The curious case of Turritopsis dohrni jellyfish – elucidating epigenetic principles of immortality

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Project description:
Immortality refers to the concept of living forever or having an endless lifespan. The idea of immortality has fascinated human beings for centuries. In this project, we aim to investigate the molecular mechanisms responsible for T.dohrnii's biological immortality. Turritopsis dohrnii, also known as the 'immortal jellyfish', is a species of jellyfish that can revert to its juvenile form after reaching sexual maturity, potentially enabling it to live forever. This unique ability is due to trans-differentiation, a process where fully differentiated cells in the adult jellyfish convert into undifferentiated stem cells, allowing the jellyfish to regenerate its cells and tissues and effectively reverse the ageing process. While the molecular mechanism of T.dohrnii's trans-differentiation is not well understood, recent genomic analysis has revealed extensive changes in gene expression profiles and duplications of genes essential for DNA repair during rejuvenation. However, no single gene granting T.dohrnii immortality has been identified, suggesting that a more complex molecular program is required for rejuvenation.

Functionally, the trans-differentiation of Turritopsis cells resembles the reprogramming of mammalian cells to pluripotency, suggesting that the 'immortal jellyfish' genome also needs to undergo global changes to reset its epigenetic state. As the epigenetic mechanisms in Turritopsis are unexplored, it is not clear which specific epigenetic marks play a role in rejuvenation nor which epigenetic mechanisms are responsible for driving this process. We also do not know if epigenetic changes can drive the process, or are they simply a consequence of it? Finally, it is unclear whether the rejuvenation ability of Turritopsis could be mediated solely by epigenetic mechanisms.

The first goal is to understand the epigenetic system of this unique jellyfish. For this, we will investigate the genomic distribution of key epigenetic marks and examine their correlation with transcriptional activity to pinpoint the fundamental principles of Turritopsis' epigenetic regulation. For this, we will use state-of-the-art epigenomic and transcriptomic methods to investigate DNA methylation profiles and identify genomic locations where methylation is actively removed. We will study histone modification patterns to understand their crosstalk with DNA modifications and effects exerted on gene regulation. Once we understand the fundamental principles of the Turritopsis epigenetic system, we will identify the epigenetic programme responsible for driving rejuvenation. For this, together with our partners, we will initiate Turritopsis rejuvenation and gather jellyfish at consecutive stages of trans-differentiation and study the epigenetic and transcriptional changes driving rejuvenation. Overall, in this project, we aim to reveal the epigenetic and transcriptional profiles and identify the key epigenetic factors involved in the rejuvenation process.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.