

# Strategies to Optimize Mitochondrial Health in Long COVID

Analysis by [Dr. Joseph Mercola](#)

✓ Fact Checked

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## STORY AT-A-GLANCE

- › Mitochondrial dysfunction is at the root of most all chronic diseases, and it also plays a crucial role in conditions such as long COVID, which is becoming quite common. It's also a root factor that must be addressed in COVID jab injuries, regardless of symptoms or severity
- › One of the most foundational lifestyle components that can make or break your mitochondrial health is electromagnetic field (EMF) exposure. To allow your body to heal, you'll want to minimize EMF exposure as much as possible
- › The cristae of the inner membrane of the mitochondria contains a fat called cardiolipin, the function of which is dependent on the type of fat you get from your diet. Cardiolipin is important because, if cardiolipin is damaged, mitochondrial energy production will be impaired. The most damaging fat is omega-6 linoleic acid, found in seed oils
- › Another major culprit that destroys mitochondrial function is excess iron, and almost everyone has too much iron. Copper is also important for energy metabolism, detoxification and mitochondrial function, and copper deficiency is common. Copper is also required for proper iron recycling, and low ferritin is typically a sign of copper insufficiency
- › Other strategies reviewed include sun exposure and near-infrared light therapy, time-restricted eating, NAD+ optimizers and methylene blue, which can be a valuable rescue remedy

The video above features a recent lecture I gave to the American College for Advancement in Medicine (ACAM) on how to optimize your mitochondrial health and function.

Mitochondrial dysfunction is at the root of most all chronic diseases, and it also plays a crucial role in conditions such as long COVID, which is becoming quite common. It's also a root factor that must be addressed in COVID job injuries, regardless of symptoms or severity.

Features of the post-job injuries we see point to severe mitochondrial dysfunction, which in turn causes energy failure. The same goes for long COVID in people who struggle with unrelenting fatigue and other symptoms for months after they've recovered from COVID-19 infection.

If you can improve your mitochondrial function and restore energy supply to your cells, you're going to massively increase your odds of reversing the problems caused by the job or the virus.

## **US Life Expectancy Falls in Historic Decline**

Allopathic medicine has been a leading cause of death in the U.S. for over two decades. In 1998, researchers concluded that properly prescribed and correctly taken pharmaceutical drugs were the fourth leading cause of death in the U.S.

Two years later, in 2000, Dr. Barbara Starfield published her groundbreaking paper, "Is US Health Really the Best in the World?"<sup>1</sup> in which she provided data showing that medical errors by doctors were the third leading cause of death. Little has changed since then.

In 2016, Johns Hopkins patient safety experts calculated that more than 250,000

patients died each year from medical errors, again pegging it as the third leading cause of death.<sup>2</sup>

In July 2022, the National Institutes of Health concluded the annual death toll from medical errors could be as high as 440,000 – and possibly even more because of lack of reporting – making it, still, the third leading cause of death.<sup>3</sup>

In future years, I believe the medical intervention sold as "COVID vaccines" will prove to be the No. 1 killer of Americans, and we're already seeing that trend. Something extraordinarily odd happened in 2020 and 2021, something that shaved nearly three years off the life expectancy in the U.S.<sup>4</sup>

Even a tenth or two-tenths of a year mean decline in life expectancy on a population level is a big deal, as it means a lot more people are dying prematurely than they really should be. A three-year drop is simply unheard of.

While media blame this drop on COVID-19 infection, that makes no sense because the average age of those who died from COVID was about 85, well over the life expectancy in 2019. No, this massive drop in life expectancy is due to younger people dying decades earlier than they should, and the only factor that can account for that is the mass injection of people with an experimental bioweapon.

## **Limit Your EMF Exposure**

One of the most foundational lifestyle components that can make or break your mitochondrial health is electromagnetic field (EMF) exposure. To allow your body to heal, you'll want to minimize EMF exposure as much as possible. The World Health Organization classified cell phone radiation as a 2B carcinogen in May 2011.

However, as I detail in my 2020 book, "EMF\*D," it's actually a Class 2A carcinogen. To minimize your EMF exposure, which includes electric fields, magnetic fields and radiofrequencies:

- Keep your cell phone in airplane mode whenever you're not actively using it
- Do not sleep with it near your bed
- At night, be sure to turn off your Wi-Fi
- Turn the breakers off to your bedroom, as the electrical wiring in most homes also emit dirty electricity
- Alternatively, sleep in an EMF-shielding tent, which is what I use whenever I travel and have no control over the EMF exposure in my room

## **Dietary Fat Choices Influence Energy Production**

You have about 40 quadrillion to 100 quadrillion mitochondria throughout the cells of your body. In my lecture, I show a picture of the structure of your mitochondria. The cristae of the inner membrane of the mitochondria contains a fat called cardiolipin,<sup>5</sup> the function of which is dependent on the type of fat you get from your diet.

Cardiolipin is important, because it influences the structure of the cristae inside your mitochondria, which is the area where energy production occurs. If cardiolipin is damaged, then the complexes will not be close enough together to form supercomplexes and thus the mitochondrial energy production will be impaired.

Cardiolipin also works like a cellular alarm system that triggers apoptosis (cell death) by signaling caspase-3 when something goes wrong with the cell. If the cardiolipin is damaged from oxidative stress due to having too much LA, it cannot signal caspase-3, and hence apoptosis does not occur. As a result, dysfunctional cells are allowed to continue to grow, which can turn into a cancerous cell.

The type of dietary fat that promotes healthy cardiolipin is omega-3 fat, and the type that destroys it is omega-6, especially linoleic acid (LA), which is highly susceptible to oxidation. So, to optimize your mitochondrial function, you want to avoid LA as much as possible, and increase your intake of omega-3s.

Primary sources of LA include seed oils used in cooking, processed foods and restaurant foods made with seed oils, condiments, seeds and nuts, most olive oils and avocado oils (due to the high prevalence of adulteration with cheaper seed oils), and animal foods raised on grains such as conventional chicken and pork.

Ideally, consider cutting LA down to below 7 grams per day, which is close to what our ancestors used to get. If you're not sure how much you're eating, enter your food intake into [Cronometer](#) – a free online nutrition tracker – and it will provide you with your total LA intake.

Cronometer will tell you how much omega-6 you're getting from your food down to the tenth of a gram, and you can assume 90% of that is LA. Anything over 10 grams of LA is likely to cause problems. Healthy fat replacements include tallow, butter or ghee, all of which are excellent for cooking.

## **Address Iron Excess and Copper Insufficiency**

Another major culprit that destroys mitochondrial function is excess iron, and almost everyone, with the exception of menstruating women and those with large blood losses, have too much iron. On the other side of this coin is copper, which most people are deficient in.

Iron and copper are highly interdependent and need to be considered together. Low ferritin is rarely indicative of low iron. In most cases, it's a sign that copper insufficiency is preventing proper iron recycling. Copper is also crucial for energy metabolism, detoxification and mitochondrial function.<sup>6</sup> You can learn more about this in "[The Poorly-Understood Role of Copper in Anemia](#)."

To increase your copper level, you can either take 4 to 10 milligrams of copper bisglycinate per day, or eat more copper-rich foods, such as bee pollen, grass fed beef liver and acerola cherry. (Acerola cherry is very high in vitamin C, which contains the copper-rich tyrosinase enzyme.)

The other side of the equation is to lower your iron, which is easily done through regular blood donations. One way is to simply donate blood two to four times a year. If losing 10% of your blood in one sitting is problematic, then you can remove blood in smaller amounts once a month on the schedule I have listed below. If you have congestive heart failure or severe COPD, you should discuss this with your doctor, but otherwise this is a fairly appropriate recommendation for most.

Men	150 ml
Postmenopausal Women	100 ml
Premenopausal Women	50 ml

## The Importance of Sun Exposure

A third leading contributor to mitochondrial dysfunction is lack of sun exposure. Getting regular sun exposure is crucial for several different reasons:

1. UVB triggers vitamin D production in your skin – In addition to playing an important role in infections, vitamin D is also necessary for mitochondrial function and cell health in general.<sup>7,8</sup> The ideal source of vitamin D is sun exposure, so if you live in an area with plenty of year-round sunshine, aim to expose as much bare skin as possible for about an hour during solar noon.

If you live in an area that doesn't get enough sunshine during parts of the year, you'll want to take a vitamin D3 supplement, along with magnesium and vitamin K2.

You need 244% more oral vitamin D if you're not also taking magnesium and vitamin K2,<sup>9</sup> so taking them together means you need far less vitamin D in order to achieve a healthy vitamin D level, which is between 60 ng/mL and 80 ng/mL

(150 nmol/L to 200 nmol/L).

2. Near-infrared rays in sunlight shining on your bare skin trigger melatonin production in your mitochondria<sup>10</sup> – The vast majority of the melatonin your body produces (95%) is made inside your mitochondria in response to near-infrared radiation from the sun. Only 5% of melatonin is produced in your pineal gland.

Melatonin is a master hormone,<sup>11</sup> a potent antioxidant<sup>12</sup> and antioxidant recycler,<sup>13</sup> a master regulator of inflammation and cell death,<sup>14</sup> and an important anticancer molecule.<sup>15</sup>

Melatonin has also been shown to be an important part of COVID treatment, reducing incidence of thrombosis and sepsis<sup>16</sup> and lowering mortality,<sup>17,18</sup> and is a known cytoprotector with neuroprotective properties that can potentially reduce the neurological sequelae documented in patients infected with COVID-19.<sup>19</sup>

When your mitochondria produce ATP (the energy currency of your cells), reactive oxygen species (ROS) are created as a byproduct. ROS are responsible for oxidative stress, and excessive amounts of ROS will damage your mitochondria, contributing to suboptimal health, inflammation and thrombosis (blood clots).

Melatonin production in your mitochondria is your body's built-in mechanism to counteract this damage, but in order for this invaluable system to work, you must expose your body to near-infrared light. While you can raise your vitamin D level using a supplement, this cannot be done with melatonin.

Oral melatonin supplements do not wind up in your mitochondria where they are needed most to quench the damage from oxidative stress produced in the electron transport chain. An alternative to sun exposure would be to use a near-infrared sauna, described in "[Near-Infrared Sauna Therapy – A Key Biohack for Health.](#)"

### 3. Near-infrared light also:

- a. Increases mitochondrial ATP production
- b. Increases autophagy
- c. Increases heat shock proteins, which help proteins maintain their three-dimensional structure and refold misfolded proteins
- d. Reduces inflammation
- e. Triggers the conversion of retinol (vitamin A) to retinoids, which are crucial for immune function
- f. Structures the water in your body – Structured water acts like a storage battery that stores energy in your body in your blood, and helps push blood cells through your capillaries

## Restore Metabolic Function With Time-Restricted Eating

The vast majority of people eat across 12 hours or more, which is a recipe for metabolic disaster. Health statistics bear this out. In July 2022, the Journal of the American College of Cardiology<sup>20</sup> posted an update on the metabolic fitness or flexibility of the American population.

Metabolic fitness includes things like blood glucose and blood sugar, blood pressure and weight, and metabolic flexibility refers to your body's ability to seamlessly transition between burning fat and carbohydrates as your primary fuel.

**“ TRE is one of the easiest yet most powerful interventions for restoring metabolic flexibility and optimizing your mitochondrial function, which is key for recovery from any illness or disease.”**



In 2016, 12.2% of Americans were considered metabolically fit.<sup>21</sup> Two years later, in 2018, only 6.8% of U.S. adults had optimal cardiometabolic health.<sup>22</sup> That was four years ago so, today, that ratio is probably even lower, especially if you consider the number of people who are now struggling with mitochondrial dysfunction as a result of the COVID jab.

TRE is one of the easiest yet most powerful interventions for restoring metabolic flexibility and optimizing your mitochondrial function, which is key for recovery from any illness or disease.

As a general rule, I recommend compressing your eating window to between six and eight hours, and fasting for the remaining 14 to 16 hours each day. The timing of that eating window is important though.

You want to avoid eating first thing in the morning (wait at least two or three hours) and you want to avoid eating right before bed. Ideally, have your last meal at least three hours or more before bedtime. So, to give you an example, you could eat all your meals between 10 a.m. and 6 p.m., or 11 a.m. and 5 p.m.

## **Optimize NAD+**

Boosting nicotinamide adenine dinucleotide (NAD+) is, I believe, another crucial component when treating COVID jab injuries and long COVID. NAD+ is a crucial signaling molecule believed to play an important role in mitochondrial function and longevity.

NAD is used up by DNA repair enzymes and enzymes involved in inflammation and immunity, such that chronic inflammation or acute illness can rapidly result in depletion. To learn more about the role of NAD+ in health, see my interview with Nichola Conlon, Ph.D., a molecular biologist, featured in "[The Crucial Role of NAD+ in Optimal Health](#)." There are a number of ways to boost NAD+ without resorting to expensive supplements, including:

- Circadian rhythm optimization
- TRE and other forms of intermittent fasting
- **Low-dose niacinamide** (not niacin), taken at a dose of 50 mg three times a day. More is not better as it will impair the function of your longevity proteins (sirtuins)
- Intense exercise in a fasted state

## **Mitochondrial Rescuer: Methylene Blue**

Methylene blue can be particularly useful for addressing the fatigue and neurological problems that are common in long COVID and COVID job injuries, as it works as an electron cyler. It basically acts like a battery, but unlike other compounds that do the same thing, it doesn't cause damaging oxidation in the process.

If anything interferes with oxygenation or cellular respiration, methylene blue is able to bypass that point of interference through electron cycling, thus allowing mitochondrial respiration, oxygen consumption and energy production to function as it normally would.

Methylene blue can also be helpful in instances where you have impaired blood flow that prevents the delivery of oxygenated hemoglobin to the tissues. In this case, methylene blue helps counteract the reduced blood flow by optimizing the efficiency of mitochondrial respiration.

Methylene blue also activates the Nrf2 pathway. Nrf2 is a transcription factor that, when activated, goes into the cell's nucleus and binds to the antioxidant response element (AREs) in the DNA. It then induces the transcription of further cytoprotective enzymes such as glutathione, superoxide dismutase catalase, glutathione peroxidase, phase II enzymes, heme-1 oxygenase and many others.

Methylene blue's action on mitochondrial respiration is also coupled with biochemical

upregulation of your oxygen consumption machinery in general. This upregulation remains even after the methylene blue is expelled from your system, and over time, it can actually increase the number of mitochondria.

For neurological conditions, consider using methylene blue in combination with near-infrared sauna therapy. A 2020 paper<sup>23</sup> in *Translational Neurodegeneration* reviews the benefits of this combination, specifically as it refers to neuroprotection.

## **Methylene Blue Dosages and Quality Considerations**

Methylene blue is a hormetic, so low dosages have the opposite effect of high dosages. While every possible dose response has not been tested, as a general guideline, the benefits mentioned here are based on lower dosages, ranging from 0.5 mg per kilogram of bodyweight to 4 mg per kg at most. For brain health and nootropic effects, a dosage between 0.5 mg to 1 mg per kg per day is recommended.

Selecting the correct product is of crucial importance. There are three basic types of methylene blue: industrial, chemical and pharmaceutical-grade. The only version you'll want to use medicinally is pharmaceutical-grade, which is 99%+ pure. Lower grades will contain varying levels of heavy metals and other contaminants.

Pharmaceutical grade will be marked USP, which stands for United States Pharmacopeia. Taking it with some ascorbic acid (vitamin C) facilitates absorption. To learn more, see "[The Surprising Health Benefits of Methylene Blue](#)," in which I interview Francisco Gonzalez-Lima, Ph.D., who has spent many years studying this drug.

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## Guillermou

Gratitude to Dr. Mercola for his excellent advice to help people who are suffering from prolonged Covid. Mitochondria are especially abundant in the organs and tissues of the body with higher energy requirements. Supplements and lifestyle changes can improve mitochondrial health by increasing the availability of proteins needed for ATP production (activation of AMPK, PGC-1a, NAD+, SIRT1. They also act as antioxidants, helping mitochondria to reduce oxidative stress and other important functions, including: signaling, differentiation, programmed cell death and control of cell growth. Related to Dr. Mercola's reports additional support for mitochondrial function includes acetyl-L-carnitine, Q10, pyrroloquinoline quinone, vitamin C, choline, NADH, -lipoic acid, -ketoglutaric acid, resveratrol, N-acetylcysteine, magnesium and a quality multivitamin and mineral complex.

In the following link more references: 33 NATURAL WAYS TO IMPROVE MITOCHONDRIAL FUNCTION.--- [selfhacked.com/blog/natural-ways-to-improve-mitochondrial-function/](https://selfhacked.com/blog/natural-ways-to-improve-mitochondrial-function/) (2022).

Regarding Q10. The most common metabolic and mitochondrial diseases (MMDs) are cardiovascular diseases, cancer, respiratory diseases, diabetes and chronic kidney diseases are a great epidemic.

Prevention of the development of mitochondrial EMM by coenzyme Q 10 is one of the basic forms of protection of human health. [www.sciencedirect.com/.../B9780128198155000495](https://www.sciencedirect.com/.../B9780128198155000495) (2022).--- Targeted mitochondrial therapy with CoQ10 supplementation and rehabilitation may improve mitochondrial health and speed recovery for patients after COVID-19. [pubmed.ncbi.nlm.nih.gov/34967652](https://pubmed.ncbi.nlm.nih.gov/34967652) (2022).--- Putting two things together: A ketogenic diet combined with exercise can improve mitochondrial function and metabolic health. [journals.physiology.org/.../ajpendo.00305.2020](https://journals.physiology.org/.../ajpendo.00305.2020) (2020).-----

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Prolonged COVID and mitochondrial dysregulation. Some relevant aspects: SARS-CoV-2 hijacks mitochondria and uses them for protection and viral replication, diverting resources away from supporting normal cell function to now serve as a viral factory. Viral influence on mitochondrial activities leads to suboptimal energy production. The binding of this receptor by the SARS-CoV-2 virus decreases the production of ACE2, which has a regulatory effect on mitochondrial function. The aging process results in fewer mitochondria and lower ATP production with a decrease in mitochondria autophagy, contributing to chronic inflammation.

The overall effect reduces mitochondrial capacity by approximately 50%, leading to fatigue and muscle weakness. [www.zrtlab.com/blog/archive/long-covid-and-mitochondrial-dysregulation..](http://www.zrtlab.com/blog/archive/long-covid-and-mitochondrial-dysregulation..)

Long-term disturbance of the peripheral immune system months after SARS-CoV-2 infection [link.springer.com/.../s12916-021-02228-6](https://link.springer.com/.../s12916-021-02228-6) (2022) Mitochondria also induce immune responses. During an infection, they release mitochondrial hazard associated molecules (DAMPs). Said DAMPs, mitochondria guide the immune response towards an inflammatory response against pathogens. Mitochondrial DAMPs can also have a negative impact. If damaged cells release mitochondrial DAMPs, without the presence of infection, such as after trauma, mitochondrial DAMPs can induce an unwanted inflammatory response, resulting in tissue damage and organ dysfunction.

The focus should not only be on the mitochondria themselves, but also on the mTOR pathway and other pathways that affect mitochondrial function and that could be inhibited or activated to stimulate or inhibit certain immune cells. In the present narrative review, the current view of mitochondria in the regulation of immune responses and the pathophysiology of autoimmune disease is described. [www.sciencedirect.com/.../S0925443920301927](http://www.sciencedirect.com/.../S0925443920301927) (2020)--

NRPT is a combination of nicotinamide riboside and (NAD<sup>+</sup>), found in milk, and pterostilbene, a polyphenol found in blueberries, was administered to a population of 120 healthy adults between the ages of 60 and 80. The study consisted of three treatment groups: placebo, a recommended dose, and another double-dose group. The concentration of NAD + increased by approximately 40% in the group and approximately 90% in the double administration group, after 4 weeks.

[www.nature.com/.../s41514-017-0016-9](http://www.nature.com/.../s41514-017-0016-9) (2017).--- Pyrroloquinoline quinone (PQQ) is a large component of mitochondrial stimulation. PQQ not only protects mitochondria from oxidative stress, but also promotes the spontaneous generation of new mitochondria within cells in the aging process, a process known as mitochondrial biogenesis.

PQQ is also a powerful antioxidant capable of carrying out 20,000 catalytic conversions. PQQ is a compound found in trace amounts in plant-based foods. PQQ provides considerable benefits in conditions revolving around low mitochondrial function including aging, many brain and neurological diseases (for example, and many other chronic diseases). degenerative diseases.) PQQ combined with coenzyme Q10 has shown better results.

Pyrroloquinoline-quinone is more than an antioxidant, it is important in health and disease prevention [michaelrucker.com/.../pqq-foods](http://michaelrucker.com/.../pqq-foods) (2020).--- [www.mdpi.com/.../1441](http://www.mdpi.com/.../1441) (2021).-- [www.ncbi.nlm.nih.gov/.../PMC8829629](http://www.ncbi.nlm.nih.gov/.../PMC8829629) (2022).--- [www.nature.com/.../s41514-022-00083-0](http://www.nature.com/.../s41514-022-00083-0) (2022) [selfhacked.com/.../pqq-review](http://selfhacked.com/.../pqq-review) (2022).--- Glycine and N-acetylcysteine (GlyNAC) supplementation in older adults improves glutathione deficiency, oxidative stress, mitochondrial dysfunction, insulin resistance, inflammation, physical function, and hallmarks of aging. [academic.oup.com/biomedgerontology/article/78/1/75/6668639?login=false](http://academic.oup.com/biomedgerontology/article/78/1/75/6668639?login=false) (2022) [www.mdpi.com/.../154](http://www.mdpi.com/.../154) (2022).--

## Guillermou

Fasting, exercise and nutrition are basic pillars for longevity. To consider also certain genes. Klotho, a natural human protein, has great potential to delay these diseases of aging. Exercise is related to the Klotho gene for longevity. Membrane Klotho acts through (FGF)-23, and regulates nitric oxide produced in the endothelium. Inactivity accelerates aging and its consequences, it is suggested as one of the main reasons for the increase in disease and mortality. The circulating s-klotho response has been shown to depend on the level of aerobic fitness: s-Klotho values were significantly higher in trained compared to untrained individuals.

The present review suggests that aerobic exercise delays the aging process by increasing Klotho gene expression, which, in turn, reduces ROS damage to the cell.

[pdfs.semanticscholar.org/3499/02f79e6cef77bd5b6785cc392a5455438f0d.pdf](https://pdfs.semanticscholar.org/3499/02f79e6cef77bd5b6785cc392a5455438f0d.pdf) (2015).---

[www.ingentaconnect.com/contentone/ben/cas/2018/00000011/00000002/art00..](http://www.ingentaconnect.com/contentone/ben/cas/2018/00000011/00000002/art00..) (2018).---

[shapeamerica.tandfonline.com/doi/abs/10.1080/02640414.2019.1626048#.Xj..](https://shapeamerica.tandfonline.com/doi/abs/10.1080/02640414.2019.1626048#.Xj..) (2019).----

[www.nature.com/.../s41598-022-22123-1](https://www.nature.com/.../s41598-022-22123-1) (2022).--- [www.frontiersin.org/.../full](https://www.frontiersin.org/.../full) (2022).--

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## Guillermou

Loss of cognition, kidney failure, diabetes, and cancer are things thought to be associated with the body's production of this Klotho protein. Klotho deficiency exhibit an aging phenotype.

[www.nature.com/.../tp201581](http://www.nature.com/.../tp201581) (2015).----- [www.ncbi.nlm.nih.gov/.../PMC4176932](http://www.ncbi.nlm.nih.gov/.../PMC4176932) (2015).-----

[www.ncbi.nlm.nih.gov/.../PMC5592833](http://www.ncbi.nlm.nih.gov/.../PMC5592833) (2017).--- [www.mdpi.com/.../705](http://www.mdpi.com/.../705) (2022) .---

[www.mdpi.com/.../239](http://www.mdpi.com/.../239) (2023).---- Klotho has been linked to the prevention of muscle atrophy, osteopenia, and cardiovascular disease. Similar anti-aging effects have also been attributed to exercise and physical activity, helping to regenerate muscle

[www.ncbi.nlm.nih.gov/.../PMC4060456](http://www.ncbi.nlm.nih.gov/.../PMC4060456) (2014).---

Low serum Klotho associated with all-cause mortality among a nationally representative sample of US adults and as an effective biomarker to characterize inflammatory states

[academic.oup.com/biomedgerontology/article/77/3/452/6386302?login=fals..](http://academic.oup.com/biomedgerontology/article/77/3/452/6386302?login=fals..) (2022).---

[www.tandfonline.com/.../07853890.2022.2077428](http://www.tandfonline.com/.../07853890.2022.2077428) (2022).--- Dietary antioxidants were positively correlated with plasma S-Klotho levels after controlling for covariates.

[www.hindawi.com/.../3524611](http://www.hindawi.com/.../3524611) (2023).---- Current experimental evidence suggests that the ketogenic diet may positively impact mitochondrial bioenergetics, mitochondrial ROS/redox metabolism, and mitochondrial dynamics. [www.sciencedirect.com/.../S1357272521001308](http://www.sciencedirect.com/.../S1357272521001308) (2021).--

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## Guillermou

Each year, more than 70% of disease-related deaths worldwide are due to chronic noncommunicable diseases; the deadliest is cardiometabolic syndrome. Cardiometabolic diseases, including atherosclerosis, hypertension, obesity, type 2 diabetes mellitus, metabolic syndrome, metabolic-cognitive syndrome, and cerebrovascular dementia, are associated with age and have in common dysregulated mitochondrial function and levels of nutrients, atypical immune, neurotrophic and metabotropic. Berberine increased Klotho expression and protected against cardiac senescence. Berberine partially activated the Klotho/SIRT1 signaling pathway to protect against cardiac senescence.

Ferulic acid and berberine, via Sirt1 and AMPK, may act as cellular cleansing promoters of healthy longevity [www.sciencedirect.com/.../S0006295221004251](http://www.sciencedirect.com/.../S0006295221004251) (2021)  
[www.sciencedirect.com/.../S0753332222004863](http://www.sciencedirect.com/.../S0753332222004863) (2022) [openheart.bmj.com/.../e001801.abstract](http://openheart.bmj.com/.../e001801.abstract) (2022) D-ribose is essential for energy metabolism and forms the backbone of the vital ATP molecule that cells use to transfer energy. Cellular damage from oxidants, inflammation, and ischemia/reperfusion damage cause loss of ATP and increased vulnerability to disease.

Research has shown that taking ribose has a positive effect on ATP production in all types of muscle fibers, especially the heart. Ribose supplementation increases de novo ATP production via oxidative phosphorylation by more than 300 percent. Ribose also activates the salvage pathway, causing nucleotides to revitalize in ATP manufacturing by more than 500 percent.

[www.ncbi.nlm.nih.gov/.../PMC5959283](http://www.ncbi.nlm.nih.gov/.../PMC5959283) (2018) .---

[www.spandidos-publications.com/.../etm.2021.9927](http://www.spandidos-publications.com/.../etm.2021.9927) (2021) .---

[www.ncbi.nlm.nih.gov/.../PMC8573443](http://www.ncbi.nlm.nih.gov/.../PMC8573443) (2021) .----

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Sleep pathology may be an underreported complication of primary mitochondrial diseases. The likely underlying mechanism is cellular power failure causing both central neurological and peripheral neuromuscular degenerative changes that commonly present as central sleep apnea and impaired ventilatory response to hypercapnia. In turn, sleep disturbances in affected patients contribute to a vicious cycle of progressive daytime fatigue and exercise intolerance.

[www.ncbi.nlm.nih.gov/.../PMC4224726](http://www.ncbi.nlm.nih.gov/.../PMC4224726) (2014) The findings of this study support the role of sleep disorders in increasing the accumulation of mitochondrial damage, increasing cellular senescence, shortening of telomere length, altering the expression of telomerase activity and the acceleration of epigenetic aging.

Specific pathways, including mitochondrial metabolism, account for DNA damage and repair, altered by sleep deprivation [www.sciencedirect.com/.../S2451965021000466](http://www.sciencedirect.com/.../S2451965021000466) (2021)

Mitochondrial calcium retention in the heart during sleep dissipates membrane potential, slows respiratory activities, and increases ROS levels, which may contribute to increased vulnerability to cardiac stress during the sleep-wake transition. These pronounced daily oscillations in mitochondrial functions related to vulnerability to stress may explain, at least in part, the daytime prevalence of cardiac pathologies.

[www.sciencedirect.com/.../S2090123221000138](http://www.sciencedirect.com/.../S2090123221000138) (2021) A five-night period of sleep restriction leads to reductions in mitochondrial respiratory function, glucose tolerance with concomitant reductions in mitochondrial function and sarcoplasmic protein synthesis and the amplitude of the diurnal rhythms of skin temperature. The data provide evidence supporting the use of exercise as an intervention to mitigate the detrimental physiological effects of sleep loss.

[www.sciencedirect.com/.../S2212877820301848](http://www.sciencedirect.com/.../S2212877820301848) (2021)--

In these reviews some of the potential effects of curcumin are reported, such as inhibiting virus entry into the cell, inhibiting virus encapsulation and viral protease, as well as modulating various cell signaling pathways. Curcumin's ability to modulate a wide range of molecular targets makes it a suitable candidate for managing coronavirus infection and mitigating the effects of prolonged Covid. Curcumin may have beneficial effects against COVID-19 infection through its ability to modulate the various molecular targets that contribute to the binding and internalization of SARS-CoV-2 in many organs, including the liver, cardiovascular system, and blood vessels.

kidneys. Curcumin might also modulate cell signaling pathways, such as inflammation, apoptosis, and RNA replication. Curcumin may also suppress pulmonary edema and fibrosis-associated pathways in COVID-19 infection. Curcumin is known to have strong inhibitory effects on NF- $\kappa$ B and several proinflammatory cytokines, and may be particularly useful as an adjuvant in reversing the fatal cytokine storm that occurs in severe cases and its subsequent complications.

Curcumin supplementation led to a significant decrease in common symptoms, length of hospitalization, and deaths. Curcumin exerts its beneficial effects through at least partial restoration of the pro-inflammatory/anti-inflammatory balance. Curcumin could be a safe and natural therapeutic option to prevent Post-Covid thromboembolic events.

[livinoe.com/wp-content/uploads/2020/08/efectos-beneficos-de-la-CURCUMI..](https://www.livinoe.com/wp-content/uploads/2020/08/efectos-beneficos-de-la-CURCUMI..) (2020)

[www.frontiersin.org/articles/10.3389/fphar.2021.669362/full?crsi=66249..](https://www.frontiersin.org/articles/10.3389/fphar.2021.669362/full?crsi=66249..) (2021)

[www.mdpi.com/.../256](https://www.mdpi.com/.../256) (2022).-

## Guillermou

Studies reported post-COVID-19 neuropsychiatric symptoms in 20% to 70% of patients lasting for longer periods even after respiratory symptoms resolved, suggesting brain involvement. Infection with COVID-19 can have an adverse impact on mental health well-being in both the short and long term. Interestingly, studies have reported that patients with severe COVID-19 infection experience elevated serum levels of proinflammatory cytokines, thereby affecting its permeability that allows TNF- to directly cross the BBB, leading to activation. microglia and astrocytes. These activated microglia secrete inflammatory mediators, including glutamate, quinolinic acid, complement proteins, IL, and TNF-.

Importantly, an increase in quinolinic acid results in higher glutamate levels and upregulation of NMDA (glutamate and ion channel receptor protein) receptors, possibly inducing memory and impaired neuroplasticity. Neuroinflammation can contribute to reducing the activity of neurotransmitters and increasing excitotoxicity. This review reports on the management of mental health by nutraceuticals and, in general, the ways of acting against COVID.

[onlinelibrary.wiley.com/.../jfb.14445](https://onlinelibrary.wiley.com/.../jfb.14445) (2022) COVID-19 causes severe respiratory problems, but also a long-lasting syndrome associated mainly with cognitive dysfunction and fatigue.

Symptoms of prolonged COVID syndrome, especially brain fog, The pathogenesis of brain fog in these diseases is currently unknown, but may involve neuroinflammation via mast cells stimulated by pathogenic and stress stimuli to release mediators that activate microglia and lead to inflammation in the hypothalamus. These processes could be mitigated by the phytosomal formulation of the natural flavonoid luteolin. [www.ncbi.nlm.nih.gov/.../PMC8250989](https://www.ncbi.nlm.nih.gov/.../PMC8250989) (2021)

Posted On 03/12/2023

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## juststeve

Gui if we indeed had actual and real fact checkers all this would be the message 24/7 instead of the Safe & Effective drivel still being pushed!

Posted On 04/02/2023

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## ragus

Thanks as always Dr Mercola for a great article, and GUI for extra info! I forgot taking Vitamin C for a while (2-3 grams a day) but recently started again, and now taking 4 grams of Vitamin C, as well as 1 gram of NAC and 1 gram of baking soda 3 times a day, and it feels like I got a boost of energy, and just generally feeling better.

Posted On 04/02/2023

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## fvomasch

Gui- Very well stated. Here is a more detailed look at how magnesium helps with long covid and other health problems and it is properly entitled "Long Covid-Short Magnesium".

[www.scirp.org/.../paperinformation.aspx](http://www.scirp.org/.../paperinformation.aspx) Also don't forget D-Ribose is needed beside CoQ10.

[abcnews.go.com/US/covid-long-hauler-marks-years-grappling-bewildering-..](http://abcnews.go.com/US/covid-long-hauler-marks-years-grappling-bewildering-..)

[medium.com/silicon-valley-global-news/d-ribose-coronavirus-covid-19-sa..](http://medium.com/silicon-valley-global-news/d-ribose-coronavirus-covid-19-sa..) Many people with long covid or just in general are low in many key nutrients before they got covid so how can they fight an illness without optimum nutrient levels. The body most likely used up the meager stores of minerals and vitamins due to all the medications they were given to combat Covid. B-12 is very important especially in those with induced coma while being on a ventilator. This article provides some insight. [www.bmj.com/.../rr-0](http://www.bmj.com/.../rr-0) . Omega 3's are also important [pubmed.ncbi.nlm.nih.gov/33377319](http://pubmed.ncbi.nlm.nih.gov/33377319)

Posted On 04/02/2023

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Gui, you are right that our tissues with the highest energy requirements (e.g. the brain) have the most mitochondria. Since key mitochondrial enzymes are Thiamine-dependent, It is no wonder that Thiamine (B1) deficiency causes bilateral/ symmetrical lesions on brain imaging, and many brain-related side effects: seizures, tremors, ataxia, Parkinson's, dizziness, delirium, anxiety, depression, psychosis, dementia and so on, as well as symptoms of Dysautonomia (a wide swath of symptoms including GERD, arrhythmia, tachycardia, GI disturbance, POTS, hyperhidrosis, hypo- or hypertension, CFS/ME and more).

In other words, there are a LOT of conditions that respond to thiamine due to its central role in mitochondrial function. Thiamine is depleted by sugar, simple carbohydrates and alcohol, and our requirement for B1 depends on our carbohydrate intake: [pubmed.ncbi.nlm.nih.gov/11582856](https://pubmed.ncbi.nlm.nih.gov/11582856) It is also depleted by trauma, infection, toxins and certain medications (e.g. metformin, flagyl, bactrim). Elliott Overton discusses all of this in his YouTube channel "EO Nutrition" (I have no affiliation with him).

He mentions the published work of Derrick Lonsdale, M.D., Chandler Marrs, Ph.D. and Antonio Costantini, M.D.. A good overview: [www.ncbi.nlm.nih.gov/.../PMC8533683](https://www.ncbi.nlm.nih.gov/.../PMC8533683) The best test for B1 deficiency is Erythrocyte Transketolase (TKA) but even then, people can still test "normal" despite having symptoms that respond well to B1 supplementation. It's important to take B1 together with its cofactor Magnesium; also the B vitamins in general work in synergy with one another.

Posted On 04/03/2023

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## **Greebo**

Excellent article with in depth explanations. Thank you. knowing the biochemical activity that is required to support a healthy cell & how various vitamins, minerals , & nutrients act to promote cellular health is crucial to having some control over your health. Too few physicians have any idea of what happens within our cells to make healthy tissues, healthy organs & healthy bodies. The pharmaceutical industry that subsidizes medical schools probably discourages that in favor of creating an army of drug pushers for their drugs. I am profoundly grateful to find physicians who bother to learn the basics of health & fight to make it public knowledge.

Posted On 03/12/2023

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## **MMaster**

Why bother with airplane mode for your cell phone? Just turn it off and put it into a Faraday bag. Saves battery.

Posted On 04/02/2023

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## gardenbe

Regarding niaciamide: I've read some other articles and books mentioning the use of niacinamide for other ailments. What specifically stood out to me was a doctor named William Kaufman, had successfully used 250mg, frequent doses for the treatment of arthritis. He was using this for his patients back in the 1940s. The only side effect mentioned was some nausea by some people possibly caused by additives to the niaminamide powder. I'm interested because I have arthritis in in my knees & low back. So I was considering this as a supplement. [www.doctoryourself.com/kaufman3.html](http://www.doctoryourself.com/kaufman3.html) [www.doctoryourself.com/JOM1.html](http://www.doctoryourself.com/JOM1.html) So I'm curious about the concern Mercola mentioned with "Low-dose niacinamide (not niacin), taken at a dose of 50 mg three times a day. More is not better as it will impair the function of your longevity proteins (sirtuins)". He doesn't explain this at all- just briefly mentions it. Anyone have more info on this?

Posted On 04/02/2023

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## ChrisColes

gardenbe Go and first of all read The Borax Conspiracy by Walter Last [health-science-spirit.com/Healing\\_the\\_Body/The-Borax-Conspiracy.html](http://health-science-spirit.com/Healing_the_Body/The-Borax-Conspiracy.html) Also especially: [www.the-heal-yourself-series.com/Overcoming\\_Arthritis.html](http://www.the-heal-yourself-series.com/Overcoming_Arthritis.html) Enjoy.

Posted On 04/02/2023

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