

The evolution of cell-cell signalling in unicellular eukaryotes

Supervisory team:

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Submit applications for this project to University of Exeter

Project description:

The amino acid L-glutamate plays a key role in cell-cell communication in multicellular organisms, acting as the primary neurotransmitter in the human brain and in long range signalling during wounding in land plants. Sensing of extracellular glutamate may have emerged as a mechanism to detect wounding of neighbouring cells, but the evolution of glutamate signalling and its roles in unicellular eukaryotes remain largely unexplored.

Diatoms are a major group of unicellular algae that represent one of the most important photosynthetic organisms in marine and freshwater ecosystems. They are responsible for 20% of annual global photosynthesis and represent the base of food web in highly productive ecosystems. Whilst diatom cells often exist in close proximity, e.g. during algal blooms or biofilms, mechanisms of cell-cell communication are not well known.

We have identified that diatoms possess homologues of the ionotropic glutamate receptors required for sensing extracellular glutamate in animal and plant cells. We have also found that extracellular glutamate induces strong calcium signalling responses in diatom cells, in a manner similar to plants and animals. Glutamate therefore appears to be an important signalling molecule in these unicellular organisms, although its role remains unknown.

This project will explore the cellular roles of glutamate signalling in diatoms and other algae. The role of ionotropic glutamate receptors, the response to algal toxins and the downstream responses to glutamate-induced calcium elevations will be examined. The project will also examine the wider distribution of ionotropic glutamate receptors in a range of algae and the responses to extracellular glutamate.

The project will address the following key research questions:

What are the cellular roles of glutamate signalling in diatoms?

Does glutamate signalling allow integrated responses of a diatom population to specific stressors?

Is glutamate a conserved cell-cell signalling molecule across multiple algal lineages?

Methodology

The project will examine signalling processes in the model diatom *Phaeodactylum tricornutum* using genetically encoded calcium reporters and CRISPR-Cas gene knockout approaches. This will involve full training in algal culturing, genetic manipulation and live cell imaging approaches. Phylogenetic analyses will be used to examine the evolution of the ionotropic glutamate receptors in different eukaryote lineages.

Outputs

The project will characterise novel mechanisms of cell-cell communication in a major phytoplankton lineage. The findings will provide broad insight into the evolutionary origins of cell-cell signalling mechanisms in unicellular eukaryotes that ultimately facilitated the development of the complex glutamate-dependent signalling networks in multicellular organisms.

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.