Year in Industry Proposal for 2027/28

Title of Project	How plants produce photosynthetic proteins: electron microscopy and gene expression
Name of Supervisor	Michael Webster
email	Michael.Webster@jic.ac.uk
Telephone number	01603 452038
weblink	https://www.jic.ac.uk/people/michael-webster

Project on Offer

Plants capture solar energy through photosynthesis; a series of chemical reactions that are fairly well understood. There remains a lot to learn, however, about how the proteins that perform photosynthesis are made – how the genes that encode them are expressed. Fundamental questions, such as how the timing and level of photosynthetic production is controlled at the molecular level, remain unanswered. Given the central role of photosynthesis in plant development and adaptation, understanding the molecular mechanisms that underpin it will aid in developing robust crops for a changing climate[1].

Research in the Webster Group focuses on purifying proteins that perform gene expression and studying their biochemical activity and structural architecture. We recently characterised the chloroplast gene expression machinery[2,3], and the regulatory mechanism of transcription-translation coupling[4]. We are now focusing on how photosynthetic proteins encoded in the chloroplast genome are expressed: a unique and fascinating process that is poorly understood. To visualise this, we determine three-dimensional models of the proteins at near-atomic resolution using cryogenic electron microscopy (cryo-EM).

In this project, you will purify gene expression complexes from chloroplasts isolated from plants. Training in subcellular fractionation, chromatography and protein identification by mass spectrometry will be provided to identify the molecular composition of the sample (months 1-4). Modern bioinformatic tools based on AI, such as AlphaFold, will be employed to generate hypotheses of the role of proteins in gene expression. We will then examine the structural architecture of the complex using electron microscopy techniques: negative stain EM and cryo-EM (months 5-9). This work will be directly supervised by Michael Webster with support from an enthusiastic team of Postdocs and PhD students in the Webster Group. Technical training will be available from experts within the Bioimaging, Proteomics and Structural Biology Platforms of the JIC. You will be part of the vibrant research environment of the JIC Department of Biochemistry and Metabolism and an inclusive and supportive JIC student community.

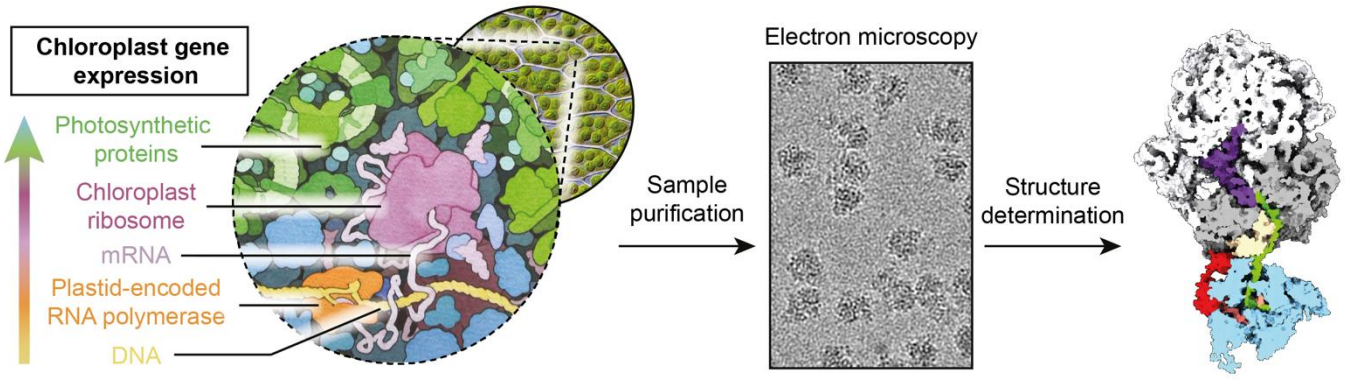

Figure 1: Left: The chloroplast contains genes encoding photosynthetic proteins and a unique molecular machinery (ribosome and RNAP polymerase) that expresses them. Right: Our research involves the isolation and characterisation of these complexes using electron microscopy.

References

1. Zhang *et al.* (2020) The Role of Chloroplast Gene Expression in Plant Responses to Environmental Stress. IJMS 21:6082. PMID: 32846932. DOI: 10.3390/ijms21176082
2. Conservation and evolution of the ribosome across the photosynthetic lineage. Pearce *et al.* (2026). BioRxiv. DOI:10.64898/2026.07.03.736309
3. Structure of the plant plastid-encoded RNA polymerase. Vergara-Cruces *et al.* (2024). Cell 187:1145-1159. PMID: 38428394. DOI: 10.1016/j.cell.2024.01.036
4. Webster *et al.* (2020) Structural basis of transcription-translation coupling and collision in bacteria. Science 369:1355-1359. PMID: 32820062. DOI: 10.1126/science.abb5036

PERSON PROFILE *2 bullets max per box*	**Essential**	**Desirable**
Education *e.g. degree subject*	A level or equivalent qualification in a scientific subject.	
Specialist knowledge and skills *e.g. course module*	• An interest in learning how purified biological molecules can be structurally and biochemically characterised. • Familiarity with genes and how they make proteins	An understanding of how genes encode proteins, and an appreciation of the atomic structure of biological molecules.
Relevant experience *e.g. lab/research work*	Experience in interpreting experimental data, critically evaluating data, presenting findings through text and figures.	Experience with laboratory techniques (pipetting, preparing chemical solutions etc.)
Interpersonal and communication skills *e.g. teamwork and record-keeping*	A strong capacity to work with other team members, learn new methods and keep detailed notes	
Additional requirements *e.g. outdoor working*		