Universität Bielefeld

CeBiTec
Center for Biotechnology

CeBiTec – Quarterly

Winter 2018 / 2019

In this Issue

Gold medal and special prize for Best Safety & Biosecurity for the iGEM team

On October 28, 2018, the iGEM team Bielefeld-CeBiTec was awarded with a gold medal and the special prize for Best Safety & Biosecurity for their project "nanoFactory: Recycling metal resources – Every particle matters!".

The team, comprised of nine students from Bielefeld, participated in the renowned iGEM (international Genetically Engineered Machine) competition, which took place at the Hynes Convention Center in Boston, MA, USA. Their project deals with the production of heavy metal nanoparticles out of drainage water. Drainage water is often contaminated with heavy metal salts which can be used for medicine or industrial purposes when turned into nanoparticles. The team successfully produced iron oxide, silver and gold nanoparticles with the heavy chain of the protein human ferritin. Besides, toxic effects due to reactive oxygen species could be reduced. As a side project an alternative to gene knockouts comprising a two plasmid system for gene silencing in prokaryotes has been designed. Since Dual Use and Dual Use Research of Concern aspects are crucial to be considered in any scientific project, the team spread awareness among the iGEM community.

Teams from the CeBiTec have been successfully participating in the iGEM competition for nine years. Students in the team of 2018 are enrolled in various Bachelor and Master programs like Molecular Biotechnology, Bioinformatics and Genome Research, Biochemistry, Molecular Biology, and Genome-Based Systems Biology. Special thanks go out to the team's instructors, Svenja Vinke, Julian Droste, Boas Pucker, Pascal Schmidt, Carsten Hain, Marten Linder, Dr. Christian Rückert and Prof. Dr. Jörn Kalinowski, as well as other members of the CeBiTec and Bielefeld University who supported the team at different points during their project. The project of team Bielefeld-CeBiTec and its success in the iGEM competition underline the strong position of the CeBiTec in research and education in the Life Sciences.

The first iGEM High School Team provided by the students laboratory *teutolab*-biotechnologie

In the academic year 2017/2018 seven high school students of the *Einstein Gymnasium* in Rheda-Wiedenbrück researched on a self-chosen topic in the field of synthetic biology at the students laboratory *teutolab*-biotechnologie in order to participate in the iGEM competition in Boston, USA. The young people set themselves the task of developing a DNA-based pollen detection system that would make it possible to estimate the daily pollen density. After an intensive theoretical introduction, the experimental implementation of the project idea took place. The laboratory work included DNA isolation from self-collected pollen and plant leaves, the subsequent amplification of species-specific DNA regions, the establishment of a pectin detection system and genetic work with the model organism *E. coli*. Beside the lab work a further task of the participants was to reflect sociological, economic and safety-relevant aspects of their project idea. All results of the work were presented both on a specially designed homepage and at the big final in Boston, USA, (the Giant Jamboree from October 24 to 28, 2018) with a poster and a lecture. The young researchers convinced the international jury and were awarded a bronze medal. The research work and the participation in the competition were financially supported by the Doris-Wolf-Foundation, Bielefeld, the Joachim-Herz-Foundation, Hamburg and the Andreas-Mohn-Foundation, Bielefeld.

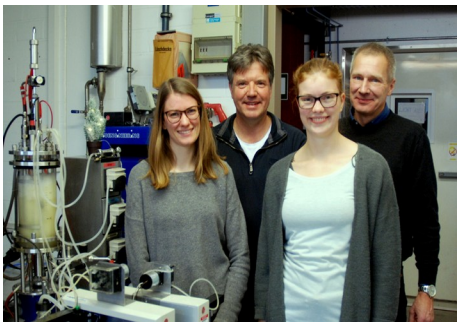
Third *teutolab*-academy systems biology

From October 15 to 18, 2018, the third *teutolab*-academy took place at the students laboratory *teutolab*-biotechnologie. The academy "Systems Biology – Biological Experimentation and Mathematical Modelling" was designed for high school students from all over *Ostwestfalen-Lippe* (a region of North Rhine-Westphalia) who are particularly interested in the natural sciences. During the academy, 16 pupils from 13 different schools intensively explored the topic "systems biology in the *lac* operon". In three different experimental approaches they investigated to what extent the presence or absence of different sugars has an influence on bacterial growth and on gene and protein activity. In addition, the young people learned how substance flows can be visualised and simulated using a modelling programme. By attending lectures and visiting laboratories, the participants gained a direct insight into the relevance of research work and a broad perspective on application examples of systems biology. The *teutolab*-academy was financed by the Joachim-Herz-Foundation, Hamburg, and by the joint initiative *Zukunft durch Innovation* (zdi), Bielefeld district. The fourth *teutolab*-academy will take place in the autumn holidays of 2019.

Distinguished Lecture by Tobias Erb about an artificial chloroplast

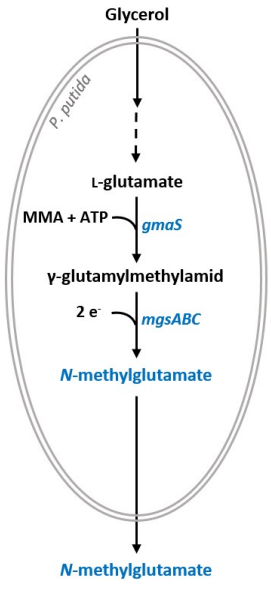
Prof. Dr. Tobias Erb, Director at the Max-Planck-Institute for Terrestrial Microbiology in Marburg, gave an inspiring talk entitled "Fixing CO_2-fixation: Building an artificial chloroplast drop-by-drop" in the CeBiTec Distinguished Lecture Series on November 26, 2018. In the crowded lecture hall of the Centre for Interdisciplinary Research (ZiF) of Bielefeld University Prof. Erb discussed the evolution and limitation of naturally existing CO_2 fixing enzymes and pathways and presented strategies for the design and engineering of artificial CO_2 fixation. In particular he reported about a synthetic CO_2 fixation pathway, which is an *in vitro*-reaction network of 17 enzymes that was established with enzymes originating from nine different organisms. After the lecture, Prof. Erb answered questions of attendees and colleagues during a stand-up reception.

Metabolic engineering of *Pseudomonas putida* for production of *N*-methylglutamate



(from left to right) Melanie Mindt, Thomas Schäffer, Tatjana Walter, Dr. Joe Max Risse

Melanie Mindt and Tatjana Walter from the group of Prof. Dr. Volker F. Wendisch (CeBiTec and Faculty of Biology) have engineered the industrially relevant GRAS (generally recognized as safe) organism *Pseudomonas putida* KT2440 for production of the *N*-alkylated amino acid *N*-methylglutamate. When used as building blocks for peptide-based drugs *N*-methylated amino acids may alter the characteristics to higher bioactivity *in vivo* compared to the non-methylated peptides. The metabolic engineering strategy was based on interception of the monomethylamine (MMA) assimilation pathway of *Methylobacterium extorquens*, a methylotrophic bacterium. Heterologous expression of *gmaS–mgsABC* from *M. extorquens* DM4 enabled fermentative production of the *N*-methylated amino acid *N*-methylglutamate by *P. putida* (surprisingly not by *C. glutamicum*). The work also revealed a glimpse into the enzymatic conversions catalysed by the *gmaS–mgsABC* encoded enzymes that apparently operate similar to glutamine synthetase (GS, EC 6.3.1.2) and glutamate synthase (GOGAT, EC 1.4.1.13). ATP-dependent methylamidation of L-glutamate to γ-glutamylmethylamide by γ-glutamylmethylamide synthetase (GMAS, EC 6.3.4.12) resembles ATP-dependent amidation of L-glutamate to L-glutamine by GS. On the other hand, the transfer of the methylamide group of γ-glutamylmethylamide to 2-oxoglutarate by *N*-methylglutamate synthase (NMGS, EC 2.1.1.21) resembles the amide transfer from L-glutamine to 2-oxoglutarate by GOGAT. Further strain construction comprised gene regulatory engineering that enabled fast growth and utilization of glycerol, a waste product of the biodiesel process. Additionally, precursor provision was improved by chromosomal overexpression of the glutamate dehydrogenase gene *gdhA*. After medium optimization, the process was scaled up. Together with Dr. Joe Max Risse and Thomas Schäffer from CeBiTec's technology platform fermentation, fed-batch bioreactor cultivation was performed. The surprisingly high product titers of 18 g L^{-1} *N*-methylglutamate were obtained using the feedstock glycerol.



The Wendisch lab can now make use of two independent routes to *N*-alkylated amino acids: the fermentative route in *P. putida* described here and a fermentative route depending on the IRED DpkA established in *C. glutamicum* (*cp.* CeBiTec Quaterly Autumn 2018 or Mindt *et al.*, 2018. Sci. Rep. 8: 12895).

Mindt, M., Walter, T., Risse, J.M., Wendisch, V.F., 2018. Front. Bioeng. Biotechnol. 6: 159. https://doi.org/10.3389/fbioe.2018.00159

Sustainable European food systems using microorganisms – the SIMBA Project

A ground-breaking new project funded by the European Union will explore the potential of exploiting microorganisms in plants and animals to improve food security and promote sustainable food production. The project SIMBA (Sustainable Innovation of Microbiome Applications in Food System) aims at tackling the increasing challenge of supplying food to a growing global population in the face of the climate change crisis, through innovative activities around food systems using microorganisms. The project marks the beginning of a unique plan that will explore the value and potential of microbiomes in our food production systems. Microbiomes are a community of microorganisms such as bacteria, fungi, and viruses that inhabit a particular environment. These communities play a vital role in the productivity and health of plants and animals. Exploitation of the communities associated with species used as food sources could then lead to the production of healthier, more stable and secure crops and livestock.

SIMBA will focus on two interconnected food chains: crop production and aquaculture. Contribution of microbiomes to soil fertility and plant defense will be studied, especially for dry areas susceptible to erosion. The potential of marine microbiomes to boost algal biomass, to facilitate natural feed production and to reduce intensive use of antibiotics will be studied. Exploration and exploitation of microbiomes are instrumental for the development of healthier food and feed products. Microbes can also be applied as ingredients to food to improve gut microflora and to ensure a better uptake of nutrients.

Scientists from the CeBiTec are part of the international project team. "SIMBA aims to explore large numbers of microbiomes which requires high-throughput bioinformatics analyses" says Dr. Alexander Sczyrba, head of the "Computational Metagenomics" research group. "As part of the German Network for Bioinformatics Infrastructure (de.NBI) we can perform such analyses in the recently established de.NBI Cloud computing environments". Prof. Dr. Alfred Pühler and Dr. Andreas Schlüter of the research group "Genome Research of Industrial Microorganisms" are experienced in the biological interpretation of microbiomes exploiting their deeply sequenced metagenomes by application of bioinformatics methods.

Worldwide, the demand for food and for agricultural products is predicted to increase by up to 70% until 2050. There is an urgent need to create and develop new food production systems which meet this forecasted demand for food. SIMBA's innovative approach will contribute to a growing body of research aimed at stimulating food production not only in Europe, but also in countries where food insecurity is an ongoing issue. These countries, as well as those which are beginning to experience these negative impacts, are expected to benefit from the project's findings. The SIMBA project will run from 2018 to 2022 with an overall budget of 10 million euros. It is funded by the European Union Horizon 2020 programme. The 23 strong multi-stakeholder, multi-disciplinary SIMBA consortium is well distributed over the European continent and brings together Northern countries (Finland, Norway, Denmark and Iceland), central Europe (Netherlands, Germany, Belgium, Ireland) and south of Europe (Portugal, Spain, Italy).

Miscellaneous

The lab of Prof. Dr. Volker F. Wendisch has recently received funding for two collaborative projects with the National Institute for Interdisciplinary Science and Technology (NIIST) in Trivandrum, belonging to the Council for Scientific and Industrial Research (CSIR) of India. Silvin Hannibal from the Wendisch lab and Keerthi Sasikumar from the lab of Dr. K. Madhavan Nampoothiri, both PhD students funded by the Federal Ministry of Education and Research – Department of Biotechnology (BMBF, Germany; DBT, India) project BIOCON, collaborate on using second-generation feedstocks for the production of value-added compounds by recombinant *Corynebacterium glutamicum* strains. The product focus is on ω-amino acids, diamines, and lactams. Carsten Haupka collaborates with Vivek Narisetty from Dr. P. Binod's lab on genetic engineering of *Lactobacillus brevis* for 1,3-propanediol production. S. Hannibal, C. Haupka, and V. Narisetty, accompanied by Prof. Wendisch, Dr. Nampoothiri, and Dr. Binod, attended the International Conference on Biotechnological Research and Innovation for Sustainable Development (BioSD 2018) held November 22 to 25, 2018, in Hyderabad, India. In the session Industrial Biotechnology of BioSD 2018, C. Haupka won the best poster prize, and V. Narisetty won the prize for the best Young Researchers Rapid Presentation.

Upcoming Events

- September 9 – 10, 2019 | Landwirtschaftszentrum Haus Düsse, Bad Sassendorf
  5th CeBiTec Retreat
- September 23 – 25, 2019 | Center for Interdisciplinary Reseach (ZiF), Bielefeld University
  9th International CeBiTec Research Conference Bielefeld
- September 30 – October 02, 2019 | Center for Interdisciplinary Research (ZiF), Bielefeld University
  ZiF Workshop: Computational Pan-Genomics
- further events are announced on the CeBiTec web page

Publisher
Universität Bielefeld
Centrum für Biotechnologie
Universitätsstr. 27
D-33615 Bielefeld

Conception and Realisation
Dr. Stefan Weidner

Publication
published quarterly

Photos and Figures
p 4: Erkki Oksanen (Natural Resources Institute Finland)
all others: CeBiTec