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Review IJIBB

Trends and Latest Developments in Industrial Biotechnology

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Abstract

Microbial fermentations are used to produce a variety of goods in a sustainable manner. Because of the growing trend in the food industry toward plant-based foods and meat and dairy product substitutes, microbial fermentation will play an increasingly important role in this sector, as it will enable the production of valuable foods and food ingredients in a sustainable and scalable manner. Microbial fermentation will also be employed to improve and expand the production of environmentally friendly chemicals and natural items. New firms that translate academic research into breakthrough processes and products using cutting-edge technologies will account for a large portion of this market expansion. Here, we look at current innovation and technological trends and offer advice on how to start and expand a company in industrial biotechnology.

Keywords: Fermentation, industrial, biotechnology, trends, development, engineering, discoveries

INTRODUCTION

The modification and development of bacteria, filamentous fungi and yeast are the foundations of industrial biotechnology. Since the dawn of civilization, living beings have used regulated microbiological fermentation process to produce fermenting foods and drinks [1]. The whole first industrial-scale fermentation methods for manufacturing chemicals like acetone, Citric acid and butanol were created in the early 20th century. Citric acid synthesis by *Aspergillus niger* in 1919 was a significant advance since it was the first aerobic fermentation method, necessitating the development of technology that could ensure the supply of sterile air in sufficient quantities to support the process. This invention allowed for about the first industrial-scale production of penicillin during World War II, and shortly afterward, numerous unique procedures to produce a variety of antibiotics were developed. In the 1960s and 1970s, microbial fermentation produced a large range of chemicals, including amino acids used in food and feed, as well as industrial enzymes with a wide range of applications. The biotech sector was founded in the early 1970s with the introduction of genetic engineering to manufacture proteins for medicinal use [1]. The majority of top-selling medications are currently produced through fermentation (including cell cultures), with Insulin as well as other hormones, for example, are created through microbial fermentation [2]. The ability to influence microbes sparked the concept of creating a wide range of products by constructing cell factories. Several large-scale ventures were formed, such as Eastman Chemical Company, which extensively engaged in the commercial production of dyes, including indigo [3]. The technology for engineering microorganisms, on the other hand, was not yet developed, and most of these ventures failed to deliver financially or at scale. Additional

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knowledge about microbial cells was collected as a result of the apparent genomics revolution that occurred 2000s, additional information regarding microbial cells was gathered, shotgun DNA sequencing creation of modern ‘omics data processing and data evaluation of microorganisms, as well as the development of current ‘omics data processing and data analysis of microorganisms were critical parts of this study. As a result, their metabolic pathways and pathophysiology have improved [4, 5]. The development of mathematical models describing the metabolism, first of the bacterium *Escherichia coli* [6], was possible based on this genomic data, and then of the yeast *Saccharomyces cerevisiae* [7], two widely used cell factories and models for bacterial and eukaryotes biology, respectively. It also became possible to further develop these genome-scale metabolic stoichiometric models beyond descriptive functions and to start using different additional data and constraints that yielded better predictions that could be confirmed experimentally [8]. Simultaneously, genetic, and genomic engineering approaches evolved, resulting in metabolic engineering (see Glossary) and later synthetic biology disciplines. Cell factories are being employed to generate important chemicals, solvents, monomers, medicines, nutraceuticals, antibiotics, and other products because of all these conceptual, computational, and experimental approaches.

REVIEW

Due to a mix of scientific limits, societal, economic, and commercial concerns, as well as existing molecular and analytical tools, industrial biotechnology has experienced challenges. On either hand, the sociopolitical context where these cellular manufacturers are intended to operate has been unstable. There has been a massive effort put into creating sustainable manufacturing processes to substitute petro or related fuels, mechanical and chemical over the previous couple of decades. Many major chemical companies, including BASF, DP, DSM, and total have established large metabolic engineering disciplines and partnerships. Moreover, several start-up companies have been established with the purpose of developing novel bio-based production techniques for long-term pharmaceuticals. Due to a major study issued by the US Department of Energy (DoE) in 2004 then updated in 2010, efforts have generally based on the production of petrochemical products that might potentially replace essential building blocks employed with in chemical sector. itaconic acid and lactic acid are the only two chemicals on the DoE list, lactic acid and itaconic acid, have industrial output, with lactate being added to a list in 2010 after massive production. Lactic acid is manufactured in enormous numbers, with a deal valued more than US$2.5 billion, with the majority of it going into the production of polylactate. Despite substantial progress in the creation of novel bioreactors for petroleum products, there will still be a considerable distance should go [9]. There may well be greater interest in producing bio-based commodities chemicals and biofuels. The industry of bio-based chemicals was anticipated to be worth US$59 billion in 2018, with a compound annual growth rate (CAGR) of 10.3 percent likely to reach US$130 billion by 2026. The movement is being driven by the biological substitution of chemicals in a wide range of customer goods, as well as the elevated areas of functional foods and biofuels. Large firms are constantly upgrading their biomanufacturing and infrastructural facilities with new technologies and advanced. Companies reportedly seemed to be refocusing their efforts away from commodity chemicals and into food, healthcare, feed, and agriculture. Despite substantial progress in the development of innovative bioreactors for petrochemical products, there is still a long way to go. Industrial biotechnology can provide new solutions and products through expanding markets. We wrap up our discussion by presenting some suggestions for biotechnological research [10–13].

Scientific Discoveries in Synthetic Biology and Metabolic Engineering

Numerous technological innovations in industrial biotechnology, biotechnological applications, and synthetic biology have analysis with the help creation of novel technologies to ensure various compounds. These advancements can be divided into four categories:

1. New synthetic biology technologies that have aided in the creation of quicker strains
2. Analysis of Data and integration, which has also allowed for greater in-depth phenotypic analysis of created strains.

3. Skills for producing synthetic genes and even complete genomes in a short amount of time. As a consequence, new companies like Twist Biosciences and Codex DNA have sprung up to provide synthetic DNA services to the synthetic biology industry.
4. The use of enhanced metabolic simulations to enhance the quantitative description of metabolism has allowed for a greater predictions of multiple design techniques [14].

Synthetic biology arose from such an interest in electronics, with the goal of developing specialized regulatory circuits utilizing biomolecules that can be used in a variety of design schemes as plug-and-play [15–17]. The strain modelling approach started gaining popularity in the field of genetic manipulation, where it has a variety of applications [18]. As a result, a number of unique methodologies for constructing cell factories have been developed, as well as technologies which have allowed the automating of experimentation phases in the biotechnological design–build–learn–test cycle [19–20]. There were considerable advancements in ‘omics data studies of important cell manufacturers in current history. Numerous multi-omics interpreting and integration investigations on *S. cerevisiae* and *E. coli* have yielded additional insight and improved our knowledge of all these organisms’ physiology and metabolism. Quantitative proteomics advances have been particularly important because these data integrate well with mathematical modelling of metabolism and improve the predictive strength of such models, such as modelling overflow metabolism in both *E. coli* and *S. cerevisiae* and new insights into the Crabtree effect in various yeast species [17, 19, 20].

DISCUSSION

Even though it is difficult to pinpoint the exact needs for implementing strong biotechnological start-ups, they give suggestions based on experiences in founding, advising, financing, and assisting start-ups. We believe there are four major groups.

1. Consider the ‘zero-to-one’ concept; that is, consider simple thoughts that result in numerous modifications.
2. Be prepared to pivot when the time comes; that is, do not get too tied to your original concept; instead, examine it objectively and change its course if necessary.
3. Consider the intended product profile or aim for an MVP as soon as possible, because this will advise them well about specific challenges of a specific investment.
4. Failing often and as soon as feasible, with the goal of learning as much as possible and cutting losses when necessary, preparing oneself for change or a new venture.

Furthermore, biological discovery leads to a range of new solutions that implies that even if they have invested large resources, the very first adopters do not always have an edge or total IP protection. It can be a problem for investors because they will have to concentrate on quickly advancing start-up enterprises to the point where they can place their products available and become industry leaders. The discovery of immunological check-point inhibitors, which have revolutionized cancer treatment, is a good example of how biology’s complexities may lead to alternative approaches.

CONCLUSION

Despite its turbulent history, they are confident that forthcoming industrial biotechnology development will be large and revolutionary. As explained previously, advancements in essential wet-lab and dry-lab technologies are enabling cell producers and support products to produce faster and better products. If somebody can prepare and learn, the road to triumph is well-marked and attainable these crucial skills with the goal of gaining access to large markets or disrupting existing markets.

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