Reconstructing ancestral animal cell types by a single cell analysis and comparative genomic approach

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Project description:
Cell types are the fundamental building blocks of multicellular organisms and are central to understanding the biosciences. While many cell types, such as neurons and muscle cells, are shared across animal lineages, others appear specific to certain groups, like vertebrate immune cells or cnidarian cnidocytes. This raises important questions: How did this vast diversity of cell types emerge? Are new cell types frequently created during evolution, or are they conserved across groups? Answering these questions is crucial for understanding the evolution of cell types and, consequently, multicellular organisms.

Recent advances in single-cell technologies have enabled the detailed investigation of cell types within species, yet comparing these cell types across species remains challenging. The evolution of cell types is deeply tied to the genomic history of each gene and its expression patterns. However, there is a lack of methods that integrate single-cell analyses with comparative genomics comparisons to reveal these evolutionary relationships.

Our project aims to reconstruct the ancestral cell types and their evolution within an animal group by combining single-cell analysis with phylogenomic data. We will develop innovative algorithms and data analysis tools that build upon established computational methods to map the evolutionary history of genes and their associated cell type expression patterns. To validate our hypotheses, we will generate single-cell data from key evolutionary nodes. Additionally, we will incorporate advanced artificial intelligence and machine learning techniques to classify genes based on shared expression profiles.

The tools and algorithms developed will allow us to trace the evolutionary trajectory of each cell type and reconstruct the ancestral cell types within the chosen animal group, Platyhelminthes. This group is particularly suitable due to its well-studied cell types and evolutionary history. Moreover, Platyhelminthes, such as planarians, possess stem cells that continuously differentiate into all cell types, providing a unique opportunity to profile the entire cell type repertoire from adult samples.

Understanding the evolution of cell types is a critical yet enigmatic area of study. This project will address fundamental questions, shedding light on cell type evolution in multicellular organisms and offering insights valuable to a broad range of fields, from developmental biology to evolutionary biology.

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.