Molecular control of resource mobilisation in plants

Supervisory team:
Main supervisor: Dr Vinod Kumar (University of Exeter)
Second supervisor: Prof Nick Smirnoff (University of Exeter)

Collaborators: Dr Sreeramaiah Gangappa (Indian Institute of Science Education and Research, Kolkata)

Host institution: University of Exeter (Streatham)

Project description:
This project will exploit the unique physiology of young germinating seedlings to unlock the molecular details of energy budgeting in plants. After germination the seedlings undergo a remarkable transformation from heterotrophic lifestyle to becoming photosynthetic and self-sustaining. During this period, they utilize metabolic reserves such as lipids and seed storage proteins to drive cellular processes. The transition is remarkably flexible and can adapt to suboptimal growth conditions such as extended darkness, which could prolong the transition phase. Normally, germinating seedlings can survive under soil, in the dark, for several days until emergence and establishment. How do plants ensure that the nutrient reserves are not exhausted under such conditions? How do the cells regulate the mobilisation of the finite reserves in response to the environment to sustain life until photosynthesis begins? These are important fundamental questions that remain unanswered. Although cellular energy signalling orchestrated by the master regulators such as Snf1-Related Protein Kinases (SnRKs) is known, how the energy signalling and mobilisation mechanisms adapt to the environment is not understood.

This project will answer the above questions by studying the 'spent' mutants in Arabidopsis that we have recently identified. The spent mutants have lost their ability to sustain viability for longer periods of heterotrophy, suggesting that SPENT plays a crucial role in ensuring that nutrient reserves are not exhausted. Early analyses show that SPENT loci are involved in transcriptional reprogramming upon prolonged, dark-induced metabolic starvation. SPENT genes are normally involved in environmental signalling and integration of seasonal cues such as light and temperature. Their role in resource mobilisation offers a promising lead to answering the long-standing questions of how energy signalling is controlled.

Bringing together the expertise and longstanding interests of Kumar and Smirnoff labs, this project will use a combination of genetic, molecular, metabolic, and physiological analyses to answer fundamental questions on energy signalling and resource mobilisation. In addition to understanding the molecular mechanisms that underpin seedling establishment, quantitative analyses will generate a dynamic mechanistic model to link the molecular outputs such as changes in gene expression and enzyme activities to metabolic adaptations.

While addressing important fundamental biology questions, this multidisciplinary project offers the student the opportunity to develop a wide range of scientific and technical skills. The project offers the flexibility to be tailored according to the scientific interests of the student. In addition to the project specific elements, the student will also receive generic training, and discipline-specific training.

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.