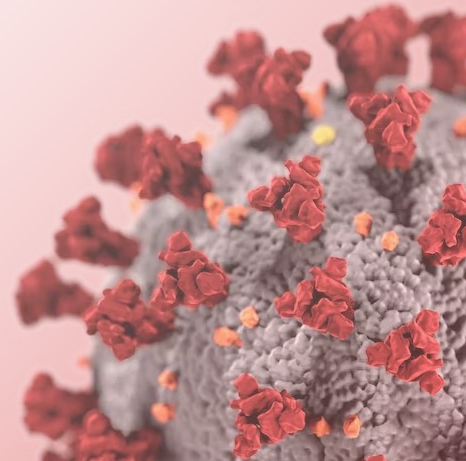
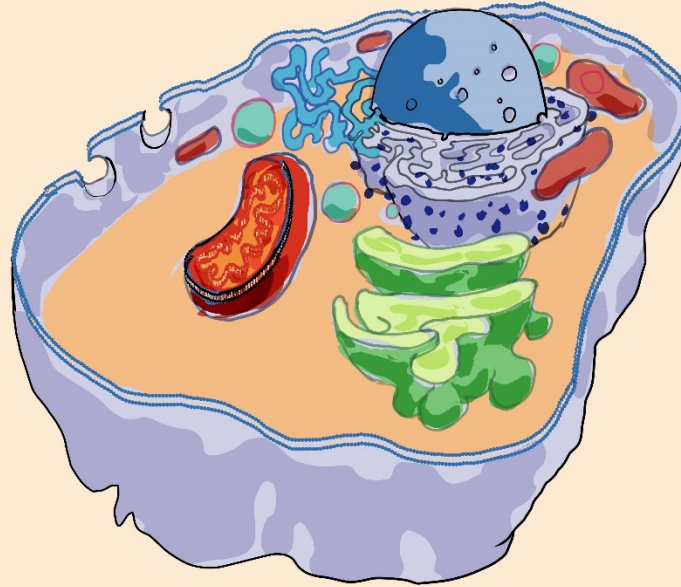


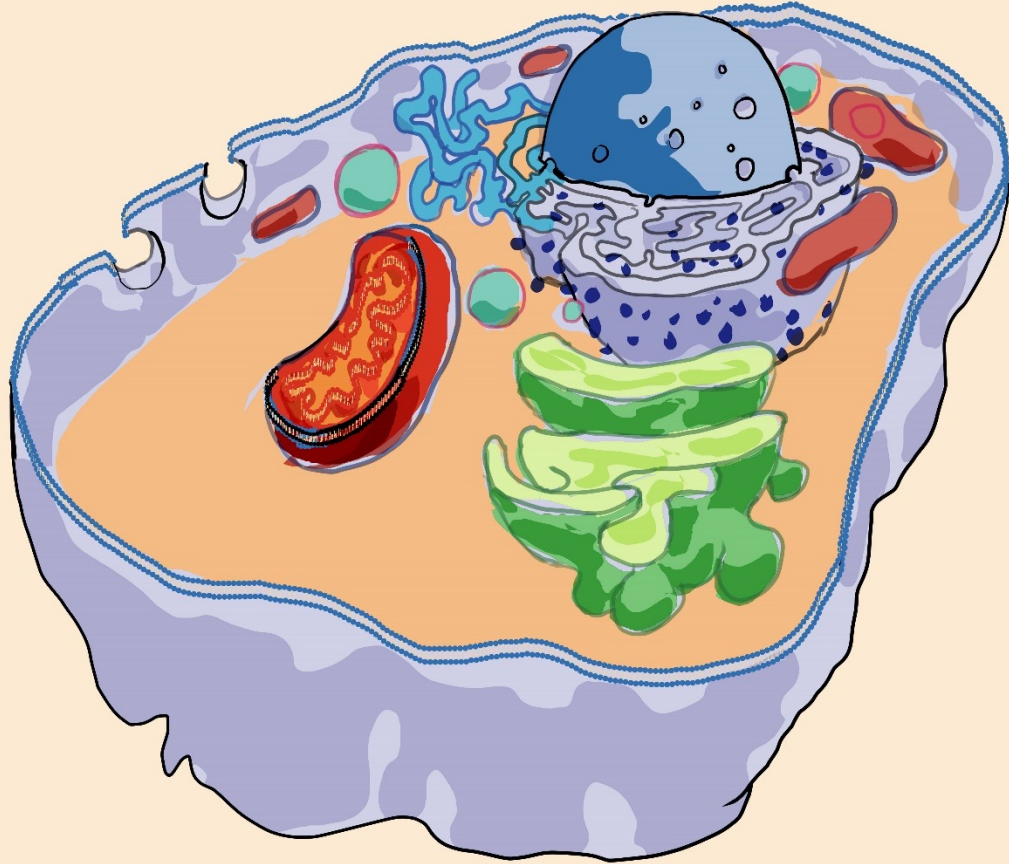
# **Methylene Blue for Long COVID and Vaccine Injury**

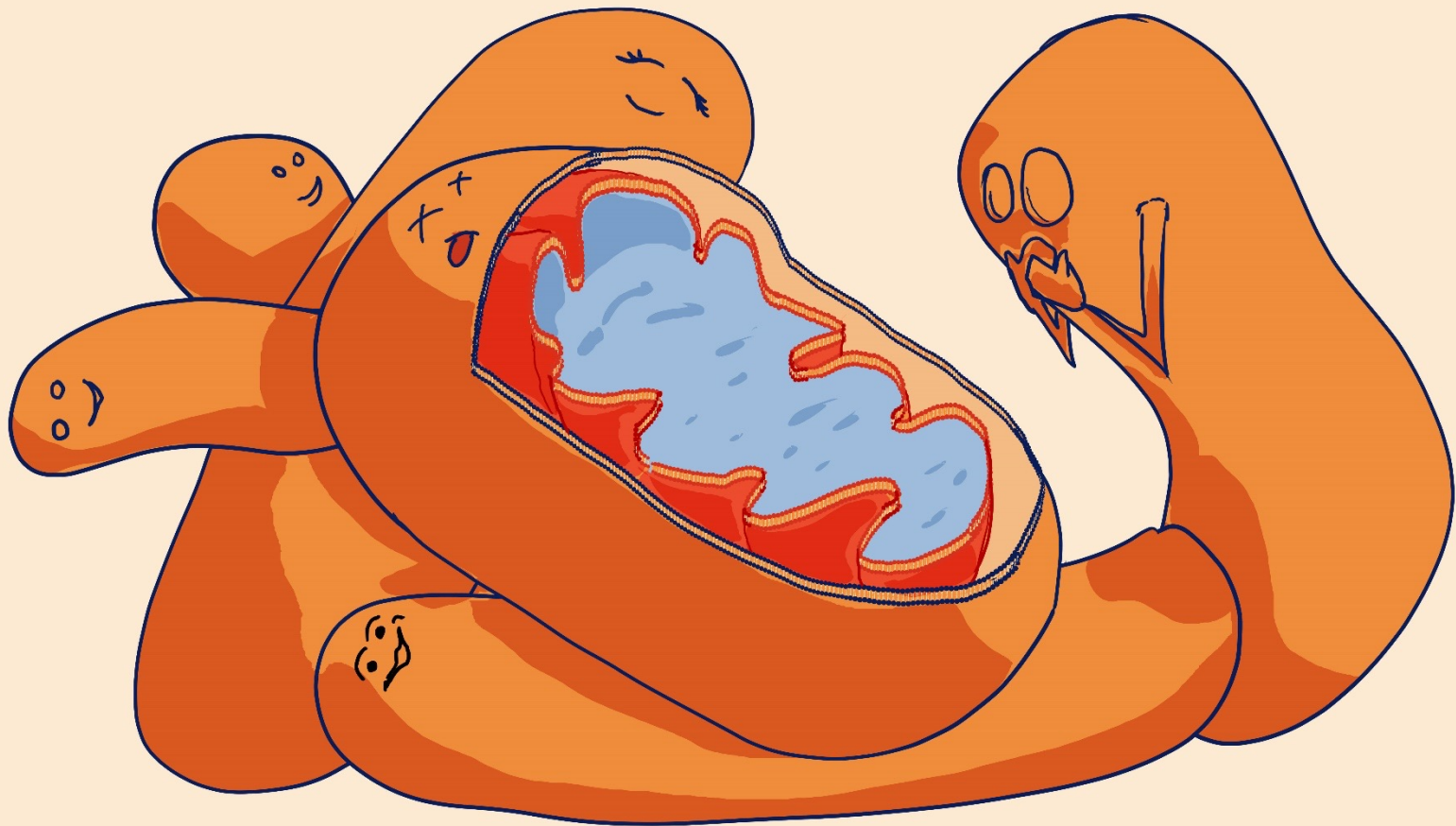
**Presented By:  
Mobeen Syed MD.**

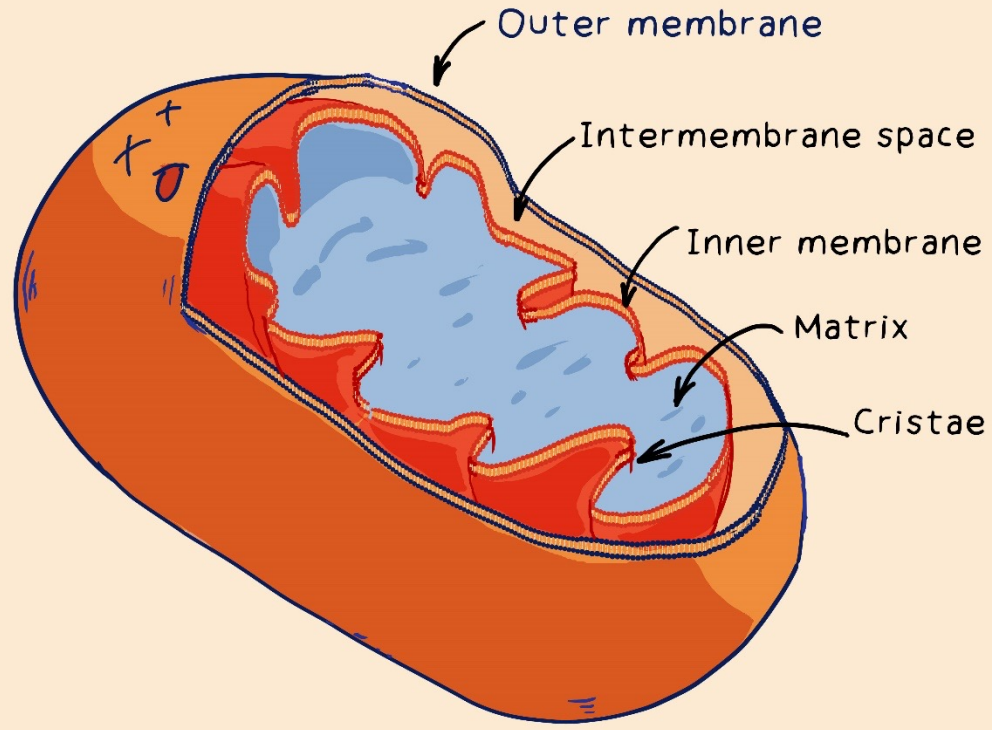


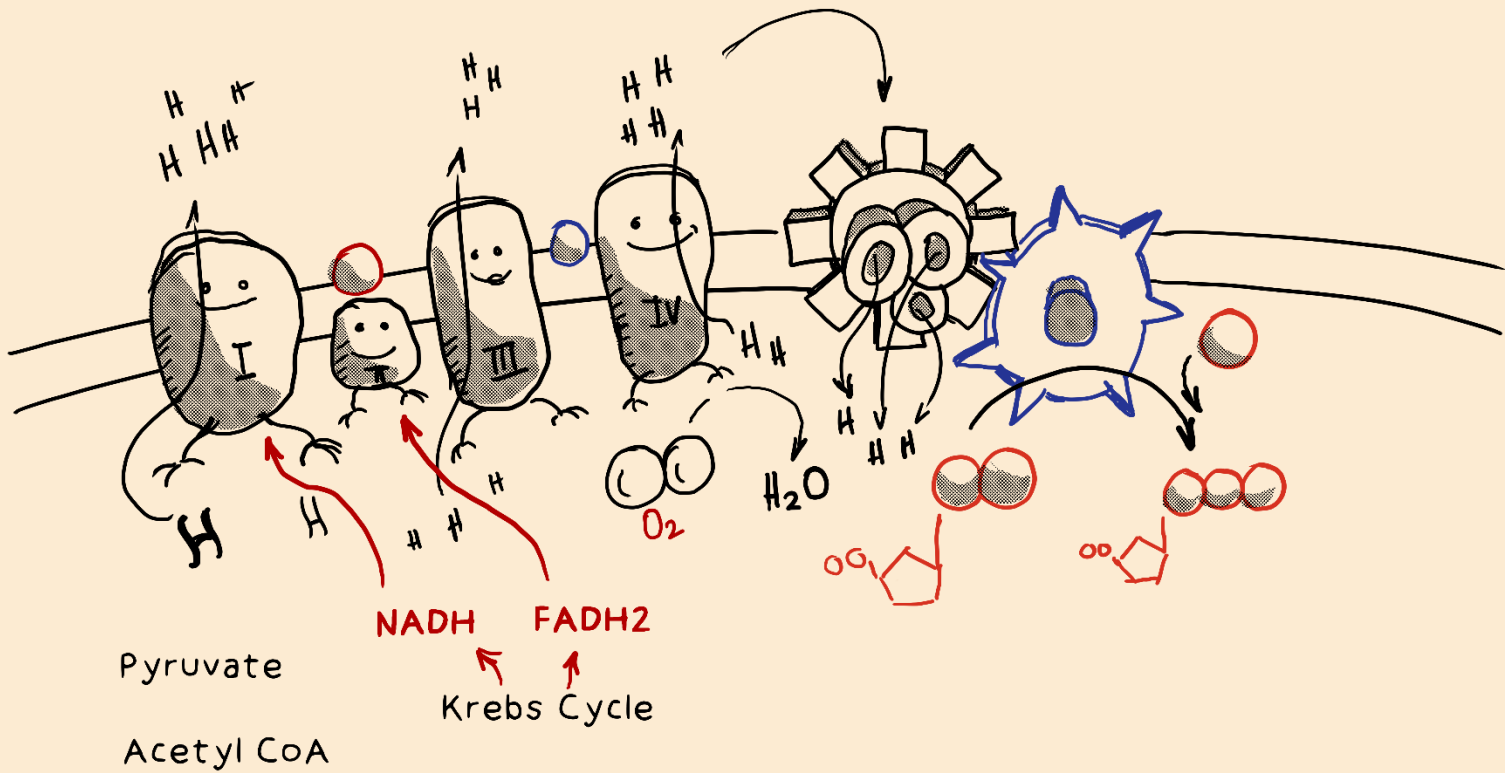
Methylene Blue and Near infra-red light  
to protect mitochondria and neuronal tissues.



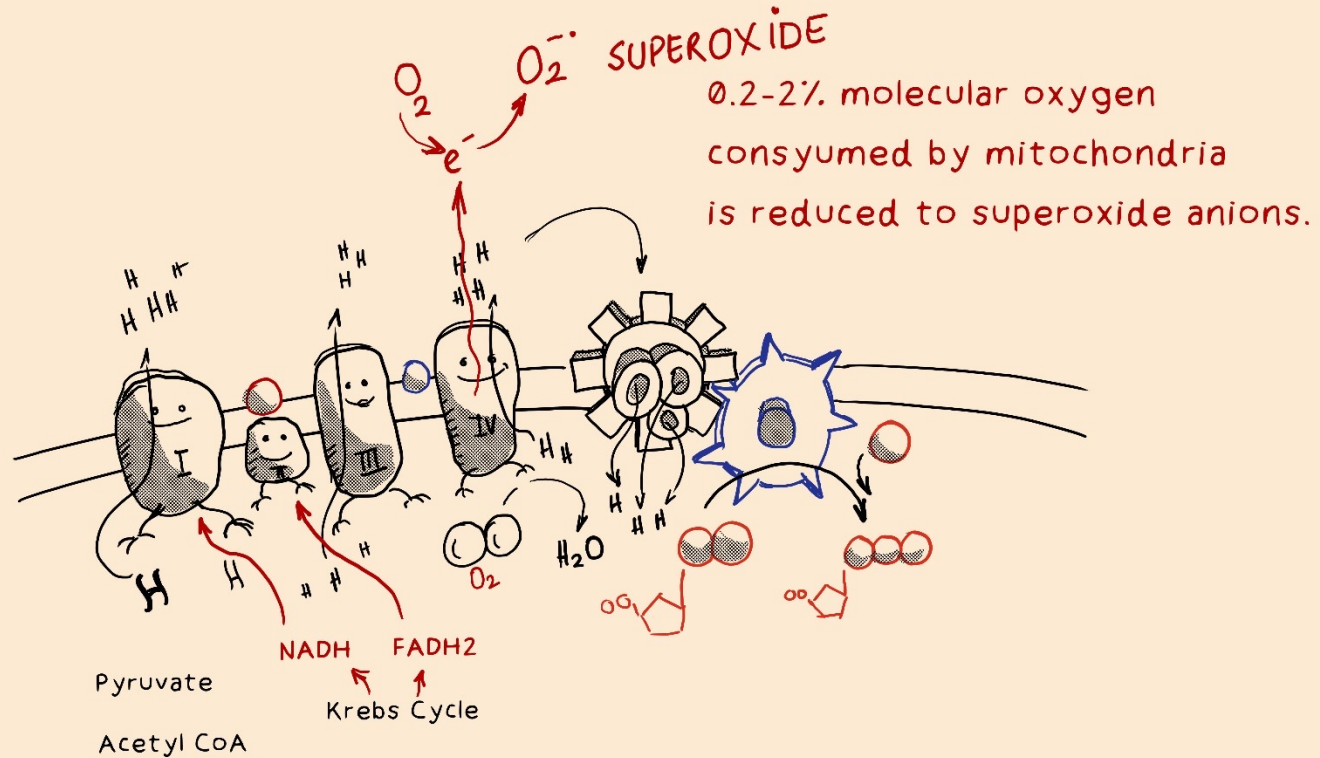




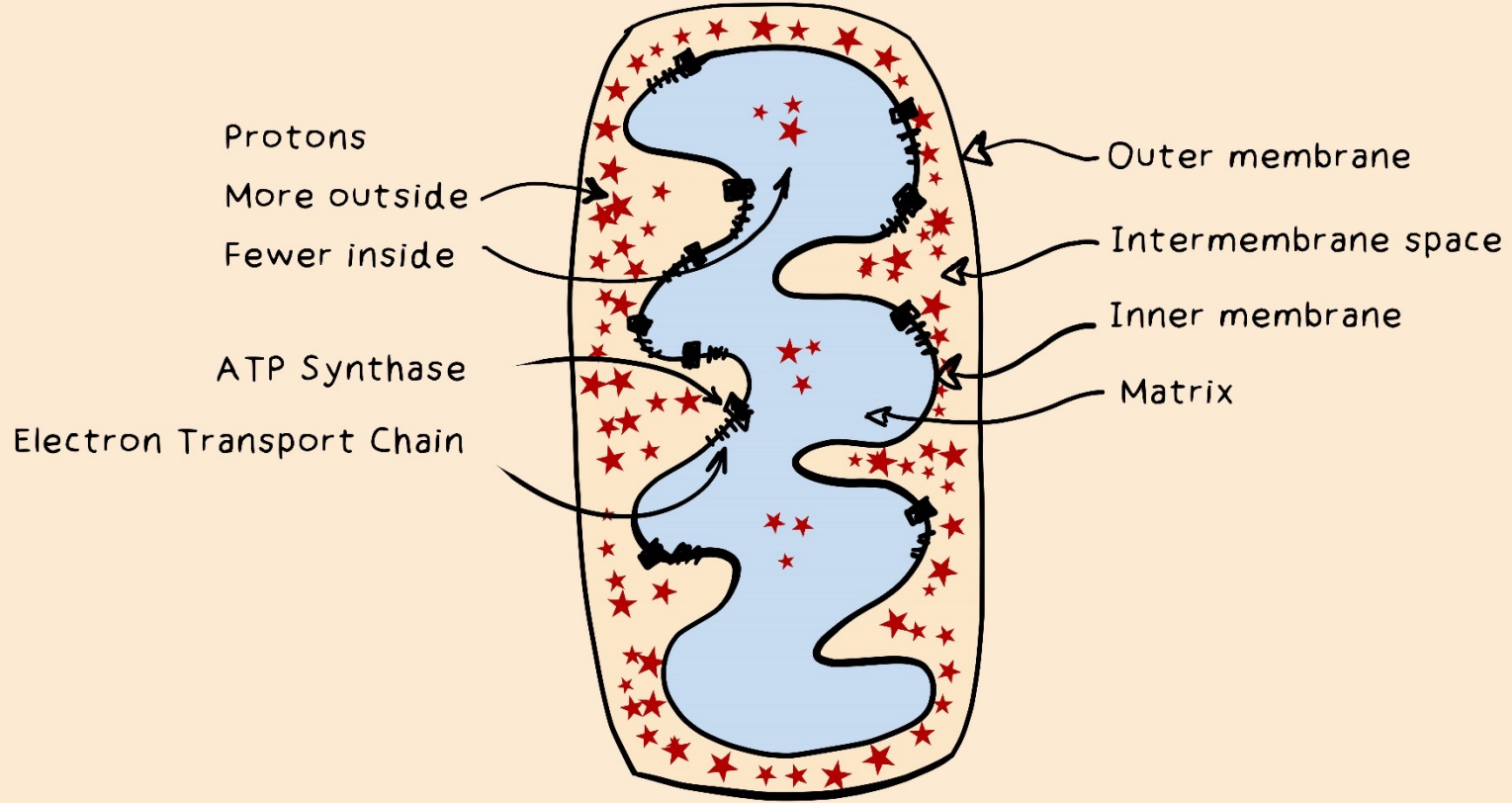




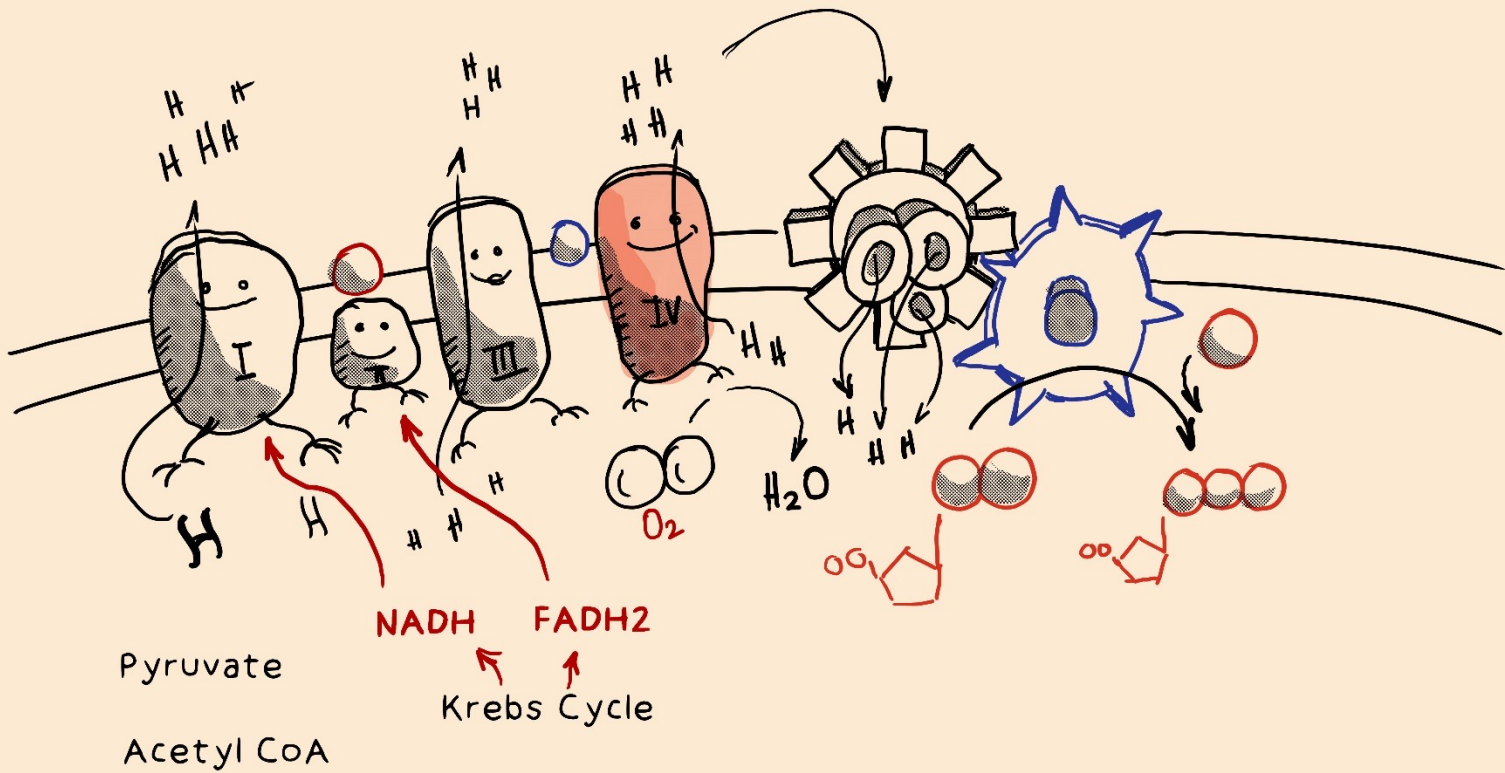
# Reactive Oxygen Species (ROS) Generation







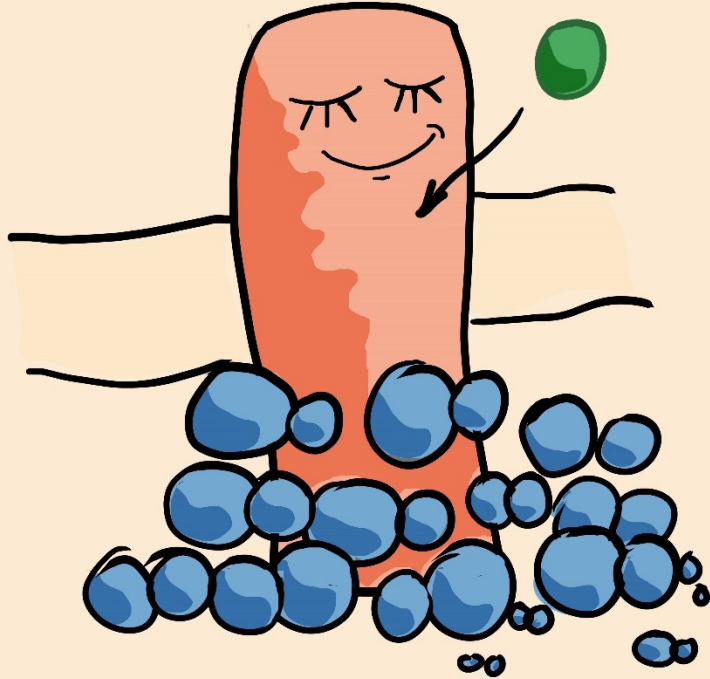




Ample oxygen

Complex IV in oxidized state

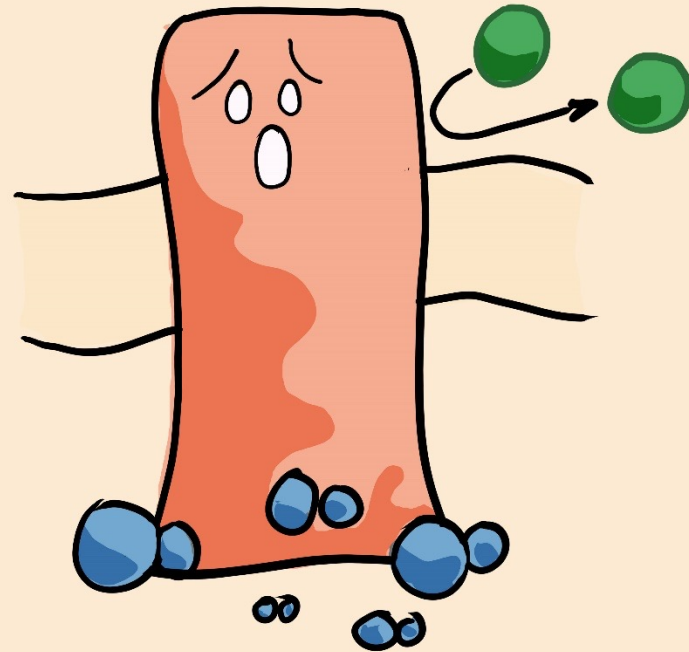
Consumes Nitric Oxide



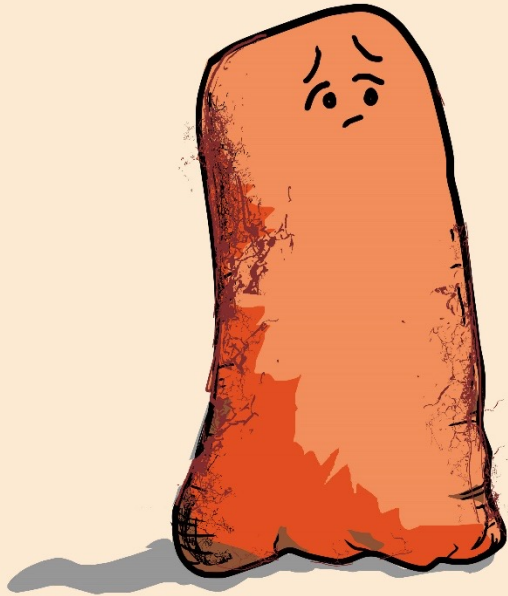
Less oxygen

Complex IV in reduced state

Does Not Consumes Nitric Oxide



Damaged Mitochondria

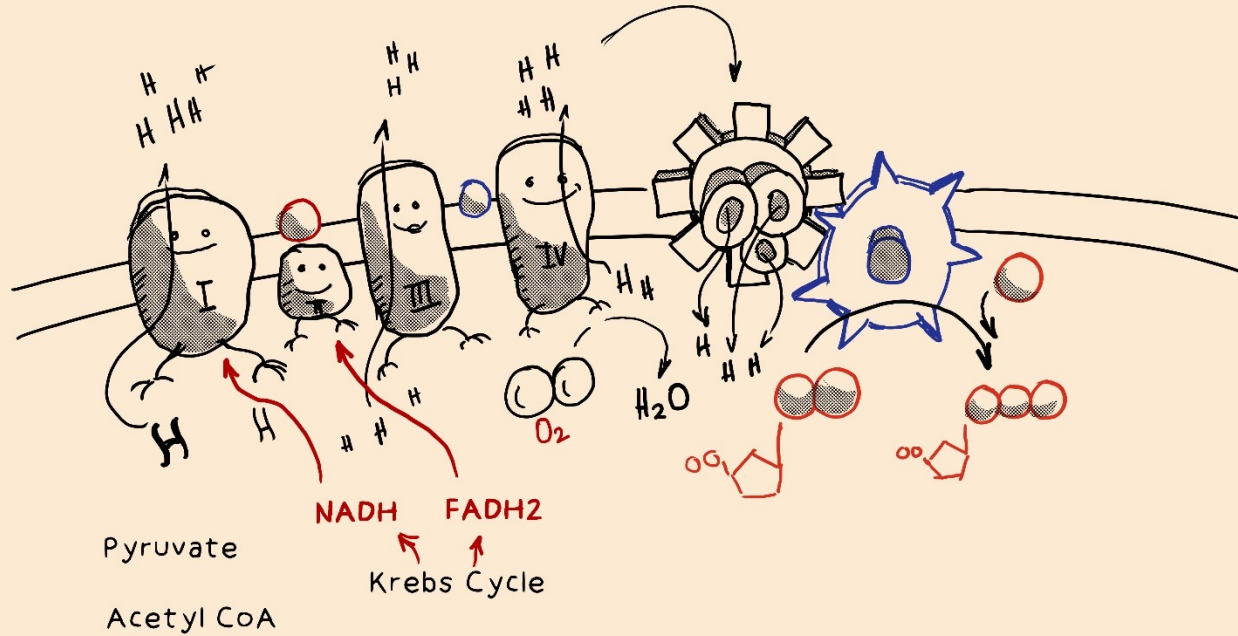


Reduced  
ATP  
Production



Increased production of  
Reactive oxygen species  
Increased escape



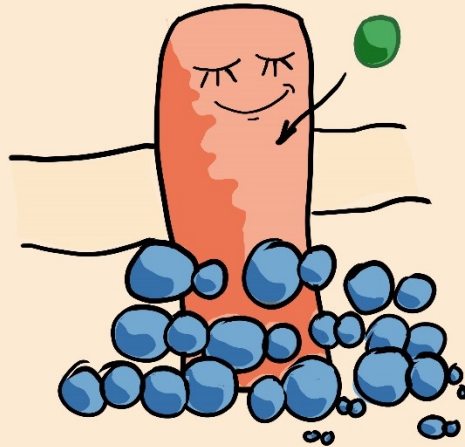


Methylene Blue (MB) in low dose  
 can donate and accept electrons.  
 Stimulates mitochondrial respiration.

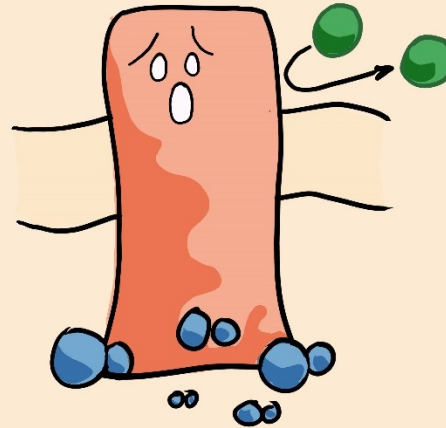
Directly reduces oxygen to water.  
 Increasing the rate of  
 oxygen consumption

As MB consumes oxygen causing a local hypoxia,  
the mitochondria start helping preserve and create NO.  
Resulting in vasodilation and more blood flow and tissue glucose uptake.

Ample oxygen  
Complex IV in oxidized state  
Consumes Nitric Oxide

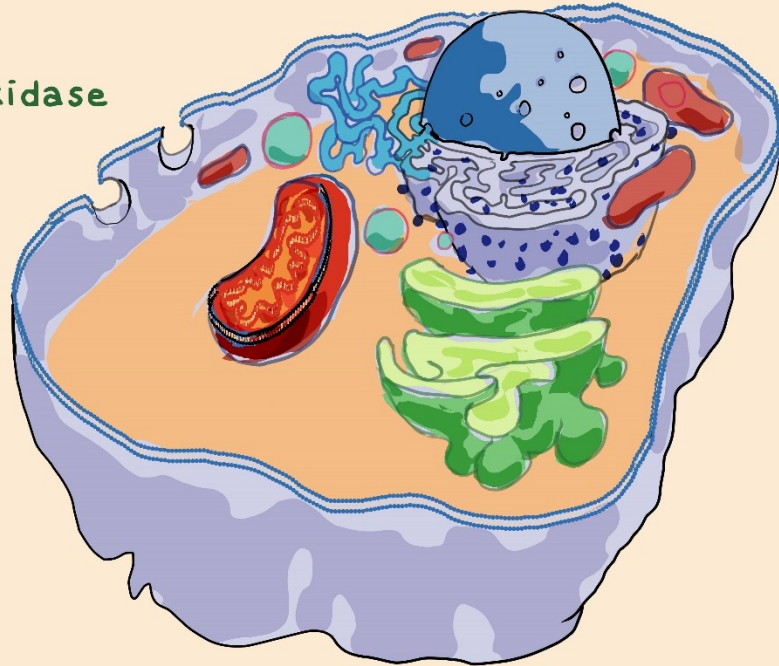


Less oxygen  
Complex IV in reduced state  
Does Not Consume Nitric Oxide



This metabolic cascade promotes gene expression for cytochrome oxidase and other holoenzyme.

Context: neuronal tissue.





level, as different doses produce opposite effects. For example, while high doses may inhibit tau aggregation and nitric oxide formation *in vitro*, they are toxic *in vivo* (Riha et al., 2005; O'Leary et al., 2010). But systemic low-doses (0.5–4 mg/kg) of methylene blue that stimulate mitochondrial respiration *in vivo* are safe and effective in both animals and humans (Rojas et al., 2012a). Similarly, only low-level near-infrared light is beneficial because higher doses become ineffective or produce opposite effects. The



## Near Infra-red Light

Low power laser and light emitting diodes.

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For example, forehead transcranial stimulation of the human cerebral cortex has been done effectively with a continuous wave 1064 nm laser at  $60 \text{ J/cm}^2$  (fluence),  $250 \text{ mW/cm}^2$  (irradiance) for 4 min, which corresponds to about  $1.2 \text{ J/cm}^2$  energy density reaching the cortical surface with a 2% transmission (Barrett and Gonzalez-Lima, 2013).

Increased activity.

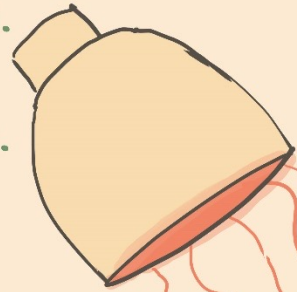
More oxygen consumption.

More water production.

ATP production increases.

Enzyme induction causes  
long-term metabolic capacity  
increase.

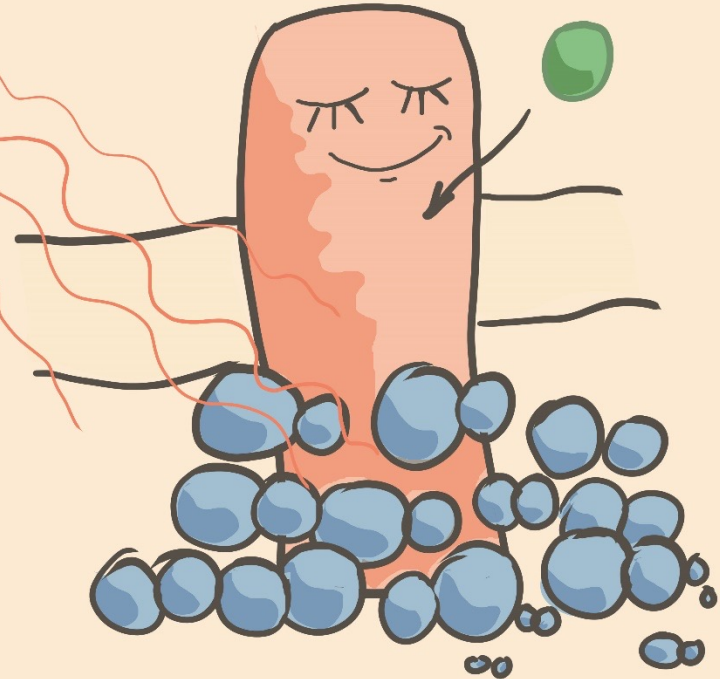
Increase blood flow.



Ample oxygen

Complex IV in oxidized state

Consumes Nitric Oxide



## Conclusion

An effective mechanism of stimulation of mitochondrial respiration protects against neurodegeneration by increasing the oxidative metabolic energy capacity of neurons and reducing oxidative damage (Wen et al., 2011). With increases in the capacity to produce ATP by up-regulation of cytochrome oxidase, multiple secondary benefits accrue such as enhancement of neuronal metabolic energy and bigenomic responses, antiapoptotic signaling, DNA repair, mitogenic signaling, axonal sprouting, synaptogenesis and brain-derived neurotrophic factor (Martijn and Wiklund, 2010; Gomes et al., 2012; Poteet et al., 2012; Rojas and Gonzalez-Lima, 2013; Xuan et al., 2014). Low-doses of methylene blue and near-infrared light that up-regulate mitochondrial respiration *in vivo* have similar neuroprotective effects in multiple model systems featuring neurodegeneration.

**THANK YOU**

