

Abstract

## **Bioportide mediated transformation in cyanobacteria**

Sofia Doello, Janette Alford, Soumila Mondal, Jörg Scholl, and Karl Forchhammer  
Dept. of Microbiology/ Organismic Interactions, University of Tübingen

Cyanobacteria are prokaryotic, Gram negative, photosynthetic microorganisms that hold immense potential for biotechnological applications, including biofuel production, carbon capture, and the synthesis of various secondary metabolites that has pharmaceutical and industrial values. Thus, they are often genetically modified/engineered for the mass production of sustainable energy sources (ethanol, butanol and hydrogen); to synthesize a variety of high value products that includes pharmaceuticals, bioplastics, pigments, and nutraceuticals which offers sustainable alternatives to chemical synthesis and also for the degrade environmental pollutants or capture excess carbon dioxide, aiding in efforts to combat climate change and clean contaminated environments. However, till date, the efficient transformation of cyanobacteria is still a significant challenge. This limitation is primarily due to the thick cell walls and complex regulatory mechanisms that hinder the uptake and expression of exogenous genes. Improving transformation techniques is crucial for advancing cyanobacterial research and unlocking their full potential in sustainable biotechnology. Enhanced transformation efficiency could accelerate the development of genetically modified cyanobacteria strains with optimized traits, such as increased photosynthetic efficiency, enhanced stress tolerance, and/or higher yields of various secondary metabolites. Moreover, advancements in transformation methods would facilitate more precise genetic manipulations, enabling scientists to explore gene functions and regulatory networks with greater accuracy. This would not only deepen our understanding of cyanobacterial biology but also pave the way for innovative solutions to global challenges such as climate change and energy scarcity. Therefore, the improvement of cyanobacteria transformation is a critical step toward harnessing their full potential in various industrial and environmental applications. Till date, cyanobacteria are transformed by a variety of techniques, including as electroporation, tri-parental conjugation, and natural transformation. These techniques are frequently laborious, inefficient, and not suitable for all cyanobacteria; for instance, natural transformation can only be carried out by naturally competent cells, such as *Synechococcus* and *Synechocystis*. Therefore, we are using Bioportide, a transmembrane protein that binds to the target gene and transfers it across the cell membrane, to induce more successful transformation in a variety of cyanobacteria species.