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BAKER SCIENTIFIC APPLICATION NOTE

Oxygen consumption rate tells about the wellbeing of cells

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BACKGROUND

Measuring oxygen consumption by cells provides ample information on how cells are doing. It is in the core of mitochondrial function, metabolism and carbon cycling. Cells take up oxygen that then serves as the final electron acceptor in the mitochondrial electron transport chain.

Therefore, the level of oxygen and the ability of mitochondria to process it influences the entire wellbeing of the cell and tissue. The ability to study cellular metabolism and mitochondrial function is essential in understanding redox processes in basic biology.

CONTENT

Cells need energy to survive. This energy comes from oxygen through the process of cellular respiration. In cellular respiration, high energy bonds are oxidized, which then releases energy. The majority of energy production is done by mitochondria through oxidative phosphorylation like the oxygen-dependent production of ATP (Nunnari & Suomalainen 2012).

Depending on cell type and function, cells have a wide range of oxygen utilization: small red blood cells with no mitochondria use much less oxygen than the relatively large hepatocytes. Cell volume and cell protein production correlate somewhat with cellular oxygen consumption rate (OCR; Wagner et al 2011).

OCR is used to measure the function of mitochondria, be a marker of cells switching from oxidative phosphorylation to anaerobic glycolysis in cancer cells, as well as being used to signal altered metabolic activity of mitochondria.

How cells and tissues use oxygen is of fundamental importance and depends on the intracellular and extracellular redox environment. This environment is affected largely by the rate of oxygen utilization. In the energy producing mitochondria, disruptions in redox processes contribute to the development of various human disorders like cancer, neurogenerative diseases, and aging (Hu et al 2008). When only a fraction of oxygen is partially reduced, superoxide and hydrogen peroxide are formed and the redox balance in the cells is affected.

This changes the flux of oxidants and the levels of redox molecules and eventually may lead to repression or activation of signaling pathways that respond in order to regain homeostasis (Jones 2006).

To understand these processes qualitatively or quantitatively, the function of mitochondria has to be understood and ideally measured. The ability to measure oxygen consumption rate of mitochondria in cellular samples is generally considered to be a good readout of the activity of mitochondria (Dranka et al 2011).

Mitochondrial changes have been implicated in the progression of disease states (Wu et al 2007). Monitoring changes in the OCR rates in response to stimuli gives information not only of the function of a single cell but it can also be used as a readout for complex ecosystems (Strovas et al 2006).

The ability to measure cellular oxygen consumption rate that gives direct information on cell metabolism leads to insights into diagnosing and treating infections, stroke, diabetes, heart disease, and cancer (Bell and Chandel 2007). Applications that enable direct measurements of OCR are a useful gauge of cellular health and metabolic state.

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