esib SPOTLIGHT

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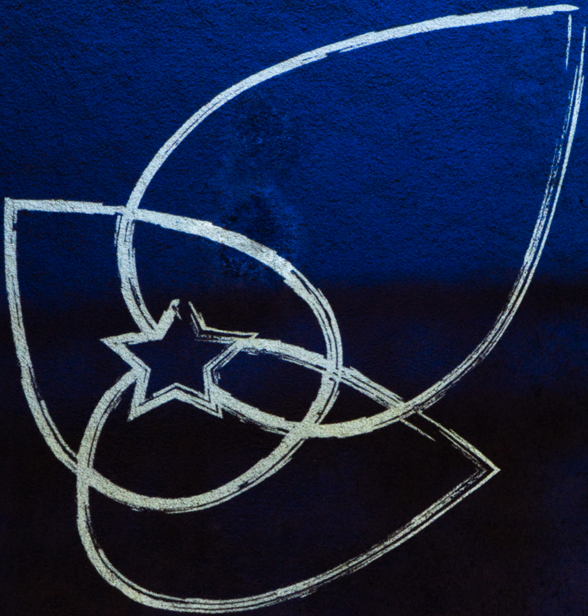


Dear esib community,

It is a great pleasure to welcome you again at the European Summit of Industrial Biotechnology (esib 2024) in Graz, where science, innovation and sustainability converge!

This year we explore the transformative potential of sustainable bioproduction and the revolutionary integration of artificial intelligence (AI) in biotechnology. These advancements not only reflect the cutting-edge nature of our industry but also point towards a more environmentally conscious and efficient future.

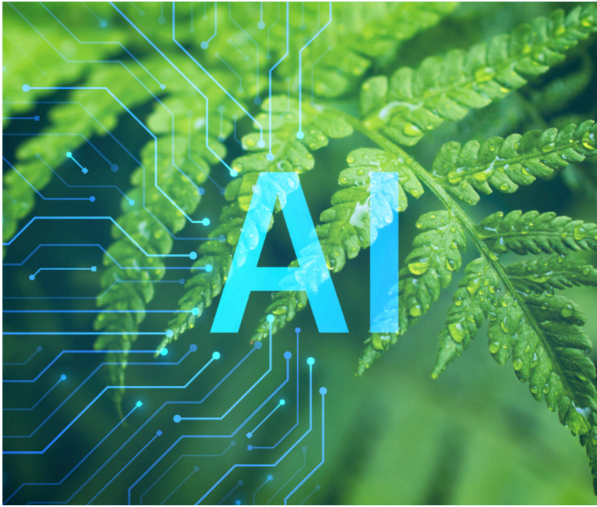
Our program is packed with insightful session on topics like eco-friendly production methods and AI-driven biotechnological processes, all aimed at tackling the environmental challenges of today. With our key note speakers Jo Dewulf (Ghent University), Douglas Clark (Berkley College of Chemistry) and Claudia E. Vickers (Queensland University of Technology) we discuss the development of the whole field of industrial biotechnology towards a green transition. The industrial speakers Stephanie Jedner (Sandoz, Kundl), Alan Hunter (AstraZeneca), Thomas Kreil (Takeda) and Arne Staby (Novonordisk) share their experiences in a sustainable approach for production in biopharma, and David Ruau (Nvidia) explains the impact of AI on biotechnology.

Over the years, esib 2024 has evolved – it is a nexus of ideas, collaborations, and groundbreaking discussions. We are proud of welcoming over 500 participants from across science, industry and politics for the fifth time and to foster dialogue around the latest trends and innovations in biopharma, bioeconomy, and beyond.

Bernd Nidetzky • CSO acib GmbH

Mathias Drexler• CEO acib GmbH

Exploring the transformative potential of sustainable bioproduction and AI in biotechnology

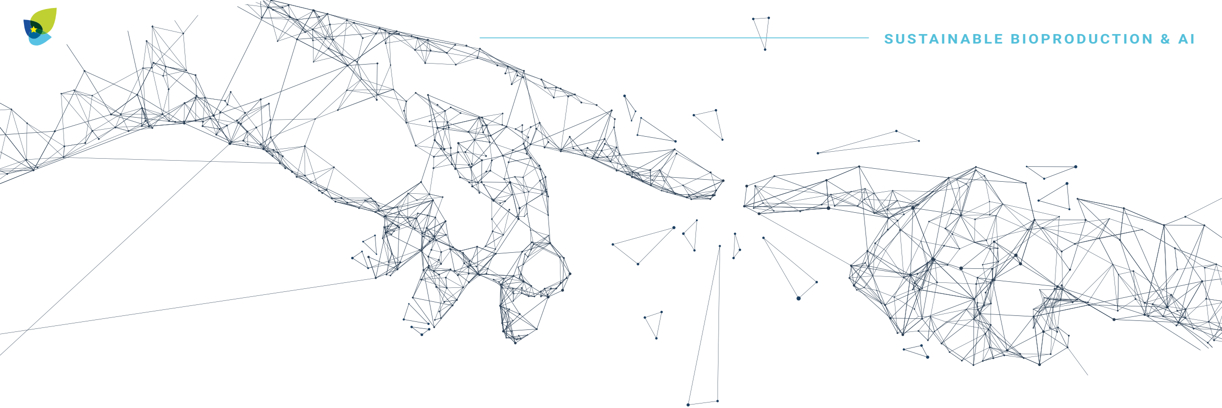


Sustainable bioproduction is at the forefront of efforts to make biotechnology more eco-friendly and resource-efficient. In essence, it refers to the development of biological products – such as biofuels, biopharmaceuticals, and bioplastics – using methods that minimize environmental impact, reduce reliance on fossil fuels, and optimize resource use. These practices align with global initiatives such as the United Nations Sustainable Development Goals (SDGs), especially those focused on climate action (SDG 13), clean energy (SDG 7), and responsible production and consumption (SDG 12).umption (SDG 12).

The transition to sustainable bioproduction is fueled by advances in bioprocessing technologies that prioritize energy efficiency and lower emissions. For example, innovations in microbial fermentation and bioengineering are making it possible to produce bioproducts more efficiently, with a significantly smaller carbon footprint. Additionally, the move towards circular bioeconomies – where biological waste is reused in production – further supports sustainability efforts, enabling industries to close the loop on resource use.

Parallel to the advancements in sustainable bioproduction is the revolutionary integration of artificial intelligence into biotechnology. AI is transforming the way biotechnological processes are optimized, particularly in the fields of biopharma, agriculture, and environmental biotechnology. By analyzing vast datasets, AI can accelerate research and development, optimize production methods, and predict outcomes with greater accuracy.

Honored with the 2024 Nobel Prize in Chemistry, the breakthroughs of David Baker, Demis Hassabis, and John Jumper have elevated molecular modelling: Baker's work in computational protein design facilitates the creation of entirely new proteins for applications in medicine and nanotechnology, while AlphaFold, developed by Hassabis and Jumper, has solved a decades-old challenge by predicting protein structures from their amino



acid sequences. These advancements are paving the way for targeted drug discovery and precision therapeutics.

More broadly, these developments mark a pivotal moment for life sciences by deepening our understanding of molecular biology and providing essential tools to drive synthetic biology forward. AI, in turn, plays a crucial role in synthetic biology itself, where it accelerates progress by enabling the design and simulation of biological systems, the mapping of molecular interaction, and thus making new bioproductions faster and more precise.

This same AI-driven precision extends into bioprocess optimization, where algorithms can fine-tune conditions in real-time, ensuring that microbial growth, fermentation processes, or protein production occur under the most efficient parameters. This not only reduces waste but also increases productivity, reducing costs for companies and improving their environmental performance.

The combined impact of sustainable bioproduction and AI integration is greater than the sum of its parts. AI's ability to optimize processes complements the goals of sustainability by reducing waste, energy consumption, and emissions throughout the production cycle. In the context of a bioeconomy, where efficiency and resource conservation are paramount, AI serves as a powerful tool to enhance the environmental benefits of bioproduction.

This synergy is particularly evident in the biopharmaceutical industry, where the demand for sustainable production is rising. AI-driven models can predict the most resource-efficient ways to produce biologics, reducing the use of chemicals, water, and energy in production processes. By embedding AI into the DNA of biotechnology, we are creating a future where bioproduction is not only smart but also sustainable.

As we look towards the future, the integration of AI and sustainable bioproduction represents a paradigm shift in biotechnology. These advancements are not just about improving processes – they reflect a broader movement towards environmental stewardship and resource efficiency in an industry that plays a crucial role in addressing global challenges such as climate change and sustainable development.

At esib 2024, we are proud to explore these pioneering developments and offer a platform for collaboration, innovation, and discussion. Together, as leaders in biotechnology, we can ensure that these transformative technologies contribute to a more sustainable and efficient future, driving both economic growth and environmental responsibility.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Industrial biotechnology towards a green transition

Jo Dewulf

Professor at Ghent University and Director of the Research Group Sustainable Systems Engineering, Belgium

In your view, what are the most promising advancements in industrial biotechnology contributing to the green transition?
I am not a specialist in industrial biotechnology but from my chemical engineering background, I feel that the capability to start from biobased resources is a competitive advantage in the current transition period. Equally, the moderate need of energy through operations at mild conditions is from a thermodynamic viewpoint a key asset. Another important strength lies in the ability to produce complex molecules with substantial added value.

Your work often highlights the potential of biorefineries in transforming traditional industries. What are the main technological barriers you see in the adoption of biorefineries for a green transition? And how should we overcome these barriers?
Some companies are not (yet) so familiar with biotechnology and know it for its complexity. I feel that quite substantial advanced knowledge is needed for the implementation of biotech processes. Basically, these are elements in terms of acceptance. At a more technical level, I see the downstream processing as an important challenge; in various cases the downstream processing may nullify some of the environmental benefits offered by the bioconversions themselves. Equally important can be the quite demanding conditions that you need to run some biotechnology processes, e.g. with respect to HVAC: many do not realize what these conditions bring in terms of footprint.

In light of your extensive research on biorefineries and sustainability, what are the key breakthroughs you expect in the next decade that will significantly advance the green transition?
In more traditional and somewhat higher-volume markets, biocatalysis can gain some share in conversions, enabling the chemical and fine chemical sector to move towards greener processes. An even larger potential might be not in offering alternatives in existing production pathways, but more in developing new high added value chains. I am a bit familiar with the pharma and health care sector; there I think major opportunities are with developing healthcare new treatments, being alternatives for current health care pathways that are somehow limited in terms of healing and that also entail substantial environmental footprint.

Claudia E. Vickers

Professor at Queensland University of Technology and Director at BioBuilt Solutions, Australia

Your work has been instrumental in advancing synthetic biology and metabolic engineering. What first inspired you to apply these technologies to sustainability challenges, and what keeps you passionate about this area?

When I was training in plant molecular biology, sustainability was more of a catchphrase – it didn't have the urgency that we now have in the face of climate change. By the time I was working with microbial metabolic engineering in the late 2000's, sustainable aviation fuels were a major target, and that's when I started focusing more on sustainability challenges. Since then, it's become more and more important to me, especially since I've had children. In the last decade it's really been my primary focus to determine how synthetic biology can meaningfully address sustainability and climate change challenges. Climate change policy is very much about mitigation, and it's often relying on technologies that haven't yet been invented. That means that sustainability is really the primary scientific and engineering challenge of our age. There isn't enough time deliver the technology to go off-planet, and it would be a miserable existence if we did. It is demonstrably easier and more feasible to deal with the problems we have here on Earth, so that's what we need to focus on.

One of your research focuses is isoprenoids. Could you explain how engineering metabolic pathways for isoprenoid production can contribute to a more sustainable industrial ecosystem?

Isoprenoids are super exciting as a product class, because their extremely diverse chemistry lends them to myriad different applications – ranging from high value, low volume products like pharmaceuticals to high value low volume products like biofuels, and everything in between. All of those molecules are produced using the same core metabolic pathways, so once you can engineer flux and control key nodes of those pathways, you can make a huge variety of molecules. Low volume/high value products don't contribute to sustainability, and biofuels are such high volume and low value that they are extremely challenging to deliver in a cost-effective way when competing with fossil fuels. But there are many other target molecules and applications that can contribute to sustainability. The keys are having a large market size (otherwise you can't have a reasonable impact); understanding the price you can sell the molecule for; being able to produce the molecule at an appropriate rate, yield, and titre; scaling the bioprocess; and being able to make the molecule economically compared to market competitors. So, technoeconomic analysis and life cycle analysis are critical early stage steps in the process of identifying meaningful targets. Bulk chemicals and monomers that can by polymerized to make resins and rubbers are good targets. Agricultural chemicals that improve productivity are also great targets – most of the plant hormones belong to the isoprenoid class of natural products, and many plant hormones have already been developed as agricultural chemicals. Food ingredients and additives are also targets with sufficient market volume to potentially have impact.

We often hear about the importance of reducing the environmental impact of industrial processes. What potential risks or unintended environmental consequences do you foresee in the widespread adoption of biotechnological solutions, and how can they be mitigated?

Currently, there are a lot of assumptions about feedstock availability and cost, as well as waste management. For bulk products, if you have to move the feedstock more than about 80 km, then the cost of transport will probably kill the economics of the bioprocess. And while waste products look promising as feedstock now, the time may come when they aren't cheap or feely available. Moreover, issues such as the 'feed/food vs fuel' problem we saw with biofuels will likely arise when the broader socioeconomic and political context isn't considered. Systems analysis can help a lot when forecasting for emerging technologies like these. In terms of environmental consequences, the use of resources (feedstocks) and management of waste from these processes will need to be considered carefully.

If you were advising a young researcher entering the field of synthetic biology today, what areas of industrial biotechnology would you encourage them to explore to make the most impact in the green transition?

I encourage young researchers to tackle meaningful problems – problems that will shift the needle for sustainability and/or climate change. It might be a big shift or it might be a small shift – but if you can't measure the shift, it's not a shift. You don't need to know how to do a full technoeconomic and lifecycle analysis; just run a Fermi analysis (a back-of-the-envelope calculation) to make an estimation. Use a set of simple, unchallengeable assumptions about the technology development, molecule production, scale-up, and market that can tell you if it's a good idea or not at the given scales. This will help you determine if it's likely to have real world impact.


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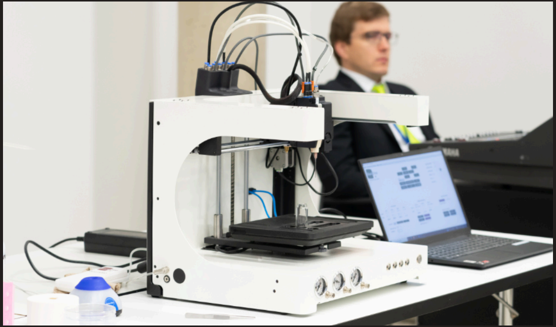


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Sustainable Production in Biopharma

Thomas Kreil
Associate Professor of Virology, Vice President, Global Pathogen Safety at Takeda Vienna

Can you provide an overview of Takeda's sustainability goals, particularly in relation to biopharmaceutical production? How does sustainable production fit into the company's broader environmental initiatives?

Takeda has set some of the most ambitious environmental sustainability targets in the healthcare industry, including achieving net-zero greenhouse gas emissions in our operations by 2035 and across our value chain by 2040 – targets that have just been validated by SBTi.

We've already made significant progress, reducing Scope 1 and 2 emissions by 53% since 2016. This progress has been driven by implementing sustainable solutions, such as shifting 47% of our freight to sea shipping. Reducing waste and advancing recyclable materials is also a priority. Over 50% of our paperboard packaging is now FSC-certified or includes recycled content, a goal we achieved two years ahead of schedule.

Sustainable production is a central component of our broader environmental initiatives, adopting a holistic approach that encompasses both direct and indirect emissions. Key actions for reducing direct emissions include implementing manufacturing site-specific net-zero roadmaps, investing in transformative technologies for renewable heat and achieving 100% renewable electricity across operations. Key actions for reducing indirect emissions include encouraging suppliers to set science-based targets, shifting 50% of shipped volume to sea freight instead of air freight, establishing a Sustainability by Design Program for life-cycle assessments of high-impact products and making strategic investments in new technologies to address hard-to-abate emissions.

Are there any recent technological advancements in sustainable biopharma production that you're particularly excited about? How are these being implemented at Takeda?

We are taking decisive action to decarbonize where viable solutions already exist, while boldly driving innovation to tackle emissions in areas where scalable solutions are yet to be developed. One of the most exciting recent technological advancements in sustainable biopharma production is our AHEAD (Advanced Heat Pump Demonstrator) project. This innovative project is being implemented at our Vienna production site and exemplifies innovation and leadership in sustainable production. In the AHEAD research project, a natural gas-free steam-generating heat pump will be integrated into industrial operation for the first time, aiming to achieve a greenhouse-gas emission reduction of up to 80 percent at one of Takeda's major manufacturing sites in Vienna using only natural refrigerants. This groundbreaking technology is aiming to achieve unprecedented heat utilization temperatures over 200°C. AHEAD has been awarded the Net Zero Industries Award 2023 and was presented at COP28, showcasing its global significance and Takeda's leadership in sustainability. The project, which is a partnership between Takeda, the Austrian government and the Austrian Institute of Technology, includes developing a concept to replicate the system at our other locations worldwide. It could serve as an example for the pharmaceutical and other industries and make a significant environmental impact globally.

What do you see as the most promising technologies or approaches for achieving sustainability in biopharma production over the next decade?

The highly regulated nature of the sector makes it challenging to implement new materials and processes, as patient and worker safety and compliance must remain the top priority. This creates challenges to innovate in reducing waste and emissions, but it also highlights the importance of finding sustainable solutions. It is the collective effort of several promising sustainability technologies and approaches which will help to achieve the desired outcomes. The mix aims to enhance energy efficiency and promote the use of renewable energy sources in biopharma production. There is a lot of potential in utilities (steam, heat, hot water, pure water etc.), where we can ideally drive real improvement through CO_2-free generation and minimal demand. Moving away from gas towards efficient electricity usage, such as heat pumps and energy recovery, is crucial (example AHEAD). Using 100% renewable electricity across operations is a critical step towards reducing Scope 1 and 2 emissions. Transitioning to electric-powered facilities helps to minimize our carbon footprints. Scaling digital solutions provides greater transparency of value chain emissions and improves participant experiences in clinical trials. Redesigning primary packaging materials to be more sustainable, such as PVC-free blister packs and bioplastics (plant-based vs fossil fuel based plastic), is another important step. Implementing disposable equipment decreases water and energy use while minimizing contamination risks. Finally, employing innovative recycling and waste treatment methods help to recover valuable by-products, keep resources in the production cycle and reduce environmental impact.

How does Takeda plan to maintain its leadership in sustainability as biopharma production continues to grow and evolve?

For the last two centuries, our company has been committed to considering patients, and society across every action we take. That's why Takeda's sustainability strategy is not just about reducing emissions, its rooted in improving both human and planetary health. Takeda views the climate crisis not just as an environmental issue, but as a public health challenge. A healthier planet means healthier people. That's why we act with urgency to minimize our environmental impact, developing sustainable solutions to improve public health and working with our peers and strategic partners to foster responsible innovation to protect the world in which we live. At Takeda we believe that collaboration is the only way to effectively accelerate our effort to reduce our common environmental footprint. Through partnerships and recognition, such as collaboration with institutions like the AIT Austrian Institute of Technology and winning the Net Zero Industries Award 2023, Takeda demonstrates its commitment to science-based targets. Our net zero near term and long-term targets were recently verified by the Science Based Target initiative. We plan to maintain our leadership in sustainability through a mix of different approaches.


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The Role of AI in Revolutionizing Biotechnology:

Insights from NVIDIA's David Ruau

At the 2024 European Summit of Industrial Biotechnology (ESIB), David Ruau from NVIDIA delivered an impactful keynote exploring the transformative role of artificial intelligence (AI) in biotechnology. His presentation covered groundbreaking developments across healthcare, life sciences, digital biology, and genomics, emphasizing NVIDIA's pivotal role in driving innovation in these domains.

Healthcare & Life Sciences:

Advancing Patient Care

AI is revolutionizing healthcare by enhancing areas such as medical imaging, drug discovery, genomics, and digital health. Medical imaging, a cornerstone of patient care, exemplifies this transformation. AI enables the analysis of 2D and microscopic images and optimizes the patient journey by leveraging X-rays and other modalities. NVIDIA provides pre-trained models available at ai.nvidia.com, which can be fine-tuned to specific applications, reducing the development timeline and improving accuracy.

David Ruau introduced the concept of an "AI Factory for Medical Imaging" – a comprehensive blueprint encompassing data preparation, model training, and deployment. By standardizing AI workflows, such as through the NIM (NVIDIA Inference Microservice) format for prototyping, organizations can move from concept to scalable solutions efficiently.

Digital Biology:

AI-Driven Protein Design

In the realm of protein design, AI frameworks such as NVIDIA's BioNeMo are reshaping the industry. Traditionally, screening billions of molecules for drug discovery was time-consuming and expensive. NVIDIA's MolMIM, a generative AI for biomolecular design, has streamlined this process. Now, only around 1,000 molecules need to be screened to achieve a high hit rate, significantly reducing costs and time.

Ruau highlighted advancements in antibody development by a pharma partner. By integrating AI model and an integrated lab platform, the pharma partner shortened the drug discovery process from two years to just nine months. Such advancements underscore AI's potential to accelerate timelines while maintaining precision.

Another innovation discussed was DiffDock NIM, a model for predicting protein-molecule interactions. This tool is vital for understanding how drugs interact with biological targets, enabling more effective therapies.

Genomics:

The Frontier of Personalized Medicine

Genomics, the study of the genome and its functions, is another field where AI is making substantial inroads. By analyzing multiscale omics data, AI tools are helping researchers unravel complex biological networks. These insights pave the way for personalized medicine, where treatments are tailored to individual genetic profiles.

The Broader Impact:

of AI in Biotechnology

NVIDIA's emphasis on standardization and scalability reflects the industry's move toward systematic AI adoption. By providing tools like the NIM format for prototyping and production-ready models, NVIDIA is lowering the entry barriers for organizations and fostering innovation.

David Ruau's keynote at ESIB 2024 painted an exciting picture of biotechnology's future. From accelerating drug discovery to enabling precision medicine, AI's integration into biotechnology promises to revolutionize how we approach healthcare and life sciences.

As NVIDIA continues to innovate in AI, the biotechnology industry stands to benefit from reduced timelines, optimized processes, and breakthroughs in patient care. David Ruau's insights reaffirm the transformative potential of AI, heralding a new era of discovery and innovation. The future of biotechnology is here, and it's powered by AI.


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A PLATFORM FOR Start-ups

The HTS Start-up corner emphasized the relevance of Styria as a breeding ground for start-ups in the sector of biotechnology. Five cluster members made use of the opportunity and showcased their companies at esib 2024.

bisy group

bisy, is a leading and worldwide active technology and tool provider for microbial protein expression and engineering. Bisy provides innovative strains, vectors and processes for the balanced coexpression of multiple proteins and metabolic pathways and for an environmentally friendly, as well as, highly efficient production of enzymes, protein materials and pharma proteins. Own inventions enable the necessary throughput for innovative R&D solutions and production. Bisy's tools and training on site enable an accelerated generation of production strains and their direct implementation in bio-production processes by bisy's partners.

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Stefan Payer

Enzyan aims to be the number one platform for biosolutions. Enzyan simplifies and accelerates the development of new cell-free multistep bioprocesses (cascades) in the laboratory in order to take full advantage of their benefits. We combine automated workflows with AI elements in a self-driving lab (SDL) to generate experimental data for process development more efficiently and faster. Enzyan licenses proprietary processes to chemical manufacturers or co-develop new solutions with industry partners. The customized IP developed by Enzyan should drive the establishment of greener enzyme processes in industrial plants.

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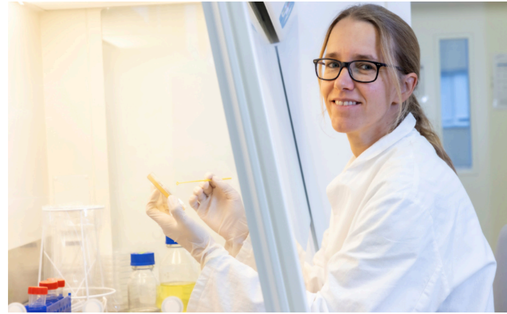

Claudia Rinnofner

myBIOS offers solutions to produce proteins and enzymes, relying on precision fermentation and the yeast Pichia pastoris. Based on license-free tools and in-house developments, myBIOS has developed its own production platform. Alternatives to animal proteins are particularly in demand! For the food and feed industry, myBIOS relies on methanol- and antibiotic-free processes. Since 2022, myBIOS has been successfully supporting customers with strain development. In 2024 myBIOS focuses on the implementation of an automated protein production platform that enables individual selection of tools and scales. In addition, the company invest in process development and equipment to accompany customers from strain to product.

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Philipp Eibl & Christian Witz

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Chilling Life Science

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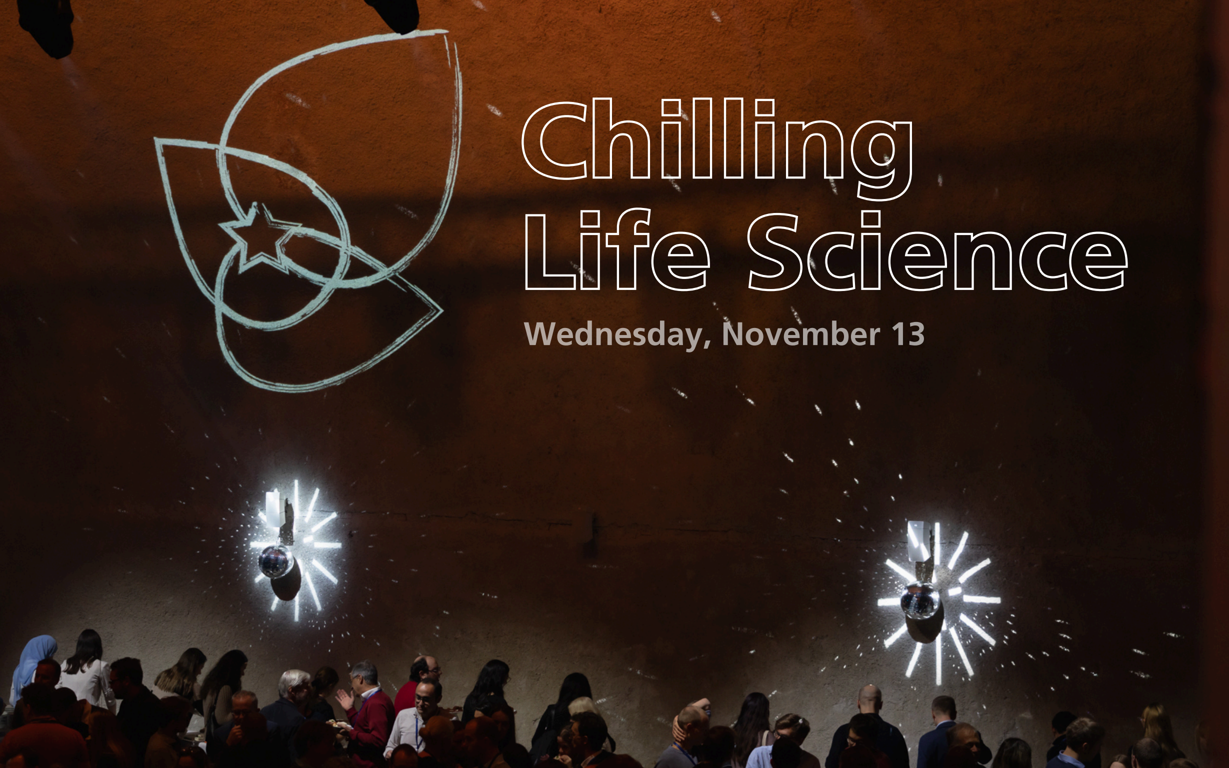


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