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# Introduction to Biotechnology

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# INTRODUCTION TO BIOTECHNOLOGY

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Biotechnology, as the word suggests, is combination of biology and technology. Biotechnology is the use of technology to use, modify or upgrade the part or whole of biological system for industrial and human welfare.

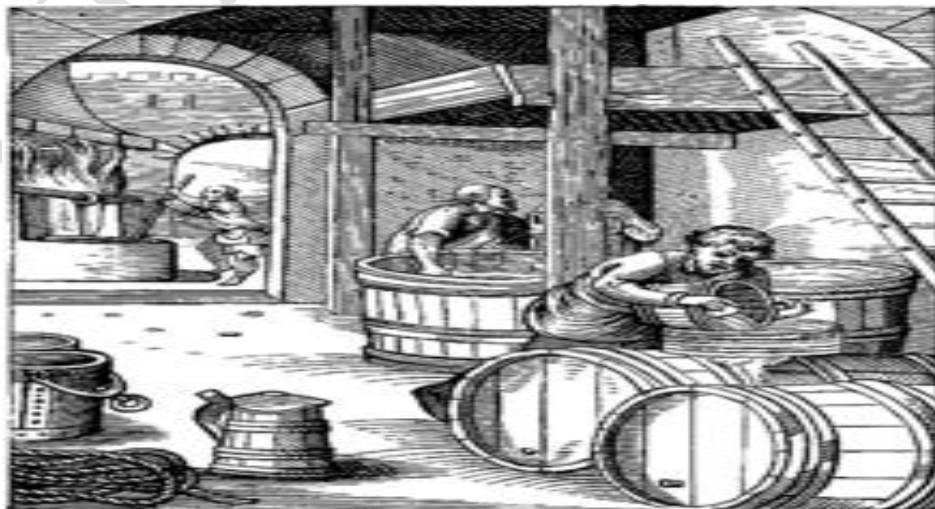
Biotechnology is defined as:

- 1) "Biotechnology is the application of biological organisms, system or process to manufacturing and service industries." (British or processes to manufacturing and Biotechnologist)
- 2) "Biotechnology is the integrated use of biochemistry, microbiology, and engineering sciences in order to achieve technological (industrial) application of the capabilities of micro-organisms, cultured tissue cells." (European Federation of Biotechnology).
- 3) "Biotechnology is the controlled use of biological agents, such as microorganisms or cellular components." (US National Science Foundation)

Bio-Technology is the use of living things especially cells and bacteria for production of various products for benefiting human beings. It is a combination of various technologies, applied together to living cells, including not only biology, but also subjects like mathematics, physics, chemistry and engineering. Its application ranges from agriculture (Animal Husbandry, Cropping system, Soil science and Soil Conservation, Plant Physiology, Seed Technology etc and Crop Management) to industry (food, pharmaceutical, chemical, byproducts, textiles etc.), medicine, nutrition, environmental conservation, Cell Biology, making it one of the fastest growing fields. Biotechnology is to modify genetic structure in animals and plants to improve them in desired way for getting beneficial products.

## History

People were using biotechnology techniques thousands years before but they did not named their working field as biotechnology. The name biotechnology was given by Hungarian engineer Karoly Ereky in 1919 to describe a technology based on converting raw materials into a more useful product.



- The ancient Egyptians made wine using fermentation techniques based on an understanding of the microbiological processes that occur in the absence of oxygen.

- Egyptians also applied fermentation technologies to make dough rise during bread-making. Due in part to this application, there were more than 50 varieties of bread in Egypt more than 4,000 years ago.
- In wetter parts of the Nile Valley, Egyptians also bred geese and cattle to meet their society's nutritional and dietary needs.
- Yogurt was made at homes but the reason of the conversion of milk into yogurt was unknown to old people. Later researches showed that yogurt is made due to the action of yeast added to milk; which is also biotechnology as it uses a micro-organism for benefiting human.
- People have used selective breeding to improve production of crops and livestock to use them for food. In selective breeding, organisms with desirable characteristics are mated to produce offspring with the same characteristics. For example, this technique was used with corn to produce the largest and sweetest crops.

## Modern biotechnology

The Second World War became a major impediment in scientific discoveries. After the end of the second world war some, very crucial discoveries were reported, which paved the path for modern biotechnology and to its current status.

- In 1953, JD Watson and FHC Crick for the first time cleared the mysteries around the DNA as a genetic material, by giving a structural model of DNA, popularly known as, 'Double Helix Model of DNA'. This model was able to explain various phenomena related to DNA replication, and its role in inheritance.



Structure of DNA by Watson and Crick (1953)

- Dr. Hargobind Khorana was able to synthesize the DNA in test tube, while Karl Mullis added value to Khorana's discovery by amplifying DNA in a test tube, thousand times more than the original amount of DNA.
- Using this technological advancement, other scientists were able to insert a foreign DNA into another host and were even able to monitor the transfer of a foreign DNA into the next generation.
- In 1997, Ian Wilmut an Irish scientist, was successful to clone a sheep and named the cloned sheep as 'Dolly'.
- In 2003, the Human Genome Project completes sequencing of the human genome.
- In 1978, Boyer was able to isolate a gene for insulin(a hormone to regulate blood sugar levels) from human genome using biotechnology. He then inserted it into bacteria, which allowed the gene to reproduce a larger quantity of insulin for diabetics.

Modern biotechnology provides breakthrough products and technologies to combat rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes. Currently, there are :

- More than 250 biotechnology health care products and vaccines available to patients, many for previously untreatable diseases.
- More than 13.3 million farmers around the world use agricultural biotechnology to increase yields, prevent damage from pests and reduce farming's impact on the environment.
- More than 50 biorefineries are being built across North America to test and refine technologies to produce biofuels and chemicals from renewable biomass, which can help reduce greenhouse gas emissions.



Biotechnology in Medical



Biotechnology in industry

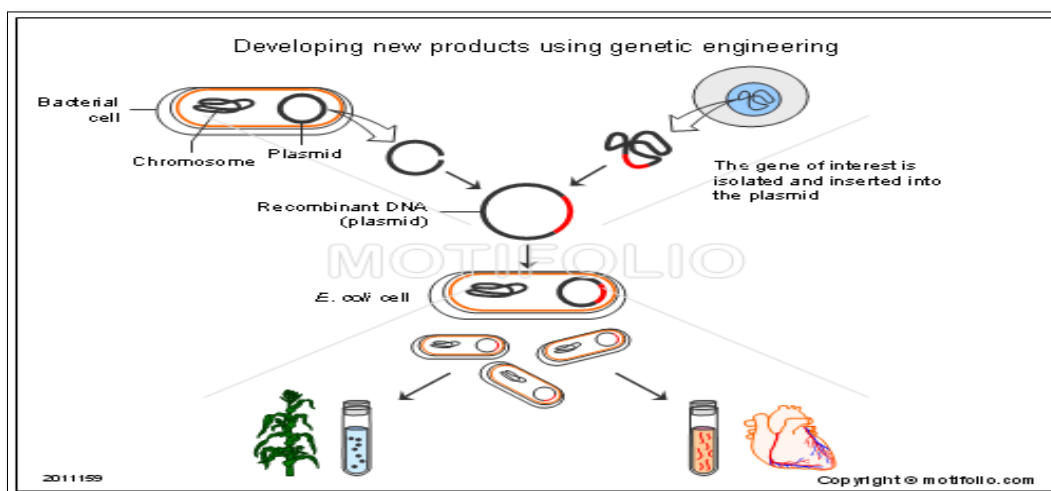
## Fields in biotechnology

Famous biotechnological fields are:

### 1) Genetic engineering

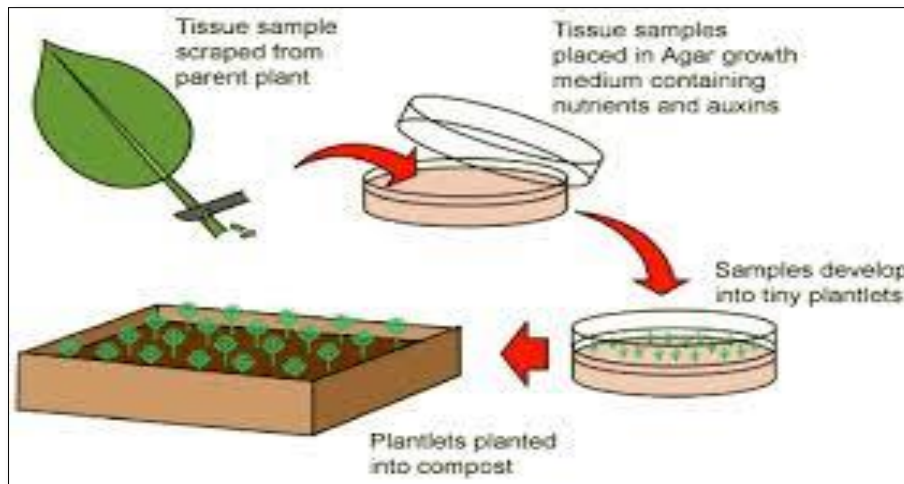
Genetic engineering, also called genetic modification, is the direct manipulation of an organism's genome using biotechnology.

Genes are the chemical blueprints that determine an organism's traits. Moving genes from one organism to another transfers those traits. Through genetic engineering, organisms can be given targeted combinations of new genes, and therefore new combinations of traits that do not occur in nature and, indeed, cannot be developed by natural means. Such an approach is different from classical plant and animal breeding, which operates through selection across many generations for traits of interest.



## 2) Tissue culture

Tissue culture, a method of biological research in which fragments of tissue from an animal or plant are transferred to an artificial environment in which they can continue to survive and function. The cultured tissue may consist of a single cell, a population of cells, or a whole or part of an organ. Cells in culture may multiply; change size, form, or function; exhibit specialized activity (muscle cells, for example, may contract); or interact with other cells.



## 3) Cloning

Cloning describes the processes used to create an exact genetic replica of another cell, tissue or organism. The copied material, which has the same genetic makeup as the original, is referred to as a clone. The most famous clone was a Scottish sheep named Dolly.

There are three different types of cloning:

- Gene cloning, which creates copies of genes or segments of DNA
- Reproductive cloning, which creates copies of whole animals
- Therapeutic cloning, which creates embryonic stem cells. Researchers hope to use these cells to grow healthy tissue to replace injured or diseased tissues in the human body.



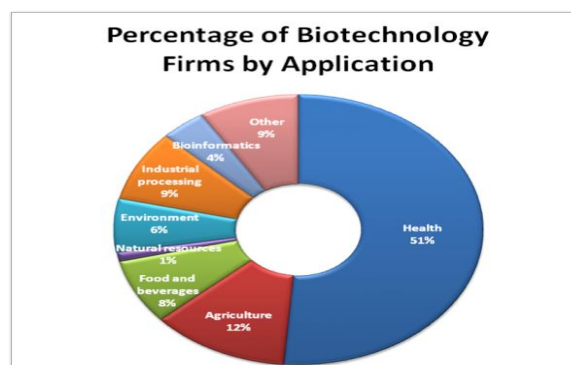
## Impact of Biotechnology

Biotech is helping to heal the world by harnessing nature's own toolbox and using our own genetic makeup. Biotech improves crop insect resistance, enhances crop herbicide tolerance and facilitates the use of more environmentally sustainable farming practices. Biotechnology is:

- Reducing rates of infectious disease;
- Tailoring treatments to individuals to minimize health risks and side effects;
- Creating more precise tools for disease detection Combating serious illnesses and everyday threats confronting the developing world
- Improving manufacturing process efficiency
- Reducing use of and reliance on petrochemicals;
- Using biofuels to cut greenhouse gas emissions
- Decreasing water usage and waste generation
- Generating higher crop yields with fewer inputs;
- Lowering volumes of agricultural chemicals required by crops-limiting the run-off of these products into the environment;
- Using biotech crops that need fewer applications of pesticides
- Developing crops with enhanced nutrition profiles that solve vitamin and nutrient deficiencies;
- Producing foods free of allergens and toxins
- Improving food and crop oil content to help improve cardiovascular health.

So, we can say that Biotechnologists have a broad scope. They can:-

- Help in increasing productivity and in improving energy production and conservation by conducting research and development work.
- Work with chemical processes, genetic engineering, textile development cosmetic development etc...
- Exploit and control the potential of micro-organisms and living systems for the benefit of mankind as by using micro-organisms in the production of drinks, bread, cheese and yogurt.
- Find new ways to design and use antibiotics and pesticides
- Use genetic modification and genome mapping to improve crop production or crop resistance to pests and diseases.
- Combating environmental pollution by developing the use of biosensors for early detection of pollutants.
- Find new ways to treat industrial waste for recycling of sewage sludge.
- Carry out their work in the laboratories, as it is a scientific research oriented field.
- Help medical professionals in improving in the methods of diagnosis, medicines and vaccinations for diseases.



## Drawbacks of biotechnology

### ❖ Ethics

Debates over the ethics of biotechnology have been ongoing for decades. The question mostly lies in the morality of various practices employed in research and development. Ethics-related concerns include cloning, xenotransplantation, stem cell research, fetal tissue use, and genetic modification of organisms.

### ❖ Uncertainty

The biggest concern over biotechnology is the uncertainty in its long term effects. The immediate advantages are clear in many circumstances, but they may directly or indirectly impact the future in unforeseen ways.

### ❖ Cost

Balancing benefits of biotechnology with cost, especially in the field of medicine, can be one tricky aspect. In terms of investment, the value of biotech products is often miscalculated with failure to include the factors of risk and product development periods, which can ultimately lower the return on profit. Thus far, biotech products are often more expensive and less practical than alternatives.

- ❖ Too much altering of crops is destroying the soul of natural farming
- ❖ Genetically modified species can damage the natural ecosystem.

In short, Today's biotechnology is continuing to help improve the way we live, and it helps us do so more responsibly.

The result of biotechnology is a diverse and nearly endless set of practical biotechnology products helping us live longer and healthier lives, have a more abundant and sustainable food supply.

Biotechnology has brought humanity to this level of comfort; the next question is, where will it take us? Biotechnology has both beneficial and destructive potentials. It is, WE who should decide how to use this technology to help humanity rather than to destroy it.



Biotechnology & plants



Yeast responsible for bread & curd formation



Product of biotechnology, The DOLLY sheep