

Open Ph.D. projects

1.

Announcer: Tibor Páli

Doctoral School: University of Szeged, Doctoral School of Multidisciplinary Medicine

Title of the research topic: The biophysics of a universal bio-nano-engine, the vacuolar proton-ATPase

Description of the research topic: The internal compartments of eukaryotic cells are more acidic than the cytoplasm. The transport protein complex that is responsible for the acidification is nature's most universal proton pump, the vacuolar proton-ATPase (V-ATPase). It is a membrane-bound molecular rotary engine, which converts the chemical energy from ATP hydrolysis to the rotation of the rotor domain via a torque between specific subunits. This leads to trans-membrane proton pumping in the interface between the stator and rotor domains. Our studies on V-ATPase aim at subunit-subunit and subunit-lipid interactions, the effect of synthetic inhibitors on function and subunit assembly, the uncoupling of passive proton translocation and ATP hydrolysis, and the details of the rotary mechanism.

2.

Announcer: Tibor Páli

Doctoral School: University of Szeged, Doctoral School of Multidisciplinary Medicine

Title of the research topic: Protein insertion, folding and assembly in biomembranes and on membrane surfaces

Description of the research topic: Membrane protein folding is a most challenging problem in biophysics today because membrane lipids and proteins are coupled structurally, dynamically and functionally. The protein-lipid interface takes several different forms, all of which are crucial to biology. Studies on the structure, dynamics and function of both membrane proteins and lipids are essential for understanding membrane protein folding. Activity measurements on purified membrane proteins require that they are inserted and assembled in the bilayer properly. Our objective is to obtain various spectroscopic and calorimetric data on factors controlling insertion, folding and assembly of selected proteins and polypeptides in membranes and on membrane surfaces. These data are then used as constraints in molecular and physical models.

3.

Announcer: Tibor Páli

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

Title of the research topic: Biophysics of biological and model membranes: a spectroscopic view

Description of the research topic: The lipids assure the insulation capacity of the membranes, and their hydrophilic-hydrophobic-hydrophilic structure provides the proper conditions for the membrane proteins. Therefore, the role of the lipid-protein interface is crucial in all biomembrane functions, and isolated membrane proteins are very difficult to study. We use both non-invasive and labelling techniques (in part developed by us) for studying the lipid-protein, or, more generally, the solvent-protein interfaces.

4.

Announcer: Tibor Páli

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

Title of the research topic: Structure prediction of membrane proteins using machine learning and molecular mechanics

Description of the research topic: Structural biology of membrane proteins faces the challenges of isolating, solubilising and crystallising proteins (that are natively hosted by the lipid matrix) in a foreign environment. In addition, there is always the intriguing question: to what extent the obtained structures and features of isolated membrane proteins correlate with those under native, in-membrane conditions. Theoretical approaches have therefore enormous importance. Since the native fold of a membrane protein assumes a native environment, namely the lipid bilayer, the sequence-to-fold coding is valid only in the native membranous environment. In this project, the structural code in the sequence is analysed using neuronal network type machine learning, and the obtained structural information is combined with experimental data in our structure prediction algorithm.

5.

Announcer: Tibor Páli

Doctoral School: University of Szeged, Doctoral School of Multidisciplinary Medicine

Title of the research topic: Free radicals and free radical reactions in biological samples and food products

Description of the research topic: Since EPR spectroscopy is the most reliable and most established technique for detecting free radicals, we are involved in several collaborative projects aiming at detecting free radicals (such as singlet oxygen, nitric oxide) in biological samples. In addition, we are routinely measuring non-specific and cellulose based radicals in food products, such as paprika and milk powder, dried onion and, currently, milled coffee. In these experiments we detect free radicals both directly (spin-trapping) and indirectly (oxidation of spin labels).