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Biotechnology: Impact on our Life

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Currently, the word “Biotechnology” is commonly used as evidenced by the fact that in the Google search engine. It is found 6,480,000 results, which means that the term, in addition to being present in numerous discussion forums, both in press and on television and radio, it has been incorporated into our vocabulary.

The interest that has attracted biotechnology in academic and business circles, has led to a proliferation of definitions a direct result of its observation from different approaches, which have in common the use of living beings, their processes or products for profit by the revision of these and of their environment. The OECD defines biotechnology as “the application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services”. Colloquially, it would be a set of techniques and sophisticated technologies, which are replacing classical methodologies, allowing more immediate results, and making it possible to address new challenges unthinkable until recently. These challenges include the majority of the lines of biotechnology research aimed at solving health problems. It is a technology; you can apply to a large number of areas or sectors independent of health, such as agriculture, food, the environment, industrial production or energy. Therefore, biotechnology is not in itself a science, is a multidisciplinary approach involving several disciplines and Sciences (biology, biochemistry, genetics, virology, agronomy, engineering, chemistry, and medicine, among others) and represents a considerable diversity of industrial activities. Consequently, Biotechnology will have a global impact at three levels:

1. Nature, since it is a technology, it can be applied to a large number of areas or sectors such as medicine, pharmaceutical industry, agriculture, food, environment, industrial production or energy.
2. Reach, because the population demands throughout its life quality health care, healthy foods and an adequate management and conservation of natural resources, as well as the environment.
3. Economy, since it can be considered one of the main engines of global economic growth in both developed economies and emerging economies.

Biotechnology is classified according to a scale of colors that is merely indicative in red, green, white, gray and blue. As a reminder, we detail below the skills of each color:

1. **Red biotechnology:** Refers to biotechnological applications in the areas of human and animal health. It includes technologies such as molecular diagnostics, cellular engineering, new therapeutic molecules of biotechnological origin and gene therapy.
2. **Green biotechnology:** It refers to the applications of biotechnology in Agriculture and agrifood. In addition, it includes research and obtaining genetically modified plants, such as transgenic plants.
3. **White biotechnology:** It is related to the use of systems biological for the manufacture, transformation or degradation of molecules, thanks to enzymatic and fermentative processes, for industrial applications in sectors such as materials, chemical and energy. In these cases, biotechnological processes are used as an alternative to conventional chemical processes, which brings economic and environmental benefits. The importance of white biotechnology for a more sustainable industry has been repeatedly pointed out by entities, such as the European Commission or the OECD, being one of the challenges of the European Platform for Sustainable Chemistry.
4. **Gray biotechnology:** Focuses on environmental applications, creating sustainable technological solutions that help protect the environment. As an example of what was said, bioremediation would be.
5. **Blue biotechnology:** Refers to applications of marine biotechnology. For example, search for substances of biomedical interest from marine organisms.
6. **Golden biotechnology:** is the branch dedicated almost exclusively to bioinformatics, an essential tool in biotechnology.
7. **Brown biotechnology:** a branch dedicated to obtaining components and the use of resources from the desert.
8. **Orange biotechnology:** this area is dedicated to the training and dissemination of biotechnology and its applications.

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9. Purple biotechnology: it is the branch that tries to clarify the legal aspects of biotechnology and its application.

10. Yellow biotechnology: focused on production and nutritional control, is another branch with greater projection of recent times.

The chemical industry manufactures products that guarantee our quality of life, from the most basic, such as health, food and hygiene needs, to those that allow us to enjoy greater well-being. Without the contributions of chemistry, our life expectancy barely surpasses 40 years, since it is the science that heals our diseases, multiplies the performance of crops and allows us to have drinking water. For decades, these processes have been made without taking into account their impact on the environment, and in many cases highly polluting. Now, we have to take on the challenge that these products, which make our life more comfortable, can be prepared through non-polluting procedures, following the principles of sustainable chemistry (Green Chemistry according to the terminology used in North America).

"Sustainable chemistry is a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services. Sustainable chemistry encompasses the design, manufacture and use of efficient, effective, safe and more environmentally benign chemical products and processes." [1].

In these cases, biotechnological processes are used as an alternative to conventional chemical processes, which brings economic and environmental benefits.

White biotechnology, is a field on the rise of the modern biotechnology at the service of industry in general and the pharmaceutical industry in particular, related to the use of biological systems as whole cells (fungi, yeasts, bacteria, as well) as enzymes) and can be used to produce products of interest in the pharmaceutical industry. Among these, we can cite the biocatalysts, which are effective and selective to produce modified antibiotics, drugs homochiral, etc.

The transformation of one substance into another is carried out in nature through the use of enzymes to increase the speed of the process. The use of enzymes with non-natural substrates is what we call Biocatalysis. In addition, it should be noted that the enzymes produce in a specific and selective only one of the possible isomers, which will be obtained enantiopure. The separation of these enantiomers is of crucial importance when it is intended to use these compounds as possible drugs, since the properties can be very different, being able to give the case that one of the enantiomers produces a beneficial effect, while the other is highly damaging to the organism [2]. To illustrate this idea, we just have to go back to the sad case of thalidomide. The different pharmacological activity of the two optical isomers, made the European Medicines Agency, as well as the American FDA, only accept since 1992 the isomer that has pharmacological activity, imposing severe restrictions in the case of racemic mixtures. It should be noted in this regard, that of the ten most sold drugs in the world, four are optically active compounds and many of them have used biotechnological techniques to obtain them.

The use of enzymes *in vitro* offers an alternative to the chemical process in more sustainable and less polluting conditions. The enzymes consume less water, fewer starting products and less energy than the same processes catalyzed by conventional catalysts. The environmental impact is lower, obtaining more pure products and at lower cost. The highly specific nature of enzymes means that biological processes not only require lower contributions from chemicals, but also to produce smaller and more manageable waste streams. To illustrate the above, we can give as an example the obtaining of 6-amino penicillanic acid, known as 6-APA and used as an intermediate in the synthesis of a great variety of antibiotics. The synthesis of 1 Kg of 6-APA, by means of a conventional chemical process, involves the use of 20.4 Kg of reagents, while that same Kg of 6-APA can be obtained by means of biotechnological procedures, starting from 0.09 Kg of ammonia and 2 liters of water [3].

This boom in biotechnology has been accompanied by the fact pharmaceutical companies find it increasingly difficult to develop

and market new products. The number of drugs approved each year has decreased since 1996, while R & D expenditures have increased enormously. Despite the global reach of Biotechnology on almost all living organisms, Green Biotechnology registers the highest number of entries when doing a Google search. A search in Science Direct, to see the articles published in this field, also leaves it in first place with respect to the others. In this sense, it is important to indicate the interest in the present and future of transgenic foods that has been shown to have a different scope in public opinion.

In this regard, indicate that there are voices for and against. In addition, from an objective point of view, there is an argument in favor and against since, the subject presents a great complexity. If we analyze the problem from the point of view of food shortages, simplifying the debate to a technological discussion is at least simplistic since in the world there is enough food today to feed 12 billion people, that is, one and a half times the current population, without the need to increase production levels. Therefore, hunger in the world is not a problem of production but lack of economic resources to pay for food, which makes it a political issue that must be resolved politically.

Currently transgenic genetically modified plants are genetically modified to improve their productivity making them resistant to bacteria or drought. There is various health, ecological and socioeconomic arguments to this type of food. The appearance of allergy and other negative effects on health is not the strongest argument made since there are no cases reported in the scientific literature in this regard.

The environmental arguments would be an important reason, due to the unwanted propagation of this type of crops and the consequent disappearance of the traditional varieties. However, there are global seed banks to conserve genetic wealth. On the positive side would be the fact that transgenic greatly reduces the use of herbicides and pesticides since they are born for this purpose. These types of crops do not germinate and, as a result, there is a great dependence on suppliers of transgenic seeds, which are on the other hand marketed by large business groups that generally operate as oligopolies. Therefore there are arguments for and against the use of transgenic, although, as we have seen, it is not the solution to the problem of hunger in the world.

In 1982, the Nobel Prize Amartya Sen published *Poverty and Famines: An Essay on Entitlement and Deprivation* (1982), a book in which he argued that famine occurs not only from a lack of food, but from inequalities built into mechanisms for distributing food [4].

Returning to the transgenic issue, obviously, it is controversial, but this does not apply only to food. It refers to all body modified or manipulated in its genome to produce or to express a characteristic different from those typical of their species. Although this theme will try it later, refers to genetically modified products when these are obtained, precisely, by modifying some body. The advantages of this are numerous, ranging from resistance to pests, in the case of vegetables, even the production of organs for transplants in humans. In recent years, science has taken great strides thanks to bacteria, yeasts and transgenic animals. You have been able to study diseases such as AIDS and cancer, and in many cases, we have been able to produce drugs and vaccines in a greater quantity and quality.

In 2010 appeared in the media a manifesto in defense of agricultural biotechnology, signed by a total of 25 Nobel Laureates and more than 3,400 scientists international prestige. The document, promoted by AgroBio World, advocates the use of genetic modification in plants, as a safe way to help the conservation of the environment, prevent hunger and poverty in the third world, increase the productivity of crops, as well as achieving greater nutritional security in food.

"The responsible modification of plant genes is nothing new or dangerous. (...) The adoption of a new or different gene using recombinant DNA techniques to an organism does not cause new risks or higher risks in comparison with the modification of organisms through traditional methods," says the document. The signatories,

endorse that transgenic crops can help “prevent the degradation of the environment, help prevent hunger and poverty in the third world, provide more agricultural productivity and more nutritional security.” The document concludes that the signatories strongly support the use of recombinant DNA as a powerful tool for the achievement of a sustainable and productive agrarian system. “We support legislators who use appropriate scientific principles to regulate products obtained by recombinant DNA.” Above all, it would be interesting to know the opinion of those millions of people who pass by and die of hunger.

On the other hand, the interest in biotechnology, is due to many reasons as well as biopharmaceuticals currently in use, new medicines in unlimited quantities; they are inventing You can help prevent diseases through new techniques of genetic diagnosis, multiply plants with default properties (higher content of certain essential fatty acids, new fibres, etc.). Also change certain characteristics of plants and animals, destroy polluting waste, food with new properties and features, new materials, etc. That is, you can change our vision of the current world. There are several concrete examples that can be given: soybean crops that are genetically resistant to herbicides; new drugs-like Erythropoietin-to increase red blood cells in patients with kidney disease, or a vaccine against Hepatitis B; early detection of genetic diseases or determination of filiations of people. Nevertheless perhaps, they are the studies on the Human Genome (Genomic) and the cloning of superior animals, which demonstrate the high degree of evolution of the biological sciences and Biotechnology. In particular, the Human Genome project has been one of the great adventures of contemporary science in which an international consortium with an allocation of 3,000 million dollars faced the objective of determining the sequence of base pairs that make up the DNA, in a period that was set at 15 years. Stephen Hall, in an article entitled “genomic revolution” states that “the scientific community is discouraged and divided.” In fact, there are no doubts about the genomic project, since there is unanimity about the genome project, which has meant a radical change in the way in which biomedical research is carried out. The problem lies in the fact that the studies derived from the genomic project have not reached the medical results announced a decade ago.

Great specialists in the field of oncology, recognize that in comparison with the resources invested the benefits brought by genomics in this field have been modest. The problem lies in the question of whether the modest medical impact of the research is due to the ineffectiveness of the strategy used, which has been based on the hypothesis that certain frequent variants would have a greater presence in individuals with a certain disease. This question has opened a gap in the scientific community. There are experts, among which Eric S. Lander of the Technological Institute of Massachusetts, which defend the effectiveness of the strategy of frequent variants. Although, the vast majority of frequent variants have not shed light on the biology of diseases [5].

The debate focuses on the need for an alternative method to solve the problem of “lost heritability”. Another approach is to direct the focus to the “rare variants”, a concept that is not easy to distinguish from that of frequent variants. Bodmer proposes that “rare” refers to a mutation that affects between 0.1 and 1-2% of the population; frequency that is below the resolution offered by the current studies of complete genome association. It seems that traditional genetics must be transcended, given the molecular complexity of the genome: non-modifying regions, epigenetics and their signals, and that it is fundamental to compare sequences of complete genomes, for which the technique of new generation of techniques is needed of fast and cheap sequencing.

On the other hand, a growing group of biologists question the validity of the hypothesis of frequent variants; among them are scientists as relevant in medical genetics as Mary-Claire King and Jon McClellan, of the University of Washington and Walter Bodmer. The strategy followed by the experts in genomics who embraced the hypothesis of frequent variants, was oriented to identify the polymorphisms of a single nucleotide (SNP of its name in English, “single nucleotide polymorphism”) and to examine the

dispersed SNPs that usually exist between people, to determine the predominant versions among those suffering from certain diseases. Next, SNPs statistically associated with the disease will identify nearby gene variants (inherited along with the markers) that would be responsible for the disease.

The reproduction and manipulation of human embryos and in vitro fertilization, has made it possible to have descendants to millions of people, although in return there has been an incessant bioethical debate between supporters and detractors of the use of this technique. Genetic research has made a huge advance in pre-implant genetic diagnosis, which has generated an added ethical debate. For example, in Spain, it applies only in cases of serious genetic diseases. The selection of embryos for therapeutic purposes, has allowed the birth of children designed to cure a brother. The benefits for medicine will be immense, even though, as we said before, all expectations have not yet been met. In addition, the development of the Human Genome Project will serve for the development of predictive medicine. Another application that has generated The Human Genome Project (PGH), is referred to what we call personalized medicine, ie take into account the characteristics of the genome of each individual, both in the administration of drugs (Pharmacogenomics), as in toxicology (Toxicogenomics) and in nutrition (Nutrigenomics).

The HGP, is going to be an important base of the Medicine of the future. At present, we can say that a first stage has been concluded, since the second one is the human proteome or Proteomics project. Craig Venter, the scientist who presented, more than 15 years ago, the human genome in the White House before Bill Clinton, has taken another step towards the creation of life. After more than 15 years of work, he and his team managed to manufacture in the laboratory the complete DNA of the bacterium ‘*Mycoplasma mycoides*’ and introduce it in a recipient cell of another species called ‘*Mycoplasma capricolum*’. This work, published in the journal ‘*Science*’, deals with the first time that a researcher creates, with all the implications that this word has, a synthetic life form, whose genetic material comes from four cans of chemical products. To achieve this, the researchers fabricated the basic DNA units of the bacterium ‘*Mycoplasma mycoides*’ and assembled them as if they were a puzzle. Once the complicated puzzle was assembled, they emptied a cell of another species of bacteria and introduced the synthetic genetic code into the recipient cell. Without to enter to debate on the ethics, the importance of the Biotechnology in the Medicine of the Future, that studies the use of the biotechnology in the human health to obtain diagnoses, to develop treatments or to determine the future of those treatments, is sufficiently demonstrated.

The issue of human health leads the sector of Biotechnology. It accounts for 70% of studies in this area, having the cell as a factory, the use of the immune system as a defender against specific ‘enemies’ causing diseases, the development of very specific medicines or the use of genetic material and tissues for the repair of complications in the organism.

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The application of genomics to the environment (environmental genomics), developed by Craig Venter, arose to analyze the genetic

variety of the marine world, discovering 400 new microorganisms and six million new genes. Also, this researcher is responsible for the chemical synthesis of a complete bacterial genome. A practical application of this project would be to obtain cheap fuels from synthetic organisms. We cannot forget the gene therapies, considering that the candidate diseases to be treated must be monogenic and recessive.

From the above, we could conclude that the word Biotechnology has entered our society and our lives, not as a fad. This term, which is used in a global way, is the way to fight hunger, diseases and improve our health and quality of life in the overpopulated world that we live and that our children will inherit.

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