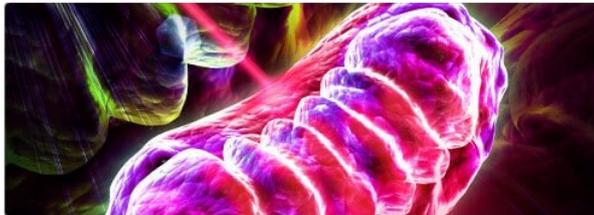


The Benefits of Low Level Laser Therapy (LLLT) and Photobiomodulation

“LLLT supplies the brain with metabolic energy in a way analogous to the conversion of nutrients into metabolic energy, but with light instead of nutrients providing the source for ATP-based metabolic energy.” (R)



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mitochondria-image

Whether you're healthy or not, Low-Level Laser Therapy or LLLT is probably the single most effective tool for cognitive enhancement

The studies cited in this article are based on LLLT usage in various parts of the body, but LLLT works very similarly no matter where it's pointed. I've come across many studies that talk about the same mechanism's no matter which cells/tissues are involved.

The studies are all over the map here when it comes to quality. The point is it's safe and reason to experiment with and see if it works for you. This post isn't meant to prove anything, as none of my posts are. They are to give you some food for thought.

What LLLT is Used For In The Scientific Literature

There are too many studies to list all of them, so I just referenced the ones I found first. So while maybe dozens of studies demonstrate a reduction of inflammation, I just referenced the ones I found first.

In general, lowering inflammation where ever applied (R, R2). Specifically, by reducing levels of PGE(2), Cox 2, IL-1b, TNF, neutrophil cell influx and oxidative stress (R)

Wound healing/Tissue growth and repair (R)

Depression (R)

Anxiety (R)

Pain relief in various syndromes (R, R2, R3)

Arthritis (R, R2)

Back pain (R), neck pain (R)

Autoimmune conditions like thyroiditis (R) and others

Traumatic brain injuries (R), strokes (R) and other brain injuries (R)

Tooth repair (R, R2), pain from orthodontics (R)

Hair growth and male pattern baldness (R) – different wavelength and power are required.

Acne (R, R2)

Heart attack – hastens healing of the damage (R, R2)

Fractures (R) – seemingly not sprains, though (R)

Skin conditions like psoriasis and others (R)

Fibromyalgia (R)

Improving bone density (R, R2)

Increasing testosterone (R)

Enhancing liver regeneration (R) and protection (R)

Allergic rhinitis (R)

Neuropathy (R)

Candida infection (R, R2, R3)

Vision disorder like macular degeneration (R) and retinitis pigmentosa (R)

Hearing problems such as tinnitus (R) – in the short term or when combined with rTMS (R)

Muscle tissue for performance, fatigue and repair (R, R2)

Spinal cord injury (R)

Parkinson's (R)

Alzheimer's (R, R2)

Injuries in connective tissue/joints (R), Achilles tendon (R), Elbow tendinopathy (R)

Carpal Tunnel Syndrome (R)

Burns (R, R2)

Smoking Cessation (R)

Laryngitis/Hoarseness (R) Laryngitis can be hoarseness, globus, chronic cough, voice fatigue, throat pain, and dysphagia.

Some migraines and headaches (R) – may make them worse too if you have vasodilatory headaches.

Weight loss? (R) – probably with infrared sauna (have not used).

Peptic ulcers (R), Venous Leg Ulcers (R), Pressure ulcers (R), Oral Mucositis (R) Aphthous stomatitis (R)

Edema (R, R2)

Lung inflammation (R), COPD (R)

Alcohol addiction (R)

Narcolepsy based on theory (R). Narcolepsy is likely an autoimmune disorder (R)

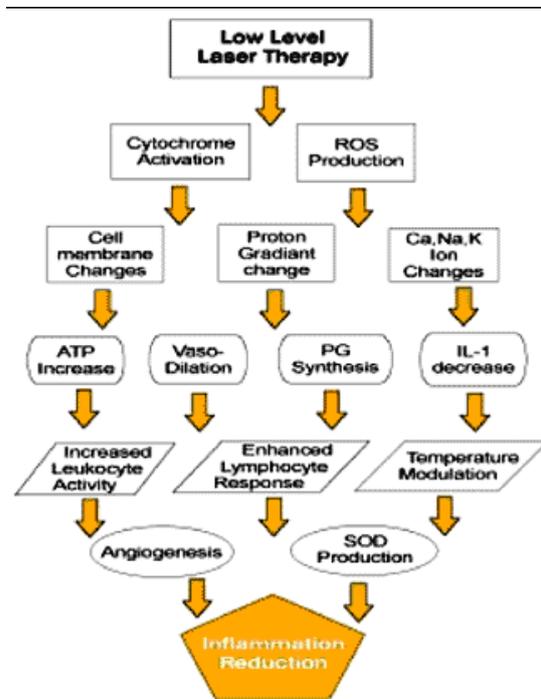
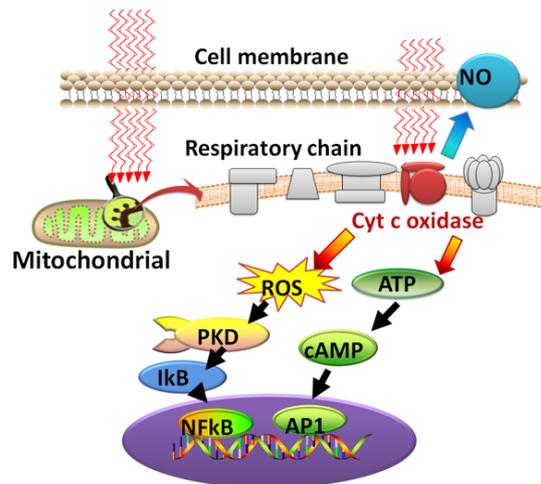
Oral Lichen Planus (R)

Cancer: Various tumors, when used with a photosensitizer (R)

Type 1 and type 2 diabetes (R, R2/R2) "It should be well noted that the common thought, that it is impossible for the pancreas to restore its function and morphology in case of diabetes mellitus, has definitely come to an end in the history of this disease and mankind.....Secondly, it has been ascertained from this study that the quantum energy of laser rays is capable of stimulating and causing the regeneration of pancreatic tissues, including the B-cells of the Islets of Langerhans,

even in advanced disease states.” I can’t find these studies in any journal, but it’s quite intriguing. Skepticism is always advised, although I don’t see the harm in trying it on the pancreas. Based on the mechanism’s involved I’d expect it to help for cognitive-based disorders like Autism, Schizophrenia, and Bipolar disorders. Autism, for example, is in part a result of mitochondrial dysfunction (R) and inflammation (R). Deficiencies in the cells’ ability to fuel brain neurons might lead to some of the cognitive impairments associated with autism and higher levels of free radicals also might contribute to autism severity (R). Mitochondrial abnormalities also occur in bipolar and schizophrenia (R), as well as inflammation (R, R2) It should also help with inflammatory gut problems like Crohn’s and Colitis.

Biological Mechanisms: How Laser Therapy Enhances Cognitive Function



LLLT works by hormesis and invoking your body's stress response, specifically nitric oxide/free radicals. Therefore, like any kind of hormetic tool, use it wisely and prudently.

LLLT increases free radicals (ROS), but the level of ROS produced by LLLT in normal cells are beneficial (R).

I mainly use LLLT on my brain, but I also use it for many other things. For this section, I speak about its mechanism with regard to the brain.

LLLT:

You can see my interview with Dr. Hamblin, the world expert on Light Therapy.

Suppresses inflammation: PGE(2), COX2, IL-1b, TNF, IL-8, IL-6, neutrophil cell influx, etc.. (R, R2, R3)

Increases internal antioxidants (SOD) (R)

Decreases free radicals and oxidative stress in neurons (R)

Increases brain Hypoxia-inducible factors (HIF-1 α) and vascular endothelial growth factor (VEGF) (R). HIFs are normally increased under low oxygen conditions. This is the body's stress response. HIF-1 increases several genes to promote survival in low-oxygen conditions. These include enzymes that allow ATP (cellular energy currency) synthesis in an oxygen-independent manner, and VEGF, which promotes the formation of new blood vessels (angiogenesis) in the brain. This makes sense because when the brain is starved for energy it will try to make up for it.

Increases stem cells (R, R2, R3)

Increases Nerve growth factor (NGF) (R)

Increases Brain-derived neurotrophic factor (BDNF) (R)

Increases Neurotrophin-3-contradictory (NT-3) (R)

Increases IGF-1, TGF-b (R, R2), PDGF, FGF2 (R)

Increases ATP production (R)

Increases the number of mitochondria (R) i.e mitochondrial biogenesis

Promotes the synthesis of DNA and RNA (R)

Increases neuronal mitochondrial metabolism by photostimulation (stimulation by light) of an enzyme (cytochrome oxidase) involved in increasing mitochondrial oxygen usage (R) and increases mitochondrial membrane potential (R)

Increases blood flow and circulation (R)

Decreases amyloid- β aggregates in human brain cells (in-vitro) (R), the protein responsible for Alzheimer's.

Activates PKC (R)

Upregulates heat shock proteins (R)

Stimulates mast cell degranulation (R)

Modifies extracellular matrix components (R)

Prevents neuronal death by greater membrane stability and resistance to depolarization, which has been shown to transiently reduce neuronal excitability (R)

Prevents cell death, improves cell proliferation, migration, and adhesion (R)

Increases the expression of genes in the brain by increasing the transcription factors Nf-kb (R), AP-1 and CREB (R). Transcription factors are proteins that bind to DNA and supports growth and repair. See this video animation on how these proteins bind to DNA.

Increases expression of antioxidant gene MnSOD (second most expressed gene after Nf-kB). (R, R2)

Increases our body's natural opioids (R).

Interestingly, in normal neurons, LLLT increased oxidative stress/ROS. In oxidatively stressed cells, LLLT reduced high ROS levels and protected cultured cortical neurons from death (R)

Some of the mechanisms are similar to methylene blue. Read my post about how to use it.

What Effects Did I Experience?

Increases higher order cognitive function
Improves memory via growth factors and brain metabolism (R, R2)
Improves attention (R)
Improves working memory (R)
Improves mood (R)
Improves motivation
Increased wakefulness
Increases sports performance (via sensory and motor improvements) (R)
Decreased need for sleep
LLLT Goes Well With

Exercise, Kombucha, sourdough bread or other sources of lactate (read about the cognitive benefits of lactate). I've never seen this reported, but my experience suggests this.
Hi-maize resistant starch, based on my experience.

PQQ

Niagen NAD+

LLLT Doesn't Go Well With

Antioxidants (like NAC) within a few hours of applying it. Part of the mechanism that LLLT works is by increasing ROS, so NAC will prevent this. Taking antioxidant supplements the next day probably won't diminish the benefits.

I used to caution about C60, but not anymore. I asked Dr. Hamblin, the world expert on Light Therapy.

Where To Use It On The Head

If you suffer from fatigue, you want to use it all over the head (including back), because you are targeting your hypothalamus, which is close to the center of your brain.

Use on the forehead and on top of the forward part of your head for increased focus and increased analytic ability. Dr. Hamblin uses it on his forehead for ~15 minutes.

Use on upper and side portions of the head for creativity.

If you have CFS then do it in the back, as there's evidence that CFS is as a result of brain stem inflammation.

Other Places I Use it

I mainly use it on my brain, but sometimes other locations.

Sports injuries/other injuries. I've had one on my finger, my shoulder, etc.. (Effective)

I use it rarely on my thymus to increase my immune system and immune tolerance (used it maybe 20 times in total) (Effective)

I use it rarely on my thyroid to increase thyroid hormones (used it maybe 20 times in total) (Effective)

I use it rarely on my liver to increase liver regeneration (maybe 15 times total) (Effective)

I use it rarely on my stomach to increase stomach acidity, GI repair (maybe 10 times). (Effective)

I use it in my teeth to increase dentin. One tooth has some dentin that's been worn away. (Effective)

I've used it once on my testes to increase testosterone. I've only used it once there because I'm a bit scared to use it there as I don't understand its interaction with sperm enough. (Unable to determine effectiveness.)

I use it sometimes on the side of my face to heal nerve damage as a result of bells palsy as a kid. (Effective)

Massive sting. I was recently attacked by a flying creature that was massive – bigger than a queen bee. It attacked a spot in my foot and injected a poison that caused a large portion of my foot to swell. I put LLLT on it and it practically disappeared in like 2 days.

Although I don't use it for my skin, it can very well be used for it (R)

I have not used it for this, but if you get hemorrhoids you can place this laser pointer up your rectum.

How To Use It

I recommend using this before bed, as it causes fatigue in many. I believe the mechanism is by increasing TNF-alpha acutely (R). While it may acutely increase TNF-alpha, it down-regulates the production chronically (R). Read my posts about how inflammation and TNF-alpha are related to fatigue.

First use: Place on each spot on the head for 10 seconds and switch to a different spot. Cover the whole head, except the back. Total time should be 2 min.

Second use: If you felt tired after the first usage then continue at that dosage for a week. If not increase by 10 seconds to a total of 20 seconds per a spot and 4 minutes in total.

If you feel tired and groggy the next day, you had too much. If not, keep on increasing the dosage by 10 seconds until you hit 2 minutes per a spot and a total of 15 minutes.

If you feel groggy the next day and only took 30 seconds per a spot (less than 6 minutes in total) then it means you have an inflammatory and/or mitochondrial issue. LLLT will help with it.

If you feel tired after 2 minutes of putting it on your head this also means you likely have an inflammatory and mitochondrial issue. Again, LLLT will help with it.

Use every other day. I recommend every third day if you're generally functioning pretty well. If you're taking a lot of other supplements then use once a week perhaps. That's what I do. The benefits are abolished if used daily for a few weeks.

An alternative way of using it is to put it on your head in the daytime for two minutes in total. This isn't enough to make most people tired, but it still stimulates Cytochrome C Oxidase. I would definitely recommend using it this way if your sleep is disturbed by LLLT.

Last, don't worry about the detailed instructions or screwing up. This is very safe if you use it even somewhat right. The reason I give these instructions is so that people with underlying inflammatory issues aren't scared off if they see some negative effects.

When Will You See Results?

LLLT is like exercise – benefits are accrued and realized after the healing stage, but there's usually a noticeable effect the next day.

If you don't notice anything from laser therapy then congratulations – you likely have healthy mitochondria and low levels of inflammation. It still can help you, though. Gwern didn't notice any effect, but still had significant increases in productivity the days he used it.

You may not notice a difference right away, just like how you may not notice an increase in muscle size after a single weight lifting session.

The following are side effects only if you've used too much:

Degraded sleep

Cognitive laziness/grogginess the day after

More relaxed feeling

Headache

Eye pain

Theoretical long-term risks for usage on the brain:

Long term risks are unknown since there're no human studies that have been going on for decades. However, there're reasons to think that brain cancer risk is both decreased and increased. I haven't seen this discussed anywhere, but my knowledge of cancer research leads me to this opinion.

Brain cancer risk is possibly increased in my opinion as a result of the growth factors and stem cell increase. LLLT also increases a transcription factor (NF-kb), which is implicated in cancer initiation and progression (R).

Since it decreases inflammation, oxidative stress and improves mitochondria, it may decrease your risk of developing a tumor, to begin with, but if you already have a tumor or get a tumor, the increase in growth factors will make it spread more quickly.

Again, there're reasons to think it will cause and prevent cancer, but I'm leaning more towards causing it (where ever it's used in the body). Obviously using it once won't matter, but every other day for the rest of your life might be significant.

For every 100,000 people in the United States, approximately 221 are living following the diagnosis of a brain tumor, but only 20-25% of that number is malignant (R).

Approximately 0.6 percent of men and women will be diagnosed with brain and other nervous system cancer at some point during their lifetime, based on 2008-2010 data (R).

If you have a very high incidence of cancer in your family, specifically brain cancer, then this might not be a risk you want to take, since we don't have long-term studies on people yet who use it on their brain.

I'm extremely cautious, even though I probably don't come off as such. For me, I feel the risk is worth it. I think the increased cancer risk is small at the end of the day and the benefits outweigh the risks by a good margin. That said, it's likely wise to take breaks if your brain is already functioning well.

If you think about it another way, however, intelligence is highly correlated with lifespan (R, R2) and disease reduction (R). This is probably because more intelligent people make more money and can take better care of themselves better (R) (by understanding health information, etc..). Neuroticism is also associated with increased mortality (risk of dying) (R) and LLLT decreases neuroticism.

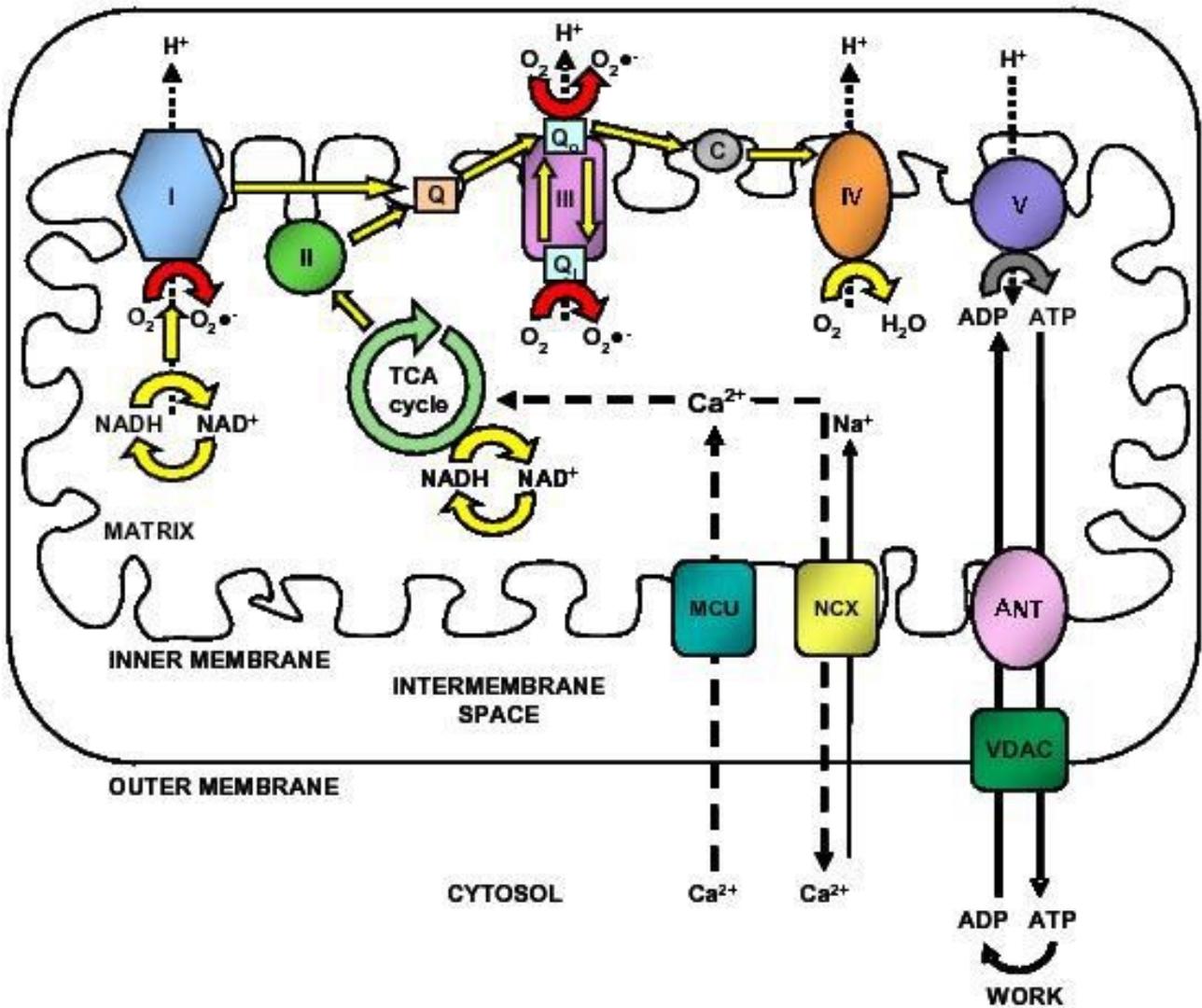
So life is one big trade-off and this is a risk I'm willing to take and I think most of the population should also take since it's such a powerful tool. It's only a risk insofar as we don't know the long-term effects.

I also take supplements that inhibit cancer growth, so hopefully this balances the risk increase. In general, my genetics makes me more prone to autoimmune conditions rather than cancer, so the risk is especially worthwhile for me.

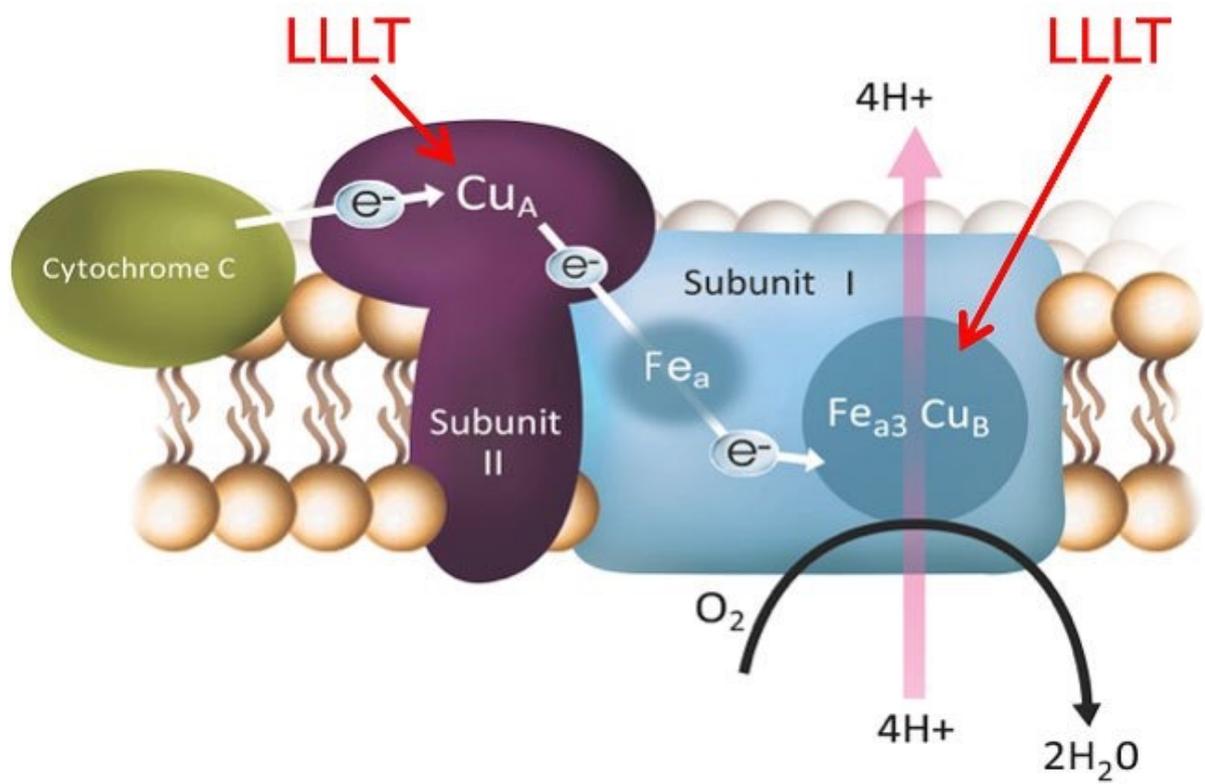
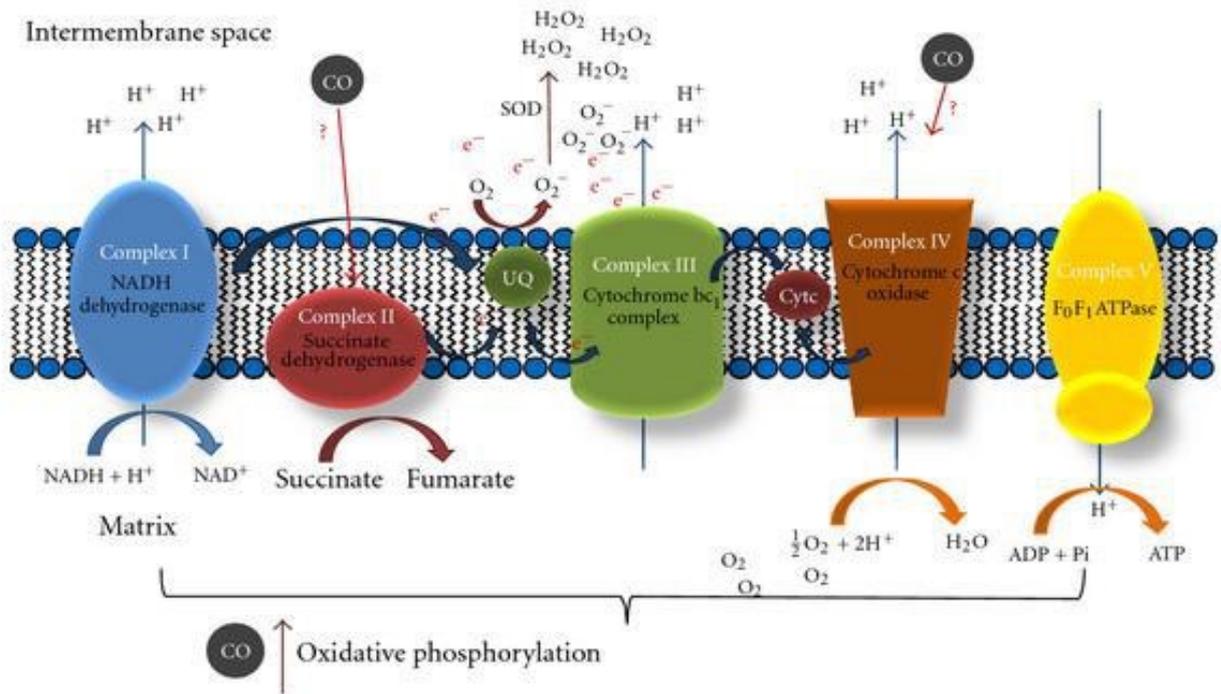
A Primer On The Mitochondria, How It Makes Energy and Cytochrome C Oxidase

The mitochondria are the main source of oxygen free radicals in cells, which are very reactive and can harm cellular structures and DNA. Cells can repair typical levels of oxidative damage.

Notice that the mitochondria have an “outer” membrane and an “inner” membrane. In between is the intermembrane space. H⁺’s/protons get pumped out of the inner membrane into the intermembrane space. They then go through a protein (ATPase) to spin it into producing ATP.



A protein on the inner membrane of the mitochondria called Cytochrome C oxidase (unit IV – see pictures) is capable of absorbing light, which increases its activity or ability to pump H⁺’s, which leads to increased ATP production. This process of producing ATP is known as “oxidative phosphorylation.”



Research Snippets

-Cytochrome oxidase is an ideal target for cognitive enhancement, as its expression reflects the changes in metabolic capacity underlying higher-order brain functions. Brain photobiomodulation with LLLT is paralleled by pharmacological effects of low-dose USP methylene blue, a non-photic electron donor with the ability to stimulate cytochrome oxidase activity, redox, and free radical processes. Both interventions provide neuroprotection and cognitive enhancement by facilitating

mitochondrial respiration, with hormetic dose-response effects and brain region activational specificity.

-We found that at low fluences (0.3–3Jcm²) mitochondrial respiration was stimulated, as shown by the increase in adenosine triphosphate (ATP), Ca²⁺, and mitochondrial membrane potential. This, in turn, generated low amounts of reactive oxygen species (ROS) and nitric oxide (NO) that activated signaling pathways and gene transcription without causing cytotoxicity

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