

Methylene Blue Is Beneficial for Slowing Skeletal Aging and Treating Brain Disorders

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STORY AT-A-GLANCE

- › Methylene blue, first synthesized in 1876, evolved from a textile dye to an essential medical compound. It promotes mitochondrial health by enhancing energy production and reducing oxidative stress
- › Recent research suggests methylene blue is useful in the treatment of traumatic brain injury and conditions like Alzheimer's disease
- › A March 2024 study indicates methylene blue supports bone health by inhibiting osteoclast differentiation, reducing the risk of age-related bone loss when combined with lifestyle modifications
- › Methylene blue offers various other health benefits, including reducing UTI risk, improving skin health, managing osteoarthritis and enhancing the effects of niacinamide on metabolic health
- › When selecting methylene blue, opt for pharmaceutical-grade (USP) varieties with 99% purity; avoid industrial or chemical-grade options, as they contain harmful contaminants. Recommended dosages are included

Methylene blue, first created in 1876, started as a fabric dye. Scientists soon realized it had medical benefits, and in 1891, it became the first synthetic compound used to treat malaria.¹

It was also the first synthetic compound to be used as an antiseptic. To this day, methylene blue remains indispensable in hospitals worldwide, as it's also the only known antidote for metabolic poisons such as cyanide and carbon monoxide.² In fact, it's on the World Health Organization's (WHO) "Model List of Essential Medicines."³

Indeed, I believe that methylene blue is one of the most important medicines to have at home. Adding to its long list of benefits, emerging research suggests it also benefits your brain and skeletal health.

How Does Methylene Blue Work?

Methylene blue is a versatile compound with numerous applications, but its most significant effect is on cellular energy production. It primarily interacts with the mitochondrial electron transport chain, which is crucial for generating energy in cells.

In normal cellular respiration, electrons derived from the food we consume are passed through a series of protein complexes in the mitochondria. This process, known as the electron transport chain, ultimately leads to the production of ATP, the cell's energy currency. Oxygen serves as the final electron acceptor in this chain.

Methylene blue's unique property lies in its ability to accept electrons and transfer them directly to oxygen, effectively bypassing parts of the conventional electron transport chain. This alternative electron shuttle enhances energy production, particularly in situations where normal cellular processes are impaired or inefficient.

By facilitating more efficient electron transfer and energy production, methylene blue improves various aspects of cellular function and overall health. This capacity to interact with and optimize cellular energetics is what makes methylene blue a subject of interest in both scientific research and therapeutic applications. In my [interview with Francisco Gonzalez-Lima, Ph.D.](#), an expert on methylene blue, he explained:

"Methylene blue donates its electrons directly to the electron transport chain. It obtains electrons from surrounding compounds, and maintains oxygen

consumption and energy production. By doing this, it helps oxygen to be fully reduced into water.

It becomes two things that are often not found together. It acts as an antioxidant, because oxygen is neutralized into water by donating electrons to the electron transport, and it produces energy, because when the electron transport pumps are moving along oxidative phosphorylation, you have an increase in ATP formation.

Oftentimes, we have things that improve energy metabolism, but then they lead to oxidative stress. In the case of methylene blue, that's not the case.

You will increase oxygen consumption rates, increase ATP production for energy metabolism, and at the same time reduce oxidative stress which, of course, will lead to reduction in oxidative damage at the level of mitochondria, then at the level of the other parts of the cells, and eventually membranes of the cells, and reactions that are cascades of this oxidative damage."

Methylene Blue Protects Against Brain Injury and Neurodegenerative Diseases

A March 2024 review published in *Reviews in the Neurosciences*⁴ explores the use of methylene blue as a therapeutic agent for traumatic brain injury (TBI), which is characterized by damage to brain tissue from an external force. TBI damage leads to a cascade of neurodegenerative processes that continue long after the initial injury.

It shares many pathological features with neurodegenerative diseases such as Alzheimer's disease (AD), including the accumulation of beta-amyloid plaques and tau protein tangles. This similarity is significant because it suggests that treatments effective for one condition might be beneficial for the other. The authors explained:⁵

"In the pathogenesis of AD as well as in the pathogenesis of cerebral ischemia and TBI oxidative stress, progressive inflammation, glial activation, blood-brain

barrier dysfunction and excessive activation of autophagy are involved, which implies the presence of many targets ... affected by neuroprotectors.

That is, multivariate cascades of nerve tissue damage represent many ... targets for therapeutic interventions. One of such substances ... used in multipurpose therapeutic strategies is methylene blue (MB).

This drug ... [has] an antiapoptotic and anti-inflammatory effect, activate autophagy, inhibit the aggregation of proteins with an irregular shape, inhibit NO synthase and bypass impaired electron transfer in the respiratory chain of mitochondria."

These insights are supported by other studies.^{6,7} For instance, a study published in Medical Hypotheses⁸ explored how methylene blue mitigates the neurodegenerative damage caused by excessive iron deposits in the brain, which triggers the production of highly reactive hydroxyl radicals through the Fenton reaction, a process involving iron and hydrogen peroxide (H₂O₂).

These radicals cause significant oxidative stress, damaging cellular components, and accelerating neuronal dysfunction and death. This process not only harms neurons but also promotes the aggregation of misfolded proteins, exacerbating the progression of neurodegenerative diseases like Alzheimer's and Parkinson's disease. Methylene blue mitigates these effects by inhibiting the Fenton reaction and reducing hydroxyl radical production.

Methylene Blue's Role in Supporting Bone Health

Another study published March 2024 in the journal Aging⁹ investigated how methylene blue improves skeletal aging when administered over a long-term period. It also examined the effects of mitoquinone (MitoQ), a mitochondrial-targeted antioxidant that reduces the accumulation of reactive oxygen species.

The researchers conducted both in vitro and in vivo experiments on mice. Results from both experiments showed that while methylene blue and MitoQ did not alter the

progression of ongoing age-related bone loss, they did show a dose-dependent inhibition of osteoclast differentiation.

This is important because osteoclasts play a role in bone resorption, which is the process of breaking down bones. An excess of osteoclast activity leads to bone loss and diseases like osteoporosis. By inhibiting osteoclast differentiation, methylene blue, as well as MitoQ, reduces your risk for bone loss.

The authors also noted that while methylene blue and MitoQ reduce bone resorption, taking them alone may not be enough to inhibit bone loss. To maximize their benefits, they need to be combined with lifestyle modifications such as regular exercise or anabolic bone loading. This multifaceted approach is a more effective strategy for mitigating age-related decreases in skeletal health.

Other Ways Methylene Blue Benefits Your Health

Methylene blue has also been shown to have several other health benefits, such as:

Reduces the risk of urinary tract infections (UTIs) — I consider this one of the most significant uses of methylene blue, as it offers a powerful, gut-friendly alternative to antibiotics for treating UTIs. This is especially beneficial for the elderly, who often have compromised gut health.

Since methylene blue isn't metabolized by your body, it gets excreted by the kidneys into your bladder, where it accumulates and eventually reaches concentrations high enough to act as a strong oxidant, effectively targeting and eliminating pathogens in the bladder.¹⁰

Improves skin health — According to a study published in the journal *Cells*,¹¹ methylene blue promotes skin firmness and elasticity while reducing signs of aging by inhibiting oxidative damage, increasing the lifespan of fibroblasts and promoting cell proliferation.

Manages osteoarthritis — A 2022 animal study published in *Acta Pharmacologica Sinica*¹² found that methylene blue helps manage osteoarthritis by protecting the cartilage from degeneration, reducing synovitis (inflammation of the joint lining) and relieving joint pain. It does these actions by upregulating the enzymes Nrf2 and PRDX1, which are essential for managing oxidative stress and inflammatory responses.

Reduces risk of vasoplegia — This condition is characterized by persistently low systemic vascular resistance even though the heart is pumping normally, leading to severe and uncontrollable blood vessel widening.

Research shows that methylene blue helps manage this condition by reducing the effects of cytokines that cause blood vessels to widen. It does this by inhibiting enzymes like NO synthase and guanylyl cyclase, and by blocking M3 receptors as a cholinesterase inhibitor.¹³

Promotes mitochondrial health — A study published in the *International Journal of Molecular Sciences*¹⁴ found that methylene blue increases hydrogen peroxide levels, which activates the Nrf2/ARE signaling pathway. This, in turn, boosts antioxidant gene activity and reduces mitochondrial DNA damage.

Reduces reperfusion injury — Reperfusion injury occurs when blood supply returns to tissue after a period of ischemia, such as when surviving a heart attack or stroke.

According to a 2021 animal study published in *Acta Pharmacologica Sinica*,¹⁵ methylene blue reduces brain edema following an ischemic stroke by inhibiting the activation of the enzymes AQP4 and ERK1/2, which are involved in regulating fluid balance and inflammation in brain cells.

Enhances the effects of niacinamide — Methylene blue enhances the benefits of niacinamide (vitamin B3) on brain health and metabolism, according to bioenergetic medicine expert Georgi Dinkov.¹⁶

Prevents further environmental damage from sunscreens — I don't recommend using sunscreen as it interferes with your body's vitamin D production. Instead, it's far better to cover up your skin with clothing once you've reached your ideal sun exposure time.

However, if you want to use sunscreen, such as for extended outdoor activities, choose one with zinc oxide and/or titanium dioxide that avoids nanosized particles.

In addition to these ingredients, consider a sunscreen that has methylene blue, as it has been shown to be safe for coral reefs. Most sunscreens sold today contain oxybenzone, a chemical that damages aquatic ecosystems.¹⁷

General Dosing Recommendations

Methylene blue exhibits hormesis, meaning low doses produce beneficial effects while higher doses cause adverse outcomes, so finding the right dose is important to maximize its benefits. As a general guideline, dosages between 0.5 and 4 milligram per kilogram (mg/kg) of bodyweight are recommended.

For an acute treatment, such as in the case of cyanide poisoning, the upper limit is between 3 and 4 mg/kg, which is typically the range given as an IV antidote. For nonacute, more long-term treatment, a much lower dose of 3 to 5 mg once a day for most adults per day works better. It has a half-life of 12 to 13 hours, so once-a-day dosing is fine. Taking it with ascorbic acid enhances its absorption.

This low dose works particularly well for those who have reductive stress. However, an easier to find and safer to use alternative would be molecular hydrogen. Learn more from my recent [interview with Dr. Tyler Lebaron](#).

Selecting the Right Methylene Blue for Your Medicine Cabinet

With its numerous health benefits, methylene blue is a valuable addition to your medicine cabinet. However, choosing the right type is important. You'll find three

primary grades on the market — industrial-grade, chemical-grade (laboratory-grade) and pharmaceutical grade.

The only one I recommend using is the pharmaceutical-grade variety, available by prescription. Avoid industrial-grade methylene blue that's often found in pet stores for aquarium maintenance. They contain significant amounts of impurities, with only 10% to 25% being actual methylene blue. Similarly, chemical-grade methylene blue is intended for laboratory staining experiments and contain trace amounts of harmful metals like lead, cadmium and arsenic.

While pharmaceutical-grade methylene blue might not be available at your local pharmacy, many compounding pharmacies stock it. If you're having difficulty finding a reliable source, ask your physician for a prescription to obtain it from a compounding pharmacy.

Sources and References

- ^{1, 2} [Some Drugs and Herbal Products, Exposure Data](#)
- ³ [WHO Model List of Essential Medicines 2023, Page 4](#)
- ^{4, 5} [Rev Neurosci. 2024 Mar 27;35\(5\):585-595](#)
- ⁶ [Brain Research Volume 1805, 15 April 2023, 148290](#)
- ⁷ [Biochemistry Moscow 87, 940–956 \(2022\)](#)
- ⁸ [Medical Hypotheses Volume 185, April 2024, 111299](#)
- ⁹ [Aging \(Albany NY\). 2024 Mar 25;16\(6\):4948-4964](#)
- ¹⁰ [Research and Reports in Urology 2020;12 639–649](#)
- ¹¹ [Cells. 2021 Dec; 10\(12\): 3379](#)
- ¹² [Acta Pharmacologica Sinica Volume 43, Pages 417–428 \(2022\)](#)
- ¹³ [Methodist Debaque Cardiovasc J. 2023; 19\(4\): 38–47](#)
- ¹⁴ [Int J Mol Sci. 2023 Mar 24;24\(7\):6118](#)
- ¹⁵ [Acta Pharmacologica Sinica Volume 42, Pages 382–392 \(2021\)](#)
- ¹⁶ [Haidut.me October 22, 2020 \(Archived\)](#)
- ¹⁷ [EurekAlert! March 1, 2022](#)