Biotechnology: what it is and how it helps mankind to develop

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ABSTRACT:

Biotechnology has been used by the human species since ancient times. This is because, in its broadest sense, biotechnology comprises the application of microorganisms, plants and animals to obtain processes and products of interest to society. Thus, ever since we used microorganisms to ferment bread, beverages, and other foods, we were already performing biotechnology. As time went by and science advanced, new technological tools were developed and started to complement biotechnology as we know it today.

Keywords: Biotechnology; healthcare; innovation; patents; biotechnology; health; microorganisms

INTRODUCTION:

Biotechnology is the set of procedures involving manipulation of living organisms to manufacture or modify products. The word has a Greek origin: "bio" means life, "tecnos" means technique, and "logos" means "knowledge".

Since the Babylonian civilization, biotechnology has been used to make bread and beer from living microorganisms. This strategy became known as classical biotechnology.

Over time, biotechnology has been transformed by incorporating new tools and applications. Advances in knowledge about genetics, microbiology, chemistry, physiology, molecular biology, among others, were decisive in developing what we now call modern biotechnology.

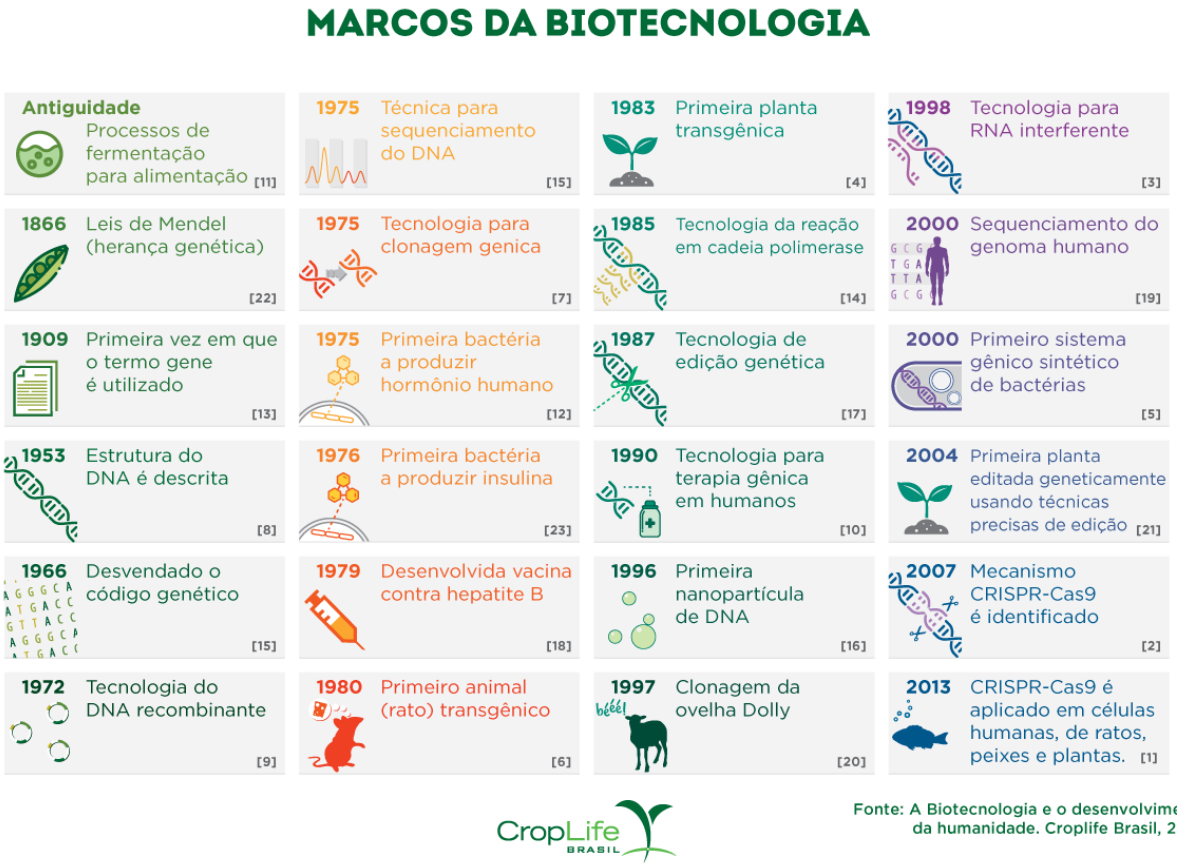
Modern biotechnology

The transition from classical to modern biotechnology began with the discoveries of the monk Gregor Mendel, considered the father of genetics. The scientist monk was the first to demonstrate DNA recombination (1866) during sexual reproduction, through his experiments involving the crossing of peas.

This discovery raised the hypothesis that there would be transfer of characteristics between living organisms, opening the way for the development of microorganisms and plants with characteristics of interest.

In light of this, several researches related to genes were intensified, resulting in major milestones that made modern biotechnology possible. Noteworthy are

1. The discovery of the structure of DNA by Watson and Crick in 1953.
2. The identification of restriction enzymes, led by researcher Werner Arber and his collaborators in the 1960s. Recognized as molecular scissors, restriction enzymes are essential in molecular biology, as they cut specific stretches of DNA.
3. The development of recombinant DNA technology in 1972 by researcher Paul Berg, making it possible to introduce specific, controlled characteristics into organisms.



Fonte: A Biotecnologia e o desenvolvimento da humanidade. Croplife Brasil, 2020

Biotechnology's application area

These molecular discoveries have resulted in a technological revolution. From the recombinant DNA technology, scientists, for the first time, were able to manipulate DNA. With this technique, the isolation and manipulation of genes has become a reality.

The manipulation of genes has made it possible to optimize microorganisms for the production of substances in greater quantity and efficiency in the area of foodstuffs. An example immediately applied was the enhancement of catalase and chymosin developed by microorganisms for cheese fermentation.

The same strategy employed in microorganisms started to be used in the development of plants with improved characteristics. As is the case of some soy plants that have an oil composition similar to olive oil, i.e., from this soybean we started to produce healthier oil.

In fact, different sectors of society have benefited and developed viable and safe strategies for the development of Genetically Modified Organisms (GMOs) aimed at meeting consumer demands and sustainable production of food, fiber, and energy.

Biotechnology in Agriculture

Biotechnology has accelerated the genetic improvement of important crops used in agriculture.

Thus, biotechnology's contribution to agriculture occurs mainly through the adoption of plants that receive, lose or have genes modified using very precise molecular techniques. Thanks to biotechnology, genetic improvement can occur without the need for transmission of characteristics only between plants of the same species.

Present in the world's crops for more than 20 years, GM plants have increased production in the field. This is because most of the modifications made to date make the plants resistant to certain pests and/or tolerant to herbicides. In this way, in several cases, the use of GM plants has optimized the use of pesticides.

Since 1998 Brazil has adopted transgenics in agriculture. Soy, corn, cotton and, more recently, eucalyptus and sugar cane are the transgenic crops planted in the country.

In addition to insect-resistant and herbicide-tolerant plants, the use of biotechnology can also lead to the development of varieties that are more resistant to disease, foods of higher nutritional value, cultivars adapted to urban farms, and plants better adapted to climatic adversities, such as drought.

The combination of biotechnology and agriculture will be key for Brazil to meet its commitment to reduce greenhouse gas emissions by 43 percent by 2030, as agreed at the 2015 United Nations Conference.

Biotechnology in health

DNA manipulation techniques have also contributed to advances in medicine. Various vaccines have been developed by means of modern biotechnology techniques. Inclusive, one of its first applications was in the health area.

As recently as 1982, insulin began to be produced by transgenic microorganisms and made available to society. Moreover, medicines produced from monoclonal antibodies (made by cloning a single lymphocyte), hormones and vaccines (by recombining the DNA or RNA of disease-causing agents) are examples of how biotechnology continues to contribute to health.

Still impacting directly on health, insect vectors of disease are being genetically modified (GM). An example of this strategy has been applied in the control of dengue fever, where the GM Aedes aegypti carries a gene that, when transmitted to offspring, does not allow them to develop.

Industrial biotechnology

Industrial biotechnology uses GM microorganisms to produce numerous products. Known as cell factories, these GMOs are engineered to achieve high yields and tolerance to adverse industrial conditions.

From them, many food products, chemicals, fuels, enzymes, antibiotics, materials (such as tissues), and health products can be developed.

The use of industrial biotechnology to replace traditional processes gives these companies a more efficient and sustainable production character.

As is the case with GM microorganisms that can be used in the transformation of plant biomass into fuel. This technology replaces the use of fossil energy sources, derived from petroleum, which are non-renewable and highly polluting.

Enzymes derived from GM bacteria are used in the production of soap powder, aiding in the efficiency of the product to certain conditions of washing processes and obtaining specific effects such as the "fading" of jeans.

In the food industry, in addition to transgenic plants and their derivatives (such as oils, proteins, starches), other ingredients and additives are produced from fermentation performed by GM microorganisms.

These include:

- Vitamins: B12, B2 and C;
- Flavors: vanilla, diacetyl, and citronellol;
- Enzymes: proteases, amylases, and lipases;
- Amino acids: glutamate, threonine, and lysine;

- Organic acids: lactic, citric, and acetic;
- Gums: gellan, xanthan and dextran;
- Antimicrobials: nisin.

Biotechnology and biosafety

We know that biosafety is related to the control and minimization of risks that may arise from the exposure, manipulation and use of living organisms (whether genetically modified or not). Such controls have been applied in medical schools and experimental laboratories since the 19th century.

However, the concept of biosafety was only proposed in 1975 at the Asilomar Conference in California, USA. At this time, the scientific community began to discuss the risks of gene manipulation.

Researchers, concerned about the possible consequences of their work in relation to new molecular techniques, drew up preliminary guidelines for the physical and biological containment of experiments with GMOs. These principles served as the basis for establishing protocols and standards in modern biotechnology at the international level.

Later, at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, a commitment was made in the Convention on Biological Diversity (CBD) to formulate a protocol.

This protocol sought to ensure an adequate level of environmental and human health protection in relation to the use of GMOs and modern biotechnology. The results of this commitment resulted in the Cartagena Protocol, signed on May 15, 2000.

Biosafety in Brazil

Brazil has had biosafety legislation since 1995, when Law 8974/95 came into effect, establishing biosafety rules to regulate the handling and use of GMOs in the country. Ten years later, this law was revised and resulted in the Biosafety Law 11.105/05, which updated the terms of GMO regulation in Brazil, including containment research, field experimentation, transportation, importation, production, storage, and commercialization.

The Biosafety Law (11.105/05) establishes safety rules and inspection mechanisms for activities involving genetically modified organisms and their by-products. This legislation requires that any GMO undergoes a careful evaluation by the National Biosafety Technical Commission (CTNBio), a body whose existence and legitimacy are provided for in the law.

CONCLUSION

Biotechnology has been used since the dawn of civilization and continues to develop constantly, meeting different demands.

The knowledge acquired in the second half of the 20th century resulted in the deliveries of biotech products used in our daily lives.

With industrial biotechnology it will be possible to increasingly intensify production in a sustainable way. The manufacture of renewable fuels from agricultural waste (sugarcane bagasse, seeds, among others) is an example of how we can reduce the exploitation of natural resources.

Biotechnology in health has accelerated the diagnosis and treatment of diseases. Besides the products available, synthetic biology will open a new world in understanding different viruses and producing vaccines. With advances in CRISPR technology, cell therapies for the Human Immunodeficiency Virus (HIV) are being evaluated.

In agriculture, biotechnology has become indispensable. After all, it is with biotechnology that we will be able to meet the growing demand for food, without losing sight of sustainability. But we will see much more yet. Nanotechnology and synthetic biology have the great potential to bring about a new transformation in agricultural biotechnology. Just to mention an immediate possibility, with them we can increase the targeting and precision of everything we do in the field.

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