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EDITORIAL

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Editorial

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Industrial microbiology was established as a branch of microbiology with the introduction of the first large-scale fermentation processes for the production of citric acid and later penicillin. Industrial production of penicillin was rapidly followed by production of other antibiotics, and the requirement for improvement of these processes resulted in development of advanced methods for mutagenesis and screening. Furthermore, in order to design optimal fermentation processes it became necessary to understand the physiology of the microorganisms used for antibiotics production, preferentially at the quantitative levels. With the immense success in improving antibiotics production it was clear that these technologies could also be used for developing bioprocesses for the production of other metabolites, and this resulted in the development of fermentation processes for a range of other products, in particular amino acids to be used in food and feed. Screening for better producers of amino acids and other metabolites generally required more advanced screening methods, and also knowledge about regulation of the metabolism in the cell factories applied. Thus, even though efficient natural producers were initially selected for use in a given process, it was through industrial microbiology that much knowledge was accumulated on basic metabolism and its regulation and this knowledge was used for further improving the production process. One of the pioneers of the field of industrial microbiology was Professor Arnold Demain, who made many seminal contributions to improvement of processes for production of both antibiotics, amino acids and organic acids, but also provided the basis for much of our current understanding of metabolism in many industrially important microorganisms.

Even though the traditional approaches of industrial microbiology were very successful, and still today play a very important role in improvement of industrial fermentation processes, the introduction of genetic engineering enabled application of more directed approaches where specific genetic modifications are introduced with the objective of improving the titer, rate and yield (TRY) of the cell factory. The use of genetic engineering is often referred to as biotechnology and the use of biotechnology for development of industrial processes based on microbial fermentation is therefore referred to as industrial biotechnology. Although it has been more than 40 years since the introduction of genetic engineering, not until the last 10 years genetic engineering has found wide application in the fermentation industry, and the term industrial biotechnology is therefore also relatively new. With the expansion of the field to cover biotechnology, *the Journal of Industrial Microbiology* changed its name to *Journal of Industrial Microbiology and Biotechnology* (JIMB) a few years back.

The directed approach to improve the TRY is generally referred to as metabolic engineering, which is an enabling science that combines design of strategies for engineering the central carbon metabolism to ensure redirection of the carbon fluxes with implementation of these strategies through genetic engineering. This research field has in recent years had a tremendous impact on the field of industrial biotechnology, with a number of novel bioprocesses

Special Issue: Metabolic Engineering.

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being introduced and many more in the pipeline. However, the impact is likely to be even bigger in the future as new tools for rapid engineering of the genome, often referred to as genome editing, developed through synthetic biology and for detailed phenotyping of cell factories using tools from systems biology will enable faster strain characterization and faster implementation of many different design strategies.

Despite the impact on engineering natural producers and improving their TRY performance, probably the largest transformation from industrial microbiology to industrial biotechnology is that today industry to a large extend relies on a few cell factories, not necessarily naturally producing the product of interest. Thus, our ability to transfer single enzymes or even whole pathways between organisms has enabled the generation of cell factories that can produce a wide range of products. This strategy was first implemented for production of industrial enzymes, where the leaders in the field today are relying on a few cell factory platforms for producing a wide range of enzymes. The advantage of using a cell factory platform is that generic optimization can be used for production of many different products, but also a new product can rapidly be produced with the necessary TRY requirements for commercial success. In recent years, the idea of cell factory platforms has been implemented for production of advanced biofuels and chemicals. Here two key platform cell factories are the bacterium *Escherichia coli* and the yeast *Saccharomyces cerevisiae*, two organisms that are extensively studied in academic labs, but are now also widely used for industrial production [2, 3, 8].

This special issue of JIMB focuses on metabolic engineering and includes 11 reviews and 2 research articles from leaders in the field. Several methods and analytical tools are covered, including flux balance analysis [5, 9] and labeling-based estimation of intracellular fluxes [1]. A number of applications of metabolic engineering are also included, ranging from fuel and chemical production [2, 4, 6, 10] to the synthesis of recombinant proteins [7]. While *E. coli* and *S. cerevisiae* are the prevalent platform cell factories highlighted, the engineering of other bacteria, yeast and mammalian hosts is also covered.

References

1. Antoniewicz M (2015) Methods and advances in metabolic flux analysis: A mini-review. doi:10.1007/s10295-015-1585-x
2. Barton NR, Burgard AP, Burk MJ, Crater J, Handke P, Osterhout RE, Pharkya P, Steer BA, Sun J, Trawick JD, Van Dien SJ, Yang TH, Yim H (2015) An integrated biotechnology platform for developing sustainable chemical processes. J Ind Microbiol Biotechnol. doi:10.1007/s10295-014-1541-1
3. Buijs NA, Siewers V, Nielsen J (2013) Advanced biofuel production by the yeast *Saccharomyces cerevisiae*. Curr Opin Chem Biol 17:480–488
4. de Jong BW, Shi S, Valle-Rodríguez JO, Siewers V, Nielsen J (2015) Metabolic pathway engineering for fatty acid ethyl ester production in *Saccharomyces cerevisiae* using stable chromosomal integration. J Ind Microbiol Biotechnol. doi:10.1007/s10295-014-1540-2
5. Kim B, Kim WJ, Kim DI, Lee SY (2015) Applications of genome-scale metabolic network model in metabolic engineering. J Ind Microbiol Biotechnol. doi:10.1007/s10295-014-1554-9
6. Kim S, Clomburg JM, Gonzalez R (2015) Synthesis of medium-chain length (C6-C10) fuels and chemicals via β-oxidation reversal in *Escherichia coli*. J Ind Microbiol Biotechnol. doi:10.1007/s10295-015-1589-6
7. Klein T, Niklas J, Heinzle E (2015) Engineering the supply chain for protein production/secretion in yeasts and mammalian cells. J Ind Microbiol Biotechnol. doi:10.1007/s10295-014-1569-2
8. Nakamura CE, Whited GM (2003) Metabolic engineering for the microbial production of 1,3-propanediol. Curr Opin Biotechnol 14:454–459
9. Simeonidis E, Price ND (2015) Genome-scale modeling for metabolic engineering. J Ind Microbiol Biotechnol. doi:10.1007/s10295-014-1576-3
10. Tashiro Y, Rodriguez GM, Atsumi S (2015) 2-Keto acids based biosynthesis pathway for renewable fuels and chemicals. J Ind Microbiol Biotechnol. doi:10.1007/s10295-014-1547-8