Most of the enzymes, i.e., proteins that perform reactions, used in biotechnological processing of compounds do not exhibit stereoselectivity or regioselectivity, that is, they will process all functional groups in molecules that are able to access the active site. However, through evolution, some enzymes have been modified to process only selected optical isomers or selected functional groups in compounds containing several such groups.

Nitrile hydratase (NHase) is an enzyme that has been successfully used in the mass-scale production of useful amides (more than 600,000 tons per year) that are widely applied as soil improvers, feed additives (nicotinamide), an ingredient in contact lenses or even in the manufacture of clothing (polyacrylamide). Amides are formed by the hydratation process (addition of a water molecule) to toxic nitriles (Figure 1).

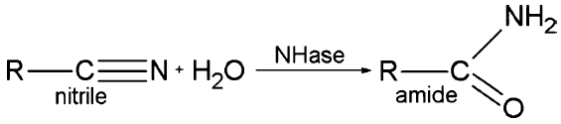

Fig. 1. Hydratation of nitriles to amides.

This project aims to explore the possibility of modifying NHase in such a way that instead of catalyzing all the nitrile groups that can reach the catalytic center, the enzyme will catalyze one or two nitrile groups in compounds that exhibit the interesting property of changing shape depending on whether they are illuminated with green or blue light (Fig. 2). Compounds that change conformation under light are called azobenzenes.

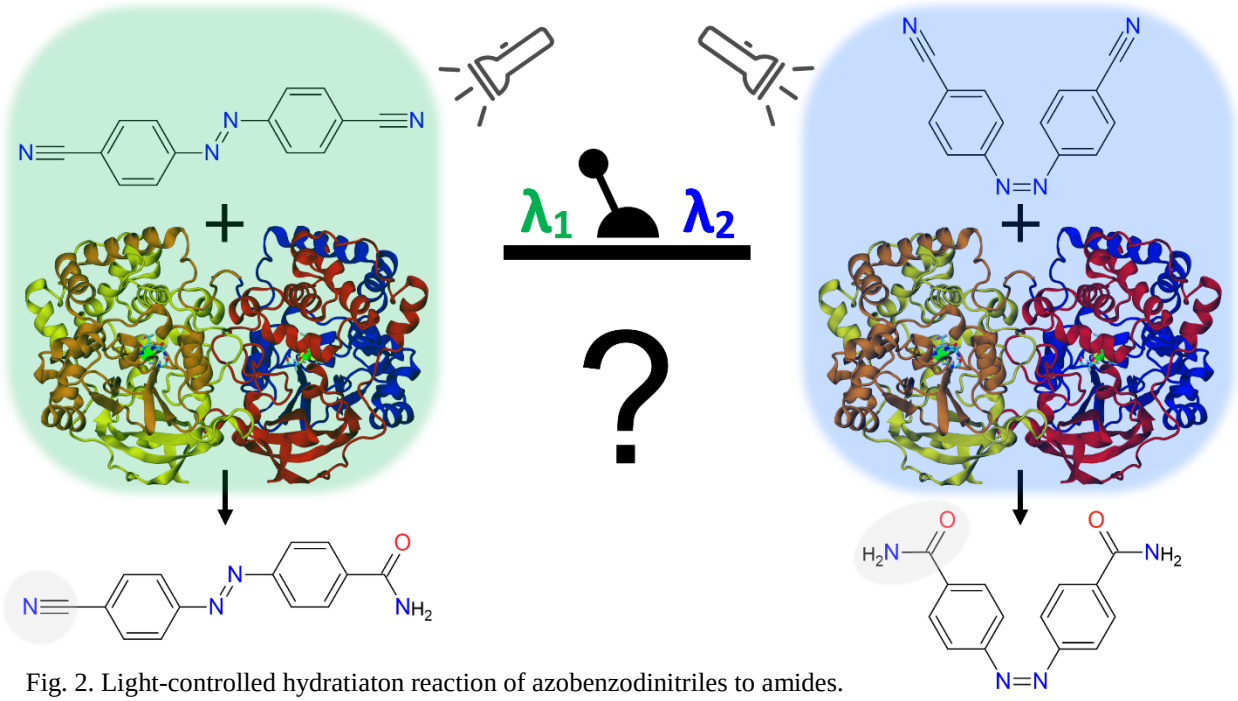

Fig. 2. Light-controlled hydratiaton reaction of azobenzodinitriles to amides. The hypothesis is that it will be possible to obtain a different reaction product only depending on lighting conditions.

Azobenzenes can be used as potential light-activated drugs. Recently, researchers showed that applying a drug containing azobenzene in its structure to mice with type II diabetes lowered blood sugar levels only after illuminating the pancreas with UV light. Another potential application of azobenzenes is to use them as photosensitive carriers for traditional drugs, which will be released after illumination only in selected areas of the body, such as cancerous tissue. Azobenzenes have applications in optoelectronics as optical materials and detectors, and in nanotechnology to induce light-induced motion.

Unfortunately, we are currently unable to synthesize many azobenzenes. It is also impossible to selectively catalyze one functional group in dinitriles using chemical technology. This project aims to address these gaps by using biotechnological processing of azobenzodinitriles, where different products can be obtained just by changing the color of falling light on the bioreactor. To date, no one has used light to control the enzymatic process.