Engineering retinal-based phototrophy via a complementary photosystem in Synechocystis sp. PCC6803
Chen, Q.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
INVITATION
You are cordially invited to the public defense of my PhD thesis entitled:

Engineering retinal-based phototrophy via a complementary photosystem in Synechocystis sp. PCC6803

Que Chen
Q.Chen@uva.nl

On Wednesday 14th June 2017 at 12:00 in the Agnietenkapel Oudezijds Voorburgwal 231, Amsterdam

Paranymphs:
Wei Du
W.Du1@uva.nl

Jeroen van der steen
jeroen.vandersteen@gmail.com
Engineering retinal-based phototrophy via a complementary photosystem in *Synechocystis* sp. PCC6803

Que Chen
Engineering retinal-based phototrophy via a complementary photosystem in *Syn-echocystis* sp. PCC6803

Que Chen

© Que Chen, 2017

All rights reserved. No part of this publication may be reproduced in any form without prior written permission from the author.

The research reported in this thesis was carried out in the Molecular Microbial Physiology group of the Swammerdam Institute for Life Sciences, Faculty of Science, University of Amsterdam. The work was funded by Biosolar Cells (BSC core project grant C2.9 to WJdG and KJH), co-financed by the Dutch Ministry of Economic Affairs. Que Chen was supported by a PhD scholarship from the Chinese Scholarship Council.

**Cover design:** The pictures on the cover page show the crystal structure of a proteorhodopsin. Image on the front and back page shows the structure of its hexametric oligomer at the intracellular side and the extracellular side, respectively. Protons (H+) are being pumped from the intracellular side (front page) to extracellular side (back page), thereby passing through the whole thesis. The cover has been designed by Jos Arents and Que Chen.

The images are reproduced based on supplementary data from Ran, Tingting, *et al.* 2013. Acta Crystallographica Section D: Biological Crystallography with permission.

**Layout:** The thesis layout has been designed by Yang Liu via software of Adobe InDesign CC 2017

**ISBN:** 978-94-028-0656-4

**Printed by:** Ipskamp Drukkers, Enschede, the Netherlands
Engineering retinal-based phototrophy via a complementary photosystem in *Synechocystis* sp. PCC6803

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. ir. K.I.J. Maex
ten overstaan van een door het College voor Promoties
ingestelde commissie,
in het openbaar te verdedigen in de Agnietenkapel
op woensdag 14 juni 2017, te 12:00 uur

door

**Que Chen**

geboren te Mian Yang, China
Promotiecommissie:

Promotor: Prof. dr. K. J. Hellingwerf Universiteit van Amsterdam

Copromotor: Dr. F. Branco dos Santos Universiteit van Amsterdam

Overige leden:

Prof. dr. R. Croce Vrije Universiteit Amsterdam
Prof. dr. J. van der Oost Wageningen University & Research
Prof. dr. W. J. de Grip Universiteit Leiden
Prof. dr. H. V. Westerhoff Universiteit van Amsterdam
Prof. dr. L. W. Hamoen Universiteit van Amsterdam
Dr. G. J. Smits Universiteit van Amsterdam

Faculteit der Natuurwetenschappen, Wiskunde en Informatica
Contents

Chapter 1  
General introduction: Engineering a proton pumping rhodopsin as a complementary photosystem in *Synechocystis* sp. PCC6803  

Chapter 2  
‘Direct conversion’: Artificial photosynthesis with cyanobacteria  

Chapter 3  
Expression of *holo*-proteorhodopsin in *Synechocystis* sp. PCC6803  

Chapter 4  
Functional expression of *Gloeobacter* rhodopsin in *Synechocystis* sp. PCC6803  

Chapter 5  
Retinal metabolism in *Synechocystis* sp. PCC6803 and the formation of *holo*-proteorhodopsin  

Chapter 6  
Combining retinal-based and chlorophyll-based (oxygenic) photosynthesis: Proteorhodopsin expression increases growth rate and fitness of a ΔPSI-strain of *Synechocystis* sp. PCC6803  

Chapter 7  
General discussion: Potential applications of PR-based photo-trophy and the challenges in exploring its physiological effect in vivo  

References 153  
Summary 175  
Samenvatting 179  
Acknowledgements 183  
List of publications 187