

Editorial



Jan Lucht

This special issue is dedicated to exploring some of the evolving landscapes of biomanufacturing in Switzerland, highlighting some of the key innovations, challenges, and opportunities shaping the sector. Switzerland's strong academic institutions, world-class research facilities and a robust regulatory framework have made it an attractive hub for both established pharmaceutical giants and innovative biotech startups.

Switzerland has been an important contributor to innovation in the chemical, pharmaceutical and life sciences, building on the foundations of this success, which was laid in the 18th century. Michael Altorfer *et al.* 'Biomanufacturing in Switzerland – Past, Present and Future' describe the development of the Swiss biotechnology sector from the early beginnings in the 1930s with a biocatalytic step in the vitamin C production to today's multifaceted application of biotechnology in Switzerland. As a matter of fact biotechnology has become a key asset to the contemporary Swiss economy, and the article outlines early steps, the current state of biomanufacturing, and key factors required to stay on a successful track.

The Swiss Industrial Biocatalysis Consortium (SIBC) was founded in 2004 to promote biocatalysis as a technology across various industries within Switzerland for fine- or agro- chemicals, flavors and fragrances, or pharmaceuticals, where there are plenty of common denominators when discussing biocatalysis. Serena Bisagni *et al.* 'The Swiss Industrial Biocatalysis Consortium (SIBC) turns 20!' share examples of using biocatalysis to solve (stereo)chemical challenges and highlighting the innovative approaches and successful implementations in various industries.

The beginnings of single-use technologies (SUT) dates back to the early 1950s with the polyethylene bags for blood. For readers who are not familiar with single use technology (SUT), the paper of Diego Schmidhalter *et al.* 'Single-Use Technology Today – A Cornucopia of Applications' is rich in technical and other information, gives an insight to SUT, applied today to the production of biopharmaceuticals ranging from cell cultures to products containing highly active compounds such as drug conjugates.

Human and animal food and feed products today come from either plant or animal production systems. The huge potential of single cell-based nutrient production, based on the natural available microbial biodiversity, is not leveraged yet. Fabian Wahl *et al.* 'Microalgae as Key to a Land-free Circular On-farm Feed Production System' addresses the options of using microalgae as nutritious biomass with excellent bioavailability using atmospheric CO₂ as a carbon source. For this purpose, the Swiss microalgae collection AlgoScope was launched to identify, catalog, characterize, and conserve native Swiss microalgae with biotechnological potential.

The perfusion mode for the production of biopharmaceuticals goes back to the 1990s. It has become increasingly important in biopharmaceutical production in recent years, and Vivianne Ott *et al.* 'Perfusion-Based Antibody Production in the Ambr[®] 250 Modular' discuss a bioreactor system for the production of a mAb with Chinese Hamster Ovary (CHO) cells with ultra-high cell densities of more than 150 × 10⁶ cells mL⁻¹ for the inoculation and continuous mAb production over 23 days in a proof-of-concept experiment, achieving a volumetric productivity of 0.65 g L⁻¹ d⁻¹.

The paper of Andrew Gomm *et al.* from Syngenta 'Biotransformations at Syngenta: A Focused Perspective on Metabolites and Natural Products' concentrates on the use of biocatalysis for the production of metabolites and the importance of fermentation for natural products. The authors point to the fact that the structural complexity of agrochemicals is steadily increasing and resembles more and more that of pharmaceuticals. As in pharmaceuticals, it is important for market registration to know and profile the possible metabolites generated by the degradation of agrochemicals. However, this is actually more complicated than with pharmaceuticals, as many different degradation pathways of fungi or bacteria must be considered to assess the environmental fate and potential noxiousness of an agrochemical.

Biomanufacturing can offer significant economic and environmental benefits compared to chemical production. Ulla Letinois *et al.* describe the biomanufacturing of vitamin B₁ (riboflavin), the antioxidant canthaxanthin and the fat-soluble vitamin A in their contribution 'Way Forward For Biomanufacturing and Biotechnology in Europe'. Global warming, loss of biodiversity, hunger and malnutrition requires immediate private-public commitments and investments, where biocatalysis, biotransformation and biosynthesis can contribute significantly to sustainable alternatives.

Precision and efficiency are key aspects of biomanufacturing, advantages which ultimately lead to more sustainable processes. The strategic importance of biomanufacturing is the topic of Roland Wohlgemuth in 'Biomanufacturing as Key Technology for a Sustainable Bioeconomy'. The author describes why industrial biomanufacturing has been considered as the future of chemical production.

The biomanufacturing initiatives which are ongoing and planned worldwide by several governments are an indication of its strategic importance. The challenges for sustainable solutions remain, and the search and innovation for future-proof solutions must be maintained. Switzerland, with its strong foundation and forward-thinking approach, is poised to play an important role in this rapidly evolving domain. We invite you to explore the articles in this issue and join the conversation on the future of biomanufacturing.

Jan Lucht, scienceindustries

Hans-Peter Meyer, Swiss Academy of Engineering Sciences (SATW)

Roland Wohlgemuth, Swiss Coordination Committee of Biotechnology (SKB)

Cover: Map of Swiss biomanufacturing locations (see Altorfer *et al.* in this issue, p. 292) and large scale microbial biomanufacturing at Lonza, Visp (image ©Lonza, used under license).

The CHIMIA Editorial is very grateful to Dr. Jan Lucht, Dr. Hans-Peter Meyer and Dr. Roland Wohlgemuth for their great efforts in organizing this issue on Biomanufacturing showcasing the diverse areas of research being carried out in Switzerland and beyond.