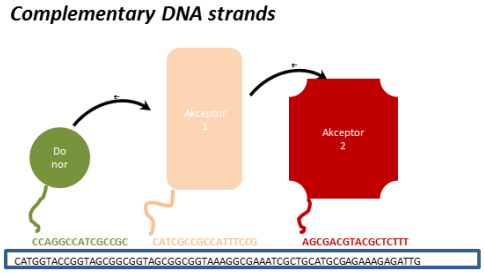
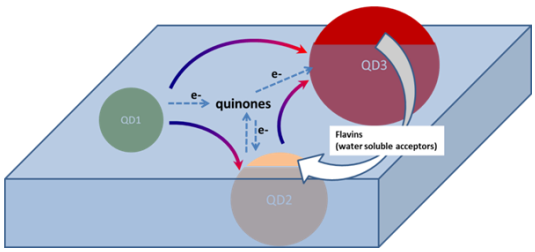
DESCRIPTION FOR THE GENERAL PUBLIC

One of big questions of Science today – and actually, ever before - is if we can really influence Nature in controlled way. Here, we are focusing on one of important possibility of such control – influencing energy transfer, and by this, the homeostasis of the system, by illumination of exogenously introduced, man-made nanomaterials. We are asking if such structures, if known to donate energy to biological acceptors, will have any specificity towards its donors or acceptors in systems more complicated than simple mixture in a laboratory tube, containing only those two individuals.

In our research, we will use elements of natural electron transfer chains (ETC) combined with nanomaterials into chains and nets. There are two very important and, at the same time, widespread ETCs – in photosynthetic and in mitochondrial membranes. The photosynthetic ETC is the basis of life on Earth, providing the only way to naturally harvest solar energy and convert it into chemical ones. ETCs of cyanobacteria and higher plants is also responsible for oxygen evolution, necessary for most organism to survive. This ETC consists of pigment-protein complexes responsible for light absorption, then the act of charge separation converting photon energy into energy of electron, pushed through following chain of redox centers. In mitochondrial ETC, there is no light act, but electrons are also transferred by chain of redox centers, to molecular oxygen, and water molecule is formed. The complexes of ECTs may be isolated as active *in vitro*, what we are going to use. There are also *de novo* designed proteins, working as models of natural ETCs elements. There are families of heme-binding proteins, varying by redox potential, iron-sulfur cluster assembling proteins, and those with heme and iron-sulfur cluster together. These proteins may be expressed in *E.coli* and included in our constructed systems. The indispensable elements of our testing systems will be nanomaterials. One of them, known for their size-tunable, high-yielded fluorescence, are colloidal quantum dots (QDs). QDs were already proven to donate electrons to some of ETC's small proteins. Among nanostructures, there are also non-luminescent ones, which may enhance light absorption by plasmon effect. Although there is growing data about interaction between particular nanostructure's type and particular type of natural ETCs elements, there is, to our best knowledge, no research on combining nanomaterials in chains and nets of ETC, both natural or "in laboratory cuvette". We are going to construct such combination using several approaches. It will include controlled binding by complementary oligonucleotides, assembly with help of lipid vesicles, sequential depositions of molecular monolayers on solid substrates and other (see examples below).





With such systems in hands and several state-of art techniques for their characterization, we are going to learn if after illumination, an electron from excited nanostructures will jump randomly to what is available, with distance as only meaning factor, or this electron will prefer particular type of acceptor (s) upon others. We will also learn is non-spherical nanostructures will help with energy transfer directing. Finally, we will also find how molecular crowding (bulk material around active systems) influence rate of energy transfer. Direct results of our research will be determined rates of energy transfer in constructed testing systems and, if applicable, constants characterizing complex formation between system elements. Such knowledge, however, is most demanded to frame significant part of guideline for rational exogenous controlling of cellular processes.