https://doi.org/10.1038/s44286-024-00051-3

Bringing biomolecular engineering on board

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Biomolecular engineering enriches the toolkit of chemical engineers, enabling them to tackle diverse challenges in biotechnology and medicine; we welcome submissions in this space.

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In the early 2000s, academic departments worldwide began to change their name from 'Chemical Engineering' to 'Chemical and Biomolecular Engineering'. This lexical change signaled an important paradigm shift in the field: the formal merger of traditional chemical engineering principles with molecular, cellular and synthetic biology. Accompanying this change was a rapid push to integrate aspects of biology into the base undergraduate curriculum to embrace more fully the emerging opportunities in the medicinal, chemical, food and agricultural industries[1]. Fast forward nearly two decades, and today we see that biomolecular engineering firmly stands entrenched as a core component of the discipline.

The origins of biomolecular engineering, however, date back much earlier to the first half of the twentieth century, with the first use of process engineering principles to extract products from biological systems. A prominent early example is the large-scale production of penicillin during the 1940s amidst the Second World War[2,3]. The finicky nature of this antibiotic posed several major design challenges for bioprocess engineers and researchers alike. These included identifying a microbial strain that maximized product yield, designing large-scale fermenters with optimized reaction conditions, recovering desired products from the fermentation broth and preventing microbial contamination throughout the entire process[2]. Applying such principles to biological systems remains a cornerstone of contemporary biomolecular engineering; some more recent examples include the large-scale production of mRNA vaccines for COVID-19 (ref. 3) and the design of a microbial gas-fermentation process for commodity chemical production[4].

In this issue of *Nature Chemical Engineering*, we feature another example of modern biomolecular engineering, here combining synthetic pathway design, metabolic engineering and bioprocess engineering. Featured on the cover and in an Article by Choi and co-workers, benzyl acetate, a small aromatic ester often used in flavors and fragrances, is produced from D-glucose in metabolically engineered *Escherichia coli*. This team of researchers designed two biosynthetic pathways consisting of upstream and downstream modules that convert metabolites of *E. coli* into benzyl acetate, as it does not naturally produce this compound. A delayed co-culture strategy was then developed to optimize production of the upstream and downstream strains, whose performance was assessed in a two-phase extractive fed-batch fermentation. As noted in a News & Views by Sokolova and Haslinger, this strategy, involving delayed inoculation of one strain, led to major titer and selectivity enhancements, but future work is needed to show that this strategy can be implemented at an industrial scale.

At *Nature Chemical Engineering*, we are interested to hear about your research advances in all areas of biomolecular engineering, not just those related to bioprocess engineering.

Indeed, today, this sub-field covers a diverse array of topics, including tissue engineering, systems biology, protein engineering, regenerative medicine and metabolic engineering, to name a few. Our pre-launch collection features 15 recent Articles on biomolecular engineering from the Nature Portfolio to give a clearer view of intended topical coverage.

For example, the collection highlights enzymes, microbes and microbial consortia for plastics degradation and upcycling; non-equilibrium phenomena in synthetic biomolecular condensates; liquid–liquid phase separation with active fluids; tailored particles for enhanced topical drug delivery to the skin; and stress relaxation mechanisms in tissue growth dynamics.

Our inaugural issue also features an Article on complex material design for granule-releasing hydrogel platforms in tissue regeneration and bioelectronics, a Comment on engineering native biological complexity from the inside–out and outside–in and a Comment on chemical engineering in medicine. As discussed in our very first Editorial, irrespective of the topic or system, papers are evaluated based on the perceived significance and potential generalizability of the results in the context of core chemical engineering principles such as mass and energy balances, thermodynamics, transport processes, separations, reactor design and reaction kinetics, and process design and control.

Biomolecular engineering empowers chemical engineers to design, optimize and scale-up biological processes and systems with enhanced efficiency, reliability and productivity. *Nature Chemical Engineering* is intended to be an inclusive home for all research that matters to the broader community; we want to hear from all researchers who are contributing to driving the field forward — whether engineering chemical or biomolecular processes.

Published online: 8 March 2024

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