Final report

Networking activity
Programme-wide Conference "Progress in synthetic biology"
3-5 October, 2012
Groningen, The Netherlands

- **Summary**

The **EuroSYNBIO Programme-wide conference** entitled "Progress in Synthetic Biology" was organised by the ESF-Eurocores EuroSYNBIO Programme and the Groningen Centre for Synthetic Biology and has taken place in Groningen, the Netherlands, from 3 to 5 October, 2012.

All major European research groups in EuroSYNBIO were represented, including 10 keynote invited speakers. All project leaders, principal investigators and project members from the EUROCORES Programme EuroSYNBIO (www.esf.org/eurosynbio), as well as coordinators of key European initiatives such as the ERA-NET of Synthetic Biology were invited to attend the conference. A total number of 76 participants attended the conference (incl. speakers).

- **Final programme**

Please find the final programme below. Due to unforeseen circumstances, Dr. Marlière could not make it to the meeting in time and was replaced by Dr. Jan Vinkenborg, University of Bonn, Germany.

EUROCORES Programme
European Collaborative Research

EUROSYNBIO

Synthetic Biology: Engineering Complex Biological Systems

Programme-wide Conference "Progress in synthetic biology"
Groningen 3-5 October, 2012

Wednesday 3 October 2012

15.30 Welcome & registration at Groninger Museum (Job Lounge)

17.00 Keynote talk (Middenzaal, Coop Himmelblau)

Introduction by **Prof. Oscar Kuipers**

Keynote speaker: **Prof. Ben Feringa**, University of Groningen, Stratingh Institute of Chemistry, the Netherlands

Lecture: "Designing Bioinspired Molecular Systems"

18.00 Tour Groninger Museum

19.30 **DINNER at Groninger Museum (Mendini restaurant)**

Thursday 4 October 2012

08.45 Registration at Het Kasteel (ground floor)

9.00 Welcome and Introduction at Het Kasteel (Congreszaal)

9.15 SYNAPTA session
Chair: Dr. Philipp Holliger

Dr. Philipp Holliger, "Synthetic genetic polymers"

10.00 SYNAPTA invited speaker
Dr. Philippe Marlière, Global Bioenergies, Evry, France
Lecture: "Chemical morphing of living organisms"

10.45 **COFFEE BREAK**

11.00 SynDiv session
Chair: Prof. Petra Schwille

Prof. Cees Dekker, “What sets the dividing plane in E. coli bacteria?"

Prof. David Sherratt, “In vivo coordination of cell division with chromosome segregation”

Prof. Petra Schwille, "In vitro reconstitution of Min oscillations – a protein clockwork"

11.45 SynDiv invited speaker
Prof. Victor Sourjik, University of Heidelberg, Zentrum für Molekulare Biologie, Germany
Lecture: "Min system in bacterial cell division and beyond"

12.30 **LUNCH**

14.00 SynMet session
Chair: Dr. Trygve Brautaset

Dr. Trygve Brautaset, “Genetic and biochemical understanding of methylotrophy as a basis for engineering of this trait into new bacterial hosts”

Prof. Wim Quax, “Turning Bacillus subtilis into a methylotrophic terpenoid produce”

14.45 SynMet invited speaker
Prof. Matthias Heinemann, University of Groningen, Molecular Systems Biology, The Netherlands
Lecture: “Stochasticity in E. coli’s central metabolism and consequences for engineering”

15.30 **COFFEE BREAK**

16.00 Policy funding session
Chair: Dr. Markus Schmidt

Dr. Annette Kremser, Projektträger Jülich, Biologische Innovation und Ökonomie, EU und Internationales (BIO3), Forschungszentrum Jülich GmbH, Germany
&
Dr. Andy Boyce, Biotechnology & Biological Sciences Research Council (BBSRC), U.K.
Lecture: ” European funding opportunities in Synthetic Biology: ERASynBio, FP7 and HORIZON 2020”

16.30 Session on ELSA
Dr. Markus Schmidt, BIOFACTION KG, Vienna, Austria
Lecture: “Biosafety and synthetic biology: risk analysis, genetic firewall, and amateur biologists”

17.00 ELSA invited speaker
Dr. Joachim Boldt, Institut für Ethik und Geschichte der Medizin, Albert-Ludwigs-Universität Freiburg, Germany
Lecture: “Engineering Life. Ethical Issues in Synthetic Biology”

17.30 Presentations by iGEM teams from Groningen and Wageningen:
iGEM Groningen: Elbrich Hendriks & Renske van Raaphorst
iGEM Wageningen: Kees van der Ark, Wouter Elings & Hugo de Vries

18.10 Closure of day

19.00 **DINNER at Het Kasteel**

20.30 Poster session with drinks

Friday 5 October 2012

9.00 NANOCELL session
Chair: Prof. Daniel Müller

Dr. Daniel Harder, "Engineering, characterization and assembly of energizing and transport modules for NANOCELLs"

Dr. Denys Pogoryelov, "Engineering the ATP synthase rotor: customized ion-to-ATP ratios and ion specificity"

9.45 NANOCELL invited speaker
Prof. Hagan Bayley, University of Oxford, Chemical Biology, U.K.
Lecture: "Droplet networks containing engineered protein pores"

10.30 **COFFEE BREAK**

10.45 SYNMOD session
Chair: Prof. Oscar Kuipers

Dr. Martin Held, "High-throughput screening in nL-reactors"

Dr. Martin Schlag, "Expression of novel lantibiotics in Staphylococcus carnosus"

11.30 SYNMOD invited speaker
Prof. Nediljko Budisa, Technical University of Berlin, Institute of Chemistry, Germany
Lecture: "Ribosomal synthesis of congeneric peptide-based complex natural products"

12.15 **Prof. Bert Poolman** Closure of conference

12.30 **LUNCH**

13.30 – 15.00 **Scientific Committee meeting** (Project Leaders only) in Het Kasteel

- **Scientific content**

Synthetic biology is the rational (re-)design of biological systems with useful properties. It is a highly interdisciplinary endeavour and can be viewed from two angles: (1) the engineering perspective, which entertains the hope of transforming biotechnology into a true engineering discipline with the corresponding reliabilities and accuracies in design; and (2) the synthetic focus provides a unique tool for confirming or challenging our current understanding of molecular events and system function, because only if we can reliably rebuild cellular properties can we claim intellectual mastership. Both these aspects of synthetic biology, transforming bioengineering and advancing understanding through synthesis, need to undergo a fundamental transition to be able to tackle systems-level questions. This transformation will happen on two fronts: (1) there is the need to transform existing and develop novel computational tools that allow taking our current computational procedures from the analysis of single items to the systems level; and (2) it is necessary to support the computational change-of-scope with the same change in our workflows towards the "biosystems design laboratory". The final element in this transition is the societal context, as synthetic biology needs to be aware of and effectively manage its societal impact. Therefore, the societal context will be integrated in its various forms from an early stage of the scientific and engineering endeavour, bearing in mind that it might be a vital element in successfully guiding the future development of synthetic biology.

The first achievements in synthetic biology include the design and implementation of synthetic genetic circuits, the design of novel biochemical pathways for the production of valuable pharmaceuticals, and the de novo synthesis of bacterial genomes. The ultimate ambition of the field is to extend the mastery of biological engineering to systems complex enough to deal with grand challenges such as the design, synthesis and delivery of novel therapeutic treatments, affordable and precise diagnosis of diseases, novel routes to vaccines, production of liquid transportation fuels, bioremediation of pollutants, biocompatible carbon sequestration, and efficient manufacturing of biopharmaceuticals and biochemicals.

The EUROSYNBIO call for proposals included 4 research topics, three of which focused on basic and applied sciences ("System assembly and molecular and cellular complexity in a context of Darwinian evolution"; "Computational design tools" and "The biosystems design laboratory") and one focused on the social context. The EuroSYNBIO Programme-wide conference which has taken place in Groningen (NL) on 3-5 October, 2012 has been a unique opportunity to fulfil the EuroSYNBIO objectives by inviting EuroSYNBIO scientists as well as well-renowned external speakers to present and discuss synthetic biology from different perspectives. It has also been an ideal venue for presenting the progress in this field and disseminating the work of the NANOCELL, SynDiv, SYNAPTA, SynMet and SYNMOD Collaborative Research Projects (see: http://www.esf.org/activities/eurocores/running-programmes/eurosynbio/projects-crps.html). Last but not least, it has fulfilled the aim of establishing connections with the ERA-NET ERASynBio (soon available from: www.erasynbio.eu).
Please find some of the abstracts of invited speakers below.

Abstract Prof. Victor Sourjik

Min system in bacterial cell division and beyond

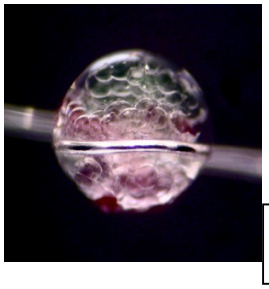
Faithful partitioning of cellular material is one of the most important steps in the process of cell division, and understanding mechanisms behind such partitioning is essential for the future design of synthetic cells. Particularly challenging is equal segregation of dynamic systems that have a non-uniform cellular distribution. As an example of such system, we have investigated partitioning of *E. coli* Min proteins, which play an important role in positioning the site of cell division to the mid-cell. The Min system exhibits spatial oscillations between cell poles, thus creating a gradient of the cell division inhibitor towards cell poles. We showed that at cell division, the Min system undergoes spontaneous segregation that relies of the interplay between the system's dynamics and cell geometry and does not require any additional segregation machinery. Such self-arising segregation may represent a general and efficient mechanism that can be utilized in synthetic cell designs. More recently, we have observed that the Min system has an additional function in cell division, playing a role in the segregation of sister chromosomes. The implication of this finding for synthetic biology will be discussed.

Abstract Prof. Hagan Bayley

DROPLET NETWORKS CONTAINING ENGINEERED PROTEIN PORES

Synthetic biology is being used to build devices through both top-down and bottom-up approaches.[1] For example, genome engineering has been used to reprogram cells, and DNA origami has been used to produce a variety of nanodevices. While progress has been made on the assembly of minimal cells, synthetic tissues have so far received limited attention. Here, assemblies of aqueous droplets joined by lipid bilayers are described. The droplets can communicate with each other and with the environment through engineered protein pores and, like tissues, exhibit emergent properties.

Aqueous droplets in an "oil", such as hexadecane, containing a lipid acquire a monolayer coat. When two such droplets are brought together, they become attached with a lipid bilayer at the junction.[2] A few or many droplets can be assembled into two- and three-dimensional arrays. Engineered protein pores can be incorporated into the bilayers allowing the droplets to communicate with small diffusing molecules or through electrical signals carried by ionic currents. Droplet networks in oil drops can be constructed that exist in an aqueous environment.[3]



Spherical aggregate of aqueous droplets

To mimic tissues, droplet networks should be endowed with various properties including the ability to store and use energy, to move and change shape, to detect signals, to carry out computations and take up and release molecules. At a certain level all of these goals have been achieved.[2,4,5]

The functional droplet networks described here are a step towards the production of tissue-like material. It might be possible to interface droplet networks with living tissues or with electronics.

References

1 D.N. Woolfson and E.H.C. Bromley, *The Biochemist*, 2011, February, 19.
2 M.A. Holden, D. Needham, and H. Bayley, *J. Am. Chem. Soc.*, 2007, **129**, 8650.
3 G. Villar, A. Heron, and H. Bayley, *Nature Nanotechnology* 2011, **6**, 803.
4 H. Bayley, B. Cronin, A. Heron et al., *Mol. BioSystems*, 2008, **4**, 1191.
5 G. Maglia, A. J. Heron, W. L. Hwang et al., *Nature Nanotechnology* 2009, **4**, 437.

Abstract Dr. Markus Schmidt

Biosafety and synthetic biology: risk analysis, genetic firewall, and amateur biologists

Acknowledging the potential benefits of SB for the knowledge based bio-economy, the European Group on Ethics in Science and Technology in 2009, and the US Presidential Commission for the Study of Bioethical Issues in 2010, published recommendations that both contained a request to investigate novel biosafety issues and risk analysis in SB.

We will discuss under which circumstances SB will need new methods of risk assessment. In order to find out, we have to ask: When is the synthetic system substantially equivalent to the natural system it is based upon, and when is it not? While this question is hard to answer for many activities regarding metabolic engineering or use of standard biological parts, it is more straightforward for xenobiological systems based on an alternative biochemical structure (e.g. genetic material based on novel types of nucleotides). In the later case the substantial *un*-equivalence is actually seen as a promising tool to establish a safer biotechnology with a so-called genetic firewall.

Another relevant issue is the expected up-scaling and de-skilling in the production of new biological systems. A number of “biohackers”, “Do-it-yourself-biologists” or “amateur biologist”, including artists, have started to take biotechnology out of the lab and into kitchens, garages and art galleries. While on the one hand, this development might lead to an improved dialogue between science and the public it could also increase the risk of biosafety accidents.

- **Assessment of the results and impact of the event on the EUROCORES Programme**

The EUROSYNBIO call for proposals included 4 research topics, three of which focused on basic and applied sciences ("System assembly and molecular and cellular complexity in a context of Darwinian evolution"; "Computational design tools" and "The biosystems design laboratory") and one focused on the social context. The EuroSYNBIO Programme-wide conference that took place in Groningen (NL) on 3-5 October 2012 was a unique opportunity to fulfill the EuroSYNBIO objectives by inviting EuroSYNBIO scientists as well as well-renowned external speakers, to present and discuss synthetic biology from different perspectives. It was an ideal venue for presenting the progress in this field and disseminating the work of the NANOCELL, SynDiv, SYNAPTA, SynMet and SYNMOD Collaborative Research Projects (see: http://www.esf.org/activities/eurocores/running-programmes/eurosynbio/projects-crps.html).

The Groningen meeting, attended by 80 scientists, was a great success, both with regard to the scientific programme and with respect to strengthening interactions between European labs. The opening lecture in the Groninger Museum by Ben Feringa, was a well appreciated add-on at the program. Also presentations of two Dutch iGEM teams were highly valued. A commonly felt improvement over the previous meeting in Cannes, was the addition of about 8 external key note speakers that presented excellent talks and broadened and depthened the discussions. Last but not least, it did further establish connections with the ERA-NET ERASynBio (soon available from: www.erasynbio.eu) through presentations of Dr. Annette Kremser and others. Several EuroSynBio scientists were invited for the recent workshop of EraNet SynBio in Basel (Kuipers, Brautaset) and there good discussions about the future of SynBio in Europe were held, which will lead to a call for proposals in the near future, fort which topics were intensively discussed. The EuroSynBio programme has already succeeded in bringing together a large part the best European scientists in Synthetic Biology.

Oscar Kuipers

Groningen, Febr. 6, 2013