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ENGINEERING CELLS FOR BIOFUEL PRODUCTION

Аннотация. Данная статья посвящена получению клеток, обладающих необходимыми характеристиками для повышения производства биоэтанола из растительных сахаров. В статье представлена информация о важности перехода производств на возобновляемые ресурсы, получении клеток с необходимыми характеристиками и описание процессов синтеза химических веществ в модифицированных клетках. Основная цель статьи – собрать информацию в целом о биотопливе, измененных клетках и протекающих в них механизмах получения этанола и других химических соединений.

Ключевые слова: биотопливо, разработка клеток, получение этанола.

Abstract. This article is devoted to the production of cells with the necessary characteristics to increase the production of bioethanol from vegetable sugars. The article provides information on the importance of transition to renewable resources, obtaining cells with the necessary characteristics and describing the processes of chemical substances synthesis in modified cells. The main purpose of the article is to collect information about biofuels, modified cells and the mechanisms of obtaining ethanol and other chemical compounds flowing in them.

Keywords: biofuel, cell development, ethanol production.

Introduction

In modern world, the problem of the deficiency of non-renewable resources (such as oil, gas and others) is becoming more and more acute. This has a negative impact on all industries and especially on the production of various types of fuel. To solve this problem, it is necessary to switch to renewable sources.

Diesel is the common fuel because of its high energy density and the high efficiency of the diesel engines. The problem with it is that so far it is entirely made from un-renewable source.

Steps in the study of a renewable fuel source

Bioinformatics and bioengineers program yeast to convert plant starches into lipids. Scientists have received great progress in the bioethanol - ethanol production from vegetable sugars.

The researchers have reprogrammed the genome of yeast cells to convert sugars into oils in purpose to increase production of ethanol. This makes it possible to produce fuels such as diesel, but from renewable resources.

The scientists improved the metabolism of yeast, that naturally produce lipids, to make them more efficient. The reactions of metabolism of these microbes have been rewired, to make them able to produce oils more efficiently.

The bioengineers have made a new strain of yeast by manipulating the yeast genome. That can tolerate elevated levels of both glucose and ethanol, while producing bioethanol faster.

Researchers manipulate the genes encoding proteins, responsible for the transcription of genes, and, in turn, to manage the repertoire of genes expressed in a particular cell. These types of transcription factors bind to DNA and enable or disable genes to control cell expression.

Renewable fuel problems

Fuels such as corn bioethanol are useful as gasoline additives for working cars, but they are not suitable for large vehicles.

Efforts to develop engines that run on biodiesel made from used plant oils have had some success, but plant oil is expensive fuel source. Sugars such as cane and corn are cheaper and more prevalent, but these carbohydrates must first be converted into lipids.

Cell genome programming

Researchers began working with a yeast known as *Yarrowia lipolytica*. It produces a lot of lipids on its own in nature. Bioengineers transformed *Yarrowia* metabolic reactions that convert surplus NADH to NADPH, which can be used to synthesize lipids.

As a result of the improvement of the metabolic pathway, yeast cells require one third of the glucose volume less than that required by unmodified yeast cells to produce the same amount of oil.

The process of transform glucose to lipid at current corn starch prices may be economically viable. Researchers expect this process to become even more efficient.

The researchers are using cheaper sources of plant material (grass, agricultural waste and others), which would require converting the cellulose into glucose.

Engineering cells for more efficient biofuel production

Alcohols are promising candidates in the search for renewable alternatives to gasoline.

Bioengineers have developed a method to significantly increase isobutenol production in yeast. They have designed yeast in such a way that it synthesis takes place in mitochondria. Engineers using this technology were able to increase isobutenol production by a factor of approximately 2.6.

This development method is applicable not only to isobutenol, but also to other chemicals. This makes it possible to make biochemicals inside the organelles, which can be much better suited to this purpose than the cytosol of yeast cells.

Explanation of the yeast produce isobutanol

Yeast produce isobutanol in a set of reactions that take place in two different cell locations. The synthesis begins with pyruvate, a product of breakdown sugar. It is transported into the mitochondria. Then pyruvate can enter reaction results in production of valine, an amino acid. Alpha-ketoisovalerate (alpha-KIV), a precursor in the valine and isobutanol biosynthetic pathways, is made in the mitochondria in the first phase of isobutanol production.

Valine and alpha-KIV can be transported out to the cytoplasm. Afterwards they are converted by a set of enzymes into isobutanol. Other scientists have tried to relocate the enzymes needed for alcohol synthesis in the cytoplasm. But some of these enzymes are more difficult to function in cytoplasm than in mitochondria.

The researchers have moved the second phase, which usually occurs in the cytoplasm, in the mitochondria. They did this by developing special enzymes for tag

expression found on the mitochondrial protein, directing the cells to their transfer in the mitochondria.

This transfer of enzymes accelerated the production of isobutanol by a factor of 2.6 times, and the yield of the two companion alcohols, isopentanol and 2-metal-1-butanol.

Reasons for increasing the productivity of engineering cells

According to researchers, the sharp increase occurred for several reasons. One cause is that clustering enzymes increase the likelihood of reactions.

Another hypothetical explanation is that the movement of the second phase of metabolism in the mitochondria makes it easier for enzymes to capture a limited number of precursors before they can enter other biochemical reactions

The enzymes of the second phase of metabolism, which are naturally in the cytoplasm, must recognize what comes out of the mitochondria and try to transform it.

Application of the results obtained

In many situations, it is necessary to limit all stages of reaction in a small space. This can prevent drift and cell damage by harmful intermediates and increase the efficiency of ethanol synthesis. The results are widely used in metabolic engineering.

Researchers are now looking for ways to increase the yield of isobutane and reduce the production of ethanol, which is the main product of sugar decomposition in yeasts. The choice of ethanol pathway is an important step towards producing yeast suitable for isobutane production.

Conclusion

Biofuel - fuel obtained from vegetable or animal raw materials. The use of such fuel reduces the depletion of non-renewable resources, which are becoming less and less every year.

Bioengineers in search of a way to increase biofuel production have come to change the metabolism of yeast cells and their genomes in general. Research in this

area has made significant progress, but scientists continue to work to improve bioethanol productivity. Their development is already being used in the fuel industry.

The production of renewable high-energy fuels will be economically feasible with these improvements. Now researchers are working on additional modifications.

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