BECOMING A BIOHACKER

An easy guide to biohacking by mitochondrial optimization

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CONTENTS

1

BIOHACKING 101

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Biohacking, a term coined by the great Dave Asprey of Bulletproof, is defined as the desire to understand the body and mind you've been given and using everything at your disposal—cutting-edge technology, tools, and science—to become the best version of yourself.

Webster defines it as: biological experimentation (as by gene editing or the use of drugs or implants) done to improve the qualities or capabilities of living organisms especially by individuals and groups working outside a traditional medical or scientific research environment.

Now seriously, who does not want to become a biohacker when you truly understand the definition? In this day and age, we are finding more and more that the norm is fatigue, brain fog, sleep issues, and weight gain—instead of vibrance, energy, and happiness. Has anyone stepped back to ask WHY?

Born with an insatiable curiosity and the daughter of an internationally known and research-oriented mathematician, asking why has always been my first response. I was also gifted the experiences of childhood leukemia, heart failure from chemo and so many more opportunities without clear answers. I was set on my biohacking path DECADES before it became a thing. I had to experiment on myself and use cutting edge and unproven modalities to be able to function. Each time I would study or find something that helped me, I would bring it to my patients and watch how they would respond.

All these years of trial and error has brought me to the conclusion that the ultimate bio-hack lies in our MITOCHONDRIA!

Keep reading to find out WHY...

2

IT'S ALL ABOUT THE MITOCHONDRIA

MITOCHONDRIA

Didn't we meet in middle school?

We are all on the constant quest for the same thing—limitless energy, a healthy body, focus/mental clarity and happiness.

It is common in my practice for even the most diligent patient to feel like they are not at the top of their game. They may eat meticulously, take the supplements recommended, exercise regularly, practice self-care, meditate, but something is STILL missing. As stated previously, the long journey for my own health and well-being has led me to finding the answer. This answer lies in the health, number and function of your MITOCHONDRIA.

The health and number of these little engines inside all of your cells (except red cells) determine if you still have your edge. What we are only just now starting to understand is that they can be supported and healed. In fact, you can even trigger and signal your body to make new mitochondria!

Billions of years ago, our mitochondria were an energy producing bacteria that we hijacked (see we were hackers even billions of years ago!). Because of this, your mitochondria have their own DNA (called mtDNA) that only comes from the MOTHER and is more vulnerable than nuclear DNA because it lacks the protective proteins.

Your mitochondria are involved in cell signaling, cell death, production of hormones and neurotransmitters, and protection against oxidative damage and are likely the best way to determine biological age. The main function of the mitochondria is the generation of ATP (energy) and over 40 different organs may have different capacity to make energy based on the number of functioning mitochondria inside.

High functioning mitochondria are needed for hormone production and signaling, so as cells age and our mitochondria get damaged (by things like processed foods, toxins, stress, etc.), we are more at risk of developing degenerative diseases.

You need to understand the structure of the mitochondria and some important basics to be able to effectively "hack" them.

Some of the most important basics are:

- Mitochondria is the location of both the Krebs cycle and Electron Transport Chain (ETC) which use the oxygen we breathe and food we eat to make energy molecules called ATP.
- Some of the electrons produced in the ETC can spill and overload the system producing free radicals.
- We need some of those free radicals but when we have too many, they damage our cells and cause aging and disease.
- Caloric restriction is the only thing across species proven to extend life span likely due to the lack of electrons from decreased food intake.

Symptoms of under-functioning mitochondria include: muscle weakness, fatigue, vision or hearing loss, GI issues, trouble with focus, dementia, and diseases like diabetes, heart disease, Parkinson's and so much more.

The following chapters will highlight several ways to optimize your mitochondrial function. You can also start on some supplements.

The top 5 supplements for optimization are:

- CoQ10
- L-Carnitine
- Alpha lipoic
- NADH
- PQQ

3

FEEDING THE HACKER

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Fuel for your mitochondria.

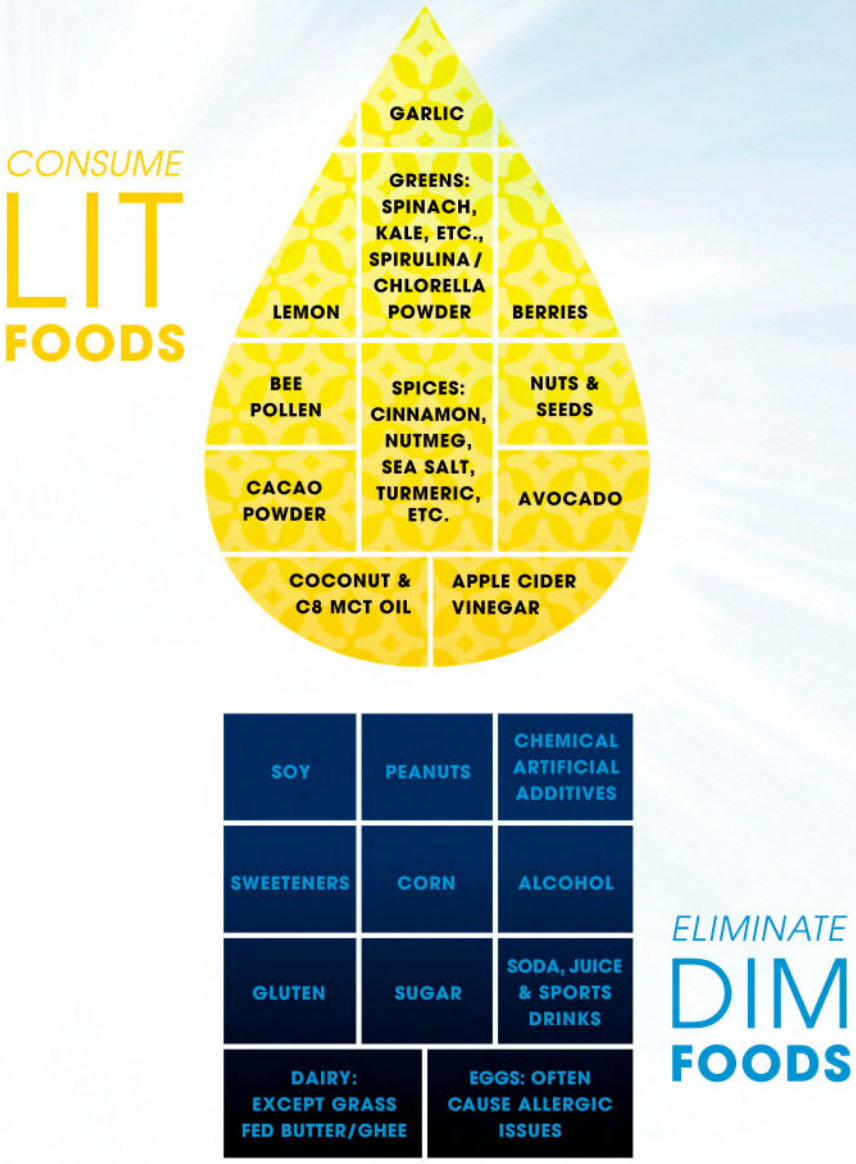
One of the main ways we have damaged our mitochondria over the years is with our diet. What we're now finding is that it's the divergence from our ancestral diet—the massive prevalence of processed, unnatural foods and excessive amounts of added sugars, net carbs and industrial fats—that causes much of the damage.

The addition of more and more chemicals and genetic modification of our food system is a direct mitochondrial stressor. You will need to remove these foods from your diet to feel your best and gain back your edge. I have called these foods DIM since they require more energy to digest and bring no nutritional value. In fact, they are the primary cause of excessive free radical and mitochondrial damage. They are also foods that tend to have high levels of toxic load. You should also remove foods that are likely to cause inflammatory reactions.

A great example of a food that has a lot of wonderful benefits but can often lead to inflammation without you realizing it is eggs. Despite their nutritious balance, they have a protein that can trigger an immune response easily in people. The same can be said for peanuts, which have become a huge issue in schools, and are likely contaminated with pesticides and mold.

Removing these foods is an imperative part of the journey because if they remain in your diet you will stay inflamed which can cause a rapid decline in mitochondrial function. Generalized inflammation is one of the number one causes of fatigue and disease.

As you go through your pantry and remove the DIM foods, don't get discouraged. The good news is that we know that there are plenty of good tasting but DIM foods but there are also plenty of LIT foods as well! These are foods that can increase the production of energy in your mitochondria and are packed with extra antioxidants and micronutrients that are often deficient in people. Other benefits like helping to maintain hydration and pH can be seen with foods like lemons. Some can help with cravings too!



Along with utilizing the DIM/LIT food recommendations, you can adopt a more mitochondria-optimizing fuel source. Our bodies are "metabolically flexible." This means the body can use a diet made primarily of carbohydrates (the standard American diet), OR one made of mostly good fats. After over 50 years of low-fat-diet advice, it is now proven that our bodies run better on good fats than on refined carbohydrates. We make more ATP (energy) and produce less free radicals (toxic waste), when we burn fat.

Using fat as your primary fuel is a much smarter approach when it comes to preserving mitochondrial function. When you eat a higher carbohydrate diet that leads to high blood levels of glucose, you spike the insulin hormone. Insulin inhibits the ability to break down fat and instead promotes the storage of fat and obesity (opposite of what we want!). Additionally, too much glucose and insulin in the blood leads to the formation of advanced glycosylated end products (AGEs) and inflammation which increase the risk of atherosclerosis and other cardio-

vascular diseases, diabetes, dementia, and many more degenerative diseases. So let's shift our mitochondria to the best fuel!!

Traditionally a ketogenic diet is made up of: 65-70% fat; 20% protein; and 5-10% carbohydrate. The ketogenic diet has been proven to help treat seizures (since the 1920's so this is not a NEW craze—LOL), lower blood glucose concentrations in type 2 diabetes mellitus, help with weight-loss, neurological diseases and as an adjunct to traditional cancer therapies (just to name a few)!

When you burn fat for fuel you can test your blood levels and see evidence of ketones. Ketones are what is made when fats in the diet or your body are broken down to be used as energy. Elevated blood ketones have been shown to support healthy mitochondrial activity and inhibits the generation of reactive oxygen species—amazing benefits for the pursuit of a LIT body.

Some of the issues with a ketogenic diet are that it is hard to stick to long term, but many of the benefits can come in just 4-6 weeks. If you stick to keto for at least 30 days and then go back to low carb, you will have taught your body the ability to be metabolically flexible. The benefits of that gift are amazing. You will not be as hungry and always searching and planning your next meal. In fact, many keto-adapted patients state that is the best part! I have found the flexibility of not having to stop at a certain time for lunch helps me to get caught up if I am behind in clinic. You will also be able to use your own fat for fuel which will aid in weight loss.

Another concept that is gaining a lot of popularity and can be utilized with any diet is that of intermittent fasting. Intermittent fasting (or "IF") is an eating pattern where you cycle between periods of eating and fasting. IF is the most effective way to quickly lower insulin and blood sugar.

Even though this fasting and caloric-restricting diet has the absolute MOST research on mitochondrial preservation and longevity, I don't recommend starting until you have become keto adapted. It is much easier to successfully fast once you are metabolically flexible.

There is a lot of research on how fasting may prevent diseases such as Alzheimer's and diabetes. Additionally, it is easy to follow and can be adjusted to your schedule. We normally fast between dinner and breakfast (usually up to 12 hours if you are not eating late night snacks). When trying intermittent fasting, you can choose any time period to skip meals. Most people will start with 16 hours a day and increase all the way up to 7 full days (that is for the die-hards!).

I recommend a full 30 days of keto or very low carb eating, then implementing a daily 16 hour fast (only eat from noon to 8:00 p.m.).

4

EXERCISING THE HACKER

EXERCISING THE HACKER

Sorry, it's necessary!

Studies have proven again and again that in order to make new mitochondria you MUST stress the ones you have. The amount of published data on this concept is incredible and not up for debate. A study in 2011 showed that regular endurance training can increase mitochondrial content from 30 to 100% and increase the volume density up to 40% within 4-6 weeks!

Prolonged exercise programs have shown to prevent mutations in the mitochondrial DNA. Additionally, your mitochondria exhibit remarkable plasticity by adapting their volume, structure, and function in a positive manner in response to chronic exercise. Even a single bout of exercise initiates signaling to make new mitochondria and get rid of those that are not working properly by a process called mitophagy. This accelerated turnover ensures the presence of a high functioning network of mitochondria designed for optimal ATP supply and therefore making you more LIT.

There was a study published in Cell Metabolism in 2017 that compared different exercise programs for their impact on mitochondrial function and found that high-intensity interval training (HIIT) in aerobic exercises such as biking and walking—caused cells to make more proteins specific for their energy-producing mitochondria. The conclusion was that HIIT can effectively stop aging at the cellular level!

HIIT exercise is characterized by relatively short bursts of repeated vigorous activity, interspersed by periods of rest or low-intensity exercise for recovery. I have recorded my easy variation that you can check out here: Try Dr. Lisa's Workout.

5

CHARGING THE HACKER

CHARGING THE HACKER

Let's GET LIT.

One of the most exciting areas of research in mitochondrial medicine is that of light frequencies. Current research is showing light as a very important component of healing. Similar to choosing what food you eat—light can be harmful (junk light) or helpful (most data in near infrared and red light therapy). Some even believe that most diseases of the modern day world started with the development of the light bulb, because it brought humans inside and were no longer getting enough exposure to the sun!

The **electromagnetic spectrum** is the term used by scientists to describe the entire range of light that exists. From radio waves to gamma rays, most of the light in the universe is actually not visible! Visual light is only a very small part of the spectrum and runs from around 390-770 nm.

There are several mechanisms of action with light therapy. Some recent studies have shown that red and near infrared light therapy works by stimulating your mitochondria. There are several ways that we think light therapy is having an impact. It seems to trigger the production of new mitochondria, enhances the amount of ATP produced by the mitochondria, and can increase nitric oxide which helps with blood flow.

Our mitochondria actually have receptors for light. When light activates the receptor it works as a messenger and turns on many different pathways in our body. Light frequencies have been shown to help with balancing hormones, decreasing wrinkles, improving bones, improving energy/brain fog/performance, and more.

Some thoughts are that the light is working on the viscosity of water in the mitochondria so that electrons can pass through more easily. Others think it is working by stimulating cytochrome c oxidase which makes mitochondria more efficient.

Consistent exposure to red light has been shown to help the gut microbiome possible by increasing circulation throughout the body.

New studies are even showing that it could help kill off cancer cells!

Many studies have shown the correlation of decreased sun exposure with higher rates of heart disease, hypertension, autoimmunity and cancer. We are understanding that we are not that different from plants! Light is vital for plant growth.

It has long been understood that plants have choloroplasts which use the substance chlorophyll to absorb light and turn it into energy. The interesting fact is how similar the choloroplast is to the mitochondria. In fact, when my daughter asked me to quiz her in her 9th grade biology class, I was complaining about the first 10 pages being about the leaf—she responded, *"Mom, what is the big deal? The cholorplast and mitochondria look and act exactly THE SAME!"* I filed that one away as super interesting and eventually read the studies showing we now know WE use light from the sun to make energy just like plants.

All the more reason to eat your leafy greens since chlorphyll in our diets help this process be even more effective!

One of my favorite biohacks is to get outside in the morning before 10:00 am and stand in the sunlight. In the morning, there is no or minimal of the harmful rays and a lot of infrared and healthy blue light that can help set your circadian rhythm and make you feel energized. It only needs to be for 5-10 minutes, and it makes all the difference. You can even make it more effective by gazing toward the sun (do not look directly into the sun) and letting the light rays reach your retina. Your retina is home to a very high concentration of your body's mitochondria, so this is a direct to mitochondria interaction with the sun's light rays. Easy, free and very effective.

6

RELAXING THE HACKER

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Shhh! Your mitochondria can hear you!

Stress is something that invariably is commonplace in our daily lives. When your body is stressed, you activate your sympathetic nervous system (fight or flight) and pump out cortisol and other stress hormones. This activation has a very negative impact on your mitochondria.

The main stress hormone, cortisol, has many important functions in the body such as regulating blood pressure, blood sugar, balancing the immune system and buffering inflammation. However, what happens when we have constant stress and the fight or flight response is consistently triggered? In early phases, the adrenals overproduce cortisol—leading to symptoms such as weight gain, feeling wired but tired, insomnia, low blood sugar, brain fog and mood issues. Over time, the glands get to the point where they can't produce enough cortisol to neutralize stress and the body tries to conserve energy. At that point dizziness with standing, low sodium and extreme exhaustion are common symptoms. In addition to mental stress, any kind of physical stress can set off this cascade as well.

This is the first place the mitochondria are involved—if they aren't working right for ANY reason you will set off the stress/adrenal response. Think about that—your mitochondria are tired just because you live in this life with processed food, toxins, leaky gut, etc. When they are not performing, the adrenals send out a stress response. Now you have TWO causes of exhaustion—mitochondria that aren't working optimally so they can't make enough ATP, AND issues with cortisol production that triggers the body to conserve energy since it can't control inflammation and the stress response. That sounds like a double whammy—makes me tired just thinking about it!

There are several studies that have shown how excess cortisol impacts the mitochondria. It seems to impede how they communicate and regulate calcium levels. When this signaling is disrupted, it can lead to many issues including neurological symptoms and disease. Additionally, chronic stress (for example care giving) can decrease the functional capacity of the mitochon-

dria. A recent systematic review of 23 animal studies showed that acute and chronic stress influenced mitochondrial function especially in the brain and showed that it is likely the mitochondria are the intersection between psychological stress and physical health.

The summary of all of this data is that "mitochondrial bioenergetics may play a role in translating stressful experiences into abnormal psychological states and their related somatic symptoms" which basically means the interface between our thoughts, life stressors, and environment is our mitochondria.

Our mitochondria talk to each other via specialized junctions and tubules. They also change shape based on what they sense in the environment and overtime this can lead to mtDNA damage which impairs energy production, has been shown to impact memory, anxiety, and circadian rhythm. Patients with mtDNA disorders have been found to have a decreased vagal nerve activity, increased heart rate at rest and decreased heart rate variability (HRV). This field of medicine is just getting going and the possible interventions are incredible.

So, if stress can damage our mitochondria and poorly functioning mitochondria promote the stress response, we need some stress reduction tools! One of the interesting connections involves the vagus nerve. The vagus nerve is a long meandering bundle of motor and sensory fibers that links the brain stem to the heart, lungs, and gut. It also branches out to touch and interact with other organs. It controls the parasympathetic nervous system—and unconscious body functions, as well as everything from keeping our heart rate constant and food digestion to breathing and sweating. It's the only nerve controlling our ability to decrease stress.

The good news is we can help our mitochondria and stress response by stimulating the vagus nerve! Many studies have shown benefits of this practice and interestingly, vagus nerve stimulation (VNS) improves cardiac mitochondrial function by decreasing mitochondrial permeability (helps to protect them!), decreases oxidative stress and inflammation. So how can we stimulate and activate our vagus nerve? You can start by downloading a HRV app on your phone. These newer technologies look at your heart rhythm and can guide you as to whether or not your vagal nerve (parasympathetic) is balanced with your sympathetic (fight or flight) response. Most of us spend our time consciously or unconsciously out of balance and in sympathetic overdrive. Enhancing vagal tone will help get you into balance.

There are newer devices on the market being used to treat migraines that allow you to stimulate your vagus nerve with impulses. This field of science and intervention is interesting but for now let's stick to some easy suggestions that you can start right now...

Ways to stimulate your vagus nerve:

- Deep breathing and meditation (many of the HRV apps have breathing techniques included)
- Cold exposure (try the last 2 minutes of your shower)
- Singing or chanting directly stimulates the nerve (get over it and try!)
- Laugh
- Exercise
- Yoga or tai chi
- Relax—try affirmations and visualization as well as my favorite—Epsom salt baths
- Positive self-talk and gratitude

Make sure to incorporate the daily practices of meditation even for 5-10 minutes with deep breathing, singing (maybe about how you can't wait to get out of the cold end of your shower), laughing, and of course exercise.

If you are new to meditation, simply go on YouTube and type in "guided meditation for stress reduction". You will find hundreds of free options—try a few to find a voice that enables you to relax. All you do is hit play and breathe.

Your mitochondria will thank you.

HELLO,
NEW BIOHACKER!

That's IT! Put those bio-hacks to use
and optimize your mitochondria!

Make sure to join my e-mail list as well as
follow me on social media for all the latest
in biohacking, anti-aging, and GETTING LIT!

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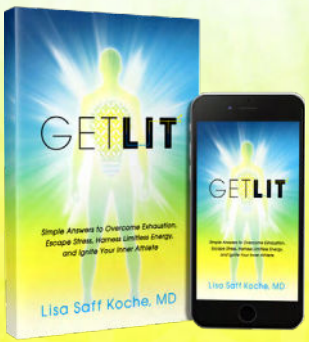

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RESOURCES

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