

Biotechnology: A Primer

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ABSTRACT

Biotechnology is a technology that utilizes biological systems or living organisms to develop products. It is basically applied biology that forms the interface between biology and engineering. It is the one of the most rapidly growing field of technology today.

Biotechnology pervades almost all aspects of our daily life; it affects the foods we eat, the safety of the water we drink, the clothes we wear, the medications we take, etc. This paper provides a primal introduction to biotechnology.

Key Words: Biotechnology, Biotech.

1. INTRODUCTION

Biotechnology (or biotech) is a combination of biology and technology. So biotech is basically technology based on biology. Biotech involves not just a single technology but a wide range of technologies that share two key characteristics: working with living cells and having a wide range of uses that can improve our lives. It embraces a wide range of procedures for modifying living organisms to suit human purposes. Related fields include molecular biology, cell biology, microbiology, biochemistry, bioengineering, biomedical engineering, biomanufacturing, molecular engineering, and bioinformatics. The multidisciplinary nature of biotechnology is illustrated in Figure 1 [1].

Modern biotechnology began in the 1970s after the development of genetic engineering that enabled scientists to modify the genetic material of living cells. Knowledge of DNA sequences has become indispensable for biotech. All organisms are made up of cells that are programmed by the same basic genetic material, called DNA (deoxyribonucleic acid). DNA is made up of four similar nucleotides (designated by an organic base they contain, abbreviated A, T, C, and G). A genome is all the DNA in an organism, including all of its genes

2. FIELDS OF BIOTECHNOLOGY

Biotechnology can roughly be divided into three main parts [2]:

- *Green Biotechnology*: This involves agricultural processes. The foundation of green biotech is crop improvement and production of novel products in plants.
- *Red Biotechnology*: This involves healthcare processes. It uses the human body's own tools and weapons to fight diseases.
- *White Biotechnology*: This field is connected with industry and environmental processes. Most of the white biotech processes results in the saving of water, energy, chemicals and in the reduction of waste.

➤ Popular biotech fields include [3]:

- *-Genetic engineering:* This is the direct manipulation of DNA molecules to produce modified plants, animals, or other organisms using biotechnology. Through genetic engineering, organisms can be given targeted combinations of new genes.
- *-Tissue culture:* This is a method where by fragments of tissue from an animal or plant are transferred to an artificial environment to continue to survive and function.
- *-Cloning:* This describes the process (of breeding) used to create an exact genetic replica of another cell. There are three different types of cloning: (a) Gene cloning, which creates copies of genes, (b) Reproductive cloning, which creates copies of whole animals, (c) Therapeutic cloning which creates embryonic stem cells.

3. APPLICATIONS

Brewing and baking bread are examples of common traditional processes that fall within the concept of biotechnology; yeast (living organism) in its natural form is used to produce the desired product. Humankind has used biotechnology in several areas such as agriculture, healthcare, environment, and industrial biotech.

- *Agriculture:* Farmers around the globe use agricultural biotechnology to increase yields, prevent damage from insects, and reduce farming's impact on the environment. As one form of biotechnology, farmers have altered the genetics of their crops through breeding them with other plants. Humans have used selective breeding to improve production of crops and livestock for human consumption [4]. The field of plant biotechnology deals with developing ways to improve the production of plants so as to supply the world's needs for food, fiber, and fuel. Many new plant varieties are being developed or grown by farmers using genetic engineering.
- *Healthcare:* Modern biotechnology has contributed to the discovery and manufacturing of drug. The first genetically engineered products were drugs for treating human diseases. Biotech has increased our ability to develop new medicines to treat previously untreatable diseases [5]. With the aid of technology, microorganisms are used to develop antibiotics and vaccines to cure diseases. Individuals react differently to the same drug or treatment. Pharmacogenomics involves designing the most effective drug treatment based on the specific genetic profile of a patient. Pharmaceuticals represent the strongest biotechnology marketplace globally. Biotechnology has not only influenced pharmaceutical education but also the pharmacy practice [6].
- *Environment:* Due to the problems associated with pollutant treatment by conventional methods, increasing consideration has been placed on the development of alternative, economical, and reliable biological treatments. Cleaning up the environment using living organisms is known as bioremediation. Environmental biotechnology involves solving environmental problems (pollution control, removing toxic wastes). It seeks preventing the environment from pollution of land, air and water.
- *Industrial Biotech:* This uses enzymes and micro-organisms to make bio-based products in manufacturing sector. Biotechnology has been used in the industry to produce new products for human consumption. Basic applications of industrial biotechnology in our daily living include beer, wine, alcohol, chemicals, food ingredients, washing detergents, paper, textiles, sweet as sugar, plastics, fabrics, biofuels, vaccines, and antibiotics.

The relationships between these various applications are shown in the biotechnology tree in Figure 2 [7].

4. CHALLENGES

In the 1990s, society as a whole, along with agriculture sector, is faced with issues of fierce international competitiveness, growing environmental concerns, global climate change, and food safety. Fortunately, we have the new powerful tool of biotechnology to help address these issues [8]. Today, biotechnology pervades almost all aspects of our daily life; it affects the foods we eat, the safety of the water we drink, the clothes we wear, the medications we take, etc. While biotechnology cannot solve all of the problems that confront us today, it has played a major role in human development [9].

While biotechnology presents enormous benefits, the implications of these new processes go well beyond the technical benefits offered. The implementation of the new techniques will largely depend on their acceptance by consumers. Problems of technology transfer into developing nations arise due to the high state of privatization of genetic engineering. Different regulatory policies around the world have created an uncertain and complicated environment for the trade of biotechnological products. Religious traditions have had more than passing interest in the developments of biotechnology, especially in regards to human life. There has been expressed religious objections to gene patenting [10].

5. CONCLUSION

We are in an era of biotechnology revolution as biotechnology is forging ahead and continuously bringing about rapid changes. Biotechnology is high-tech par excellence. The biotechnology industry is booming; manufacturing biotechnology drugs is one of the major driving forces in the U.S. economy. Governments around the world embrace biotechnology as a major technological engine for economic growth. For more information about biotechnology, one should consult books in [7, 11-15] and other similar books available at Amazon.com. One should also consult the two journals that are exclusively devoted to biotech: *Journal of Biotechnology & Biomaterials* and *Industrial Biotechnology*.

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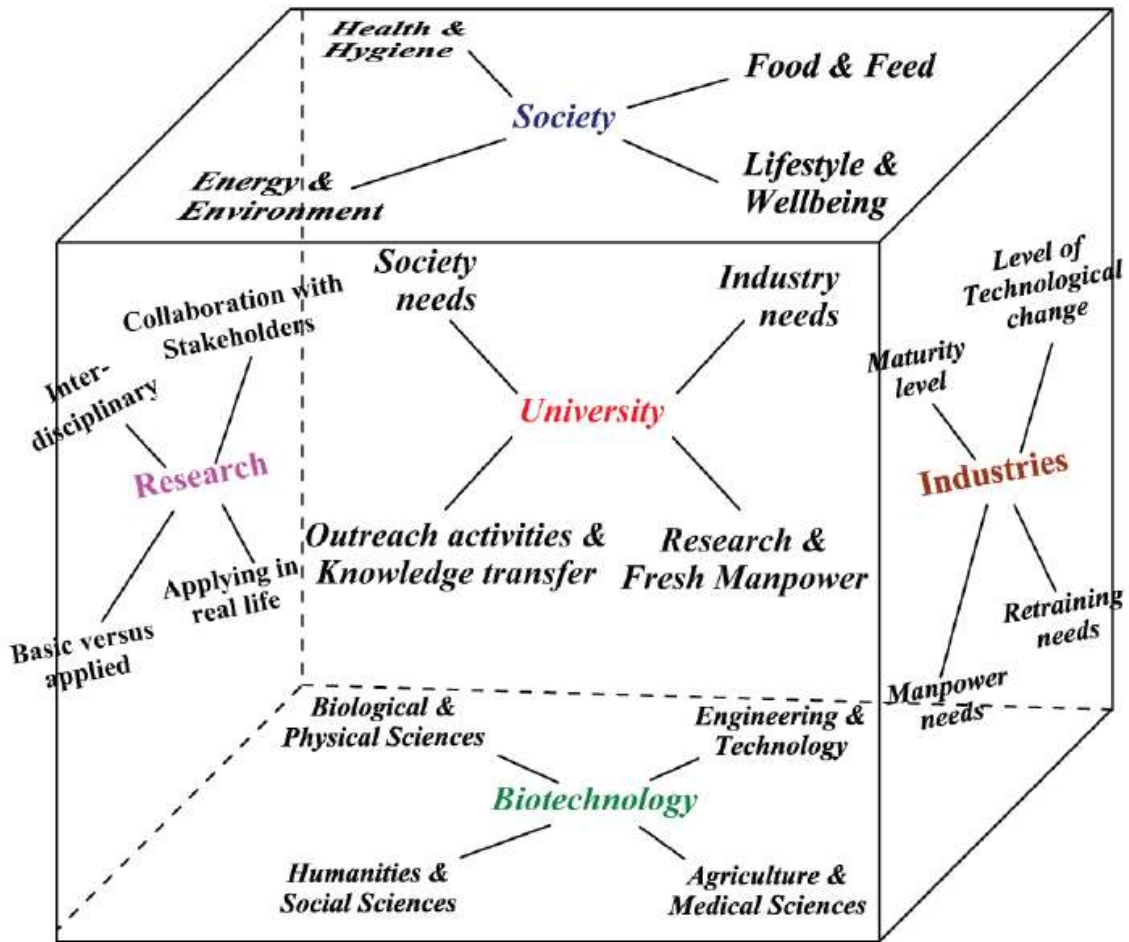


Figure 1. The multidisciplinary nature of biotechnology [1].

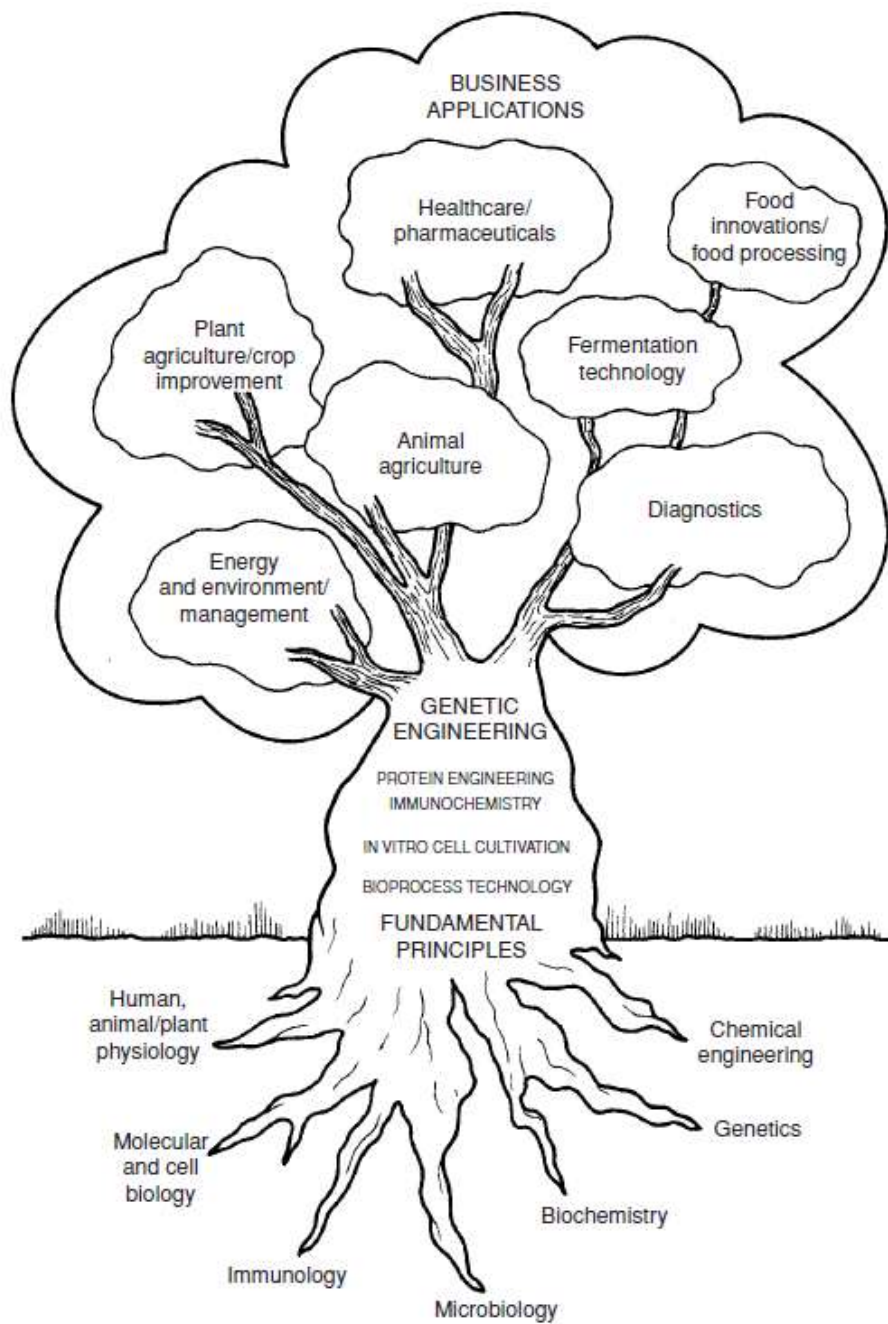


Figure 2 The biotechnology tree [7].