The curious case of Turritopsisdohrni jellyfish – elucidating epigenetic principles of immortality

Supervisory team:
Main supervisor: Dr Tomasz Jurkowski (Cardiff University)
Second supervisor: Dr Renata Jurkowska (Cardiff University)
Prof Peter Kille (Cardiff University)

Collaborators: Ms Anais Courtet (Aquarium de Paris), Mr Etienne Bourgouin (Aquarium de Paris)

Host institution: Cardiff University

Project description:
This project aims to explore the molecular mechanisms behind the biological immortality of Turritopsis dohrnii, commonly known as the 'immortal jellyfish.' This unique species can revert from its adult stage back to its juvenile form through a process called trans-differentiation, where fully differentiated adult cells transform into undifferentiated stem cells, enabling the jellyfish to regenerate tissues and effectively reverse the ageing process.
While the molecular mechanisms underlying T. dohrnii's rejuvenation remain largely unknown, recent genomic analyses have shown significant changes in gene expression and the duplication of genes critical for DNA repair during this process. However, no single gene responsible for this 'immortality' has been identified, suggesting that a complex molecular program drives rejuvenation. The process bears similarities to the reprogramming of mammalian cells to pluripotency, where extensive epigenetic and transcriptional changes are required to reset cellular states.

This project will investigate whether similar epigenetic mechanisms are involved in T. dohrnii's rejuvenation. Using state-of-the-art epigenomic and transcriptomic methods, we will examine key epigenetic marks, such as DNA methylation and histone modifications, to understand their roles in regulating gene expression during trans-differentiation. We will study how these marks are distributed across the genome and how they interact to drive the reprogramming of the jellyfish's cells.

Working with partners at Aquarium de Paris, we will initiate Turritopsis rejuvenation and collect jellyfish at different stages of the process. By analyzing epigenetic and transcriptional changes at each stage, we aim to identify the epigenetic factors that play critical roles in this remarkable biological phenomenon.
The results of this project will provide a fundamental understanding of the epigenetic system that governs T. dohrnii's ability to revert to a youthful state. This work will also offer valuable insights into the evolution of epigenetic mechanisms and provide a reference epigenome for future studies. Ultimately, understanding these rejuvenation mechanisms may open new avenues for research into human ageing and offer potential strategies for combating age-related diseases.

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.