Artificial metallo-proteins for photocatalytic water splitting: stability and activity in artificial photosynthesis

Opdam, L.V.

STELLINGEN

1. Semi-native gel electrophoresis is the most effective and efficient method to probe interactions between a metal complex and protein scaffold. (Chapter 2)
2. CB5:CoSalen 1:5, one of the first active artificial water oxidation proteins working under photocatalytic conditions, shows that design of a photoactivated artificial water oxidation protein is challenging but possible. (Chapter 3)
3. The haem acquisition system Ap is an excellent protein scaffold capable of supporting both hydrogen evolution catalysts and photosensitizers. (Chapter 4)
4. Promoting fast electron transfer along the desired photocatalytic path is key for artificial photosynthesis, but preventing unwanted reactions is just as important. (Chapter 5)
5. In the design of an artificial redox protein, rate and stability are inseparably linked, and one cannot be optimized truly without the other. (Noy, *et al., BBA-Bioenergetics* **2006**, 1757 (2), 90-105; Gray and Winkler, *Chem. Sci*. **2021**, 12 (42), 13988-14003)
6. Artificial metalloproteins combine the strengths of protein chemistry, *i.e. high* selectivities and the ability to operate under mild aqueous conditions, with the broad applicability of synthetic catalysis, making them a great tool for catalyzing challenging reactions such as water oxidation in an efficient and environmentally friendly manner. (Steinreiber *et al., Coordination Chemistry Reviews* **2008**, 252 (5-7), 751-766, this thesis)
7. The impact of improving the aqueous solubility of a catalyst on catalytic rates should not be underestimated, and proteins can play a powerful role here. (Chapter 3 & 4, Ladomenou *et al., Coordination Chemistry Reviews* **2015**, 304, 38-54)
8. Catalysis with artificial proteins does not require native folding of the protein, but only a stable active species. (Chapter 3, Villarino *et al., ASC Catal.* **2020**, 10, 11783-11790)
9. There are no bad data, only bad attitudes: Everything we learn from our experiments brings us closer to understanding our object of study.
10. Lab work generates a lot of waste, *e.g.* from single-use plastics. Minimizing the generation of such waste should become standard procedure when planning scientific experiments.
11. Mental resilience comes from dealing with, and overcoming, challenges in life. To attain such a state of mind, it is important to face one's problems with a calm and objective mind and to pay regular visits to nature.

Laura Opdam

Leiden, 26 Maart 2024