Mitochondria – the Hot Rulers of the Cell

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Abstract

Our recently published data show that intramitochondrial temperature is ~15°C higher than its cytosolic/cytoplasmic surrounding and highly resistant to several metabolic stresses such as nutrient deprivation, altered ATP demand and oxidative phosphorylation (OXPHOS) targeted toxins, indicating that intramitochondrial temperature is strictly regulated within narrow limits. Mitochondria have been attributed to an ultimate goal of ATP production via the OXPHOS system. Simultaneous heat production has been mistakenly referred as a "by-product" of mitochondrial oxidizing activity. The recognition that heat production is a core process of mitochondria, and that mitochondrial enzymes, proteins and nucleic acids, function at elevated temperature, leads to the conclusion that defects in the OXPHOS machinery can lead to temperature anomalies with potentially pathological consequences. The hot rulers of the cell are regulatory hubs for metabolism and are involved in many biological functions in response to changes in external conditions. Therefore, it is crucial to understand how heat generation is regulated in response to challenging external stresses. How is the heat distributed throughout the organelle, from the inner mitochondrial membrane to the mitochondrial matrix, intermembrane space, outer membrane and from there to cytoplasm? Here, we aim to measure temperature simultaneously in different compartments of mitochondria and at other subcellular organelles. Genetically encoded temperature indicators (GETIs) are excellent tools to determine temperature at molecular level and specific targets in cell with high sensitivity. We have been developing GETIs targeted to particular locations in mitochondria and cell to shed more light in production and regulation of heat distribution in and from mitochondria.

Keywords: heat production; mitochondria; OXPHOS; intracellular temperature