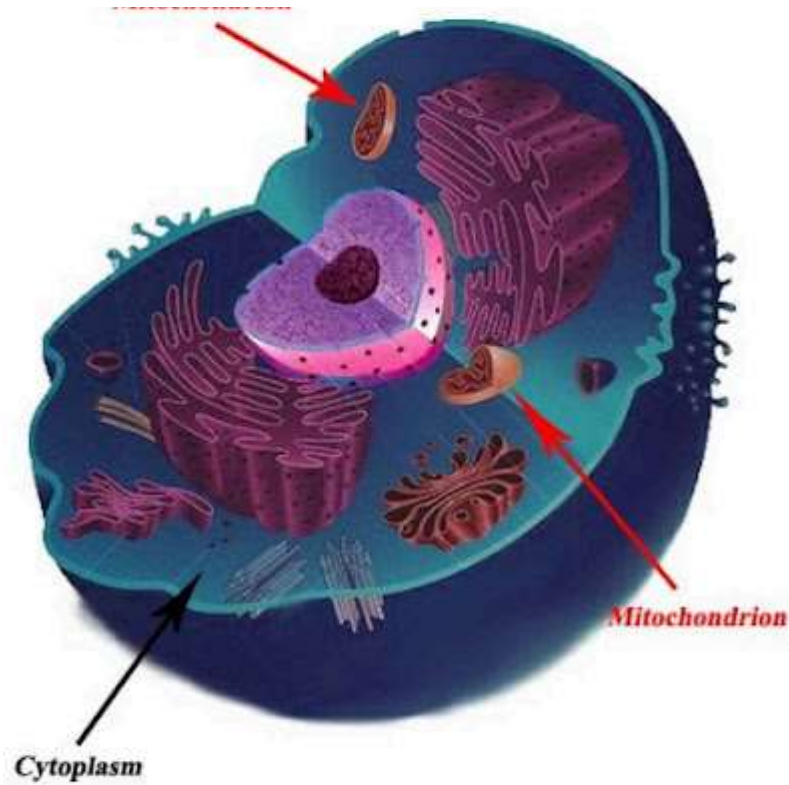
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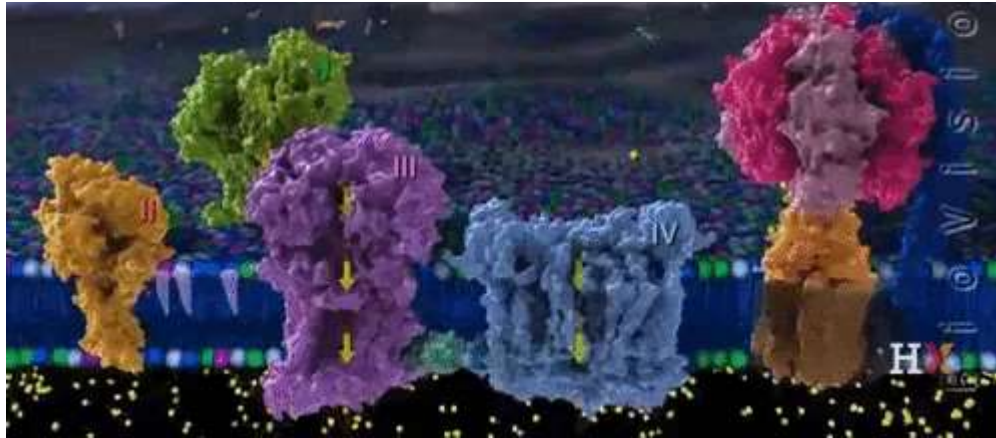
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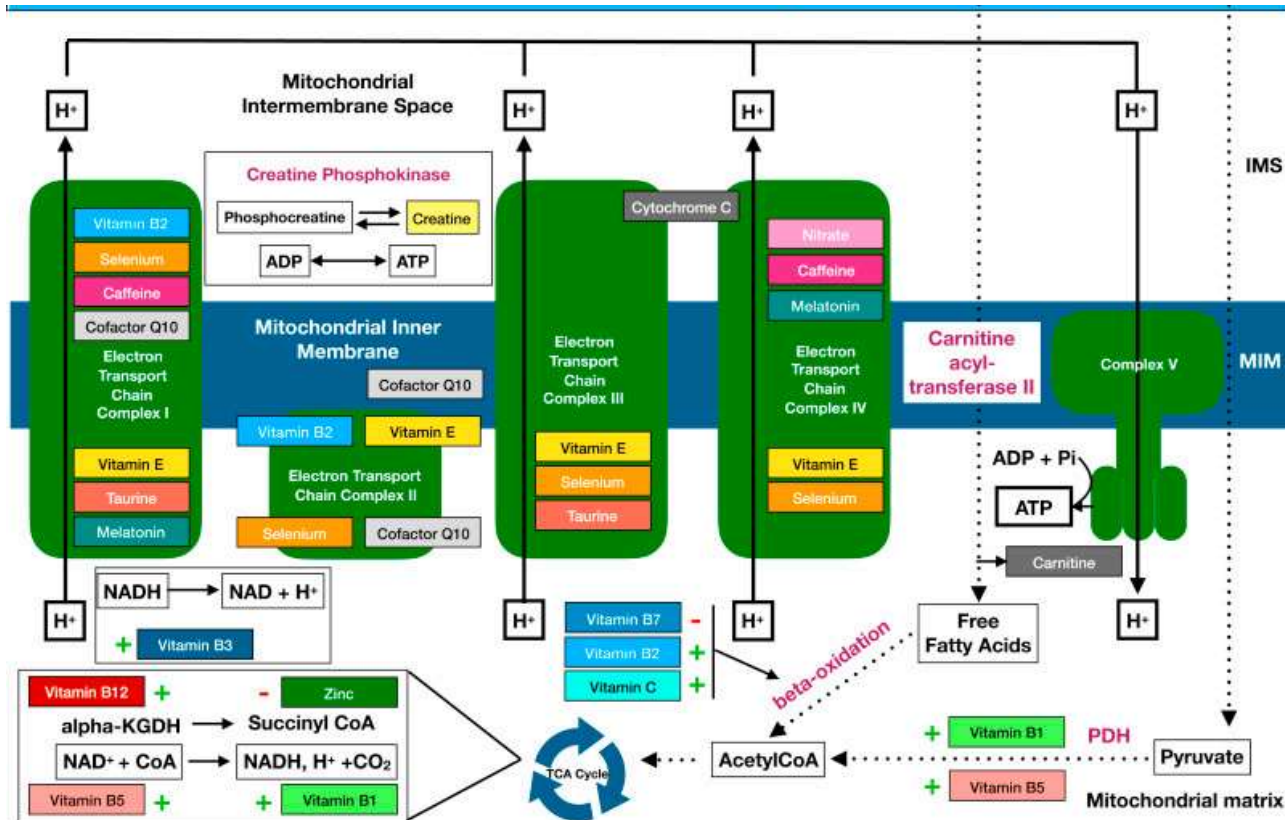
Below is an animation from HarvardX showing the final stage of ATP production in the mitochondria: the electron transport chain, made of five protein complexes embedded into membranes inside the mitochondria.



How does this relate to eating more micronutrients? Each of your roughly 37 trillion cells can contain a thousand or more mitochondria, each with innumerable proteins (like those colorful things in the image above) embedded into their membranes that act as tiny molecular machines to create ATP.

For those proteins to function correctly requires adequate levels of specific micronutrients, which we get from food. These vitamins, minerals, trace metals, and antioxidants are crucial links in chain reactions that regulate every part of your body's metabolism. In many cases, these micronutrients are bound to these large protein complexes to create the "just right" molecular conditions that let the tiny biological machines work correctly.

Below is a picture showing those same five structures in the animation above and a list of some of the micronutrients they need, like vitamin E, selenium, vitamin B2, vitamin B12, and vitamin C. No need to zero in on the details—the key point is that **each of these tiny molecular structures requires different vitamin micronutrients to function.**



Despite all the hype and debate around vitamins, remember **vitamins are just tiny organic compounds that serve as building blocks of the complex molecular structures that allow our bodies to work.** They are just parts of the machine.

Micronutrients also matter outside of the mitochondria for optimal metabolic health. For example, magnesium helps enable glucose transporter proteins (like GLUT4) to bring glucose into cells. It's also necessary for the enzymes that process Vitamin D, which is related to

Most of the micronutrients we need come from what we eat. Unfortunately, we have the most micronutrient-depleted diet that we've ever had in history—as much as **half of all Americans are deficient in at least some critical micronutrients**. This is partly because of soil depletion and because our diets lack diversity, with at least 75% of Americans not eating the recommended amounts of vegetables and fruits. Most of our calories come from refined forms of commodity crops like wheat, corn, and soy, which are micronutrient deficient and do not support optimal functioning.

Simply put, we need to think bigger than macronutrients—fat, protein, and carbs—when we consider our metabolic health. Remember that our bodies are dynamic sets of 37 trillion cells, each filled with mitochondria, and each mitochondria filled with innumerable assembly lines of molecular machines that make energy (ATP). And it's all made of food and requires micronutrients from food to work.

How I Hunt for Micronutrients

All of this is why I'm on a full-fledged micronutrient hunt whenever I open the fridge or walk down a grocery aisle. I'm thinking about the foods in front of me not just for their taste (though that's important too!) but for what information they will provide my body.

Maybe I choose pumpkin seeds today because I want to boost my magnesium intake. Or, perhaps I'll eat spinach because it has high iron levels. I'll make sure to include Brazil nuts at regular intervals to ensure I'm getting critical selenium.

Variety is your friend. **Aim for a diverse array of natural, unrefined foods**—all sorts of vegetables, fruits, nuts, seeds, beans, legumes, spices, and thoughtfully raised animal products like wild-caught fish. Challenge yourself to see how colorful and alive can your grocery cart be!

1. **Selenium** is a powerful player in the body's antioxidant pathways through a family of proteins called selenoproteins, which help quench free radicals. Selenium also impacts reproduction, thyroid hormone metabolism, and glucose absorption.

What to eat: Brazil nuts are the single best source, with one nut containing approximately 160% of the recommended daily allowance, but you can also get it from yellowfin tuna, halibut, shrimp, sardines, turkey, and beef.

2. **Omega-3s** are a type of fatty acid that serves as one of the building blocks for our cell membranes and are one of the best tools we have to regulate inflammation. Two types of omega-3s, EPA and DHA, in particular, both reduce the number of pro-inflammatory molecules and increase anti-inflammatory molecules. In addition, omega-3s help lower triglycerides and improve insulin sensitivity.

What to eat: Flaxseed and chia seed contain high amounts of ALA, another type of omega-3 that can be converted to EPA and DHA. Oily fish like sardines and salmon are a great direct source of EPA and DHA, as are fish oil supplements.

3. **Zinc** is used for more than 300 processes in the body, including synthesizing carbohydrates, fats, and proteins; insulin signaling, and vitamin D activation. It plays a key role in supporting the immune system. And zinc imbalance is associated with diabetes and insulin resistance.

What to eat: Oysters, beef, and crab can provide all or nearly all of your daily intake. If you're a vegetarian, an ounce of pumpkin seeds or cashews can provide about 15-20% of your daily intake.

day, a person's overall risk of having [metabolic syndrome](#) decreased by 17%.

What to eat: Pumpkin seeds are the single best source, with ¼ cup containing nearly half your daily needs. But you can also get magnesium from chia seeds, almonds, spinach, cashews, and peanuts.

5. **Vitamin B6** alone is involved in 150 reactions that regulate glucose, lipid and amino acid metabolism, DNA synthesis, and neurotransmitter synthesis. Higher levels of B6 and B2 may reduce the risk of Type 2 diabetes. B6 also acts as an antioxidant, and [a study in rats](#) with induced diabetes showed that B6 supplementation decreased blood glucose levels and reduced [oxidative stress](#) and associated cellular damage, particularly in the kidneys.

What to eat: [About 75% of vitamin B6](#) in food is bioavailable. One cup of chickpeas has about 65% of your daily vitamin B6 needs, and 3 ounces of yellowfin tuna counts for more than half. Three ounces of salmon has about 35%.

Learn More

Read: [8 Micronutrients essential for metabolic health](#)

Watch: [Mitochondria: the cell's powerhouse](#) (this video is technical, so ignore the details; just focus on the awe-inspiring imagery of how complex this tiny part of the cell is!)

[-Dr. Casey](#)

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NUTRITION

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