April 2010

NIH News in Health

National Institutes of Health · Department of Health and Human Services · newsinhealth.nih.gov

When Cells Face an Energy Crisis

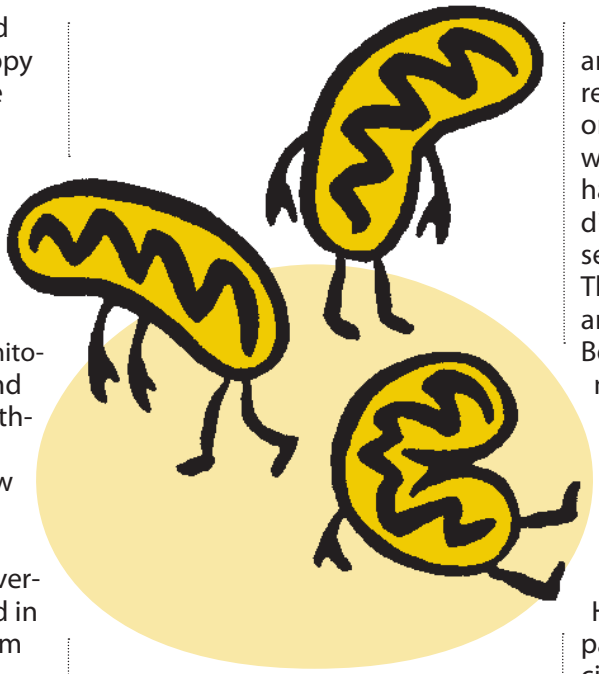
Malfunctioning Mitochondria Cause Many Disorders

A champion swimmer, 16-year-old Joe Wise seems a healthy and happy high school junior. He enjoys time with friends, and he's looking forward to college. But take a closer look, deep into his cells, and something's not quite right. There's a malfunction in the tiny capsule-shaped structures—called **mitochondria**—that power his cells. These abnormal mitochondria cause extreme fatigue and weakness in his legs, trouble breathing and a host of other problems.

"I used to play baseball, but now I can't run so I can't do that any more. Instead, I swim," Joe says. In the past few years, he's broken several national swimming records, and in 2008 he was on the U.S. Swim Team in the Beijing Paralympic games.

Joe is 1 of tens of thousands of people nationwide who have mitochondrial diseases, although estimates vary. There are dozens of subtypes, with each affecting less than 1 in 1,500 people. There's no treatment or cure for any of these rare diseases.

Mitochondrial diseases are caused by abnormal **genes** that lead to flawed proteins or other molecules in the mitochondria. The various subtypes are caused by alterations in different genes, leading to worn-down cells in different parts of the body. Hardest hit are organs and tissues that need a lot of energy, like muscles, brain, heart, kidneys and liver. When the energy supply slumps, cells can become damaged or destroyed.



But mitochondria have importance beyond rare diseases. Even in healthy people, researchers have found, mitochondria can gradually deteriorate as we grow older. Malfunctioning mitochondria have been linked to diabetes, heart disease, Alzheimer's disease, Parkinson's disease and even normal aging. "If we can learn more about the rare mitochondrial disorders, the findings could have implications for understanding more common diseases," says Dr. Vamsi Mootha of Harvard Medical School.

The rare mitochondrial diseases are notoriously difficult for doctors to recognize and diagnose. Depending on which cells are affected, people with mitochondrial diseases may have muscle weakness and pain, digestive problems, heart disease, seizures and many other symptoms. These diseases affect both children and adults. Some lead to early death. Because the symptoms vary widely, mitochondrial diseases are often mistaken for other conditions.

In Joe Wise's case, he was an avid baseball and football player before age 8, when his father noticed he was walking and running a little funny. He felt tired and weak. He had trouble swallowing. Joe's parents took him to see several specialists, who thought he might have juvenile arthritis, muscular dystrophy or maybe a problem with his hip. But eventually, a muscle biopsy showed that he had mitochondrial disease. His doctors didn't expect him to live beyond age 14. "It was a real shock to the family," Joe says. "It was something we suddenly had to learn a lot more about."

Joe had to make difficult adjustments—watching his diet, being careful while walking and using a ventilator twice a day and overnight to help him breathe. He finds he feels weaker over time but continues to

continued on page 2

Definitions

Mitochondria
Known as the cell's "powerhouse," they convert food molecules into a form of energy your cells can use.

Genes
Stretches of DNA, a substance you inherit from your parents, that define characteristics such as how likely you are to get certain diseases.