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Techniques and uses of industrial biotechnology

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Abstract

Enzymes and microbes are used in industrial biotechnology to create valuable compounds from renewable resources. The field of industrial biotechnology is expanding quickly because to its links to lower energy use, greenhouse gas emissions, and waste production. Here, we highlight some key technologies for industrial biotechnology, such as downstream processing, synthetic biology, systems biology, metabolic engineering, protein engineering, and metabolic engineering. Furthermore, we demonstrate how these instruments have been effectively used in a number of case studies, such as the synthesis of bio-fuels, lactic acid, and 1,3-propanediol. It is anticipated that the food, pharmaceutical, chemical, and agricultural sectors would all use industrial biotechnology more and more.

KEY WORDS: - biotechnology, protein engineering, synthetic bio-tool, bio-processing

INTRODUCTION

Using living cells and/or their enzymes, industrial biotechnology—also referred to as white biotechnology—is the application of contemporary biotechnology to the sustainable manufacture of chemicals, minerals, and fuels from renewable sources. In contrast to the first two waves of biotechnology, this discipline is often considered to be the third wave. Since biotechnology offers more efficient processes at lower operational and capital expenditures, the market economy is the main impetus behind the development and application of industrial biotechnology. Furthermore, this tendency will continue to advance due to societal and political demands for environmentally friendly industrial production systems and sustainability, as well as the depletion of crude oil supplies and an increase in global demand for energy and raw materials [Soetaert et al., 2006].

Metabolic engineering

Metabolic engineering is a tool of similar importance in industrial biotechnology. Metabolic engineering reroutes precursor metabolic fluxes, modifies protein cellular levels, fine-tunes gene expression, and regulates gene expression regulation in microorganism hosts like E. coli, Saccharomyces cerevisiae, and actinomycetes by modifying enzymatic, transport, and regulatory functions in the cell. For instance, different genetic alterations were applied to Corynebacterium glutamicum, which was originally a microbe that secreted L-glutamic acid, in order to create strains that are capable of producing amino acids like lysine, threonine, and isoleucine [Leuchtenberger et al., 2005].

PROTEIN ENGINEERING

Protein engineering is one of the most crucial instruments in industrial biotechnology. A wild-type enzyme found in nature is typically unsuitable for use in an industrial process. For the enzymatic process to be commercially feasible, enzyme performance must be engineered and optimized in terms of activity, selectivity on non-natural substrates, thermostability, tolerance toward organic solvents, enantio selectivity, and substrate/product inhibition [Luetz et al., 2008]. Protein engineering can be approached in two main ways: guided evolution and rational design. To achieve desired modifications by site-directed mutagenesis, rational design requires a thorough understanding of the protein's structure, function, and catalytic mechanism. The directed evolution method, on the other hand, just needs to know the protein sequence. This method entails screening or selecting for positive mutants after repeated cycles of random mutagenesis and/or gene recombination.

SYNTHETIC BIO-TOOLS

A new field of synthetic biology, in which basic genetic components and modules are integrated into a synthetic biological circuit, holds great promise for the comprehension, design, and construction of customized gene expression networks, even though protein and metabolic engineering have significantly advanced industrial biotechnology [Purnick et al., 2009]. In contrast to those found in nature, scientists are working to produce de novo genomes in artificial microbes that are simpler to comprehend and control.

Tools for downstream bioprocessing

The process of scaling up enzyme-catalyzed processes from benchtop laboratory settings to industrial settings is a broad field. Sterilization, rheology, mixing, agitator design, fluidization, heat transfer, mass transfer, separation and purification, surface phenomena, hydrodynamics, modeling, instrumentation, and process control are some of the various fields it encompasses. Although continuous and semi-continuous bioreactors are also utilized, depending on the type of bioprocess, batch-wise bioprocesses make up the bulk of bioprocesses. In downstream bioprocessing, recovering and purifying the product is frequently the most expense [Woodley et al., 2008]. Chromatographic techniques (adsorption), membrane separation, and extraction by distillation or liquid-liquid extraction are a few of the frequently employed separation procedures.

CONCLUSION

We have discussed current developments in multiple areas of industrial biotechnology in this review, including metabolic engineering, protein engineering, downstream bioprocess engineering, and a number of case studies. In the end, the economics of particular procedures determine whether industrial biotechnology succeeds. The development of industrial biotechnology would be significantly impacted by a number of issues, including the depletion and increasing cost of fossil fuel reserves, global warming, feedstock pricing, government regulations, consumer awareness, and additional scientific advancement. In the chemical and pharmaceutical industries, more and more processes will be biotechnologically driven due to the growing availability of genetic information, a developing toolkit for manipulating metabolic pathways, and engineer designer bugs.

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