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PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

Synthetic Bio(techno)logy:
November 9 and 10, 2009, DECHEMA e.V., Frankfurt

Background information

Synthetic Bio(techno)logy

Prompted by the advancements in systems and molecular biology, biotechnology is facing a transformation into a more quantitatively oriented engineering science. Synthetic biology aims at creating novel biochemical pathways, extended to synthetic genomes and even whole artificial organisms. The technology's potential and impact are promising but, since the field is not yet well defined are hard to assess. In order to illuminate some of the most relevant scientific, technical, societal and legal aspects, acatech - German Academy of Science and Engineering - and DECHEMA e.V. - Society for Chemical Engineering and Biotechnology - have jointly organised the "Synthetic Bio(techno)logy" conference. The conference has focussed on potential applications of synthetic biology, and special sessions have been devoted to related communicative, ethical, safety and legal aspects.

The conference was structured in four sessions, providing a general overview, a forum for discussing the regulatory, public, ethical and legal aspects as well as presenting the technological status in respect to engineered biomolecules & cells, and the advancements in higher organization circuits & systems. The conference was devoted to elaborate topics of public and governmental involvement in four workshops covering aspects of biosafety, responsible development, public integration and governance strategies. Especially these non-technical aspects of Synthetic Biology have been the main topics at the well received public discussion following the presentation of the workshop conclusions at day one.

Organized by:

acatech
GERMAN ACADEMY OF SCIENCE AND ENGINEERING

DECHEMA

Overview

The opening session provided an outline of different aspects related to Synthetic Biology, like the ***design principle***, the requirement for ***standardization***, the ***chassis*** topic or the ***reprogramming*** of protein synthesis in living systems. Elucidating basic principles in Synthetic Biology ***S. Panke*** started with an overview of the architecture synthetic biology conform developments would follow and emphasized the indispensable but difficult to realize demand for ***orthogonality*** in metabolic networks. ***A. Tuberfield*** presented his view and work on synthetic DNA - not in the sense of being primarily the information medium and acting via transition of genetic information into molecule-associated functions – but in the direct sense of making use of DNA and its self-assembly potential to generate ***programmable molecular machineries***. A more practical advancement has been addressed by ***V. Wendisch***, who presented the progress and future challenges of synthetic biology approaches to *Corynebacterium glutamicum* as a platform for the ***production of fine chemicals***. The session was closed with the insight into new concepts of reassigning and

expanding the genetic code for the use in designing cells with target-engineered genetic codes by ***N. Budisa***.

Implications

With his main focus on the ***societal dimension*** of the SB development, ***M. Schmidt*** made a clear distinction between the known, resurfacing risk issues and the novel arising issues, mainly ***biosecurity*** and as he called it unfamiliar biology, associated with the emergence of synthetic biology. The issue of ***biosafety*** was further addressed in a more practical effort by ***P. Staehle***r, who presented the contribution of the IASB (International Association of Synthetic Biology) in developing a catalogue of measures for screening and responsible handling of DNA. ***H. Vriend*** pointed out that the development of an agenda for a ***societal debate*** including ***Civil Society Organizations*** (CSOs) as the intermediaries between scientific and governance organizations is crucial to avoid problems similar to those raised by GMOs, and he presented strategies to help structuring the debate. ***J. Tait*** presented her concerns about the combination of upstream engagement and ***risk management***, which she classified as an European phenomenon, in terms of ***over-regulating*** the development of new technologies with the risk of constraining competition and scientific advancement. The session was continued with workshops discussing and elaborating aspects of biosafety, responsible development, public integration and governance strategies.

Engineered Biomolecules & Cells

M. Famulok reported the current status and gave insight into new developments regarding the chemical biology of ***Aptamers***, defined as small single-stranded oligonucleotides that fold into well-defined structures and interact with high affinity and specificity with their target molecules, and their uses. The advent of chemically modified organism by means of diversification using methods of directed evolution rather than relaying on not yet available synthetic biology design and whole genome manufacturing tools has been pointed out ***by P. Marliere*** as one possibility to block metabolic cross-feed and genetic cross-talk and to establish novel ***containment procedures***, thereby contributing to ***safety*** solution. ***A. Jaramillo*** presented his work on ***computational methodologies*** and evaluation results for different application in the design of novel proteins, defined genetic circuits and transcriptional devices. Following the *in silico* design, ***R. Wagner*** presented state of the art rational gene design and high ***through-put gene synthesis*** as new technological wave in genetic engineering, regarded a major enabling technology for synthetic biology. ***M. Bott*** gave an overview of the high potential of synthetic biology in the field of white biotechnology by providing methods for ***enzyme improvement*** and evolution, and implementation of ***novel metabolic pathways*** in established microbiological systems, exemplified by the use of heterologous functions to develop simple forms of synthetic metabolism in *Corynebacterium glutamicum*.

Circuits & Systems

The session was started with a deeper insight into ***systems chemistry***, introduced by ***G. Kiedrowski***, and its relation to synthetic biology based on self-replication and multi-component assembly as a basis to understand complex reaction networks with autocatalytic components. ***D. Wirth*** reported on advances of recombinase mediated ***targeted integration*** of synthetic expression modules into defined chromosomal sites, the provided opportunity to optimize the design of these modules in accordance to the integration site and the application, and the practical impact as to develop *in vitro* test systems using specifically

modified cell lines for animal models. ***P. Walde*** gave an overview of the use and nature of artificial vesicles, either being viewed from a creative synthetic biology standpoint as bottom-up developed artificial but living cell systems, or, more practically, as ***submicrometer bioreactor*** packed with enzymes and controlled by their content and bilayer composition. Approaches toward the control and biological ***combat of pest insects*** using synthetic biology have been introduced by ***L. Alphey***. In principal a tool-kit containing genetic elements to generate controlled circuits, like positive feedback-circuitry, can be used to design specific expression modules for dominant lethal proteins that can be spread among pest insects naturally from genetically engineered insects, and upon induction of the expression cassette enables the control of these species and the associated harm. The design of heterologous transgene control systems as a basis for gene expression circuitries and ***communication networks*** between mammalian cells has been exemplified by ***M. Fussenegger***, who summarized his work on an inter-species cross-talk circuit leading to the identification of compounds active against *Mycobacterium tuberculosis*. ***V. M. Santos*** presented a project aiming at the construction of a streamlined bacterial cell usable as ***chassis*** for the implementation of new circuits with a special focus on the integration of mathematical modelling and wet-lab experiments as driving force for the establishment of a functional ***engineering framework***. ***C. A. Voigt*** concluded the session with examples of the usage of synthetic ***light sensors*** to trigger complex regulatory networks, for example controlling protein-protein interactions, with implications on computational methods for genetic circuit optimization or the design of light programmable reagents.