DOCTORAL TRAINING PARTNERSHIP
ENVIRONMENTAL RESEARCH

Proposal form for a CASE or Collaborative project

<table>
<tr><td colspan="2">Project Title: Molecular responses to hypoxia in algae</td></tr>
<tr><td colspan="2">Proposed by: Rosalind Rickaby and Emily Flashman</td></tr>
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<tr><td colspan="2">Please indicate stream and whether CASE or collaborative</td></tr>
<tr><td>☐ CASE
☐ X Collaborative X</td><td>☐ Biodiversity, Ecology and Evolutionary Processes X
☐ Dynamic Earth, Surface Processes and Natural Hazards X
☐ The Physical Climate System</td></tr>
<tr><td colspan="2">Brief introduction of the project including: (boxes will expand to fit text)</td></tr>
<tr><td>Background</td><td></td></tr>
<tr><td>Key Research Question</td><td>How has the evolution of oxygen in the environment shaped ocean photosynthesisers</td></tr>
<tr><td>Aims of the project</td><td>Contrast the physiological responses of 3 algal species to suboxia/anoxia and hyperoxia using gas-controlled growth chambers
Investigate the proteomic response of these different lineages to high and low O2 stress
Determine whether PCO-like (plant cysteine oxidase) enzymes in algal species have an oxygen-sensing role and how their activity relates to physiological outcomes.
Identify metabolic consequences of reduced oxygen availability and novel signalling pathways.</td></tr>
<tr><td>Methods to be used</td><td>Phytoplankton Culture and sterile techniques, Enzyme kinetics, Proteomics, Bioinformatics</td></tr>
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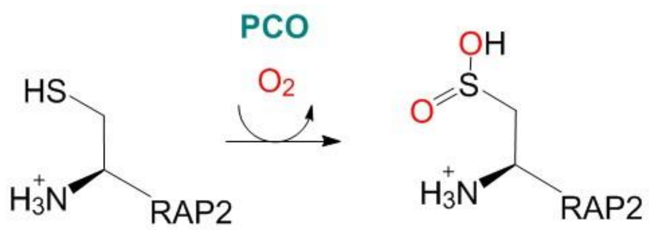
Any specialised skills the student will need to carry out the project	**Preferably a background in Biochemistry/Chemical Biology/Chemistry/ and where possible with expertise/interest in Earth/Environmental sciences**

Background: Oxygen is a highly reactive compound to life and yet is key to its physiology in an aerobic world. Over geological history, as a result of oxygenic photosynthesis, the oxygen content has increased in the atmosphere and ocean, although parts of the Earth surface remain anoxic even today. The so-called oxygen minimum zones (OMZs) of the ocean are expanding as a result of increased anthropogenic warming. As a result, it is increasingly important to understand how oxygen availability has guided evolution in the past and may affect selection and survival of aquatic photosynthesisers in the future.



The molecular pathway by which land plants sense and respond to changes in oxygen availability is understood at the molecular and physiological level and is driven by Plant Cysteine Oxidases (PCOs, Scheme) [1,2]. We have shown that the algae *Klebsormdium nitens* and *Chlamydomonas reinhardtii* have functional PCO enzymes, but no functional form has yet been identified in the Chromalveolates, the algal group which dominates the modern ocean. In addition, the 'response' components of the signalling pathway seen in land plants are not conserved in any form of algae. This project aims to understand how algae sense and respond to changes in oxygen availability and whether PCOs have a role in this. This will be achieved by investigating the biochemical, proteomic and physiological responses of three different algal lineages to changing oxygen availability.

The work in this project will aim to unravel the physiology and molecular response to changes in availability of oxygen in algae. This knowledge will contribute to an understanding of the evolution of oxygen-sensing in the plant lineage and whether tolerance to periodic anoxia allowed plant transitioning onto land. The findings will reveal how ocean algae may cope with increasing OMZs as a result of climate change and ocean warming.