

A scientific review of oxygen and its effect in ageing

by Justin Croft

Introduction

Oxygen is an essential driver of many cellular processes in living organisms. Numerous molecular systems have been developed to quickly adapt to oxygen fluctuations, and HIF factors represent their major regulators. HIF, a versatile regulator, has been shown to have various downstream effects and can influence many systems including metabolism, angiogenesis, stem cell differentiation, tumor progression and resistance, cell death and anemia to name a few.

So, the question remains, how does oxygen affect ageing though? The recent review by van Vlieta, Casciaro, and Demaria “To breathe or not to breathe: Understanding how oxygen sensing contributes to age-related phenotypes” delves deeply into this topic. The group looks at data from both cellular, animal and human studies to provide a broad yet in-depth look into oxygen's role on longevity. The review itself touches on several main areas and we have attempted to outline some of the more salient points below.

Oxygen responsive pathways and their effects on cellular physiology

Key points:

- Oxygen can affect tissue function vitality and longevity via regulation of four main branches including HIF factors, AMPK, mTOR and chromatin remodeling proteins
- While it is evident that excessive levels of oxygen species (ROS) are detrimental and may even underpinning of disease, further investigation needs to be done to clarify how hypoxia can influence such levels, as there is no clear consensus at the moment.
- Both stem cell stemness and differentiation are important in longevity. Hypoxia clearly preserves stemness, but disagreements exist about the role of oxygen tension in controlling stem cell differentiation.
- Oxygen responsive pathways have acute roles in the normal function of both innate and adaptive immunity. Disruptions in these pathways contribute to immunosenescence and inflammatory diseases.

The effects of oxygen-related pathways in disease

Key Points:

- Chronic obstructive pulmonary disease (COPD) a specific SNPs (single nucleotide polymorphisms) in the HIF-1 gene is associated with a higher risk for the development of COPD and increased mortality.
- Research has revealed that HIF-1 plays a protective role during ischemia-reperfusion injury in different organs.
- Within anemia the HIF pathway is a regulator of erythropoiesis through its regulation of Erythropoietin (EPO) which stimulates erythroid precursor cells to differentiate into RBCs in the bone marrow.

Oxygens effect on lifespan in humans and within the model organisms D. Melanogaster, C. elegans and M. musculus

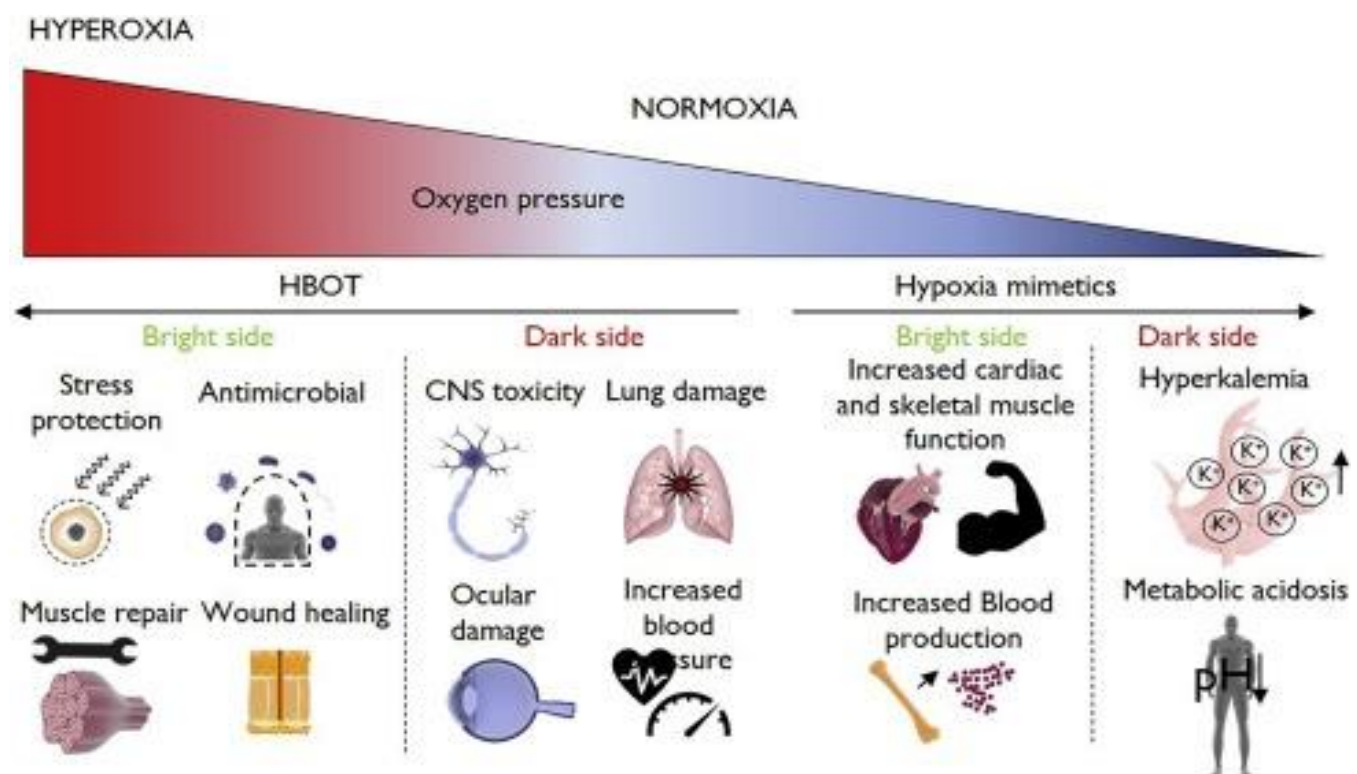
Key point:

- The takeaway here is there seems to be a correlation between oxygen and life- and healthspan. Regardless of animal type there are detrimental effects associated with severe hypoxic and hyperoxic conditions, but beneficial effects are noted in mild hypoxic conditions.

Pros and cons of hyperoxic and hypoxic therapies at the organism level

Key Point:

- This is a long section but can best be summed up by Figure 3 (below). Essentially, both hyperoxia and hypoxia do have therapeutic benefits but weighing these verses some of the negatives does need to be parsed out more in future research.



Feel free to read the [full article](#) and if this topic is of interest to you and your research, please do note that Oxford Optronix offers several options for those studying oxygen regardless of model.

- For those performing cellular studies, the [HypoxyLab](#) is the preeminent leader in hypoxic/physoxic workstations and incubators, offering a fully featured benchtop unit that is the only system to utilizes pO₂ for the most precise all-around measurement anywhere or anytime.
- Or for those working on animal models, the [OxyLite](#) is a system that allows for minimally invasive pO₂ measurements of a micro-region in nearly any tissue.