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Study on Metabolic Effects of protein for Microbial Metabolic Engineering

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Abstract: Microbial metabolic engineering is a new bioengineering technology, which can improve the yield of compounds, optimize energy utilization and solve various problems faced by human beings by changing the genetic information, metabolic pathway and metabolic flux of microorganisms. Protein is the main undertaker of life activities, and its metabolic process involves complex biochemical reactions and cell regulation mechanisms. Protein metabolism plays an important role and application in microbial metabolic engineering. The purpose of this paper is to explore the metabolic effects of protein for microbial metabolic engineering, so as to deeply understand the metabolic characteristics and regulation mechanism of microorganisms. Microbial metabolic engineering has important applications in improving the yield of compounds, optimizing energy utilization, environmental treatment and medicine. The research and application of protein metabolism can provide more in-depth theoretical basis and technical support for microbial metabolism engineering, thus promoting the development and utilization of microbial resources.

Keywords: Microbial Metabolism; Protein; Compound; Regulation Mechanism.

1. Introduction

Microbial metabolic engineering is a new bioengineering technology, which can improve the yield of compounds, optimize energy utilization and solve various problems faced by human beings by changing the genetic information, metabolic pathway and metabolic flux of microorganisms [1]. Protein metabolism is an important research field in microbial metabolic engineering, because it is directly related to the growth, reproduction and survival of microorganisms. In microbial metabolic engineering, the study on the influence of protein's metabolism is of great significance, which can provide scientific basis for optimizing industrial biological process and solving the bottleneck problem in the development of biotechnology industry [2]. In nature, there are many kinds of microorganisms with wide adaptability and metabolic ability. By means of genomics, protein genomics and metabonomics, researchers can fully understand the functions and interactions of genes, protein and metabolites of microorganisms, and then realize the genetic transformation and metabolic optimization of microorganisms [3].

Protein is the main undertaker of life activities, and its metabolic process involves complex biochemical reactions and cell regulation mechanisms. During the growth and reproduction of microorganisms, the synthesis and degradation of protein are highly regulated to adapt to different physiological needs and environmental conditions [4]. The study on the influence of protein's metabolism can help us better understand the physiological characteristics and adaptation mechanism of microorganisms, and provide theoretical basis and technical support for the application of microbial metabolic engineering. In addition, microbial metabolic engineering has a wide application prospect in industrial biological process optimization, energy utilization, environmental treatment, medicine and other fields [5]. The study on the influence of metabolism in protein can provide beneficial solutions for these fields and promote the development and utilization of microbial resources.

Based on this, the purpose of this paper is to explore the metabolic effects of protein for microbial metabolic engineering, so as to deeply understand the metabolic characteristics and regulation mechanism of microorganisms and provide reference for the research and application in related fields.

2. Overview of Microbial Metabolic Engineering

Microbial metabolic engineering is a new bioengineering technology, which can improve the yield of compounds, optimize energy utilization and solve various problems faced by human beings by changing the genetic information, metabolic pathway and metabolic flux of microorganisms. It is an interdisciplinary field of biology, chemistry, physics and engineering, and has a wide application prospect. The basic principle of microbial metabolic engineering is to use the genetic information and metabolic pathway of microorganisms to transform and optimize microorganisms through technical means such as gene editing, transcriptomics, protein genomics and metabonomics [6]. Its purpose is to find and explore new microbial resources and reveal the laws and mechanisms of microbial life activities in order to meet the higher requirements of human production and life. Figure 1 shows the cycle process of metabolic engineering in the post-genome era.

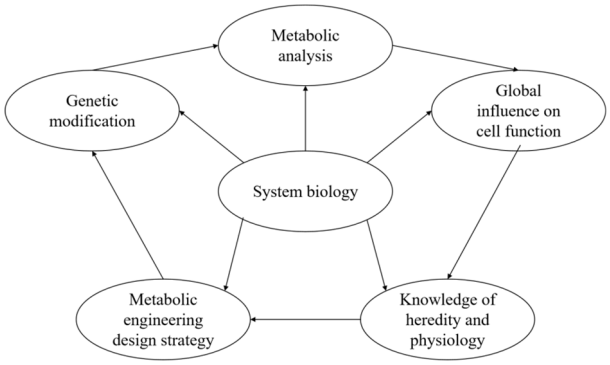

Figure 1. Metabolic engineering cycle in post-genome era

The main technical means of microbial metabolic engineering include gene editing technology, gene knockout technology, gene complementation technology, metabolic engineering technology and protein engineering technology. Among them, gene editing technology can accurately edit and transform the genes of microorganisms, thus changing the genetic characteristics of microorganisms; Gene knockout technology can regulate genes through specific expression, so that microorganisms can express specific genes under specific environmental conditions; Gene complementation technology can make use of gene complementation between different kinds of microorganisms to improve their viability and adaptability. Metabolic engineering technology can improve the yield of compounds and optimize energy utilization by changing the metabolic pathway and flow of microorganisms. Protein engineering technology can improve the adaptability and viability of microorganisms by transforming the structure and function of protein. Figure 2 shows the application of protein omics and metabonomics in microbial metabolic engineering.

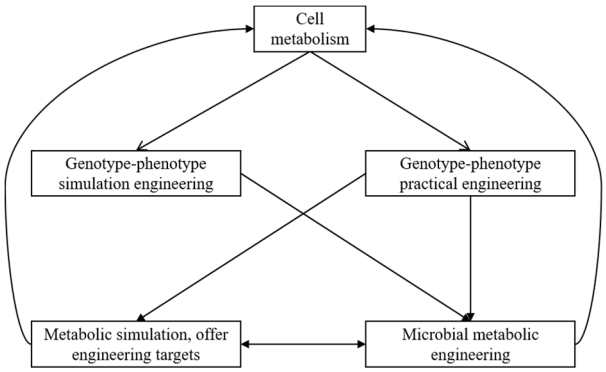

Figure 2. Application of proteomics and metabolomics in microbial metabolic engineering

Microbial metabolic engineering has a wide range of applications, including industrial fermentation, bioenergy, environmental management, medicine and other fields [7]. For example, in the field of industrial fermentation, microbial metabolic engineering can be used to improve the yield and efficiency of microbial fermentation and produce various useful compounds, such as antibiotics, vaccines, biological preservatives, etc. In the field of bioenergy, microbial metabolic engineering can be used to develop efficient biofuels, such as biodiesel and bio-hydrogen. In the field of environmental treatment, microbial metabolic engineering can be used to degrade pollutants and treat wastewater. In the field of medicine, microbial metabolic engineering can be used to develop new drugs and treatments, such as producing drug molecules by microbial fermentation.

In a word, microbial metabolic engineering is a comprehensive bioengineering technology, and its research and application involve many disciplines. With the development of science and technology and the continuous expansion of application fields, microbial metabolic engineering will surely play a more important role in the future biotechnology field.

3. Mechanisms of Protein Metabolism

Protein is an essential substance in life activities, and its metabolic process involves complex biochemical reactions and cell regulation mechanisms. The mechanism of protein metabolism includes two main processes: synthesis and degradation:

(1) Synthesis mechanism of protein.

Protein is synthesized on the ribosome in the cell, which is the place where protein is synthesized in the cell. Amino acids are the basic units for the synthesis of protein, and they form peptide bonds and connect into polypeptide chains through dehydration and condensation reaction [8]. After synthetic peptides chain, after a series of processing and modification, such as cutting, modification, adding sugar, etc., protein with specific function and structure is finally formed. Ribosomes play a key role in the synthesis of protein. Ribosomes are composed of rRNA and protein, among which rRNA is one of the important components of ribosomes, which can combine with amino acids and participate in the synthesis of peptide chains. Another important component of ribosomes is protein, which is an essential enzyme and regulator for synthetic peptides chain. In the synthetic peptides chain, ribosomes first combine with mRNA molecules to form a translation complex. MRNA molecules carry genetic information transcribed from DNA and guide the synthesis direction of polypeptide chains. Then, ribosomes continue to add amino acids through repeated synthesis cycles until a complete polypeptide chain is synthesized.

(2) Degradation mechanism of protein.

The degradation of protein is realized by the catalysis of protease. There are many kinds of proteases in cells, which can catalyze the decomposition of protein into different fragments and amino acids. In general, protein degradation is strictly regulated, and only happens under specific physiological needs, such as apoptosis and immune response [9]. Protease plays a key role in the degradation of protein. Proteases are a large family of many different kinds of enzymes, including lysosomal enzymes, metalloproteinases, cysteine proteases and so on. These enzymes have different modes of action, such as cleavage of peptide bonds, cleavage of peptide chains, etc., and can specifically act on different kinds of protein to degrade them into amino acids or small molecular peptides.

Lysosome is a kind of organelle, which can devour the substances in cells and digest them. Lysosomal enzymes are the main enzymes in lysosomes, which can decompose protein, organelles, viruses and other substances into small molecules for cell reuse. Metalloproteinases are a kind of proteases that depend on metal ions. They can catalyze the reactions of peptide chain shearing, cleavage and modification. Among them, matrix metalloproteinases are important enzymes that can degrade extracellular matrix (ECM). They can catalyze the degradation of various components in ECM, thus affecting cell migration, infiltration, growth and differentiation. Cysteine protease is a kind of protease existing in various organisms, which can catalyze the cleavage of peptide bonds and the hydrolysis of protein. Under the action of cysteine protease, protein is decomposed into specific peptides and amino acids, which can be further metabolized and utilized.

4. Influencing Factors of Protein Metabolism

(1) Genetic information of microorganisms

The genetic information of microorganisms has an important influence on protein's metabolism. Studies on genomics, transcriptomics and protein genomics show that the gene and protein expression level of microorganisms are

closely related to their growth and viability. Through gene editing technology and genomics analysis, we can reveal the metabolic mechanism and adaptive mechanism of microorganisms, and further provide theoretical basis and technical support for microbial metabolic engineering.

(2) Culture conditions

Culture conditions also have an important influence on protein's metabolism. Culture temperature, pH value, oxygen and nutrients will all affect the growth of microorganisms and the metabolism of protein. In the process of microbial fermentation, the growth rate of microorganisms and the yield of protein can be improved by optimizing the culture conditions. For example, the output of antibiotics can be improved by controlling the temperature and pH value, and the growth rate of microorganisms can be improved by adding nutrients.

(3) Environmental factors

Environmental factors also have an important influence on protein's metabolism. Physical factors (such as temperature, humidity and pressure) and chemical factors (such as redox agents and heavy metal ions) in the environment can affect the growth of microorganisms and the metabolism of protein. For example, high temperature can accelerate the synthesis and degradation of protein, while heavy metal ions can affect the structure and function of protein. The metabolic effects of these environmental factors on protein are helpful for us to deeply understand the adaptation mechanism and evolution process of microorganisms.

(4) Substrate concentration

The substrate concentration also has an important influence on the metabolism of protein. Substrate is the energy source for the growth and survival of microorganisms, and the change of substrate concentration can affect the growth rate of microorganisms and the synthesis and degradation of protein. For example, high concentration of glucose can promote the growth and glycolysis of microorganisms, while low concentration of amino acids can inhibit the growth of microorganisms and the synthesis of protein. The effects of these substrate concentrations on protein metabolism provide us with a means to regulate the growth and viability of microorganisms.

5. Application of Protein Metabolism in Microbial Metabolic Engineering

(1) Increasing the yield of compounds

In microbial metabolic engineering, the yield of compounds can be improved by changing the genetic information and metabolic pathway of microorganisms. For example, through gene editing technology, the transformation and optimization of specific genes in microorganisms can increase the rate and output of useful compounds produced by microorganisms. In addition, through metabolic engineering technology, the metabolic pathway and flow of microorganisms can be changed, and more substrates can be converted into desired compounds, thus improving the yield of compounds.

(2) Optimize energy utilization

Microbial metabolic engineering can also be used to optimize energy utilization. For example, through genetic engineering technology, the specific genes in microorganisms can be transformed and optimized, which can increase the utilization efficiency of renewable energy by microorganisms. In addition, through protein engineering technology, the enzymatic reaction rate and energy utilization efficiency of microorganisms can be changed, thus optimizing energy utilization.

(3) Environmental governance

Microbial metabolic engineering can also be used for environmental treatment. For example, through genetic engineering technology, the ability of microorganisms to degrade pollutants can be changed, so as to realize effective treatment of pollutants. In addition, through protein engineering technology, the adaptability and viability of microorganisms can be changed, so as to realize the prevention and control of harmful microorganisms in the environment.

(4) The field of medicine

In the field of medicine, microbial metabolic engineering also has important applications. For example, specific drug molecules or bioactive substances can be produced by genetic engineering technology. In addition, through protein engineering technology, biological characteristics such as immune response ability and drug metabolism rate of microorganisms can be changed, thus providing new ideas and methods for drug design and development.

6. Conclusion

Protein metabolism plays an important role in microbial metabolic engineering. Through the study of protein's metabolic mechanism, researchers can deeply understand the growth and survival mechanism of microorganisms, and how to transform and optimize the metabolic pathway and flow of microorganisms through genetic engineering technology, metabolic engineering technology, protein engineering technology and system biology methods, so as to improve the yield of compounds, optimize energy utilization, and promote the development of environmental governance and medicine.

In application, microbial metabolic engineering has a wide range of applications in improving the yield of compounds. Specific genes in microorganisms can be transformed and optimized by gene editing technology to increase the rate and yield of useful compounds produced by microorganisms. In terms of optimizing energy utilization, microbial metabolic engineering can change the enzymatic reaction rate and energy utilization efficiency of microorganisms through genetic engineering technology or protein engineering technology, thus optimizing energy utilization. In environmental treatment, microbial metabolic engineering can prevent and control harmful microorganisms in the environment by changing their adaptability and viability. In the field of medicine, microbial metabolic engineering can produce specific drug molecules or bioactive substances, and at the same time, it can change the biological characteristics of microorganisms such as immune response ability and drug metabolic rate through protein engineering technology, thus providing new ideas and methods for drug design and development.

To sum up, microbial metabolic engineering has important applications in improving the yield of compounds, optimizing energy utilization, environmental governance and medical fields. The research and application of protein metabolism can provide more in-depth theoretical basis and technical support for microbial metabolism engineering, thus promoting the development and utilization of microbial resources.

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