



LYME DISEASE
ASSOCIATION OF AUSTRALIA
For Lyme Disease Awareness & Action

Ask the Doctor: A Series on Lifestyle Recommendations to Look After Your Nervous System

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Part 6: The Terrain, The Neuro Immune System & its interface (II): Mitochondria and cell membranes.

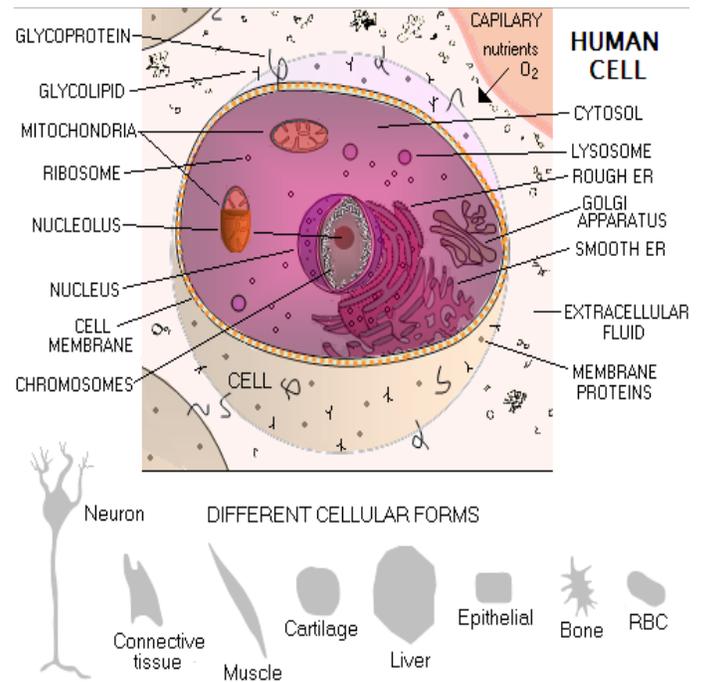
In the last article on this topic, I started the discussion on how inflammation, the nervous system and the immune system interphase with each other. In summary, the neuro immune system is protected by barriers of immunity and these can be simply thought of as the barriers between the inside world (inside cells, inside mitochondria and inside the brain & body) and the outside world (non-intracellular spaces e.g. serum, all extracellular spaces and body cavity spaces such as digestive tract, body cavities, skin). The key points were

- The outcome of infections depend on the state of the human microbiome.
- The expression of our human genes depend on the exposome (lifetime exposure to chemicals) and inflammasome (all potential triggers of inflammation).
- Antibiotics and antimicrobial therapy alone will not address these crucial factors.

In this article, we will specifically discuss how to protect mitochondrial and cell membrane barriers and it will become apparent how this has a direct impact on neuro inflammation. Almost every patient suffering from Borreliosis and associated infections suffers from neuro inflammation. Therefore, this information can be applied widely.

Starting at the most basic building block of the human system, every cell has a phospholipid bilayer around it. (Examine figure 1 here).

FIGURE 1: THE HUMAN CELL.



The phospholipid bilayer of a cell membrane has a composition of phosphatidylcholine, cholesterol, phosphatidylserine, phosphatidylethanolamine, and sphingomyelin. Over 50% of the mass of the cell is lipid (and the quality of these lipids are paramount and come from our diet). What we need to know here is that the

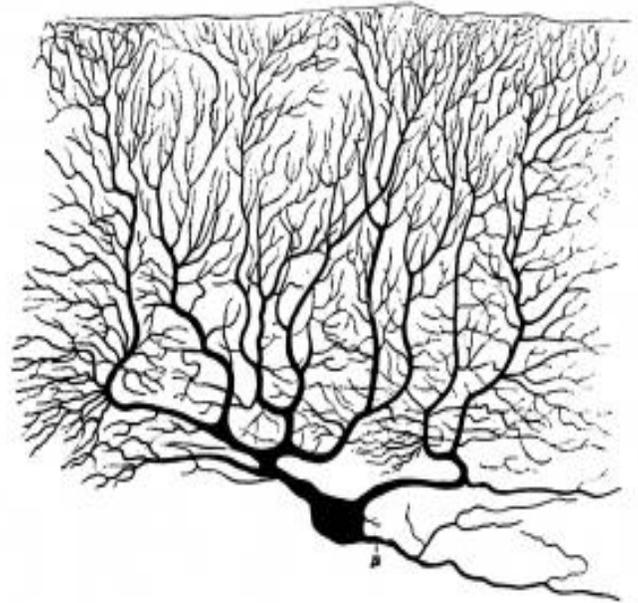
liver is also responsible for making cholesterol and that high cholesterol can reflect the body's requirement of it. Cholesterol is 40% of the body's total lipid molecules and it plays a key role in fluidity and flexibility of the membrane.

Flexibility of the membranes dictates how well that cell and the proteins spanning its cell membrane are going to function. These membrane proteins are responsible for many specialized functions; some act as receptors that allow the cell to respond to external signals, some are responsible for the selective transport of molecules across the membrane and others, participate in electron transport and oxidative phosphorylation (basic cellular metabolism and respiration).

In addition, membrane proteins control the interactions between cells of multicellular organisms. The common structural organization of membranes thus underlies a variety of fundamental biological processes and specialized membrane functions. The passage of molecules across the phospholipid bilayer determines cell to cell communication. Take a look at the image of the human cell in Figure 1 again and think about how the cell in all its many forms, has different tasks and communications to carry out. This is most obvious when thinking about a neurone since its very core function is to convey information.

Nerve dendrites are very similar in appearance to the form of a large tree. It contains thousands of branches which have membranes that act as insulators. In nerve dendrites, the neurological signal fans across the whole tree structure, unlike a single long axon where the electric current travels on the membrane of the nerve. A large amount of dendrite connection forms a current inside the neurone membrane which consists of these 10,000 synapses. This highlights that the integrity of these membranes therefore dictates the integrity of these signals. If we put partially hydrogenated and non-biological fatty acids into our body, this can compromise the cell to cell communication and electrical signals. Figure 2 here shows a nerve cell and its dendrites.

FIGURE 2: NERVE CELL & DENTRITES



As we know, a large number of patients with chronic tick borne diseases do not get diagnosed with single neurological deficit or clearly defined neurological disease. Instead, they have a variety of neurological complaints - tingling, biting, scratching, numbness, burning, shooting, rippling, tremors and so on. Many of these symptoms are frequently attributed to one type of bug versus another, but to effectively address the underlying neuropathophysiology, the neurological terrain needs to be cleaned up of its bacteria, bio-toxins, heavy metals and bad fats that can cause cell and nerve membranes to function poorly. Hence, eating bad fats should be avoided at all costs.

Aside from nerve membrane integrity being fundamental to the barrier function for the blood-brain barrier, we also need to consider the structures inside the nerve cells that signal alarm to the neuro immune system. These structures are the mitochondria.

Mitochondria are the power factories of the cell. They produce ATP which act as the currency for energy in a cell. (This occurs across the 100 trillion cells across our whole body). Each cell has a varied number of mitochondria depending how much energy that cell needs according to its function (e.g. thousands). They

have their own DNA and genome of which, the inheritance is both maternal and paternal.

But mitochondria don't just make energy, they also broadcast metabolism to the rest of the cell, just like signals from an air traffic control tower. ATP has two different functions: Its internal cell function is different to its external cell function. Inside the cell- ATP is an energy carrier molecule, outside the cell- it is a signaling molecule (a 'mitokine').

This means then that mitochondria has two completely different functions:

- 1) Cellular defense and communication
- 2) Overseeing the cell membrane electrical gradients which powers metabolism and the bioenergetic flow of life in the cell.

In figure 3, you can see that a lot of the biochemistry occurs at the membrane around the mitochondria. The driving of biochemical pathways will not occur without these fundamental transcellular membrane structures because this is where the production of ATP and the management of membrane electrical gradient occurs.

Clearly, the integrity of the mitochondrial membrane is core for all of life's processes but, this is impaired by the ingestion of bad fats, the lack of mitochondrial nutrition and the interruption from fat soluble bio-toxins. When the mitochondria are insufficiently supported from lack of reparative nutrients or overly heavy loads of cellular stress, eventually they will selectively undergo cell death (apoptosis) in order to 'save the sinking ship' – this means it is a normal response to improve the cellular outcome of the whole cell - Nature's way of evolutionary conservation to preserve the host from harm. (Refer to figure 4 on the next page)

FIGURE 3 MITOCHONDRIA

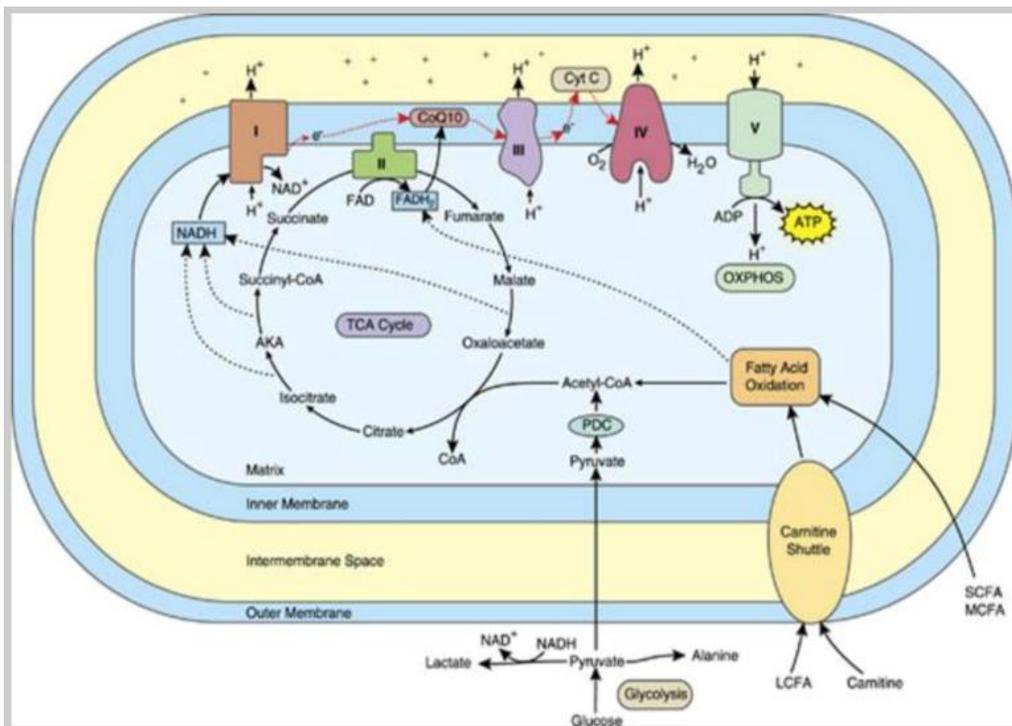
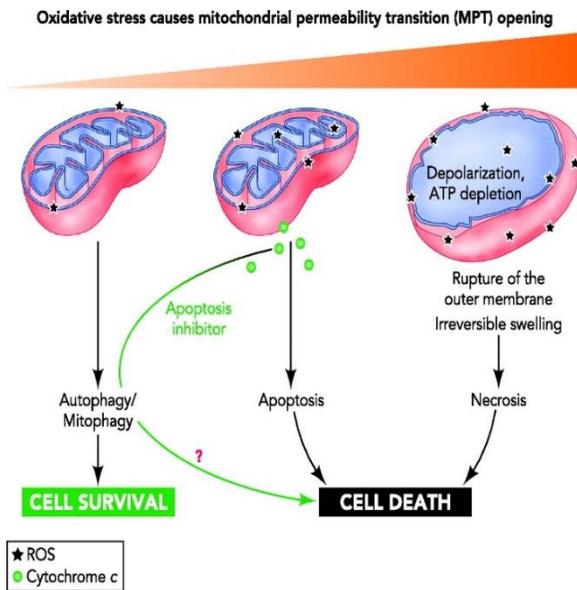


FIGURE 4: MITOCHONDRIAL DEATH.



The mitochondria put out a cell danger response which is maintained by extracellular signals (ATP, ADP, AMP, Adenosine) and mitokines. The mitokines are triggered by encounters with chemicals (heavy metals, pesticides), physical (injury, heat, physical over exertion) and biological threats (viruses, bacteria) which exceed the cellular capacity for homeostasis.

This mismatch leads to alterations in cellular electron flow, oxygen consumption, redox potential, membrane fluidity, carbon and sulfur resource allocation, protein folding, vitamin availability, metal homeostasis, pterin and polyamine metabolism.

How do mitochondria talk to the nervous system and the immune system? This is through the microglia which are the main innate immune cell in the nervous system. Microglia can get activated (primed) by a range of alarm signals, but do not need to exert a pro inflammatory cascade until there is significant systemic (e.g. flu, stress, alcohol) or peripheral (e.g. injury, insect bite) inflammation.

When this happens, the primed microglial come into an active state which triggers stronger inflammation and more pro-inflammatory cytokines will flare in the primed

brain. This leads to blood brain barrier disruption, which further allows the extravasation (leakage) of pro inflammatory cytokines and immune cells into the brain which further activate more microglia. This drives a perpetual cycle of neuro-inflammation and sensitization of the nervous system or pain. The classic example of this is Post Traumatic Stress Disorder which, is not a purely psychological condition but due to an injury to already primed microglia.

All this leads to increasing neuro dysfunction and degeneration in adults and poor development in children. Factors which activate microglia are the same as those that activates allergy responses and mitochondrial responses. When we understand this, it is easy to realize how many of us are already walking around with primed microglia in our brains. This is one reason why allergic people can suffer tick borne infections more severely than others.

Ultimately, the mitochondrial message is simple - all biotoxins which cause harm to the human host will cause a signal of alarm - telling the immune system to roll out the inflammatory cascades and begin the fight for survival. Herein lies the problem; Our fight is not only targeted to acute pathogens, as it should be, but due to our toxic lives, it has become a long drawn out war, made inefficient with weapons rusted by chemicals and deterred by stealth pathogen signals.

Whilst the mitochondria are suffering membrane damage, not supported for reparation and repeatedly sounding the immune alarm signal, chronic infections in the host can continue to survive - more in some areas of human tissue than others and neuro inflammation will go unchecked due to the already primed microglia.

Please refer to figure 5 on the next page:

This information pulls together much of the knowledge from part 1 on carbohydrates, part 2 on mucosal immunity, part 3 on fats and part 4 on protein. As you can see from figure 5, all these parts come together to create good mitochondrial nutrition and to reduce inflammation.

Below are some broad guidelines for a nutritional program to support cell membrane function.

Key nutritional points for repairing and protecting the cell membranes:

- ✧ NO dietary trans fats or any type of hydrogenated or partially hydrogenated vegetable oils (any vegetable oil, margarine, canola, corn, soy bean, grapeseed, sunflower seed and other heated/processed seed oils)
- ✧ HIGH dietary intake of good fat: saturated (animal, butter, coconut, palm oil), monounsaturated (olive, avocado, macadamia oils), cold pressed polyunsaturated fats (evening primrose oil, safflower, borage, flax, sunflower), phospholipids (liver, egg yolks, beef) and a moderate protein intake for a nutrient dense diet.
- ✧ High fat foods contain fat soluble vitamins A, D, E, K- additional supplementation may be beneficial.

- ✧ Additional supplementation that can improve phospholipid functions: phosphatidylcholine 3-4 g per day, phosphatidylserine 300mg per day, butyric acid 3-6 g per day
- ✧ Omega 6 FA: Omega 3 FA 4:1 ratio
- ✧ Methylation support
- ✧ Sulfation support
- ✧ Plant antioxidants

FURTHER NOTES:

- ✧ Vegetable and seed oils lose their integrity of fatty acid structure through heating and thus becomes a "bad Fat"
- ✧ The majority of restaurants and all fast food restaurants use vegetable oils.
- ✧ It would be helpful, when considering the information in Part 6 here, to revisit Part 2 of this series and re-read the information on fats again.

FIGURE 5: NEUROIMMUNE TERRAIN.

