Discovery of the redox-switch of a key enzyme involved in n-butanol biosynthesis

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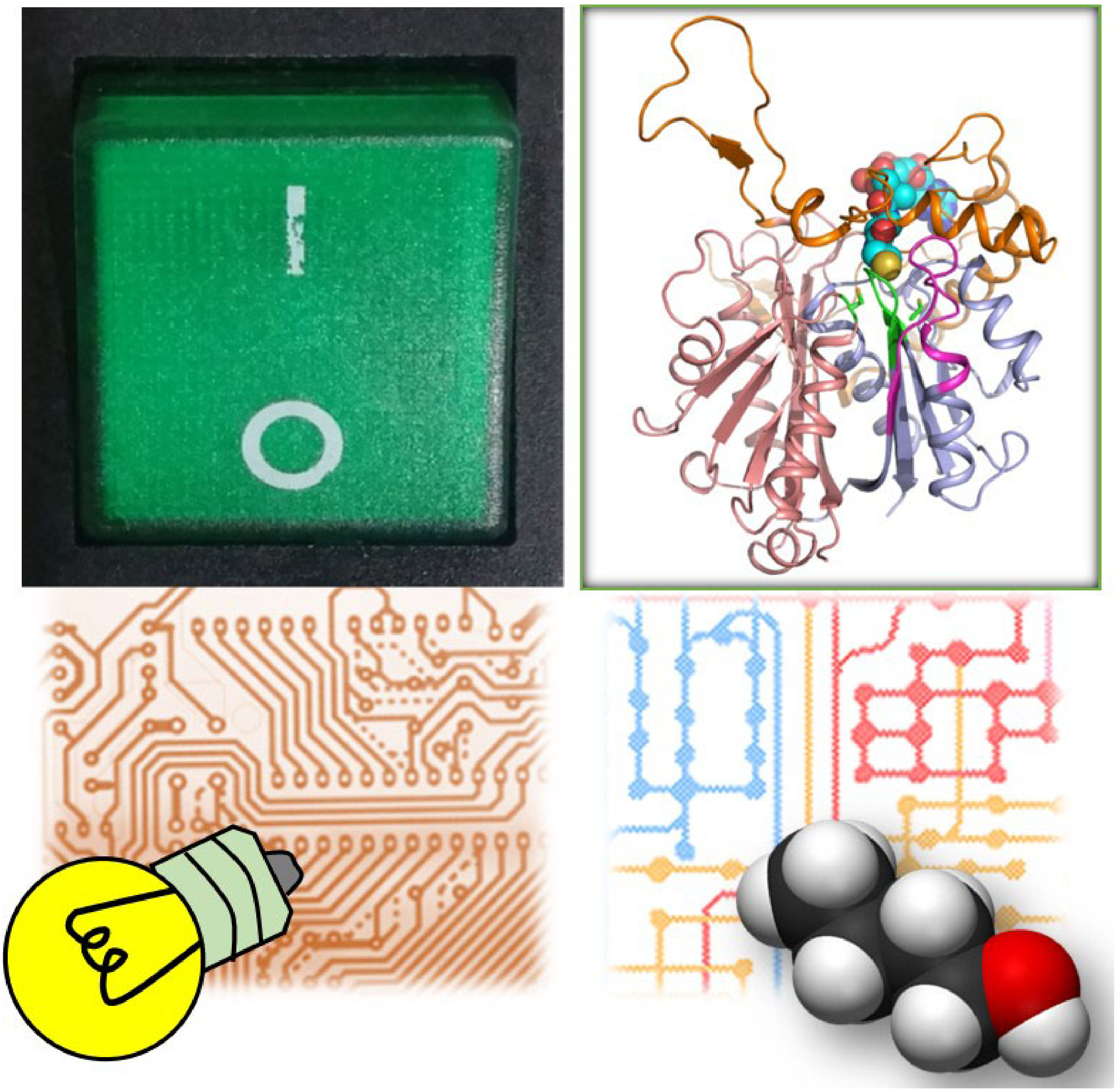

A redox-switch of thiolase involves in butanol biosynthesis in *Clostridium acetobutylicum*. Thiolase condenses two acetyl-CoA molecules for initiating four carbon flux towards butanol. Credit: KAIST

Two Korean research teams at the Kyungpook National University (KNU) and the Korea Advanced Institute of Science and Technology (KAIST) have succeeded in uncovering the redox-switch of thiolase, a key enzyme for n-butanol production in *Clostridium acetobutylicum*, one of the best known butanol-producing bacteria.

Biological n-butanol production was first reported by Louis Pasteur in 1861, and the bioprocess was industrialized using *Clostridium acetobutylicum*. The fermentation process by *Clostridium* strains has been known to be the most efficient one for n-butanol production. Due to growing world-wide issues such as energy security and climate change, the biological production of n-butanol has been receiving much renewed interest. This is because n-butanol possesses much better fuel characteristics compared to ethanol, such as higher energy content (29.2 MJ/L vs 19.6 MJ/L), less corrosiveness, less hygroscopy, and the ease with which it can be blended with gasoline and diesel.

In the paper published in *Nature Communications*, a broad-scope, online-only, and open access journal issued by the Nature Publishing Group (NPG), on September 22, 2015, Professor Kyung-Jin Kim at the School of Life Sciences, KNU, and Distinguished Professor Sang Yup Lee at the Department of Chemical and Biomolecular Engineering, KAIST, have proved that the redox-switch of thiolase plays a role in a regulation of metabolic flux in C. acetobutylicum by using in silico modeling and simulation tools.

The research team has redesigned thiolase with enhanced activity on the basis of the 3D structure of the wild-type enzyme. To reinforce a metabolic flux toward butanol production, the metabolic network of *C. acetobutylicum* strain was engineered with the redesigned enzyme. The combination of the discovery of 3D enzyme structure and systems metabolic engineering approaches resulted in increased n-butanol production in *C. acetobutylicum*, which allows the production of this important industrial chemical to be cost competitive.

Professors Kim and Lee said: "We have reported the 3D structure of C. acetobutylicum thiolase-a key enzyme involved in n-butanol biosynthesis, for the first time. Further study will be done to produce butanol more economically on the basis of the 3D structure of C. acetobutylicum thiolase."

More information: Kim et al. "Redox-switch regulatory mechanism of thiolase from Clostridium acetobutylicum," *Nature Communications* (2015)

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