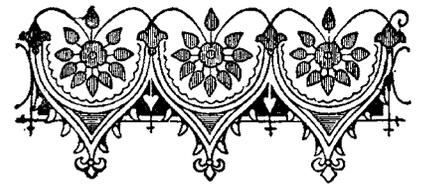


# Health & Wellness



## Mind Your Mighty Mitochondria, Your Mega Energy Generators



Dr. Kate Thomsen and Silky

What do fatigue, inability to think clearly, and a type of pre-diabetes have in common? They all involve a breakdown in the ability of a body's cells to make energy. Your body is really a big bag of cells and specific cells make up each organ – muscle cells, brain cells, liver cells... These cells do a lot of work. Where do they get their energy to do this work? They get it from food. But why are some people who are eating 3 meals per day still fatigued? People with brain fog or Alzheimer's Disease have not stopped eating.

There are many steps to getting food converted to energy to make muscles work and brains think. The proper nutrients must be taken in – these are the raw materials to make energy. Various functions and structures in the body have to be in place for processing of raw materials (digestion), transport of the processed materials from the intestines to the blood to the cells, assimilation into the cells, and the manufacturing of energy from these processed materials. And then there are the waste products of all these processes. Problems can happen anywhere in this chain of events that prevents energy from being made efficiently. The organs that feel it first are the ones that depend on energy the most: the brain, the muscles, the heart, the liver.

Energy used in cells is a chemical energy stored in the bonds of a molecule called ATP. Energy is released from a molecule of ATP when it is decomposed to ADP. Various processes can add that high energy bond back into ADP and recycle it into ATP creat-

ing more potential energy. A molecule with stored energy is ready to do work. When that molecule is oxidized and gives up its stored energy (in the form of an electron) the energy is released and able to do work in the cell. And there's a lot of work to do. A human will typically use up his or her body weight in ATP every 24 hours. That's a lot of ATP!!! It has been estimated that each ATP molecule is recycled 500 – 750 times during a day.

ATP can be created in the presence of oxygen or not. Without oxygen available, the process is called anaerobic glycolysis. In this process a sugar molecule, glucose, is broken apart to create only 2 ATP. A by-product is lactic acid and when this builds up our muscles get cramps. It is an inefficient process but some cells, like red blood cells, depend on it.

We breathe to supply oxygen to our cells. Oxygen is needed to produce cellular energy more efficiently. Aerobic glycolysis that breaks apart glucose in the presence of oxygen occurs in the Krebs Cycle. This process creates new molecules the body needs, but still only 2 ATP. This time it also creates electrons for potential energy. Electron carrying molecules, a form of niacin (Vitamin B3) and a form of riboflavin (Vitamin B2) pick up the electrons and bring them to the mitochondria. Once in the mitochondria, the molecule CoQ 10 will shuttle the electrons around.

Mitochondria are small organelles inside the cells. These are mega cell energy generators. There are thousands of them in each liver or muscle cell as these cells need to do a lot of work. Other cells have only hundreds of mitochondria. Mitochondria are made up of several layers of fatty cell membranes that separate molecules and create an electrical charge gradient. Mitochondria take the electrons made in 1 turn of the Krebs Cycle and produce 30 – 38 ATP!!

Fats can also be used as a fuel in the production of energy in a process called beta-oxidation. Because fats are

bigger molecules than glucose, they are degraded more slowly and yield even more ATP (100+ !). Carnitine is an essential nutrient for getting fats into the mitochondria.

So we really rely on the efficiency, quality and quantity of our mitochondria for our overall energy and function. The heart muscle generates >90% of its ATP through the mitochondria. The brain uses 70% of all the ATP the body produces. And in insulin resistance, a form of pre-diabetes, a buildup of fat has been found inside the cells, thought to be due to inefficient mitochondrial function.

So what happens when the mitochondria don't function well? You get tired, you can't think, you do not utilize sugar and fats efficiently and end up storing fat in your belly, your nerves tingle, your liver doesn't have the energy to remove toxins, you may have chest pain with exertion. Some of these are early warning signs of a mitochondriopathy – sick and dysfunctional mitochondria. Paying attention early on to these symptoms, one can correct the imbalances before the body functions are compromised. Without correction it is a downward spiral from there as energy equals life.

So what goes wrong with mitochondria and how do we fix it? Only 2 % of the mitochondriopathies are genetic. That's the good news - 98% are fixable. First let's think about inputs. The production of ATP requires many essential nutrients: 21 minerals, 13 vitamins, 8 amino acids and 2 fatty acids. Are you getting enough nutrients in your diet? A varied diet full of fresh, whole, and colorful foods is the best way to maximize nutrient intake. Second, what about structure and function? Is your gastrointestinal tract healthy enough to absorb the nutrients and can your cells take them in? This will depend on stomach acid, digestive enzymes, proper gut microflora, healthy immune cells, healthy intestinal cell walls, and healthy cell membranes with the right composition of fatty acids. Remember the

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**The following have been reported to produce toxic effects in the mitochondria:**

- \* Heavy Metals - Mercury, Lead, Arsenic
- \* Organophosphate Pesticides like Malathion – still used in agriculture and for mosquito control
- \* Organochlorine Pesticides (DDT, aldrin, dieldrin) and Others (Rotenone)
- \* Chemicals – Cyanide, Carbon monoxide, azide, 2,4-dinitrophenol, pentachlorophenol, oligomycin
- \* Pharmaceuticals– valproic acid, antiretrovirals, statins, aspirin, aminoglycoside antibiotics, aminoglycoside and platinum chemotherapies, amytal, acetaminophen, metformin, beta-blockers, steroids

**The following nutrients are necessary for optimal mitochondrial function:**

- \* Calcium, Potassium, Magnesium, and trace minerals
- \* B Complex, Vitamins E, C, K, A, beta-carotene
- \* Essential amino acids: methionine, phenylalanine, threonine, tryptophan, histidine, isoleucine, leucine, lysine, valine
- \* Essential Fats: EPA, DHA, GLA, AA
- \* Others: Carnitine, CoQ10, Cysteine, Taurine, Glycine, Lipoic Acid
- \* Interventions shown to increase the number of mitochondria: exercise, 12 hour fast in each 24 hours, modified Atkins type diet (modified ketogenic diet)

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mitochondria are made up of many layers of these fatty membranes. Proper fat intake is extremely important as I have written in several previous articles. Third, what about toxins? The fats that make up the cell membranes are subject to free radical damage (rancidity). Free radicals (oxygen derivatives) are the waste products of energy production and are easy to generate in the high oxygen environment of the mitochondria. Lack of antioxidant protection can lead to mitochondrial damage. Environmental toxins (heavy metals and pesticides) as well as some pharmaceutical drugs have been shown to disrupt mitochondrial function. Here's what to do: Review your pharmaceuticals, check your cell nutrient and

antioxidant status, evaluate the health of your cell membranes, and test for environmental toxins. You can correct the imbalances, add healthy fuel and get back on the go!!! It's do-able!!

*Dr. Kate Thomsen's office for holistic health care is located in Pennington, NJ. She is board certified in Family Medicine and in Integrative/Holistic Medicine. She has been practicing Functional Medicine for over 15 years. For more information see [www.drkatethomsen.com](http://www.drkatethomsen.com) or call the office at 609-818-9700.*

**The key is to keep company only with people who uplift you, whose presence calls forth your best. — Epictetus**