Ph.D. projects in progress

1.

Mentor: Szilvia Zita Tóth

Doctoral School: University of Szeged, Faculty of Science and Informatics, Doctoral School of Biology

Ph.D. Student: Anna Podmaniczki

Title of the research topic: Hydrogen production of the green alga Chlamydomonas reinhardtii by sulfur deprivation and anaerobic treatment

Description of the research topic: During photosynthesis, organic compounds are produced from CO_2 and water and as a by-product, O_2 is evolved. Certain green algae are capable of producing H_2 during photosynthesis with the aid of their hydrogenase enzymes. H_2 production may be used as a renewable energy source; however, commercial applicability is hindered by the extreme O_2 sensitivity of the hydrogenase enzyme. This can be partially solved by sulphur deprivation, resulting in decreased O_2 evolving activity and induction of hydrogenase expression; this method has the drawbacks that the photosynthetic apparatus is degraded within a few days and that the process is strongly dependent on organic carbon sources.

We have developed an alternative protocol, which consists of incubating the algae in O_2-free atmosphere in darkness for a few hours and exposing them to light in the absence of CO_2 or other carbon sources for several days. Under these conditions, CO_2 fixation cannot occur, thus the electrons originating from photosynthetic electron transport are used for H_2 production. Our method is very simple, highly efficient and sustainable.

2.

Mentor: Szilvia Zita Tóth

Doctoral School: University of Szeged, Faculty of Science and Informatics, Doctoral School of Biology

Ph.D. Student: Dávid Tóth

Title of the research topic: Identification and characterization of phosphate transporters in the green alga Chlamydomonas reinhardtii

Description of the research topic: Phosphorus is essential for many fundamental processes that sustain life, including energy metabolism, redox reactions, nucleic acid synthesis, membrane synthesis, signaling, and post-translational modification of proteins. The major form of phosphorus readily assimilated and utilized by most organisms is the phosphate anion.

We investigate an as of yet uncharacterized phosphate transporter of Chlamydomonas reinhardtii. This transporter belongs to the family of inorganic phosphate transporters, among which many are described in seed plants, but none in green algae. In order to study the phosphate transporter in detail, the CRISPR/Cpf1 genome editing technique is used to generate knockout lines and their growth phenotype, photosynthetic parameters and high light sensitivity are studied. The connection between the mutant phenotype and the absence of the phosphate transporter is confirmed by genetic complementation.

The substrate specificity of the phosphate transporter is investigated in the yeast mutant EY917 that lacks all phosphate transporters. The cellular localization of the phosphate transporter will be revealed via immunolocalisation.

3.

Mentor: Szilvia Zita Tóth

Doctoral School: University of Szeged, Faculty of Science and Informatics, Doctoral School of Biology

Ph.D. student: Eszter Széles

Title of the research topic: Development of microfluidic chambers for morphological and photosynthetic investigations of green algae

Description of the research topic: Life on Earth is essentially based on the conversion of sunlight into energy through photosynthesis. In plants and green algae, the conversion of light energy to chemical energy, together with the reactions of the electron transport chain and the creation of a proton gradient, takes place within the chloroplast, in the thylakoid membrane.

Green algae are of outstanding ecological importance and appropriate model organisms for studying different cellular processes and have an increasing importance in biotechnology. In order to better understand their life cycle processes, we aim at establishing single-cell analysis for the green alga species *Chlamydomonas reinhardtii*. Our approach is based on microfluidics, which allows the trapping of a small number or unique algae cells for several days, during which morphological examinations can be performed by microscopy. We combined this with chlorophyll-a fluorescence measurements, which provide valuable information on photosynthetic activity.