Episode 9: Mitochondrial dysfunction – could it be the missing link?

Expert Voice - Dr Christobelle Yeoh Podcast transcript

Victor [00:00:03] Hello, I'm Victor Tuballa and this is Expert Voice, Eagle Natural Health's podcast and your partner in natural health and well-being. Joining us on the line today is Christabelle Yeoh, a leading medical doctor with an interest in nutritional and environmental medicine. Christabelle graduated from medicine at the University of London in 1999 and has obtained her membership with the Royal College of Physicians, which is based in the UK. She has a master's degree in nutrition from King's College in London. She has a strong interest in chronic disease management, neurological, gastrointestinal and metabolic health. She is also passionate about teaching on the interconnectedness of human metabolism, biology and behaviour. Christabelle is a Director and Past President at the Australasian College of Nutritional and Environmental Medicine, also known as ACNEM, Christabelle is the medical director of Next Practice GenBiome, which is a cutting edge integrative health clinic in Sydney, providing a range of modalities, addressing brain health and gut health. I'm pleased to welcome Christabelle to today's podcast. Christabelle, thank you very much for your time today and welcome to Expert Voice.

Christabelle [00:01:13] Hi, happy to be here.

Victor [00:01:15] Fantastic, so the mitochondria is, of course the subject for today, which is the microscopic powerhouse organelles within our cells that has one of the most important functions in the human body, to create energy. So today we'll be talking about how mitochondrial function helps us to stay healthy, active and ward off infection and disease. It's such a broad area of research. So today we're focusing specifically on mitochondrial function and brain health and the important role our diet and lifestyle plays in our mental health and wellbeing. So, Christabelle, my first question for you today is what is mitochondrial dysfunction and what causes it?

Christabelle [00:01:57] So first, I'll make a distinction between mitochondrial disease and mitochondrial dysfunction because mitochondrial disease is a more fixed medical entity, which is often inherited genetic and long term, whereas what we're talking about here today is primarily mitochondrial dysfunction, where it's more related to nutritional lifestyle, environmental factors and it's reversible, so you know what causes it. I like to explain to people that the three main burdens of what the mitochondria have to do for us day by day is in three main categories. What causes a dysfunction falls into largely these three main categories. The first category would be around toxins as the mitochondria are very much involved in handling our toxins. Toxin over-exposure is going to cause so much dysfunction. The second category will be around pathogens and chronic exposure. All chronic infectious burden is going to lead to mitochondrial dysfunction and that really is what you might call lifestyle habits that I like to call metabolic burdens. Metabolic burdens, and metabolic demands and requirements is really what we regenerate or recover depending on what we do with our lifestyle. So, that's how we eat, when we don't eat, how much we sleep, how hard we exercise, how well we recover. It's really the total metabolic

burden of those three major categories which constitutes mitochondrial dysfunction and the imbalances within them.

Victor [00:03:50] You think about what happens in today's lifestyle in terms of the fact that we're constantly being exposed to toxins in the environment. Pathogens, how many times do we suffer from colds and flus for example and of course, the dreaded lifestyle habits. It doesn't have to be dreaded but it's just the things that we don't do with our lifestyle that could potentially help us to not only support our mitochondria but also to allow us to live a much more healthier life, improved general wellbeing and so forth. Those lifestyle habits that you spoke about; eating and sleeping for example, these are the things that we do every day and more often than not, we take for granted. These factors can certainly, once addressed properly (if a condition like mitochondrial dysfunction is diagnosed) be managed effectively. We can improve our mitochondrial health which supports general health and wellbeing. I mentioned earlier about the mitochondria being the powerhouses of our bodies with regards to being the little organelles that help to produce energy and of course we're looking at energy in terms of ATP production. So Christabelle, could you explain what ATP production is?

Christabelle [00:05:19] ATP production; I'll take you through that process. It's also known as cellular respiration but before I do that, I will say that whenever you Google mitochondria and you look at all those statements about mitochondria being the powerhouses of our cells, I would just like to say that even before ATP production and ATP synthesis, the mitochondria have other obligatory functions. There's a whole hierarchy to this cellular intracellular organ now and what it does. Yes, it does ATP production very efficiently but first, it's going to want to consume oxygen and it's going to want to be the first messengers in innate immunity. Now, we're going to come back to that because that's related to what you were saying about dealing with infections and our immune system. ATP production/cellular respiration involves three steps. The first step in making energy is, in fact, not in the mitochondria, it's in the cytoplasm outside of the mitochondria and inside the cell. This is what I mean by, you don't really need mitochondria to make ATP. You could just about cope on the first step of ATP production, with glycolysis where you change one glucose molecule into two little ATP molecules. But if our mitochondria and our energy production is going to be more efficient, then it proceeds on to the next step. The second step is called the Krebs cycle also known as the TCA cycle and that's where you need oxygen. Oxygen with what the glucose has turned into (called pyruvate) goes into the mitochondria and together produces more ATP as well as lots of high-energy electrons. It's those energy electrons that really are the gold to our energy and our mitochondria. Those high energy electrons that are inside the mitochondria membranes in these things called electron transport carriers are passed down. It's almost like you are hand passing to the next hand, all the way down these chains of electron transport carriers where then they produce another 32 ATP. So, if your cellular respiration or ATP production cycle is going well and your mitochondria are really ticking over efficiently, that glucose energy is going to give you 36 ATPs produced, but if it is inefficient, you may get two or four.

Victor [00:08:31] Okay, so looking at the electron transport chain and also the Krebs cycle, one would say that both of those areas of ATP production are going to be more important for more of your endurance type athletes, for example people who are going to be doing a lot of aerobic activity for an extended period of time. Whereas, if we're looking at the glycolysis, that's more for a short term or an anaerobic activity? Basically, that's where you're not necessarily relying on oxygen to produce the ATP because you're only

relying on that burst of energy that those two ATP produce for perhaps 10 or 15 seconds for example, an athlete doing a 100-meter sprint. Is that correct?

Christabelle [00:09:16] Yes, absolutely. So anaerobic metabolism versus aerobic metabolism - anaerobic is that short fast sprint where you don't need a lot of oxygen and anaerobic metabolism is that long distance runner that needs a good amount of endurance and stamina. This is a nice concept to explain to people how our mitochondria can function in the short burst versus the long endurance. We want to have efficient, long burning energy mitochondria all the time for our brain, liver, all our organs, and not just for our muscles, which certainly are very mitochondria dense.

Victor [00:10:02] So we've just spoken about mitochondrial function. In terms of mitochondrial function and our gut health, Christabelle, would you be able to give us a bit of an overview on the relationship between the two?

Christabelle [00:10:14] I would love to explain gut health and the mitochondria function because I think most people wouldn't think of that directly. Now, these days most people think about the gut brain axis and of course, they think about inflammation and leaky gut, but what I would say is that all of that is really connected probably through mitochondrial microbiome. The mitochondria have microbes and these microbes are talking to the mitochondria and we now know gut health has got so much to do with inflammation, intestinal permeability, otherwise known as leaky gut and our immune system otherwise known as our mucosal immunity. But if you connect this all up together, what the research is showing now, is that the gut microbiota (the gut bugs) are really signaling to our mitochondria and depending on what they're signaling, it's shown to alter mitochondrial metabolism. This will change and activate our immune system. It will dictate and alter our levels of inflammation through changing our genetics and that's called epigenetics (also called inflammasome signaling). The gut bacteria mitochondria connection, is really one of the new advances of technology showing that we can see what's going on between the two of them. There is this whole bio-directional crosstalk. So, we just said that the gut bacteria can change our mitochondrial function but equally mitochondrial function, because of the reactive oxygen species production, also has a crucial role in regulating the gut microbiome. They're really changing each other.

Victor [00:12:24] Again, that highlights the importance of gut health which we've not only spoken about in previous podcasts but that people in general continue to talk about in terms of not just how the gut improves (not just about digestive health), but how gut health is also a reflection on almost every other system in our body. When it comes to the nervous system, now the mitochondrial function has a role as well. There is such a connection and so it's very important to ensure that gut health is always front of mind. Now that we know that there is a connection between various conditions and mitochondrial dysfunction, it is particularly important to keep this in mind.

Christabelle [00:13:10] Certainly gut health but also think about our evolutionary history where we've come from because our mitochondria, they're what are called prokaryotic cells, which means single unit cell organisms just like bacteria and so why shouldn't our mitochondria speak to our gut bacteria because they have the same evolutionary background? They have the same messaging system. They have the same communication language. We should think of our health also from an evolutionary perspective. So conceptually, it's not needed to think of humans as a massive sea of microbes. We've already been seeing how humans are super organisms because we've got an incredible sea of microbes in us, on us and we need them to live and we need

microbiota to determine functionality of our immune system, for example. Now we can just go another step or a few steps deeper to think that our microbiota speak to our mitochondria and that they really come from the same evolutionary background.

Victor [00:14:35] So now going back to mitochondrial dysfunction, Christabelle, can you tell us what are some of the health effects or symptoms of mitochondrial dysfunction across all of our energy intensive organs for example, our liver, heart, which of course beats forever, and the brain. Could you take us through some of those details?

Christabelle [00:14:54] Yes, sure. Every single organ and cell within our organ contain hundreds to thousands of mitochondria and depending on the function of what that organ needs to do, it's going to have a lot more or quite a few less. Our tissues that contain the most mitochondria are those that have high energy demand for example, some tissues never rest like our nerves. Our nervous system never rests, your brain keeps going even when you're sleeping. Nerves and muscles have heaps and heaps of mitochondria and so whenever we have some degree of mitochondrial weakness or mitochondrial dysfunction, (mitochondrial fatigue), the tissues that are going to show up most are going to be in the muscles, in the brain. So classically a person with mitochondrial dysfunction will complain of some degree of exercise intolerance. We ask them, *how did you recover after that gym session or how did you go after going for that walk*? *Did you need three hours to lie down and sleep or, you know, a week to recover?* You're going to catch those people who have mitochondrial dysfunction as they complain of exercise intolerance. The next one often would be around muscle pain, body pain and poor muscle tone. Remember that there are so many varying degrees of dysfunction. It could be, you know, 10 percent dysfunctional theoretically or it could be 80 percent. People are really going to report different degrees of symptoms because they will have different degrees of what they're doing and how hard they're pushing themselves. I always like to ask people who are going to the gym and not necessarily diagnosed with a disorder, for example I'll say to young men, "*Hey, how you going with your training? Are you building the muscles? You think you should be building compared to your mates at the gym or do you have to work super hard at it? If you don't visit the gym for two weeks, you feel like all your muscles have gone."* It's those guys, who say*, "Oh, yes."* I just always feel like they've got no muscle tone and so on so that's a real indicator for mitochondrial dysfunction as well. So, we said exercise intolerance, we said low muscle tone and muscle pain and body pain. The third one would be around learning difficulties so that, again, depending on the age of the person if they are a child, then obviously in that whole range of learning difficulties there may be some dyslexia, much more serious learning disabilities or I suppose then at the other end of the spectrum, it would be memory loss and cognitive impairment and so on. Of course, in children would be pro-growth and then the next thing I would say is chronic fatigue, needing to sleep all the time. The last thing which would be the most obvious thing would be when someone's already been diagnosed with the disease. So. if they've been diagnosed with cancer or diabetes, metabolic syndrome, depression or Parkinson's disease, Alzheimer's disease, ie chronic diseases which are common in today's medical world. There are so many chronic diseases that people have been diagnosed with that you could pretty much go back and say that all those diseases are connected to mitochondrial dysfunction.

Victor [00:18:46] Wow, I mean, this could potentially be, well, I hate to use big words in terms of describing something like this, in terms of being grand, but it could be a revelation for so many people because when you think about, for example, you talked about exercise intolerance, most of us would think of that particularly when we're walking away from a workout, being in such pain and discomfort and so forth. It could be just since we usually blame a heavy load of lactic acid that's produced afterwards. The thing is if that is

continuing to occur on a regular basis, because we know that after you start to exercise more regularly, even your lactic acid levels tend to lower. But if that pain or that poor recovery is still occurring after exercise, despite doing the same routines and so forth, then maybe perhaps mitochondrial dysfunction could potentially be one of the answers that needs to be addressed in this situation? I guess the same thing with learning difficulties as well. Again, you might speak to a GP or a doctor or about this potential problem with learning difficulties like dyslexia. But you sort of wonder, has mitochondrial dysfunction been brought up as a potential factor in all this? It gives us another area that we can focus on to be able to achieve better results with people who may be suffering from such conditions.

Christabelle [00:20:13] Indeed and certainly there are some conditions like dyslexia or other learning disabilities that might run in families. It's not necessarily going to just completely go away with improving mitochondrial function, but it certainly would be a lot easier on the person to learn. Some conditions could possibly get a lot better and perhaps go away. For example, in children, low muscle tone is one thing that's often picked up and not thought to be related to mitochondrial dysfunction and challenges. Some children are thought to be floppy and less coordinated, but you can certainly improve their muscle function by very specifically targeting mitochondria. With exercise you go to the gym, make lactic acid and it hurts for a while, but it should. It's good to push yourself and break a few muscles and damage a few mitochondria because that's its job. You know, the job of mitochondria and our adaptive capacity to grow and be strong is to get broken and then recover. It's that recovery time that is critical. So, asking people, "*How long do you take to recover?"* If it seems longer than usual, then going back to ask, *so why don't my mitochondria help my muscles to recover as quickly as they should?* It's only exercise. Exercise is the only thing you can do to make new mitochondria. We're going to talk about supplements, but supplements don't make new mitochondria only exercise does.

Victor [00:22:00] That is fantastic to know. I guess for a lot of people out there who are wanting to engage and exercise, for many of them, it's all about weight loss or weight management. But here we have, as you just said, another reason to exercise - to simply improve and to support our mitochondria, I mean, fantastic. As you said earlier, we have these organs in our bodies, our muscles, our heart, our nerves that all have such large amounts of mitochondria to support them. So, by simply exercising, you're supporting mitochondrial function in general and you get the other health benefits on top of that. It's a very important reason, another reason why including exercise as part of your daily lifestyle is so critical.

Christabelle [00:22:53] Yes and if you don't exercise, you don't move enough. Then I mentioned those electrons going down the electron transport chain and that inner mitochondrial membrane. Without exercise they can't shift down that chain of electrons. So, you almost need to dump electrons and dump energy to generate more energy and more ATP production. Otherwise, those electron transport chains can't drop what they're already holding, and they can't function well.

Victor [00:23:24] So we know that mitochondria are the powerhouse of our cells, as we've mentioned before, which produce energy to keep the organs of our body functioning. So now can you explain the role of mitochondria specifically as it relates to brain health and neurological function?

Christabelle [00:23:39] Yes, sure. So that's a big question. Earlier I said how the mitochondria don't just make ATP but there are some other very obligatory functions. It

can't not consume oxygen and mitochondria can't not produce reactive oxygen species and manage cellular redox. There are all these systems that are ready built into the mitochondria that it's just already doing as a result of the environmental loads. So if the mitochondria is loaded with certain environmental burdens like we eat too often and we eat too much, eat too many carbohydrates and we smoke and drink too much alcohol and put stresses on the mitochondria (because the mitochondria whose job is to remove and neutralise and manage all of that), that's called reduction oxidation systems also known as redox. So, the reason why mitochondria functioning well in the nerves is so critical is because we also must think of this aspect of what we call microglial activation, essentially that's inflammation in the brain. The microglia are the immune cells in the brain and the mitochondria are constantly talking to the microglia and the crosstalk between them (ie: the mitochondria saying there's too much, there's too much, redox, imbalance and too much oxidative stress or I've got too many viruses to fight) and it's going to trigger innate immunity. Then it's going to set off the microglial cells into an inflammatory spin. It's like a one two punch. One punch is you've got inflammation driven by infection burden or metabolic burden. Then the second punch, the mitochondria can't make enough ATP to help you get over those burdens and that's why particularly brain health and neurological functioning really expresses whenever there's problems in the mitochondria, in the neurons. Let me just give you an example. The dopaminergic neurons in an area of the brain called the substantial nigra and Parkinson's disease which is known to have issues of dopamine relating to the substantia nigra. Those neurons have just enormous, huge long axons, so long nerves basically, and the density of the mitochondria in there is just incredible. Just one neuron in that area of the brain is roughly about two million mitochondria, so many mitochondria consuming oxygen, which it really needs to do. So how you breathe and how much oxygen you are exposing your cells to makes a real difference. The oxygen consumption and the ATP production (all that work going on just to keep that one cell alive in that part of the brain) is so important for preventing Parkinson's. That's just a pretty simple example.

Victor [00:27:17] Wow and that's amazing because I'm going back to my anatomy and physiology textbooks and you see the term substantia nigra. Would it be fair to say that nigra part refers to the fact that tissue is so dense of mitochondria that it makes it black, literally? I remember back to university and remembering that connection. Well, that explains it because as you said, you need so much mitochondria for that one cell. This is an off-topic sort of question but is that something that could potentially be or is it now being addressed at this moment for patients out there or customers out there who are suffering from Parkinson's disease?

Christabelle [00:28:03] If you ask is the mitochondria being addressed in Parkinson's disease, I would say at the practice level of medicine, no. It's not, because right now the only treatment for Parkinson's disease is to replace the dopamine deficiency with dopamine related drugs. We'll touch on this again later because it's an interesting field of medicine around photo biomodulation and light. So, photo biomodulation it's certainly an area being researched in Parkinson's and applying certain light frequencies to the brain is showing great promise in treating Parkinson's disease. I think that's really working via the mitochondria but that's a very new area of research. Doctors and neurologists in their clinics certainly at this stage would not be thinking about that, nor would they be applying mitochondrial concepts to their treatments.

Victor [00:29:08] The research now is saying that perhaps, maybe it should be considered in this situation, given the fact that Parkinson's disease is on the rise?

Christabelle [00:29:16] Indeed and that, of course, Alzheimer's disease, memory loss, depression and anxiety. Mitochondrial mechanisms and mitochondrial medicine should be applied in all those things.

Victor [00:29:34] And that leads to my next question. You spoke before about the issue now relating to potential problems such as Alzheimer's and dementia. Could you explain the natural process of brain ageing and the continual decrease in ability to produce the ATP?

Christabelle [00:29:49] Yes, so brain ageing. Now, some people would say that the mitochondria really are the reason why we age. Of course, you can talk about telomeres and all sorts of other genetic and cellular mechanisms of ageing, but most people have heard about parts of inflammation causing ageing, also known as inflammageing. Where does inflammation come from, it comes from the mitochondria. I mentioned earlier that the mitochondria make reactive oxygen species and that the most essential part of its day to day is it needs to make reactive oxygen species in order to produce ATP. It's just part of the normal metabolic cycles. It's a bit like if you want heat and you're going to light a fire, you're going to get smoke. You can't have one without the other - the levels of mitochondrial stress therefore and the inflammation that's being pushed out. The imbalance of the reactive oxygen species and how well we can recover and clean up the smoke or the reactive oxygen species, is what is going to determine how fast we age, that's inflammageing and what's behind that is how much are we smoking out our mitochondrial genes, because our mitochondria have their own genes of saying how many unique cellular organisms in and of themselves can exist on their own. They've got their own genes and it's the reactive oxygen species that smoke out these genes and cause mutations, which is what leads to ageing. We know that by the age of 70 or 80, our mitochondrial genome has suffered heaps and heaps of mutations and it's that mutation that really affects our ageing.

Victor [00:32:04] So the reactive oxygen species, would it be fair to say that these are also examples of pro-oxidants as opposed to antioxidants, for example?

Christabelle [00:32:14] Yes, reactive oxygen species are pro-oxidants and that's just a normal part of our chemistry that we have those cycles. That's the redox, reduction oxidation. We've got pro- oxidants and then we have antioxidants. Antioxidant molecules in our cells neutralise pro-oxidants and that's partly what we use nutrients to support, and partly where we modify our lifestyles to reduce oxidative stress. The other side of that is that if you can't recover those things enough and that's with processes like mitophagy because mitophagy is the removal of damaged parts of mitochondria. It's not just how hard we exercise; it is how fast we recover. So even at that cellular level, we've got those pro-oxidant molecules. How well are we removing them and recovering mitochondria through mitophagy? Things that stop us or slow our mitophagy processes will also lead to ageing.

Victor [00:33:38] In terms of brain ageing, is there anything we can do or support from a lifestyle perspective to help delay or maybe even reverse it?

Christabelle [00:33:45] The most obvious one that most people are not doing well enough is sleep, sleeping more, getting good sleep architecture not just the hours of sleep, but the quality and the architecture of our sleep, having a deep sleep, REM sleep and getting enough hours. We could do a whole podcast on sleep separately. Sleep, in and of itself, would be an incredible goal to have to prevent brain ageing. Then the next thing would be

just all the normal lifestyle, nutritional metabolic things to support your mitochondria but sleep is critical.

Victor [00:34:29] Big one, sleep, the many practitioners who I speak to about sleep, every single one of them say pretty much the same. Yes, it is an issue not just getting to sleep but also maintaining sleep as well and maintaining that sleep for a longer period. We spoke about sleep with Vanita Dahia on a previous podcast and how important that is. Apart from sleep, another area of course and we've touched upon this quite a bit is diet. In your opinion, how does our diet specifically affect the way our mitochondria perform and how can we influence this?

Christabelle [00:35:04] A big part of what our mitochondria must juggle (and they must juggle lots of things) is pathogens, toxins, and our metabolic burden. Diet really fits into that, because if we're eating a lot of chemicals and toxic foods and food that's sprayed with a lot of pesticides, then you're giving mitochondria more toxic burdens to deal with, particularly where a lot of these chemicals can be fat soluble. The fat-soluble toxins go into our cell membranes because they're fat and our mitochondria are also fatty. They have a double lipid membrane and these fat-soluble toxins can go into the mitochondria membranes as well and block a whole bunch of the proteins and carrier molecules that need to work well. Toxicities is one part in relation to our diet, but the other part of our diet is really (I use that analogy of smoke and fire so if you need heat, then you have to light a fire and you're always going to get smoke) that we need energy, we always have to eat and we're going to have some mitochondrial smoke to deal with. So how much we eat and how often we eat and what we eat will determine how much mitochondrial so-called smoke we produce that's the reactive oxygen species. Eating carbohydrates produces more smoke than eating fat, for example, because of the respiratory quotient of the macronutrient. So, eating less carbohydrates and more fat, going to a lower carb, high fat diet, certainly gives less mitochondrial work and then also eating less in general. Fasting a bit, intermittent fasting and not snacking all the time. When we do that, it just gives space, more space for our liver and our mitochondria to not have to deal with our food all the time. That would be the main thing I would like to explain to people on a diet. That's the macro nutrient level and we'll come to the micronutrients.

Victor [00:37:30] The next question, of course is probably going to be a big question that people are wanting to know. Could you give us an outline on the role of vitamins and antioxidants in supporting mitochondrial energy, specifically in the brain?

Christabelle [00:37:47] When I think about micronutrients and supporting mitochondria, I'm usually thinking of the mitochondrial structure and function not just antioxidants. We've touched on antioxidants a lot and with antioxidants it is more about getting the balance right and the balance is really the whole picture, the lifestyle, the sleep, how hard you're exercising, how often you're exercising or recovering or not recovering. That’s a big driver of the oxidative part but with just the micronutrients in mitochondrial systems and what's needed to drive the citric acid cycle? What's needed to drive beta-oxidation burning fat and what's needed to support the electron transport chain then the supply of nutrients that I would be thinking about and that I would give people would include co-enzyme Q10 B vitamins, particularly vitamin B3 and B5 magnesium. I do that to also give the D-ribose but that's not technically a vitamin, it's a five-carbon sugar that helps to just shortcut and boost ATP production. I like to give people creatine as well and the antioxidants, if I was to use antioxidants, it would be alpha lipoic acid and resveratrol. Those would be probably my top favourites for mitochondrial nutrients and that's more to do with the internal function. In relation to the structure, because the structure of the inner mitochondrial membrane is

critical to its function and all the electron transport carriers sit through the mitochondrial membranes, it would be to make sure that people are having the right lipids and the right fats. On a macro nutrient diet level, not eating bad fats and not eating trans fats, I'm afraid that means no take-out at all because I haven't been to a single takeaway or fish and chips or anything like that where they don't use bad fats. Certainly, I must say, many restaurants, it's questionable what oils they use to and why not bring your own olive oil to the chef and say, *"Hey, do you mind cooking my meal with this?"* Not eating bad fats can make you a bit unsociable but it's critical for the mitochondria. Then eating the good fats, so the good grass-fed butters, ghee, avocado and good saturated as well as mono and unsaturated fats would be DHA. DHA is important for mitochondria as well, because EPA and other omega 6s (for example, cold pressed saffron oil, even primrose oil) give you some of the good omega 6. Most omega 6 we get in our diet come in the processed oils and packaged foods that we eat, which are, of course, bad ones. Finally, on the lipid front, phospholipids, so egg yolks, organ meats, liver, brain. If you live in France, plenty of brain there.

Victor [00:41:50] And liver pâté as well, right?

Christabelle [00:41:53] Indeed. Liver paté, yes, pancreas. Organ meats have really a lot of possibilities. Now, in this country, that doesn't go down too well when I suggest that pâté is where people can push it to. But indeed, I like to give phosphate supplements because I think people don't have enough muscle lipids and certainly, I like to put egg yolks in smoothies.

Victor [00:42:22] Nice, I was thinking back to when we were talking about foods that contain the organ meats. I was thinking back to the good old steak and kidney pies that I used to have. I don't even know if they still have steak and kidney pies, but I remember that was quite a big one, along with things like tripe, for example, which was quite a popular organ meat food back in the day. Just referring to the COQ10 that you mentioned before. Do you have a preference between the ubiquinone or the activated version energy, ubiquinol?

Christabelle [00:42:52] Yes, thanks for bringing that up. I'd certainly use the activated ubiquinol. I find that clinically that gives people better results as well. So, the final thing I like to give for mitochondrial support, and this is probably one people don't necessarily think of as mitochondrial support because it's not necessarily in your usual COQ10 and magnesium ribose but I really like to think of electrolytes and minerals. Remember that we said the mitochondria are really the gatekeepers of redox reduction, oxidation reactions and that's that the negative positive charge across cell membranes. I think that too many people have redox issues and that redox issues really needs electrolytes and minerals to be better. Some people would talk about that in terms of maybe being more alkaline, but I do like to give minerals, particularly the fulvic acid forms of minerals. Very bioorganic minerals have been shown to be helpful across a whole number of chronic diseases and in some literature in our Ayurvedic medicine, it's known as Shilajit. It's from humus. So, it's this kind of soil humic acid, fulvic acid material from so many years of decomposed bio-organic material that's what these fulvic acid minerals contain.

Victor [00:44:42] So Christabelle, my last question for you is, is there any other new research that may impact the way we look after our cell health to help improve our mental health?

Christabelle [00:44:53] There's some really exciting stuff going on across a few fronts. Firstly, just at that cellular level of the mitochondria we've been talking about, I haven't

mentioned the cell danger response. This isn't that new, in terms of its publications it has been going on for about five, eight, maybe 10 years by Robert Naviaux. He talks about the cell danger response and what is the signaling in the mitochondria that kind of tips that cell into the so-called cell danger response, which is what then drives the vicious cycles of chronic disease. I think there's going to be a lot coming out on how to switch off those cell danger response signals, because ourselves and our mitochondria are very overburdened and overloaded. Be it from our environment and toxicity or be it from infections. There's going to be a lot there and what's really interesting too is they're starting to connect that up to the autonomic nervous system. Now, we haven't talked about the other autonomic nervous system, and that would be another fun podcast to do.

Victor [00:46:13] Absolutely. Yes.

Christabelle [00:46:16] Just at that mitochondrial level, there's probably autonomic or vagal signals that speak to cells, that speak directly to mitochondria that can drive or support inflammation or recovery pathways. There is a lot of research going on including work from Stephen Porges on the polyvagal theory and of Naviaux on the cell danger response and how these things might connect. Another area that I'm excited about is the effect of light and magnetism on our mitochondria. Mitochondria aren't just chemistry factories pumping out chemical molecules of ATP. They're like biophysics machinery. They're like biophysics computers where they interpret signals and frequencies of light and can also respond to magnetic fields. The magnetic fields we expose ourselves to have a natural EMF like gravitational forces and the sunlight and a whole spectrum of light comes from the sun that certainly impact our mitochondria. Then as well, the non-native EMF that could be impacting our mitochondria in an adverse way. For example, cell phone radiation, 4G, 5G, Wi-Fi radiation. So, our cells are electrically driven thanks to our mitochondria and therefore we can't ignore that electricity impacts them as well and therefore our whole cell health.

Victor [00:48:12] I look forward to reading and hearing more about this research because it is something that's widely being discussed, isn't it? But the whole issue with non-natural types of EMF that's being emitted from the source, as you mentioned before, the Wi-Fi, 4G, 5G. I mean you read up about the concerns being raised about 5G now. I guess it's an area that shouldn't be ignored. I do hope that further research, there's some great research as you as you've said, there's already great research out there but certainly more and more research from this, which the public need to know about as well. Again, it could be something that a lot of us aren't aware of.

Christabelle [00:48:52] That's right and even down to just blue light. Your electricity at home, once the sun's gone down, you put your lights on. Sitting in your kitchen, having dinner with your lights overhead and that blue light is signaling to our brain and our mitochondria pick it up and change our melatonin responses. There's a whole lot of exciting things coming out in that research that I think we're going to hear a lot more about in the next decade.

Victor [00:49:24] So it's certainly interesting to hear about the important role that diet and certain nutrients in our lifestyles indeed can play when it comes to looking after our mitochondrial health. So, Christabelle, thank you very much for your time today and talking through these critical points about mitochondrial health and general wellbeing.

Christabelle [00:49:43] You're welcome, I'm a complete mitochondriac. I'm happy to talk to people about mitochondria at any time. If we all looked after mitochondria, we would be much healthier.

Victor [00:49:56] Absolutely and I think you turned me to one as well. Thank again Christabelle. Thank you.

Victor [00:50:02] We encourage you to consult with your healthcare practitioner for advice on whether supplements are suitable for you. If you've enjoyed what you've heard today, we'd appreciate you jumping onto iTunes to provide us with a rating and a review. If you have a topic that you'd like us to cover. We want to hear from you. Get in touch with us via the Eagle Natural Health website, which is www.eaglenaturalhealth.com.au. in the contact section. I'm Victor Tuballa, thanks for listening.

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