Supplementary material:

Nernst equation:

$$E = -59 \log \frac{[K_{in}]}{[K_{out}]} \quad (1)$$

where $[K_{in}]$ is the concentration of radioactive K^+ icons in the matrix and $[K_{out}]$ is the concentration of radioactive K^+ icons in the surrounding medium.

Proton motive force (pmf) in millivolts:

$$pmf = \Psi - \left(\frac{RT}{F} \times \Delta pH\right) = \Psi - 59\Delta pH \quad (2)$$

where Ψ is the electric potential across the inner membrane, R is the gas constant, T is the temperature, F is the Faraday constant and ΔpH is the pH gradient.

Methodology:
Mitochondria can oxidize $FADH_2$ and NADH only as long as there is a source of ADP and Pi to generate ATP. The well-known respiratory control occurs due to oxidation of NADH and succinate ($FADH_2$), coupled with proton transport across the inner membrane is obligatory. The respiratory control causes oxidation of NADH thus succinate ($FADH_2$) is coupled to proton transport across the inner membrane. If the proton-motive force (pmf) is not dissipated during the synthesis of ATP, both the transmembrane proton concentration gradient and the membrane electric potential will increase to very high levels, actually blocking the coupled oxidation of NADH and other substrates. The proton (electrochemical) gradient at the level of the cell's membrane is a convenient form of energy. In order to calculate this energy, we use Schrödinger equation, measuring the current density on specific areas of inner mitochondrial membranes.

The Schrödinger equation for the electric load q takes the form:

$$-\frac{\hbar}{i}\frac{\partial\Psi}{\partial t} = \hat{H}\cdot\Psi = \frac{1}{2m}\left(\frac{\hbar}{i}\nabla\right)\cdot\left(\frac{\hbar}{i}\nabla\right)\Psi + q\cdot\phi\cdot\Psi, \quad (3)$$

where ϕ is the electric potential and ($q \cdot \phi$) express the potential energy.

While electrons (e^-) move in a magnetic field, we can express the Hamiltonian and the Schrödinger equation becomes:

$$-\frac{\hbar}{i}\frac{\partial\Psi}{\partial t} = \hat{H}\cdot\Psi = \frac{1}{2m}\left(\frac{\hbar}{i}\nabla - q\cdot A\right)\cdot\left(\frac{\hbar}{i}\nabla - q\cdot A\right)\Psi + q\cdot\phi\cdot\Psi. \quad (4)$$

This is the Schrödinger equation for an electric load (q), moving in an electromagnetic field described by the potentials A and ϕ. Due to the interactions of electrons with the vibrations of atoms in the membrane, there is traction between them. The result of this traction is the formation of the captive pairs. While a pair of electrons is a Bose particle, the Schrödinger equation for a pair of electrons will be formed (evidence for superconductivity):

$$-\frac{\hbar}{i}\frac{\partial\Psi}{\partial t} = \hat{H}\cdot\Psi = \frac{1}{2m}\left(\frac{\hbar}{i}\nabla - 2\cdot|q_e|\cdot A\right)\cdot\left(\frac{\hbar}{i}\nabla - 2\cdot|q_e|\cdot A\right)\Psi + 2\cdot|q_e|\cdot\phi\cdot\Psi. \quad (5)$$

At finite temperatures, there are always some pairs which have been segregated in line with the theory of Boltzmann, with the probability of dividing a pair of electrons equals to $e^{-E_{pair}/K\cdot T}$.

The electrons which are not bound in pairs will move through the membrane. We define as Ψ, the pair wave function of an electron pair in the lower energy level. While the product $\Psi \cdot \Psi^*$ is proportional to the charge density of p then:

$$\Psi(r) = p^{1/2}(r)\cdot e^{i\cdot\theta(r)}, \quad (6)$$

where p, θ are real functions of r. Thus the density J of the current:

$$J = \frac{\hbar}{m}\cdot(\nabla\theta - \frac{q}{\hbar}A)\cdot q. \quad (7)$$

Since both the current density and the charge density have a direct physical meaning for the superconducting electron gas, both p and θ are real functions with θ to be measurable. The current density J is in fact the charge density multiplied by the speed of the fluid motion of electrons that is equal to $p \cdot u$. Therefore:

$$m\cdot u = \hbar\nabla\theta - qA. \quad (8)$$

Since there is an underlying positive charge (due to the proton H+) the possibility of concentration of electrons in a specific area of the membrane leads to massive repulsion of electrons. Therefore, current J is proportional to the vector potential:

$$J = -p\frac{q}{m}A. \quad (9)$$

If the inner membrane is 'blocked' due to low potential difference of protons, then the normal flow of electrons will be 'disrupted'. Electrons will create complexes with protons through the inner membrane and their mobility will continue with great resistance due to protons presence.

Reduction of O_2 to H_2O is: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$, (10)

