To fight or to flourish: Do plants decide in the heat of the moment?
Understanding the coordination of growth and immunity

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

Host institution: University of Exeter (Streatham)

Project description:
How do plants sense and respond to changes in ambient temperature? How are multiple environmental signals integrated to mount ecologically meaningful responses? These are long-standing, fundamental questions in plant biology. While modulation of plant development in response to temperature is to harmonise the plant’s life cycle to the external environment, elevated temperature-induced disease susceptibility is underlain by the trade-off between growth and defense. With the predicted increase in severity and extended geographical ranges of crop diseases, leading to severe crop losses, with rise in global temperatures, this is extremely relevant to food security. The mechanism underlying the integration of environmental signals and the coordination of growth and immunity is currently not well-understood. This project will investigate the above questions by studying the integration of temperature and defence signalling with the objective of defining the molecular mechanisms underlying temperature-induced suppression of immunity.

Using a combination of genetic and molecular approaches, we have recently identified key molecules in the coordination of growth and immunity in response to temperature. These novel thermosensory components offer an unprecedented opportunity to dissect the molecular mechanisms underlying defence suppression at higher temperatures. This project will investigate the molecular mechanisms by which these signalling molecules control growth and immunity in response to temperature. This is a multidisciplinary project employing genetics, molecular biology and chromatin biochemistry, which will integrate mathematical and experimental approaches to define the thermosensory framework at the interface of development and defence signalling. Understanding the molecular mechanism could lead to the development of climate resilient crops.

Student training opportunities: In this multidisciplinary project the student will have the opportunity to develop a wide range of scientific and technical skills. These include molecular biology, genetics, plant phenotyping, mass spectrometry, next generation sequencing, bioinformatics. The student will be given full training in all technical and analytical aspects of the project. The project can be tailored according to the scientific interests of the student. In addition to the above project specific elements, the student will receive generic training in Exeter, and discipline-specific training via training events developed by the DTP and by the University. We are seeking a highly motivated and enthusiastic candidate with a strong interest in fundamental biology. A background in environmental biology and/or molecular biology and bioinformatics would be desirable. Training will be provided in all techniques required for the project, but some practical experience in these techniques will be an advantage.

For informal discussions please contact Dr Vinod Kumar (v.kumar@exeter.ac.uk)

For further details and to apply online please visit:  http://www.exeter.ac.uk/studying/funding/award/?id=3733

The closing date for applications is midnight on Monday, 2 December 2019
NERC-funded PhD opportunity at University of Exeter

Developing a marine microalgal system for environmental epigenetics

Supervisory team

Lead Supervisor: Dr Vinod Kumar, University of Exeter (e-mail: v.kumar@exeter.ac.uk)

Additional supervisors: Dr Katherine Helliwell (Marine Biology Association), Dr Adam Monier (University of Exeter)

Project Background: Phenotypic plasticity, the ability to optimise genetically encoded processes to the dynamic environment, defines fitness and adaptation of biological systems in both terrestrial and aquatic environments. This is mainly achieved through reprogramming of genome organization, structure and dynamics. These mechanisms are cornerstones for acclimatization of short-term fluctuations, adaptations to seasonal changes; and is also the major driving force of evolution. This is extremely important in the context of the current challenges faced by the marine ecosystem as a consequence of global climate change and increasing temperatures, which pose a severe threat to the marine ecosystems. Marine phytoplankton, the major contributors of global photosynthesis, play a significant role in biogeochemical processes and primary productivity forming the basis for marine food chain. In addition to the detrimental impact of elevated temperature on their growth and productivity, poleward migration of phytoplankton as a consequence of warming oceans threaten marine biodiversity and economy through reducing food supply for fish and other marine life. Understanding the genetic and epigenetic mechanisms that drive the response and adaptation of marine phytoplankton to dynamic and fluctuating environment is key to understanding the impact of climate change on biosphere and for devising strategies for mitigation.

Project Aims and Methods: The project aims to develop the unicellular eukaryotic phytoplanton Ostreococcus tauri as a system to study environmental epigenetics. O. tauri is widely-distributed marine alga, known to form dramatic blooms in coastal ecosystems. As a genome-sequenced, genetically-tractable model algal species, with a highly compact genome, O. tauri represents an excellent model system to study eukaryote epigenetics. The student will investigate the role of epigenetic mechanisms in governing the cellular responses to dynamic environmental conditions. The first objective will be to determine the global nucleosome occupancy and chromatin architecture as well as to investigate DNA methylation under standard growth conditions. This will be further advanced to study the role of epigenetic processes in environmental responses. As a case study the project will concentrate on temperature and light by studying chromatin dynamics and DNA methylation in the context of environmental reprogramming of gene expression. The primary aim will be to determine the possible role of these mechanisms in transcriptional reprogramming that
underpin acclimation and adaptation to changes in temperature and light. The student will use molecular biology approaches including RNA-seq and ChIP-seq in the study. The student will be involved in shaping up the final research trajectory and research focus.

**Candidate Requirements:** We seek a highly motivated and enthusiastic candidate with a strong interest in fundamental biology. A background in environmental biology and/or molecular biology epigenetics and bioinformatics would be desirable. Training will be provided in all experimental and *in silico* techniques required for the project, but some practical experience in these techniques will be an advantage.

**Collaborative Partner:** This project benefits from a multidisciplinary collaboration. The collaborative partner from Marine Biology Association (KH) is a molecular microbiologist studying photosynthetic marine microbes with extensive experience in phytoplankton biology and examining cell biology responses to environmental perturbations. The collaborator from Living Systems Institute (AM) is a marine microbiologist and bioinformatician with significant experience with working with eukaryotic phytoplankton, including *Ostreococcus*. This unique blend of collaborating partners will enrich student experience and offer excellent training opportunities.

**Training:** The student will receive training in all scientific and technical aspects of the proposed research. This include training on growth, maintenance, genetic transformation and analysis of *O. tauri* cultures, conducting temperature response experiments, molecular biology as well as sequencing and bioinformatics techniques. The sequencing experiments will be performed at the University of Exeter’s Sequencing Service, who have extensive experience in high throughput sequencing and data analysis.

In addition to the above project specific elements, the student will receive generic training in Exeter, and discipline-specific training via training events developed by the DTP and by the University.

**References / Background reading list**


For informal discussions on the project please contact Dr. Vinod Kumar (*v.kumar@exeter.ac.uk*)

For further details and to apply online please follow the link:  
[http://www.exeter.ac.uk/studying/funding/award/?id=3667](http://www.exeter.ac.uk/studying/funding/award/?id=3667)

Application closing on 6 January 2020