Fully funded BBSRC DTP Studentship 2023-2027

Molecular principles for the biogenesis and assembly of carboxysomes

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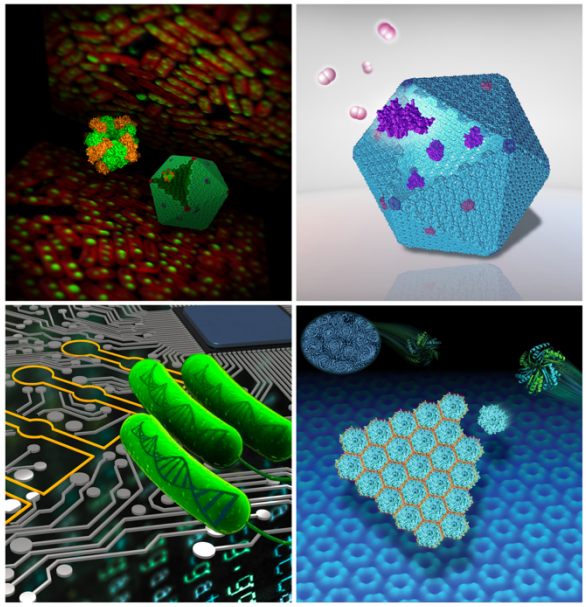
Project background:



Organelles confine specific biochemical pathways within the cell to enhance metabolic efficiency, alleviate metabolic crosstalk, and facilitate spatiotemporal regulation of sequestered pathways. Their naturally-occurring building and functional principles have inspired the synthetic engineering of self-assembling organelles and the redesign of new structures, with the potential for widespread biotechnological and biomedical applications.

The carboxysome is a natural protein-based bacterial organelle for CO_2 fixation in cyanobacteria and proteobacteria [(1)]. It encapsulates the key CO_2-fixing enzymes, Rubisco and carbonic anhydrase, within a semi-permeable protein shell. This elaborate architecture provides elevated CO_2 levels around Rubisco for enhanced carbon fixation, thus playing an important role in the global carbon cycle.

Aims:

Building on our recent research breakthroughs [(2-14)], this PhD project is aimed at deciphering in depth the molecular principles underlying the biosynthesis, assembly, and regulation of carboxysomes, using multidisciplinary techniques in molecular genetics, biochemistry, microscopy, structural biology, and synthetic biology. The study will offer advanced knowledge about how carboxysomes are generated and functionally modulated in cells to fulfil functions and the structural variability of carboxysomes to ensure environmental adaptation. Our long-term goal is to provide the framework for the bioengineering of functional and modifiable metabolic organelles and the development of new nanomaterials for diverse biotechnological applications, with the aim of addressing the grand challenges of climate change, food and energy security, and therapeutics.

Training:

This project builds on a truly multidisciplinary collaboration between the world-leading laboratories at the University of Liverpool and Newcastle University, by combining interdisciplinary skills ranging from microbiology, cell biology, biochemistry, synthetic biology, to super-resolution fluorescence imaging and cryo-electron microscopy. The student will have access to state-of-the-art facilities at the host institutions, including Cell Imaging, Cryo-electron microscopy, Synthetic Biology, Proteomics, Metabolomics, Genomics, and Computational Modelling. The student will spend 3 months and have regular visits in co-supervisors' labs for high-resolution microscopy and data process. These will provide a fantastic and vibrant training environment for the student. Moreover, external collaborations of the host labs in the UK, EU, US, Australia, and Asia will add extra value to the student's training. Collectively, this project will provide the student with extensive training in interdisciplinary techniques, project management, communications, and collaborative networking, which are vital for their research independence, international vision, and career development.

Funding Notes:

The project is intended to start in October 2023. The fully-funded 4-year studentship will be offered to UK/international students whose background and experience most fits the project. The studentship will provide tuition fees and an annual stipend allowance at UKRI rates, currently £17,668 per annum for 2022-23 on a full-time basis, in addition to research and training costs.

Selection Requirements:

We invite applications from highly motivated students in molecular biology, biochemistry, microbiology, biotechnology, or a related subject. The applicants should hold, or be about to obtain, a First or Upper Second class Honours degree, or the equivalent qualification gained outside the UK. As competition is fierce, many of our applicants also hold a Masters-level qualification. The applicants should have a demonstrated ability to work in a laboratory environment.

To apply for the studentship, please send your CV and a cover letter with contact information of two referees to Prof Luning Liu (luning.liu@liverpool.ac.uk). You are encouraged to contact by email to discuss the project details at early as possible. Detailed research activities are available on the lab website: www.luningliu.org.

The deadline for studentship application is **Monday 9th January 2023**.

References

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5. Sun Y*, et al.* (2022) Decoding the absolute stoichiometric composition and structural plasticity of α-carboxysomes. ***mBio*** 13(2):e0362921.
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8. Fang S*, et al.* (2021) Molecular mechanism underlying transport and allosteric inhibition of bicarbonate transporter SbtA. ***Proc Natl Acad Sci U S A*** 118(22):e2101632118.
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11. Huang F*, et al.* (2020) Rubisco accumulation factor 1 (Raf1) plays essential roles in mediating Rubisco assembly and carboxysome biogenesis. ***Proc Natl Acad Sci USA*** 117(29):17418-17428.
12. Sun Y, *et al.* (2019) Single-organelle quantification reveals the stoichiometric and structural variability of carboxysomes dependent on the environment. ***Plant Cell*** 31(7):1648-1664.
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14. Fang Y*, et al.* (2018) Engineering and modulating functional cyanobacterial CO_2-fixing organelles. ***Front Plant Sci*** 9:739.