

# STANDARD DEVIATIONS: Hot under the Collar?

Greetings,

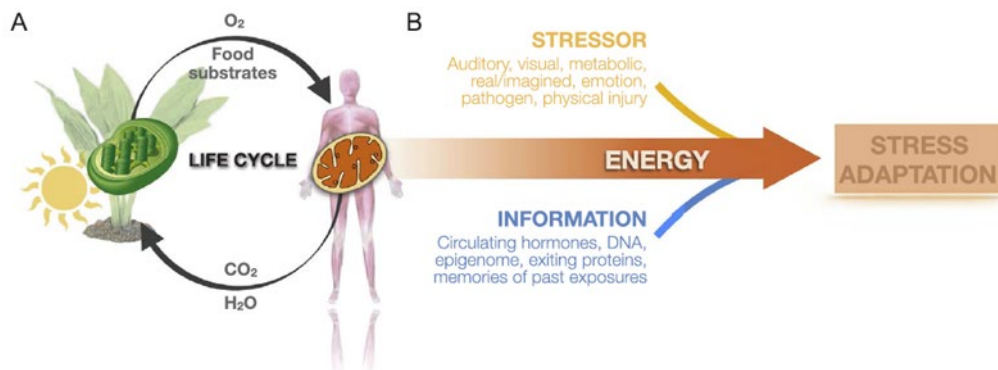
Had your temperature taken lately? I'm guessing that it's become a routine chore for most of us, but why?

Monitoring temperatures is a popular tool for screening people for infection. Fever is a major component of infection and inflammation. And fever, or pyrexia, is one of the diagnostic characteristics of COVID-19.

The cause of the fever is not SARS-CoV2; **fever is caused by mitochondria.**

Hot flashes, thermogenesis, fever, febrile prodrome, pyrexia, whatever name we give it, is the abnormal state of mitochondria generating heat. The warmth we feel in inflammation, infection, under duress, embarrassment, or rage is just mitochondria reacting to **toxic stress**.

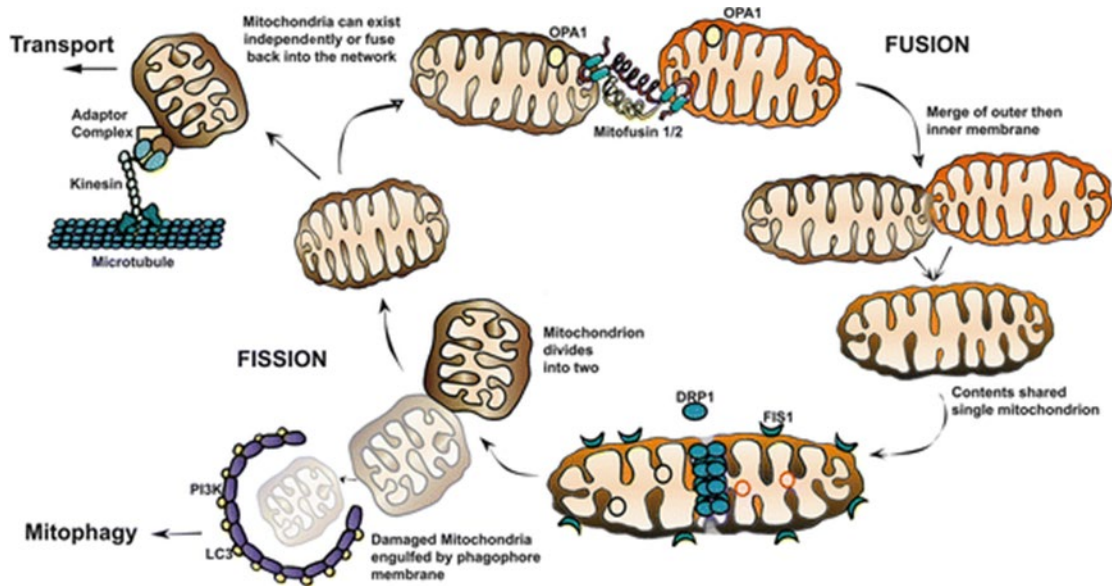
Mitochondria use food and oxygen to power a battery of electrochemical potential. Your breath supplies fuel for mitochondria to do their thing. These little generators constantly supply the energy to run the basics, the good stress, **and** the energy required for stress response above and beyond our basal needs, or the toxic stress. **A whopping 90% of all the oxygen you consume is used to fuel mitochondria.**



{Mitochondria sustain life and enable stress adaptation. (A) Oxygen is fuel. (B) We use mitochondrial energy to respond.}

These adapted endosymbionts are in constant use, fusing together when they are in high production mode, separating by fission when down-sized, and extruded when they are not needed for a cell to function. The status is controlled by our autonomic nervous system, cellular mechanisms, and the pathogens that alter signals of regulation.





{Adaptive morphologies}

These Energizer Bunnies burn fuel like gasoline. Consider that EACH contraction of cardiac muscle requires that mitochondria synthesize billions of ATP molecules. These tiny motors always run at a good clip moving cilia, micro-villi, microtubules, gene expression, biochemical synthesis, and on and on. The higher the “RPM” (mitochondrial activity) the more “gas” (oxygen) is consumed.

And, just like your car, the harder you push the motor/mitochondrion, the hotter it runs. This is the reason your body temperature rises when you exercise.

**Energy is evident in two forms in living organisms:** as **chemical energy** (like ATP) that fuels specific enzymatic or biophysical reactions; **and heat**, which permeates all structures of living organisms. The origin of heat in the human body, or thermogenesis, is the free energy released by our mitochondria. A normal (idling?) mitochondrion functions at around 50 °C (122 °F).

As humans, we happily run around at 37 °C. When we encounter toxic stress, physically, psychologically, or emotionally, our mitochondria kick in and they raise our temperature. (Bees, on the other hand, are poikilothermic (i.e. cold-blooded) but in flight raise their temperature to around 56 °C (133 °F) and use their hive to maintain a working temperature range, not mitochondria.)

As temperatures increase so do the rate of enzyme reactions. A ten degree (C) rise in temperature will increase the activity of most enzymes by 50% to 100%. Responding to toxic stress is like stepping on the accelerator: revving up mitochondria produces energy, ATP *and heat*. And that heat accelerates the reactions that ATP fuels.



Any rise in basal temperature is the result of mitochondria fusing into power-plants of energy and exponential bio-synthesis. Our bodies are constantly managing this dynamic to maintain homeostasis. Embarrassed? Mitochondria. Angry? Mitochondria. Feverish with COVID-19? Yep, Mitochondria.

Mitochondria have a much larger role. They regulate our immune response. An influx of reactants and energy fuel the cascades of immune response and release of heat we observe as inflammation and fever. And, the deaths associated with COVID-19 and age-related comorbidities are directly related to the health of our mitochondria, but that's another story.

Have a great week and be safe,

Bryan

