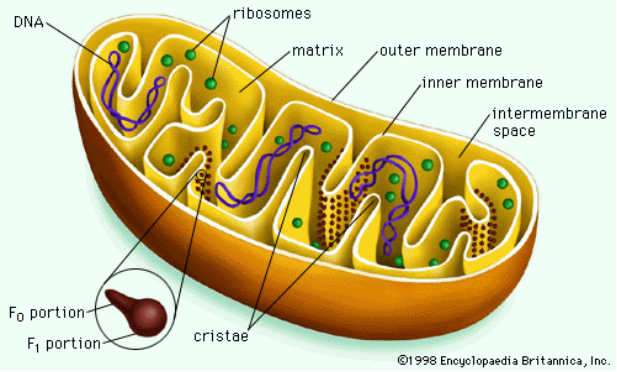
WHAT DO YOU KNOW ABOUT YOUR MITOCHONDRIA?

by John Appleton



Some of the most infrequently talked about organelles in the human body are the mitochondria. An organelle is a specialized structure inside a cell that has the same relationship to the cell as an organ has to the body. I came across mitochondria when I was first looking into the causes of heart disease and more particularly heart failure.

Mitochondria are tiny rod shaped structures within a cell which are responsible for producing and distributing the energy that our cells need in order to perform their function. They are often referred to as cellular powerhouses and they 'manufacture' cellular fuel known as Adenosine Triphosphate (ATP). The process by which this happens is known as bioenergetics (the energy system of the body).

The number of mitochondria in cells can vary greatly (from several thousand to just a few hundred) depending on the energy needs of a cell. Muscle cells (e.g. heart) are required to produce a huge amount of energy, while skin cells have a more 'relaxed life'. It is not surprising to learn that in our heart cells, 75% of the volume of the cell (known as a cardiocyte) is occupied by mitochondria.

When it comes to producing energy in our cellular 'engines' (mitochondria) there's a very important link in the process which was discovered accidently back in 1957 by American scientist Dr Fred Crane who was investigating the sequence of cellular energy production. At the time scientists had a reasonably good idea of how it all happened but there were some gaps. They were searching for a missing link, a catalyst that made the process work. While looking closely at Cauliflower mitochondria, Dr Crane discovered some pigmented material, a yellowish substance which was later found in substantial amounts in Beef Heart mitochondria. This yellow substance turned out to be the missing link in the cellular energy chain. Dr Fred Crane had discovered Coenzyme Q10 a vitamin like substance which performs the same function as a spark plug in an engine. CoQ10 (for short) provides the 'spark' which allows for cellular energy production to take place.

I have been fortunate to meet Dr Crane on two occasions at International Coenzyme Q10 symposiums. We all 'make' some CoQ10 but as we age we make less and less and low levels can lead to an energy crisis (in many disease states low levels of CoQ10 are found). CoQ10 is very important – without it there would be no life. Renowned Immunologist Dr Emile Bliznakov said *CoQ10* = *Energy* = *Life*. A fascinating 'study' which was conducted by Dr Bliznakov some years ago involved injecting 50 mice with Coenzyme Q10 while 50 'control' mice were not treated. The 50 mice given CoQ10 lived on average 50% longer than their normal life expectancy – a surprising and spectacular result. While this 'experiment' has been repeated with much the same results it is not to say it will happen for humans in this way. It does however suggest that aging is strongly linked to the performance of our mitochondria

I read an article recently titled *'Mitochondria Gone Bad'*. In this very informative article they talk about the how our health can be compromised if our mitochondria are not functioning optimally. "There is accumulating evidence to suggest that malfunctioning mitochondria could explain Alzheimer's disease, Parkinson's, Diabetes, Cardiovascular Disease, Obesity and Cancer" and they go on to say that the mitochondria could be the 'epicentre' of aging. Dr Douglas Wallace from University of California Irvine says 'all of these diseases might be solved by understanding the mitochondria."

Something that is not commonly known about mitochondria is that they have their own DNA (known as mitochondrial DNA) which is separate from the DNA that is contained in the nucleus of our cells. DNA is where our genes are found. Mitochondrial DNA is more susceptible to damage (from 'free radical' attack) than is the DNA in the nucleus of the cell and this is one of the main reasons why our mitochondria can 'Go Bad'. Damage is accumulative as their DNA becomes mutated over time and mutations are carried forward as cells replicate – the result is less and less efficient energy production. This is known as mitochondrial dysfunction. Australian molecular scientist, Dr Anthony Linnane says "progressive accumulation of ongoing mitochondrial DNA mutation leads to a decline in cellular energy which in turn contributes to pathology (disease)".

It is very interesting to know that mitochondrial DNA is inherited predominantly from the mother. While sperm have mitochondria (necessary to make energy in order to swim) they are mostly contained in the 'tail' and a section between the 'head' and the tail which falls off after fertilization. Rarely do mitochondria from sperm enter the ovum.The ovum, on the other hand is large and has a huge number of mitochondria thus the function of the mitochondria and diseases associated with our mitochondria are inherited from our mothers.

To understand more about the link with disease, we need to know a bit about 'the history' of mitochondria and how they came to be so important. Paleontologists have dated their origin back 1.6 billion years when they believe that a bacterium 'infected' a cell. It's postulated that the bacterium developed a special relationship with the cell which gave it a competitive edge by allowing it to use oxygen more effectively. The mitochondrion was 'born'. The similarity between mitochondrial DNA and bacterial DNA (mitochondria originated as bacteria) is creating problems for us due to the widespread use of antibiotics. The bacteria like DNA in the mitochondria can become damaged when exposed to a hard hitting antibiotics resulting in an energy deficient state.

I read an article about a former 'Tour de France' winner who retired at the peak of his career with what his doctor described as a mitochondrial myopathy (muscle disease) which may have manifested as a result of over training. This is consistent with studies which show that mitochondrial DNA can become mutated with sustained fatigue. If the mitochondrial energy production is lost in a certain organ or tissue, that organ or tissue changes to a degenerative mode. This degeneration becomes even more rapid when the mitochondrial DNA has mutational injuries. Why this happens has a lot to do with Coenzyme Q10 (without CoQ10 there is no 'spark'). While regular moderate exercise is thought to stimulate the production of Coenzyme Q10, the latest thinking is that exhaustive and prolonged exercise depletes it and thus the cells are deprived of the catalyst that ignites the sequence of energy production. American Cardiologist and CoQ10 researcher Peter Langsjoen says, *"high performance athletes as well as 'weekend warriors' burn up tremendous amounts of CoQ10 and if they are not replacing it, they may be hurting themselves".*

There are a number of drugs that deplete Coenzyme Q10 in the body and leading the list are the Statin Cholesterol lowering drugs and Beta Blockers for blood pressure. The bottom line is that if we don't have adequate CoQ10, our cells are not able to produce the energy that they need in order to function. One can only wonder if the huge increase in heart failure around the world might have something to do with drugs that deplete Coenzyme Q10. I think that if heart failure were regarded and treated as an energy starved heart we might be a bit further ahead. Conventional medicine however seems to struggle with a concept that might not involve drugs. Anyone taking Cholesterol lowering drugs should be taking supplemental Coenzyme Q10. Muscle aches resulting from Statin drug use are a clear signal that there is something wrong.

One day when enquiring about the health of a friend or family member we might be more specific and say *'how are your mitochondria'* because in time I believe it will be clearly demonstrated that the condition of one's mitochondria almost certainly determines their state of health. How can we protect our mitochondria'? Aside from the issues with drugs and antibiotics as mentioned above, limiting free radical damage is where the scientists would be directing us. Why? - In addition to being the principal source of energy for all cells, mitochondria are also the primary site of free radical production. Free radicals are highly reactive molecules that damage cellular structures and particularly mitochondrial DNA. Antioxidants to the rescue, with CoQ10, the B Vitamins, Vitamins C and E and Omega 3 fatty acids being on the hit list.

More information – John Appleton (09) 489-9362
appletonassoc@xtra.co.nz - www.johnappleton.co.nz

.