Chapter 1

General Introduction

Major evolutionary transitions

- High diversity of life on earth

- Events of major evolutionary transitions have helped to shape the direction of evolution and consequently brought to the current biodiversity on earth

- One primary example is the passage from prokaryote to eukaryote

- One major example within eukaryotes is the passage from unicellular organisms to multicellular organisms

- This has occurred in several independent occasions throughout eukaryotic history leading to very divers sets of multicellular organisms (e.g. plants, fungi and animals)

“During evolution, there have been several major changes in the way that genetic information is organized and transmitted from one generation to the next. These transitions include the origin of life itself, the first eukaryotic cells, reproduction by sexual means, the appearance of multicellular plants and animals, the emergence of cooperation and of animal societies, and the unique language ability of humans.”

- From The Major Transitions in Evolution. Smith and Szathmary. 1997.

“How animals evolved from their single celled ancestors is one of the great mysteries in evolution and was likely set in motion by the origin of multicellularity. A remarkable process, one so striking that it is considered one of only eight “Major Transitions” in evolutionary history (Maynard Smith, John; Szathmáry, Eörs (1995). The Major Transitions in Evolution. Oxford, England: Oxford University Press. ISBN 0-19-850294-X), the transition to multicellularity occurred not just once, but repeatedly in diverse lineages. From relatively inconspicuous beginnings—sister cells that remained attached following division rather than going it alone—evolved the many multicellular life forms that fill our visible world today: brown algae, red algae, green algae, land plants, fungi, and animals.”

-From Evolutionary Transitions to Multicellular Life: Principles and Mechanisms edited by Iñaki Ruiz-Trillo and Aurora M. Nedelcu. 2015.

- Within animals the current hypotheses about origin of multicellularity are ...

We discuss two hypotheses for the origin of animal cell types: division of labor from ancient plurifunctional cells and conversion of temporally alternating phenotypes into spatially juxtaposed cell types.

- From Brunet and King. 2017

- Current hypotheses that brought to the origin of animals through multicellularity

- Major implications/consequences of multicellularity:

1-the ability to interact with the environment as a whole organism rather than as a single cell

2-subspecialisation of different cells for different tasks

3- need for cells to communicate and coordinate amongst each other

Expansion of signal transduction systems in animals

More details of point 3 above.

- while signal transduction occurs also in unicellular eukaryotes (check) in animals it becomes even more essential – examples to defend this claim, e.g. stats of number of gpcrs.

- These systems involve all aspects of animal biology. For example, a large number of these are related to perceiving the environment and elaborating responses. These are the senses. For example vision.

- The immune system is another example of organism-wide system that requires cell coordination to identify and target external invaders/pathogens. An example of this is the chemokine system.

Power of Evolutionary Studies

Final paragraph could have some concluding remarks about the power of evolutionary studies to understand how signalling systems work in animals and introducing that in the next chapter (methods) I will explain about the methodological approaches used to answer these questions in this thesis.

Aims of the Thesis

- In this thesis, I used phylogenetic and bioinformatic approaches to understand the molecular evolution of two main systems in animals.

- First, the evolution of vision: here I wanted to understand when all the molecular and cellular components that are the minimum basic setup of vision originated. As multiple non-bilaterian organisms have vision, vision must have originated at some point in early evolution of animals, either prior to the split of extant phyla, or at one of the early splits of extant phyla. However, some of the components are involved in other cellular tasks and likely originated more anciently, so my investigation extended to all Eukraya.

- Second, the evolution of chemokine signalling: here I wanted to understand what are the evolutionary relationships between molecular components that compose the system; when they originated; and describe their evolutionary histories. Since canonical chemokine signalling has only been described in vertebrates, the focus was in searching for ancestral molecules in animals and specifically, in sister groups of vertebrates. This work was conducted in collaboration with my coworkers Matthew Goulty etc and is currently a pre-print.

**Introduction about vision**

- Phototransduction

- Photoreceptor cells

- Retinol metabolism that synthesises the 11-cis-retinal

**Introduction about chemokine signalling**

- Canonical CK signalling

- Non-canonical CK

References