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Caloric restriction and aging stem cells: the stick and the carrot?

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Abstract

Adult tissue stem cells have the ability to adjust to environmental changes and affect also the proliferation of neighboring cells, with important consequences on tissue maintenance and regeneration. Stem cell renewal and proliferation is strongly regulated during aging of the organism. Caloric restriction is the most powerful anti-aging strategy conserved throughout evolution in the animal kingdom. Recent studies relate the properties of caloric restriction to its ability in reprogramming stem-like cell states and in prolonging the capacity of stem cells to self-renew, proliferate, differentiate, and replace cells in several adult tissues. However this general paradigm presents with exceptions. The scope of this review is to highlight how caloric restriction impacts on diverse stem cell compartments and, by doing so, might differentially delay aging in the tissues of lower and higher organisms.

Keywords: aging, caloric restriction, stem cells, cell renewal, regeneration

Introduction

How to slow the aging process and treat age-related diseases is one of the urges of modern medicine. The aging process might be regarded as a disease or as a consequence of development. However, in molecular terms it can be understood as a decline of the homeostatic mechanisms that ensure the function of cells, tissues, organs, and organ systems (Vinciguerra et al., 2013, Tevy et al., 2013). With the decline of the homeostatic processes an increased risk for a series of so called age-related diseases appears (Niccoli and Partridge 2012; Vinciguerra et al., 2013). Among the many homeostatic processes which ensure cell function in the adult organism there are the cell renewal in tissues with high turnover and tissue regeneration after injury, damage or cell loss (Signer and Morrison, 2013). Such processes, in adult life are fuelled, in part, by the presence of a pool of stem cells, restricted progenitors and some differentiated cells which are also perpetuated throughout life by intermittent self-renewing divisions (Rando and Chang, 2012; Signer and Morrison, 2013). A subset of tissue specific adult stem cells persists in the quiescent state for prolonged periods of time, and enter the cell cycle when they become activated in response to extrinsic signals (Li and Clevers, 2010). An imbalance in progenitor cell populations ultimately leading to stem cell depletion may