DESCRIPTION FOR THE GENERAL PUBLIC

Scientists in their endeavors are often inspired by nature. The structure, organization and processes found in living organisms seem to be almost perfect. There is nothing strange about it, since all of this has evolved for hundreds of millions of years.

One of the processes, that fascinates scientists for a long time, is enzyme catalysis. Despite many efforts we still do not know how to create catalysts as specific and effective as enzymes. The regulation of catalytic activity is another peculiar, yet unattainable feature of enzymes. The enzymes are able to slow down the chemical reactions or accelerate them, depending on the current metabolic needs. This is due to effectors, small molecules present in the cell, which bind to the enzyme changing its spatial arrangement and thus the catalytic activity. Such a regulation is called the allosteric regulation.

The similar regulation we would like to perform in our lab using simple enzyme models. But here comes the problem. In nature, the enzyme activity is self-regulated as the effectors are typically metabolites. However, in the synthetic system, the regulation of catalytic activity would require continuous supply and removal of the effector from the reaction mixture. The latter is unlikely, unless the effector will be processed during the reaction. This approach, however, will lead to an accumulation of chemical waste due to the lack of mechanisms for the excretion. In this situation, the only possible solution is a remote control. The light in this regard is an ideal regulator because it interacts with matter at long distances with high precision. Furthermore, some molecules, called photoswitches, can change its spatial structure, i.e. conformation, in a reversible manner when exposed to light. If such photoswitch is connected to the substrate, we will be able to translate the light-induced conformational changes on the substrate, and then, upon binding to the entire catalytic system. Conformational changes should affect the catalytic activity. In nature, such a regulation, that is, if the substrate serves also as the effector, is called the homotropic regulation. In contrast, if the photoswitch is used alone or in conjunction with the colloidal particle so-called heterotopic regulation could be expected. In both approaches, the catalytic activity will be determined by the accessibility of the active site of the catalyst. The activity will be decreased, if the site is blocked by effector, and increased, if the site is unblocked. In the future, we will be able in this way to perform not only a single reaction, but many reactions at a time, controlling their sequence, selectivity or even regulate other vital functions such as movement, transmission or amplification.