Open position for the LSM call of applications

Department/Institute: LMU Faculty of Biology, Plant Sciences

Subject areas/Research fields: Botany, Biochemistry, Molecular Biology

Keywords: Chloroplast, Photosynthesis, Protein Biochemistry, Genomics, Imaging

Name of supervisor: Prof. Dr. Hans-Henning Kunz

Project title: Linking plastid ion transport and functionality

Project description:

All cellular organisms tightly control their inner pH and ion composition to ensure proper function of vital biochemical reactions. In eukaryotes this includes several distinct sub-cellular compartments, adding further complexity to the system. Internal homeostasis is maintained via transport proteins embedded in the organellar membranes. Our group researches the chloroplast, an organelle of endosymbiotic origin and the site of eukaryotic photosynthesis.

In the model plant Arabidopsis thaliana, we have shown that the loss of two inner envelope (IE) membrane homologous K+/H+ antiporters (AtKEA1 and AtKEA2) affects organelle biogenesis and photosynthetic performance. Our recent studies suggest defects in rRNA maturation and plastid gene expression (PGE) as the main cause for the developmental effects but the mechanistic link between the function of plastid ion transporters and the intricate gene expression machinery in the stroma remains unclear.
It is possible that the lack of AtKEA1/2 in the plastid indirectly affects nucleic acid processing and maintenance due to global effects of aberrant ion composition and stromal pH. However, IE AtKEA proteins were shown to adopt a polar distribution in young dividing or developing plastids. Interestingly, in mature organelles the protein localization seems to change again but remains limited to distinct patches within the IE. Both pattern hint at a more direct role for IE KEAs in biogenesis centers or cell/organelle cycle control. Within these microdomain-like spots, the antiporters may tightly regulate local pH and ion concentrations necessary for proper membrane formation and organization. Intriguingly, envelope-localized KEA carriers exhibit a large N-terminal stromal loop, which is required for the specific localization pattern. Additionally, the loop could enable IE KEA proteins to directly interact with nucleoid acids and/or other critical components of PGE.
To address these questions, we have escaped the complexity of multicellular plants and instead employed a more conducive model, the unicellular green algae Chlamydomonas reinhardtii. Here, a well-established genetic tool box allows the generation of knock-down/out lines and functional tagging of proteins of interest, while our analytical methods established for plants remain applicable. Chlamydomonas possess a haploid genome with less genetic redundancy than diploid plants. Each cell contains only one single plastid. Different from Arabidopsis, plastome transformation is relatively easy which will allow us to generate plastid expression / translation reporter lines and genetically plastome encoded ion/pH biosensors. The cell-cycle of Chlamydomonas cultures can be synchronized and chloroplast/cell division of individuals can be closely monitored by single cell live imaging. Photosynthetic performance of single algae cells will be probed by microscopy Pulse Amplitude Modulation (PAM). Elemental composition of genotypes will be analyzed by Total Reflection X-ray Fluorescence Spectroscopy (TXRF). In parallel, we aim on dissecting protein function by obtaining biochemical and structural information from in-vitro approaches. The homolog of KEA1/2 in

Chlamydomonas will be the starting point for our study before focusing on the functional characterization of other plastid localized carriers.

We seek to train a highly motivated PhD student on this project. The ideal candidate would have basic experience in plant and/or algae molecular biology and a solid background in biochemistry and cell biology.

References:

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