RED LIGHT –

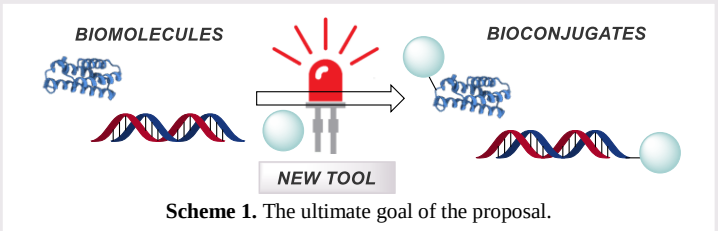
A TOOL FOR ORGANIC SYNTHESIS AND BIOORTHOGONAL CHEMISTRY

The diversity and complexity of Nature have always been an inspiration fueling human progress. Over centuries sunlight and its significance remained one of the greatest mysteries in the surrounding world that mankind has ever come across. We have discovered that solar radiation plays an essential role in natural processes including photosynthesis – the underpinning of the world of flora. This external stimuli has contribution even to human body regulation by catalyzing previtamin D_3 synthesis or affecting melatonin production. These findings triggered the development of photochemistry as a distinct research area, the essence of which are light-induced processes. Currently, taking advantage of photons' energy as a driving force for chemical transformations is a rapidly growing branch of organic synthesis, which often provides unexpected chemistries and complex structures including precious natural or pharmacologically active compounds.

Admiring the masterpieces of Nature, scientists recognized chemistry and biology as co-existing and complementary sciences. They wondered whether it is possible to perform reactions not only in glassware but also in living organisms. The ever-growing desire to understand biological processes gave birth to a new biochemical strategy – bioorthogonal chemistry referring to chemical transformations that can proceed in living systems without interfering with the surrounding biological environment. Up until now, this perfectly designed approach has enabled specific labeling and conjugation of a wide range of biomolecules inside organisms. Only recently, spatiotemporal control of biomacromolecules could be achieved with photo-modulation of biological systems. The merge between these two fields led to photo-controllable bioorthogonal chemistry. **This new perspective, though appealing for biologists, represents a challenge for chemists as it requires the development of reactions that would not perturb the structure and activity of delicate biomolecules.**

Performing designed reactions under physiological conditions is not the only difficulty to overcome. The vast majority of photochemical reactions are induced either by UV or high-energy visible light irradiation. Low-energy light is, however, more compatible with biological systems and allows for penetration of deeper tissues. T**herefore the application of red or even infra-red light is more attractive to induce bioorthogonal reactions**. Though **available, such transformations, even in the chemistry toolbox, are considerably limited** and **biological photolabeling with red light has yet to be developed.**

Hence, **the goal of this proposal is to develop a diverse set of new chemical reactions driven by red light with the ultimate goal of using them for photo-controllable bioorthogonal chemistry (Scheme 1)**.



Scheme 1. The ultimate goal of the proposal.

Our preliminary experiments showed that it is possible to form new C-C and C-N bonds under red light irradiation. Basing on our extensive experience in photocatalysis, we selected porphirynoids to the role of catalysts in these transformations. In successive stages of the project, we will test the compatibility of the developed reactions in functionalizations of the biologically active compounds in the physiological environment. **We firmly believe that our research will open whole new perspectives in photocatalysis and the future will result in the development of biology and medicine.**