

Understanding Mitochondrial Disorders

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What are Mitochondria?



Mitochondria are tiny, cucumber-shaped “factories” that are responsible for turning the food we eat into packets of energy called **ATP**. ATP can be used by all body cells.

There are many mitochondria in all cells of the body. Although all tissues make and need mitochondrial energy, the areas of the body that rely on it most are the:

- **brain**
- **spinal cord**
- **heart**
- **muscles**
- **kidneys**
- **stomach**
- **intestines and**
- **endocrine glands (e.g. thyroid and pancreas)**

These tissues have a large percentage of mitochondria. Some cells like red blood cells or hair cells have very little or no mitochondria in them. Cells like these are therefore not affected by the mitochondrial disorder.

What are Mitochondrial Disorders?

Mitochondrial disorders are a group of genetic diseases that are caused by defects in the way that mitochondria make energy for the body. The disorders affect the organs and tissues that use the most mitochondrial energy (**see page 3**). By their effects on these areas of the body, mitochondrial disorders can cause blindness, deafness, dementia, movement problems, seizures, heart disease, muscle disease, diabetes and kidney problems and can even affect growth and body temperature. **It is important to note that all of these symptoms do not affect everyone; they vary widely among individuals.**

Mitochondrial disorders can affect people of all ages, from newborns to adults. Some people can have severe symptoms while others may be only mildly affected.

Until very recently, scientists knew how mitochondria worked, but did not know how people were affected when mitochondria did not work. It is now believed that mitochondrial disorders may be playing a role in diseases whose cause was previously unknown.

Examples of specific mitochondrial syndromes are:

- Kearnes-Sayre syndrome
- Leigh's disease
- NARP
- LHON
- MELAS
- MERRF

Many people do not have a specific 'syndrome' and are diagnosed with *mitochondrial disease* in general.

How Do People Get Mitochondrial Disorders?

It is believed that millions of years ago, mitochondria were independent creatures. Somewhere along the line, they were adopted into our cells. Mitochondria therefore come with their own set of genetic material, or recipe for new mitochondria. This is called DNA. Mitochondrial DNA differs from the regular DNA found in cells in one important way: it is only passed from mother to baby, rarely from father to baby.

Damage to DNA resulting in mitochondrial disorders can be **inherited** or can happen by **chance**. If the disorder is inherited, it is important to note that the genes that cause mitochondrial dysfunction can either be passed on through the cell's DNA (called **nuclear** DNA) or through the mitochondria's DNA. Inheritance can therefore be difficult to predict. You should see a doctor who understands genetics to help you to understand just how the disorder can affect your family.



What are the Symptoms of Mitochondrial Disorders?

Remember that every cell in the body has many mitochondria. Although all tissues make and need mitochondrial energy, the areas of the body that rely on it most are the brain, spinal cord, heart, muscles, kidneys, stomach, intestines and endocrine glands (e.g. thyroid and pancreas). This is because these tissues have a large percentage of mitochondria.

In mitochondrial disorders, there is a mixture of mitochondria in the cells. Some are sick and some are healthy.

To compensate for energy deficits caused by the sick mitochondria, the cell makes extra mitochondria. These extra mitochondria make the energy to make the area of the body work properly.

Think back to the comparison of mitochondria being like factories. Imagine a city that depends on factories to make power. Some of these factories do not make enough power and so others are working overtime. The city has to build new factories to make up for the ones not making power. This keeps the city running smoothly.

The body depends on mitochondria in much the same way. Think of the muscles in the legs. When the mitochondria in muscle cells are not making enough energy for the muscle to work, the muscle becomes tired and weak because the healthy mitochondria are working overtime. This same problem can happen with cells in the brain and other areas of the body that have lots of mitochondria.

Some people with mitochondrial disorders may have a mixture of “sick and healthy” mitochondria in their hearts, others in their eyelids, others in their leg and arm muscles. Therefore, mitochondrial disorders have a wide variety

of symptoms; they depend on the area of the body where the mitochondrial “factories” are not working. Even two people with the exact same defect in their mitochondrial DNA may not show the same symptoms. This is why family members who have all inherited a mitochondrial defect will not all show symptoms, or not show them to the same degree. Some disorders are not evident until adulthood and some never cause symptoms. Some are so severe that a child does not survive infancy or becomes increasingly behind in development.

How are Mitochondrial Disorders Treated?

The symptoms of the specific mitochondrial disorder determine treatment. There is no miracle cure for the diseases. There are, however, different strategies that may help to improve symptoms.

VITAMIN COCKTAIL

The vitamin cocktail for mitochondrial disease is a combination of five to six different vitamins and cofactors that may help to improve energy production in the body. All are available at health food and drug stores. It is important to note that it may take up to three months to see any improvement in symptoms from any one of these vitamins. It is therefore important that each addition to the cocktail be made three months apart while documenting symptoms to see if the particular vitamin is helping or not.

These vitamins help symptoms in some people but not in others. They will not eliminate symptoms nor do they alter the progression of the symptoms over time.



1. Coenzyme Q 10 (Ubiquinone)

Coenzyme Q 10 is a natural substance found in all the cells of the body. It helps to make energy in the mitochondria. Coenzyme Q 10 also acts as an “antioxidant”. Oxygen free radicals are charged oxygen molecules that can destroy the cell wall. Coenzyme Q 10 acts as a “buffer” to protect the cell from these free radicals. It is taken by mouth in pill form.

2. Carnitine

Carnitine acts as a shuttle in and out of the mitochondria. It helps to transport the raw materials from food into the mitochondria so that energy can be made and it helps to clean up and move out what is not used in energy production. It is taken in the liquid or pill form by mouth. Talk to the staff of the metabolic clinic about where to best obtain carnitine.

3. Riboflavin (vitamin B2) and Thiamine (vitamin B1)

These vitamins work together with proteins in the mitochondria. They are like keys that help the mitochondrial proteins “unlock” energy from raw materials from the food we eat. For those who suffer from migraine headaches, riboflavin may help to reduce the incidence and severity. They are taken in by mouth in pill form.

4. Creatine monohydrate

Creatine is an amino acid (amino acids are the building blocks of protein), which is made in the body by the liver and kidneys, and is derived from the diet through meat and animal products. Creatine is also sold as a nutritional supplement.

In the body, creatine is changed into a molecule called “phosphocreatine” which serves as a storage reservoir for quick energy. Phosphocreatine is especially important in the muscles and nervous system, which periodically need large amounts of energy. The amount of phosphocreatine in the muscles of people with mitochondrial disorders is lower than normal.

Researchers suspect that creatine supplementation may improve muscle strength by bolstering the muscles’ energy stores. Creatine may therefore give your muscles more energy and help to prevent lactic acid from building up in your muscles (prevent the burning feeling in muscles after exercise). Creatine is taken by mouth in a powdered form.

5. Alpha-Lipoic Acid

Alpha lipoic acid is derived from dietary sources (spinach, liver, red meat, brewer’s yeast), although the body does manufacture a small supply of its own. Alpha lipoic acid is found in all cells, especially those that require a great deal of energy to work, such as the heart cells.

In order to get the concentrated doses needed to treat mitochondrial disorders, it is often helpful to take additional alpha lipoic acid as a supplement in pill form. Alpha lipoic acid helps to make energy in the mitochondria of the body.

It also acts as an “antioxidant”. Oxygen free radicals are charged oxygen molecules that can destroy the walls of cells. Alpha lipoic acid acts as a “buffer” to protect the cell walls from these free radicals. Alpha lipoic acid is taken in pill form.

DIET

No specific diet has been shown to improve the symptoms of mitochondrial disorders. However, eating a healthy diet may help to improve symptoms by providing fuel in the form that is most easily used by mitochondria. A healthy diet may also reduce the risk of developing complications such as diabetes or heart disease.



1. **Follow Canada's Food Guide**

(http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/food_guide_rainbow_e.html)

2. **Eat a balanced diet** to get all of the vitamins and minerals your body needs each day to function as best as it can. A balanced diet has plenty of variety and includes 3 out of the 4 food groups at each meal.

3. **Eat smaller amounts of food** more often as it may help to better “fuel” your daily activities.

4. **Maintain a healthy body weight** with regular exercise and heart-smart food choices.
(<http://www.nhlbi.nih.gov/health/public/heart/other/chdblack/smart1.htm>)

ENERGY CONSERVATION

People with mitochondrial disorders tend to tire easily. It is important for them to pace themselves and to alternate between rest and periods of activity to conserve energy. Sleep is very important. Symptoms may increase when the person is fatigued. Exercise, stress, illness and time of day can cause fatigue.

MONITORING

Regular visits to the metabolic clinic are very important. As needed, referrals are made to other doctors such as ophthalmologists (eye specialists) and cardiologists (heart specialists) to closely monitor the effects of mitochondrial dysfunction on the body.

Through heart ultrasounds called echocardiograms (done every 1-2 years), electrocardiograms (EKG) and lab work (both done every year), your metabolic physician is able to closely watch for potential problems with your heart, liver and kidneys that could arise due to the mitochondrial dysfunction. Attending regular clinic appointments will also provide an opportunity for you to consult with the metabolic team and to address issues that may improve your overall quality of life.

EXERCISE

Although exercise does not provide a cure for the disease, it can greatly improve quality of life and prevent complications from developing in people with mitochondrial disease. Exercise can: improve energy production in the body by increasing the number of healthy mitochondria working in your cells; improve your ability to walk; reduce your lactate production; and prevent problems arising from inactivity and disuse. Inactivity can lead to a loss of motivation, energy and mobility, all of which may reduce independence.



You may ask, “How can I exercise when I feel so lousy?” The key is to do it smartly and to know your limits. Aim low at the beginning and work up to it. For example, if all you can do is one minute of exercise before you need to stop, start with that one minute and build gradually from there. **Any exercise is better than no exercise!** Ideas for exercises are walking, water-based exercise programs, yoga, riding a stationary bicycle, and lifting very light weights. Ask the staff of the AMDC for more information on exercise, including the exercise guide for people with mitochondrial myopathy.

SUPPORT

Many people with mitochondrial disease feel very alone in living with their disorder. There are others out there with whom you can connect and share ideas. Please ask the AMDC staff about current programs and on-line support groups to connect with other adults with mitochondrial disease.

How can friends and family help?

Understanding that the person with mitochondrial disease is not “crazy” or “lazy” is the best help that you can offer. Recognize and accept that they have physical limitations and may tire easily. Become familiar with how their specific disorder affects them. Don’t make assumptions about their level of physical or mental functioning. Remember that the person is feeling frustrated by how quickly their energy level can change. The person may get angry or very depressed and sad. Sometimes the person may be forgetful or have difficulty with planning activities.

Some ideas ...

- Make your offers of help concrete. Instead of saying, “What can I do to help?” or “If there’s anything I can do, let me know”, give clear offers.

Examples are:

“I’ll take care of the kids on Friday night so you and Bob can have a night on your own.”

“I’m going to the grocery store tomorrow morning. What can I pick up for you?”

“Why don’t you go and lie down and I’ll vacuum the family room?”

“I’ll take Anne shopping so you can have a break”

Concrete offers like these are easier to accept than offers that the person may perceive as you just “trying to be nice”. Also, there is no decision-making involved, something the person you are trying to help may not have a lot of energy for.

- For people with severe physical limitations from their disorder, offer as much “normal” activity as possible. Include them in activities. Don’t treat them as different. Don’t make assumptions about their capabilities based on visible disabilities.
- For people with less severe limitations from their disorder, remember that their energy level will vary greatly during the day. Learn to look for the telltale signs of fatigue such as droopy eyelids, slow movement or memory problems. Expect less when fatigue is showing.
- Offer to give caregivers breaks.
- Learn as much as you can about the disorder and help to explain it to others. This not only increases awareness of mitochondrial disease, it helps the person affected to have a break from explaining it over and over again.

Helpful Resources

- ◆ The Adult Metabolic Diseases Clinic
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Phone: 604-875-5965
Fax: 604-875-5967
Email: adultmetabolicclinic@vch.ca
- ◆ United Mitochondrial diseases Foundation
8085 Saltsburg Rd. Suite 201
Pittsburg, PA 15239
Phone: 412-793-8077
Fax: 412-793-6477
Website: www.umdf.org

- ◆ Muscular Dystrophy association
3300 East Sunrise Drive
Tucson, Arizona 85718
Phone: 1-800-344-4863
Website: www.mdausa.org
Publish “Quest” magazine which can be found by clicking on Publications on the site’s home page.
- ◆ Muscular Dystrophy Association of Canada
7th floor, 1410 West Broadway
Vancouver, B.C.
Phone: (604) 732-8799
Fax: (604) 731-6127
Website: www.mdac.ca/
- ◆ The National Organization for Rare disorders Inc.
55 Kenosia Avenue, PO Box 1968
Danbury, CT 06813-1968
Phone: 1-800-999-6673
WebSite: www.rarediseases.org/
- ◆ The Cleveland Clinic Health information Center
Website: www.clevelandclinic.org/health

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