Seminar

Engineering cyanobacterial photosynthesis for biotechnological applications: Design cells and model systems

Speaker: Professor **Matthias Rögner**

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Date and Time: Friday, March 10, 2017, 2:00-3:00 PM

Place: 1F Lecture Hall, Institute for Protein Research

Matthias Rögner 教授は，　シアノバクテリアを用いた光合成研究の第１人者です。
国際共同研究プログラムで来日されました。
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In future, photosynthesis will be used as power supply for the generation of new products - simply due to the fact, that energy is provided free by the sun and some phototrophic organisms can grow just with sunlight and water containing some minimal components like sea water. Prerequisite is an understanding of photosynthesis on the molecular level and the manipulation of its metabolism for product optimization. We have chosen hydrogen production as an example because this product can be directly linked to photosynthetic electron transport originating from water splitting and is directly released into the surrounding water.

In order to produce hydrogen as potential future renewable energy source from water, we propose to engineer cyanobacterial photosynthesis towards increased bioenergy instead of biomass production (1). Besides the implementation of a highly active, oxygen tolerant hydrogenase from other organisms such as green algae, especially the photosynthetic electron metabolism has to be engineered in many individual steps towards this goal. Each step (such as antenna size reduction, partial uncoupling of the thylakoid membrane (2), re-routing of electrons at the photosystem 1 acceptor site) has to be monitored by both functional (for instance spectroscopy) and metabolic characterization on the whole cell level: Examples are quantitative proteome, lipidome- and metabolome analysis. The direction of engineering is also followed by model systems – for instance by measuring photocurrents of isolated key components (photosystems etc.) which have been immobilized on gold electrodes ("biobattery") (3). This approach shows, that photosystems have a much higher capacity than in their natural environment, i.e. under the limitations of a natural membrane.

Performance of such engineered cells has to be optimized by improving fermentation conditions and by an optimal photobioreactor design (4). Optimal culture conditions can be found and kept constant for several months by using continuous flow fermentation techniques which allow the systematic optimization of each individual parameter. Provided such systems are optimized both on the individual cell level and on the systems level, this could be the blueprint for the successful generation of other – possibly high value – products which are directly linked to the generation of electrons from watersplitting with minimalization of intermediate steps.

(1) Rögner (2013) *Biochemical Society Transactions* 41, 1254-1259 (2) Imashimizu et al. (2011) *J. Biol. Chem.* 286, 26595-26602
(3) Kothe et al. (2013) Angew. Chem. Int. Ed. 52, 14233-14236 (4) Kwon et al. (2013) *Algal Research* 2, 188-195