Ph.D. projects in progress

1.

Mentor: Petar Lambrev H.

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

Ph.D. Student: Mónika Lingvay (Molnárné)

Title of the research topic: Mechanisms of photodamage and protection in photosynthetic light-harvesting complexes

Description of the research topic: Light is the fundamental source of energy for life, captured through the process of photosynthesis, but is at the same time hazardous radiation especially in oxygen-rich atmosphere. All oxygenic photosynthetic organisms have evolved multiple mechanisms to avoid the harmful effects of light, which often involve the formation of reactive oxygen species. Chlorophyll-protein light-harvesting complexes, for example, are rich in carotenoids that can quench the triplet states of chlorophyll to prevent the sensitization of singlet oxygen. Nevertheless, prolonged irradiation of isolated complexes results in bleaching of the pigments and ultimately photodegradation. We study the kinetics and mechanisms of pigment photodegradation in different molecular environments, such as reconstituted lipid-protein membranes, using a variety of spectroscopic tools, including absorption, circular dichroism, fluorescence and electron paramagnetic resonance. This will let us understand the role of direct antenna damage in photoinhibition but also help to produce more stable and robust in vitro model systems and biohybrid solar devices.

2.

Mentor: Bettina Ughy

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

Ph.D. student: Sai Divya Kanna

Title of the research topic: Environmental adaptation of microalgae

Description of the research topic: Microalgae are in the focus of basic and applied research due to their importance in biotechnological applications. Growth and productivity of photosynthetic organisms are significantly affected by their growth conditions. Acclimation to environmental conditions is pivotal for plants and algae; indeed, they mobilize various strategies when exposed to stress. Photosynthesis is very sensitive to changes in the environmental conditions because it needs to balance the absorbed light energy with the energy consumed by metabolic processes of the

organisms. Accumulation of certain components and changes in the membrane composition can play important role in environmental adaptation. We are to investigate the photosynthetic performance and the changes in the membrane composition of various microalga strains under different conditions in order to better understand the adaptation mechanisms and the relations between the environmental effects and the membrane composition and the regulation of cell division.

3.

Mentor: Petar Lambrev H.

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

Ph.D. student: Avratanu Biswas

Title of the research topic: Excitation energy transfer and trapping in cyanobacteria

Description of the research topic: Cyanobacteria are the earliest known photosynthetic organisms that enriched the Earth's atmosphere with oxygen; yet they are widespread throughout aquatic habitats today and have increasing economic importance. Cyanobacteria capture sunlight using phycobilin pigments, organized in phycobilisomes - large membrane-peripheral antenna complexes, delivering excitation energy to the photosystems. Our research is focused on understanding the pathways and dynamics of energy migration through the phycobilisomes and to photosystem I and II using a combination of biochemical and spectroscopic approaches such as picosecond time-resolved fluorescence. This knowledge could help in optimizing bioengineered cyanobacteria for production of biofuels or valuable substances and even open possibilities for enhancing the energy conversion efficiency of plants and plant-based biomaterials.

4.

Mentor: Bettina Ughy

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

Ph.D. student: Kinga Ilona Böde

Title of the research topic: Control of cyanobacterial cell division

Description of the research topic: The cell proliferation is one of the most fundamental processes of all organisms. Cell division in bacteria is initiated by a ring-like protein structure at midcell. The timing and positioning of the formation of the so-called Z-ring is crucial for cell divisions. Living organisms often have to confront with changing environment and they should adapt to different stress conditions. Bacterial cell morphology and division mechanism may change in response to environmental cues. The question is how the cell division factors control the division process in cyanobacteria, ancestors of plant plastids, under different environmental conditions. It is not known in detail how the lipid composition of membranes affects the division process and the function and interactions of proteins involved in this process. It is also unclear how different environmental and stress conditions influence the cell division processes and how the participating proteins mediate cell division in cyanobacteria under different conditions. To this end, we are to investigate the cell fission and the role of cell division proteins in cyanobacteria under various conditions using molecular biological biophysical and biochemical techniques.

5.

Mentor: Bettina Ughy

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

Ph.D. student: Sarolta Nagyapáti

Title of the research topic: Control of cyanobacterial cell division

Description of the research topic: The cell proliferation is one of the most fundamental processes of all organisms. Cell division in bacteria is initiated by a ring-like protein structure at midcell. The timing and positioning of the formation of the so-called Z-ring is crucial for cell divisions. Living organisms often have to confront with changing environment and they should adapt to different stress conditions. Bacterial cell morphology and division mechanism may change in response to environmental cues. The question is how the cell division factors control the division process in cyanobacteria, ancestors of plant plastids, under different environmental conditions. It is not known in detail how the lipid composition of membranes affects the division process and the function and interactions of proteins involved in this process. It is also unclear how different environmental and stress conditions influence the cell division processes and how the participating proteins mediate cell division in cyanobacteria under different conditions. To this end, we are to investigate the cell fission and the role of cell division proteins in cyanobacteria under various conditions using molecular biological biophysical and biochemical techniques.

6.

Mentor: Győző Garab

Doctoral School: Department of Physics, Faculty of Science, University of Ostrava

Ph.D. student: Ondrej Dlouhy

Title of the research topic: Structural and functional plasticity of thylakoid membranes. Role of lipid polymorphism

Description of the research topic: In oxygenic photosynthetic organisms the light reactions of photosynthesis occur in the thylakoid membranes, flattened lipid vesicles, which contain virtually all components that carry out the light reactions of photosynthesis. The operation of the photosynthetic electron (and proton) transport system leads to the evolution of molecular oxygen, the synthesis NADPH, and generates an electrochemical potential gradient for protons ($\Delta\mu_{H^+}$), which is utilized for the synthesis of ATP. The utilization of $\Delta\mu_{H^+}$, and thus the synthesis of ATP requires the organization of the thylakoid membrane as a bilayer, which is impermeable to water and water-soluble molecules and to ions. For this reason, the functional state of all energy-converting biological membranes is the bilayer. Nevertheless, the major lipid species in thylakoid membranes, similar to all energy-converting membranes, are non-bilayer lipids. We have earlier shown the co-existence of non-bilayer lipid phases with the bilayer in fully functional isolated plant thylakoid membranes. The major aim of the PhD studies is to identify the structural entities containing these non-bilayer phases and shed light on the physiological roles of the lipid polymorphism of thylakoid membranes, with special attention to their structural and functional plasticity. To this end, the PhD student will use a large variety of biophysical, biochemical and physiological techniques on wild type and mutant plant thylakoid membranes and subchlroplast particles as well as on different lipid:protein macroassemblies.