Factors influencing exercise-induced mitochondrial biogenesis

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Mitochondria are key components of skeletal muscles, as they provide the energy required for almost all cellular activities and play an important role in ageing and cell pathology. Exercise training is one factor shown to provide a powerful stimulus to increase both mitochondrial content and/or respiratory function, yet little is known about the optimal training dose. An important focus of recent research (much of it unpublished) has been the investigation of factors that may influence exercise-induced mitochondrial biogenesis.

Recent findings, in both animals and humans, suggest that exercise intensity is a key factor regulating training-induced changes in mitochondrial respiration, whereas exercise volume may be more important for training-induced changes in mitochondrial content (Bishop *et al.*, 2014). Furthermore, there exists an apparent dissociation between training-induced changes in mitochondrial respiration and content. While further research is required, it is possible that increases in mitochondrial respiratory function, without a change in mitochondrial content, may be the result of matched changes in protein synthesis and degradation resulting in the replacement of damaged proteins with newly synthesised ones (Mai *et al.*, 2012).

Exercise-induced mitochondrial biogenesis, leading to changes in mitochondrial content and/or function, requires the coordinated integration of the nuclear and mitochondrial genome, and is the result of signalling, transcription, translation, the import of precursor proteins, and the incorporation of biologically active proteins into an expanding mitochondrial reticulum (Drake *et al.*, 2015). These processes may be influenced by the exercise stimulus, as well as factors such as genes, nutrition, and post-exercise recovery. The content of peroxisome proliferator-activated receptor γ coactivator-1α (PGC-1α), a key regulator of exercise-induced mitochondrial biogenesis, has been shown to increase in the nucleus post exercise (Little *et al.*, 2011). Unpublished data from our group indicate there is also an increase in the protein content (and phosphorylation) of p53 in the nucleus immediately post-exercise. Furthermore, exercise- and training-induced changes in both PGC-1α and p53 protein content appear to be greater with high-intensity exercise (and training), and are decreased following a period of reduced training. In addition to the exercise stimulus itself, the post-exercise recovery is emerging as an important factor influencing exercise-induced mitochondrial biogenesis. It has been shown that post-exercise cold-water immersion augments the post-exercise response of a number of signalling proteins and genes associated with exercise-induced mitochondrial adaptations. Finally, recent work from our group has shown that an individual's genotype may influence exercise-induced changes in gene expression associated with endurance training. While additional research is required, a more complete picture is emerging regarding factors that influence exercise-induced mitochondrial biogenesis

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