LMU | GRK2062

WHAT'S GOING ON

NEWSLETTER #6 2016

II nd Research Training Group Molecular Principles of Synthetic Biology

FOCUS ON RESEARCH

Prof. Dr. Dario Leister

Introduction of the newly established CRC 175: The Green Hub - Central Coordinator of Acclimation in Plants

Figure 1. *Overview of the reactions underlying acclimation of the plant cell to changes in light and temperature.*

Mankind crucially depends on cultivated plants as primary producers for all of its food, as well as important supplier of materials and energy. Although conditions in plantations can be controlled to a certain degree it is mostly the metabolic flexibility of plants that prevents substantial yield losses. Acclimation responses allow for short-term metabolic adjustments to environmental fluctuations within the frame of a plant's genetic setup. These responses are of vital importance in the light of plant sensility and crucial to global food security.

Chloroplasts emerged in the last years as major contributors to plant acclimation. They are involved in sensing and integrating environmental cues, as well as in the initiation and implementation of appropriate cellular responses. The mechanistic and molecular understanding of the functioning and cellular integration of this "green hub" is very limited, however. Our consortium aims at elucidating the pathways and processes underlying acclimation. In a joint effort groups from the HU Berlin, LMU München, MPI for Plant Molecular Physiology and TU Kaiserslautern attempt to gain detailed insights into the chloroplast's role in acclimation to heat, cold and light stresses. Taking advantage of multiple model organisms including *Arabidopsis*, tobacco, *Physcomitrella* and *Chlamydomonas* we aim to discover universal and thus broadly applicable patterns. Together we will try to address all relevant aspects of this issue including genetics, gene expression and signalling networks, metabolome and proteome dynamics, as well as feedback mechanisms modulating nuclear gene expression. Our ultimate goals are acquiring a holistic view on plastid-mediated acclimation and identifying targets for improvement to generate more flexible and resilient crop plants.

Changes in light and temperature are sensed in the chloroplast and trigger signalling events that alter gene expression and metabolic reactions in the organelle. In parallel, signals emitted by the chloroplast reprogram nuclear gene expression, which has multiple effects, including metabolic adjustments in all cellular compartments and anterograde control of mitochondrial and chloroplast gene expression. Taking into account the fact that the primary metabolic changes in the chloroplast also trigger changes in metabolic reactions in other compartments, a highly complex picture emerges. This complexity can only be dissected by applying system-wide quantitative biology approaches that consider subcellular pools of metabolites and reactions in combination with time-resolved analyses. This approach will allow us to distinguish metabolic readjustments within the inter-compartmental network of linked metabolic reactions from effects mediated by reprogramming of nuclear gene expression.

NEW MEMBERS

PhD-students

Iryna Trotsenko, M.Sc. Applied Biotechnology, is supervised by Hannes Mutschler, Schwille lab since June 2016. Working title of her PhD thesis: "In-vitro self-replication of RNA-processing nanoparticles".

PostDocs

Dr. Michael Heymann joined the Schwille lab in November 2015 to develop microfluidic tools for high-throughput biology. His interests center around building emulsion droplet workflows for directed evolution and to map biochemical reaction kinetics.

EVENTS

SAVE THE DATE:
Joint Retreat 2017 - ICMSE Pre-conference

Date: August 26-27, 2017
Location: Uni Basel, Switzerland
The pre-conference is jointly organised by fellows of the NCCR Molecular Systems Engineering, as well as FMS Research Center (Research Center for Functional Molecular Systems; University of Groningen, Radboud University Nijmegen, Eindhoven University of Technology) and students of our Research Training Group GRK2062 "Molecular Principles of Synthetic Biology".

The **invited speakers** of the pre-Conference are:

- Benjamin G. Davis, University of Oxford
- Vincent Noireaux, University of Minnesota
- Pamela Silver, Harvard Medical School
- Roy Bar-Ziv, Weizmann Institute of Science

More details ICMSE Pre-conference

The ICMSE Pre-conference will be followed by the International Conference on Molecular Systems Engineering ICMSE (August 27-29, 2017).
Of course, all GRK2062 junior researchers have the opportunity to attend both conferences (GRK will pay fees as well as accommodation and travel expenses). Hopefully, many GRK2062 PIs will also participate in the ICMSE.

Upcoming Advanced Method Courses

PyMol Workshop
Sabine Schneider will hold this course alternatively on January 17th or January 23rd 2017 in room CH 53 306 at the department of chemistry in Garching.
Details about dates, topics and what to bring
Registration: Please write an e-mail to Sabine Schneider including your preferred date.

Grand Prize, LMU-TU iGEM Team 2016

iGEM 2016: Munich Team from LMU&TUM receives Grand Prize at iGEM jamboree

The world's largest synthetic biology competition since 2003 took place in Boston (MA) from October 24th to October 31st 2016, where the joint student's team from the Technical University of Munich (TUM) and the Ludwig-Maximilian University (LMU) received the Grand Prize (1st Prize) in the overgrad category. This year, 5600 students organized in more than 300 teams across 42 countries participated in the iGEM 2016 competition.

The Munich team under guidance of Prof. Dr. Arne Skerra (TUM), initiated and sponsored by GRK2062, developed an innovative tissue printing technique based on a biological unique ink, dubbed bioINK. The printing process utilizes a re-engineered plastic 3D printer together with a two-component bioINK based on the (strep)avidin-biotin affinity system. Mixing of the modified cell suspension as one component with the functional protein as the second component induces an instantaneous polymerization reaction, creating three-dimensional live multi-cellular structures in buffered culture solution in a user-definable manner. To make use of the high affinity biotin-avidin glue for cross-linking, the cells were genetically engineered to present biotin groups or achored avidin versions on their surfaces whereas recombinant matrix proteins (based on avidin or a multi-biotinylated carrier polypeptide) were designed to allow co-polymerization under mild biological conditions upon 3D-printing into a culture dish.

Annual highlight of the iGEM competition is the Giant Jamboree, a four-day conference in Boston where all international teams meet and present their projects. Venue is the Hynes Convention Center at the heart of Boston, a huge forum where the 5600 attendees assembled to show posters and discuss their projects. To succeed in this competitive environment the students had to demonstrate more skills than just doing synthetic biology work. From Friday to Sunday the iGEM teams gave their presentations in front of Judges and an auditorium in different lecture rooms throughout the day. Hence, our team went around to attend those talks that appeared most interesting. The Giant Jamboree also held special events later in the day, for example several talks by established scientists on synthetic biology as well as social events. Even representatives of the U.S. Federal Bureau of Investigation (FBI) came by to present a guest talk on biosecurity. Between lectures the teams could mingle and, while looking at each other's posters in the grand session hall, answer Judges' questions.

The Award Ceremony started on Monday. The iGEM teams competed for various awards including medals, track awards and special prizes. Being the ceremony, the top two overgraduate and three undergraduate teams as well as the best high school team that were nominated by the Judges on the previous day(s) had to present their projects once again to the full Jury, as well as the entire iGEM community, to compete for the Grand Prize. Directly thereafter, all the medals, awards, and prizes were announced during the thrilling Awards Ceremony, which was the highlight of the Giant Jamboree. There, finally, the iGEM Team of LMU & TU-Munich was awarded the Grand Prize in the overgrad category and, furthermore, won the first prize in the track award "Manufacturing". Additionally, the team received special prizes for "Best Hardware" as well as "Best Software Tool". After encouraging placements by individual students' teams of both Munich Universities during past years (e.g., LMU: 4th place 2012; TUM: First Runner-Up Award / 2nd place 2013), the joint LMU&TUM endeavour in 2016 succeeded in the World Championship in Synthetic Biology.

Congratulations to all members and thanks a lot to all sponsors of the team!
More information about the team and their project

JOURNAL CLUB

Nature Chemistry, Nov 2016

Article
Engineering genetic circuit interactions within and between synthetic minimal cells

Katarzyna P. Adamala, Daniel A. Martin-Alarcon, Katriona R. Guthrie-Honea and Edward S. Boyden

Abstract
Genetic circuits and reaction cascades are of great importance for synthetic biology, biochemistry and bioengineering. An open question is how to maximize the modularity of their design to enable the integration of different reaction networks and to optimize their scalability and flexibility. One option is encapsulation within liposomes, which enables chemical reactions to proceed in well-isolated environments. Here we adapt liposome encapsulation to enable the modular, controlled compartmentalization of genetic circuits and cascades. We demonstrate that it is possible to engineer genetic circuit-containing synthetic minimal cells (synells) to contain multiple-part genetic cascades, and that these cascades can be controlled by external signals as well as inter-liposomal communication without crosstalk. We also show that liposomes that contain different cascades can be fused in a controlled way so that the products of incompatible reactions can be brought together. Synells thus enable a more modular creation of synthetic biology cascades, an essential step towards their ultimate programmability.

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