University of Duhok
College of Sciences
Department of Biology
4th Year Class

Lecture1. Introduction to Biotechnology

Lecture outlines:

- Definition
- Historical Perspectives
- Ancient biotechnology
- Classical biotechnology
- Modern biotechnology
- Fields in biotechnology
- Branches of Biotechnology

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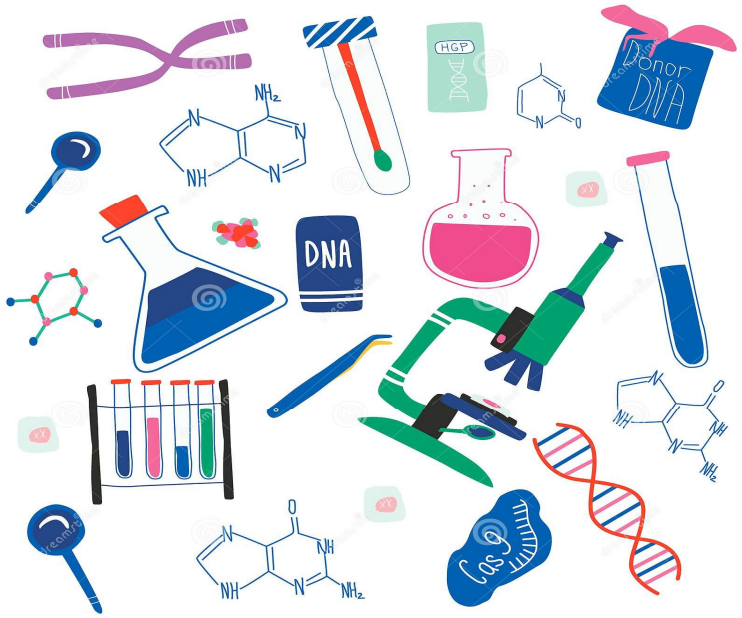
Definition

- Biotechnology is the use of biological processes, organisms, or systems to manufacture products intended to improve the quality of human life.
- The manipulation (as through genetic engineering) of living organisms or their components to produce useful commercial products (ex. pest resistant crops, new bacterial strains, or novel pharmaceuticals).



- Biotechnology covers a large number of different applications ranging from the very simple and traditional, such as the production of wines and cheeses, to highly complex molecular processes, such as the use of recombinant DNA technologies to yield new drugs or to introduce new traits into commercial crops and animals.

Historical Perspectives

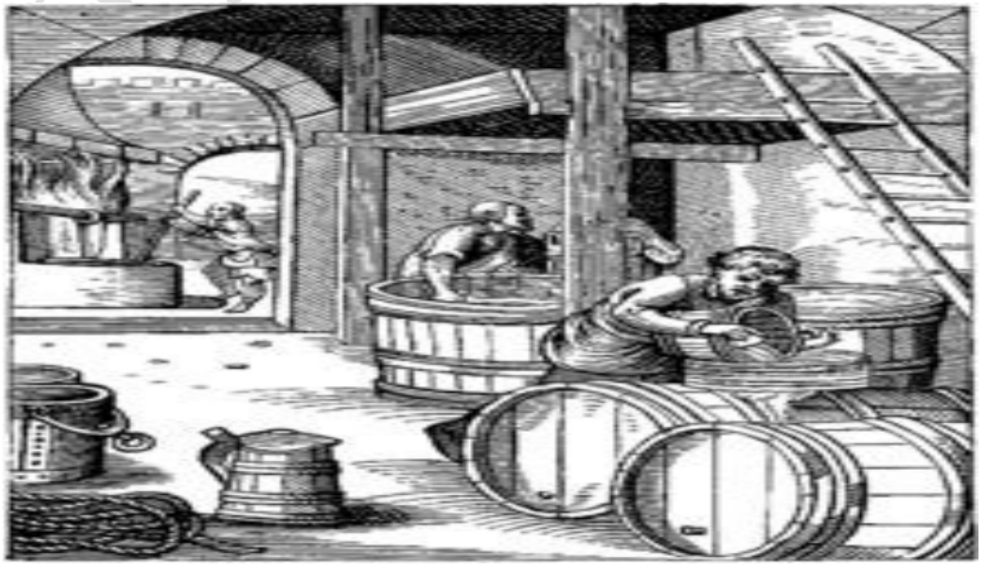
- **People were using biotechnology techniques thousands years before but they did not name their working field as biotechnology.**
- **The name biotechnology was given by Hungarian engineer Karoly Ereky in 1919 to describe a technology based on converting raw materials into a more useful product.**

Ancient biotechnology:

- **Ancient biotechnology had taken root as early as in the Paleolithic era, around 10,000 years ago, when early farmers began to cultivate crops such as wheat and barley, cultivation of wild plants and domestication of some wild animals living around them, executing, what is now known as 'selective breeding' in which organisms with desirable characteristics are mated to improve and produce offspring with the same characteristics..**
- **Sumerians and Babylonians were the first to apply direct fermentation to product development; they were making beer by 6000 BC.**
- **Egyptians were baking leavened bread by 4000 BC.**
- **The Chinese were also using fermentation technology by 4000 B.C., for production of their traditional food items, such as soy sauces and fermented vegetables.**

Classical biotechnology:

- The most classical example of biotechnology in the medieval times is the use of fermentation technology for production of bread, cheese, wine and beer.
- The fermentative ability of microorganisms was demonstrated between 1857 and 1876.
- Fermentation can be explained as a microbial process in which enzymatically-controlled conversion of organic compounds occurs.



- 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 microorganism that convert milk to yogurt; which is also biotechnology as it uses a micro-organism for benefiting human.

Example of Traditional Biotechnological Technique: Curd Making

We all must have observed our mothers making curd for the entire family. It is a classic example of fermentation technology, which can be conducted right at home.

Fresh Milk boiled to 100°C and cooled to 37°C

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Add a teaspoonful of one-day-old curd and leave undisturbed for 4–5 hours

Two phase separation of curd and whey

Observation: The raw material, milk, has been converted completely into a semisolid sour tasting product.

WHAT HAS ACTUALLY HAPPENED?

Lactobacillus bacteria from the curd react with the milk protein casein. Lactic acid formed as a by-product, denatures the globular proteins and coagulates to produce the solid curds and separates the watery whey protein layer

Modern biotechnology

After the end of the second world war, some very crucial discoveries were reported, including;

- **Discovery of DNA structure in 1953 by Watson and Crick, popularly known as, 'Double Helix Model of DNA' which was able to explain various phenomena related to DNA replication, and its role in inheritance.**
- **Discovery of restriction enzymes, extra chromosomal DNA (Plasmids) and using the technological advancement by scientists to insert a foreign DNA into another host (eg. Isolation of human insulin gene and insert it into bacteria to produce larger quantity of insulin in vitro by Boyer in 1978).**
- **Discovery of PCR by Karl Mullis in 1985 and amplifying DNA in a test tube, thousand times more than the original amount of DNA.**
- **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.**

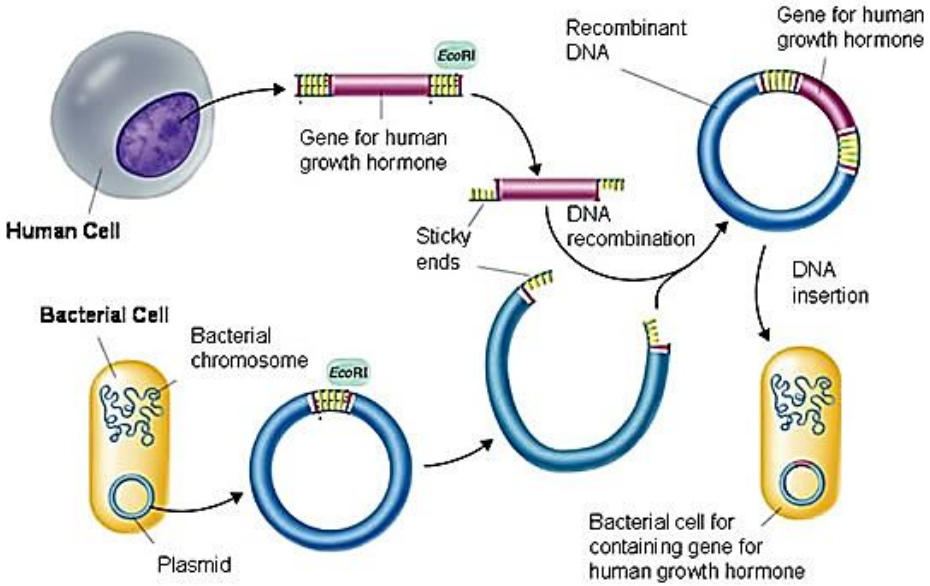
All these fundamental discoveries and technological advancements paved the path for modern biotechnology and to its current status.

Fields in biotechnology

Famous and major fields in modern biotechnology are:

1. Genetic engineering

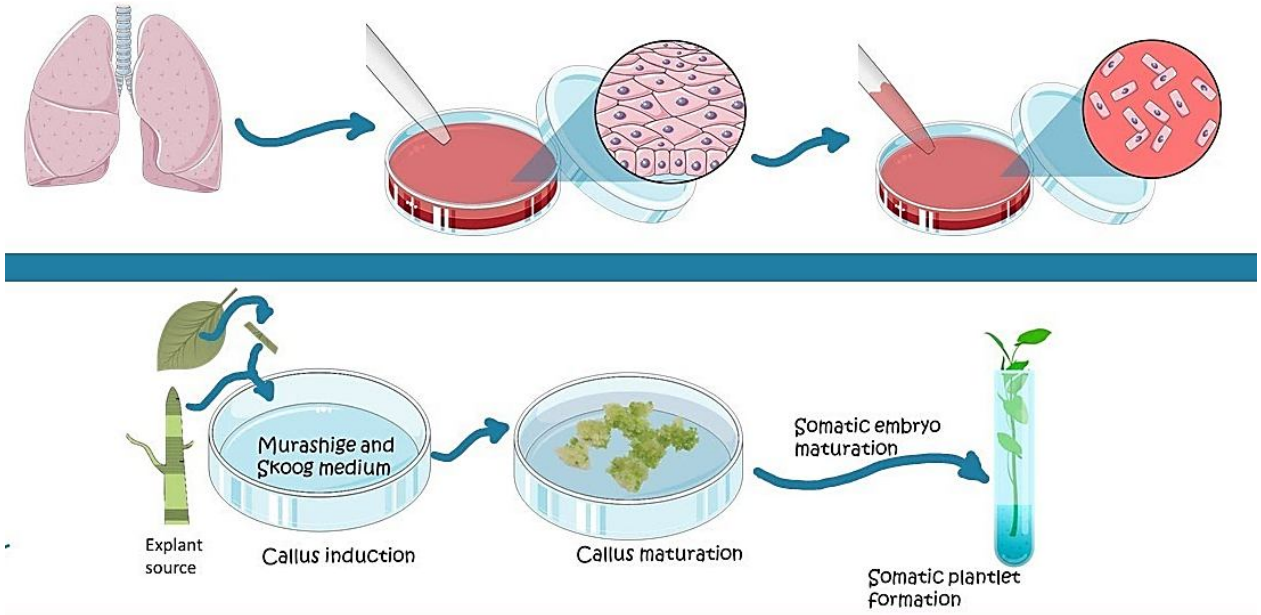
- Genetic engineering, also called genetic modification, is the direct manipulation of an organism's genome using biotechnology.
- Genes are the chemical blueprints that determine an organism's traits. Moving genes from one organism to another transfers those traits.



- 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

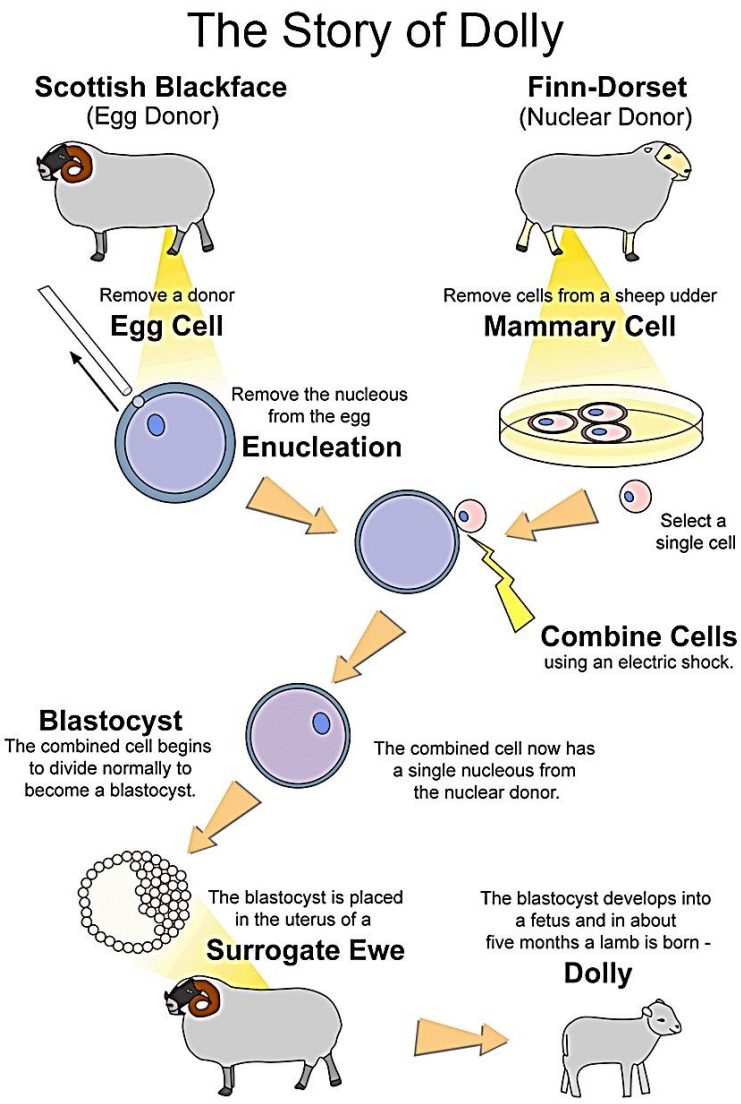
- **Tissue culture, a method of biological research in which fragments of tissue from an animal or plant are transferred to an artificial environment in which they can continue to survive and function.**



- **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.**

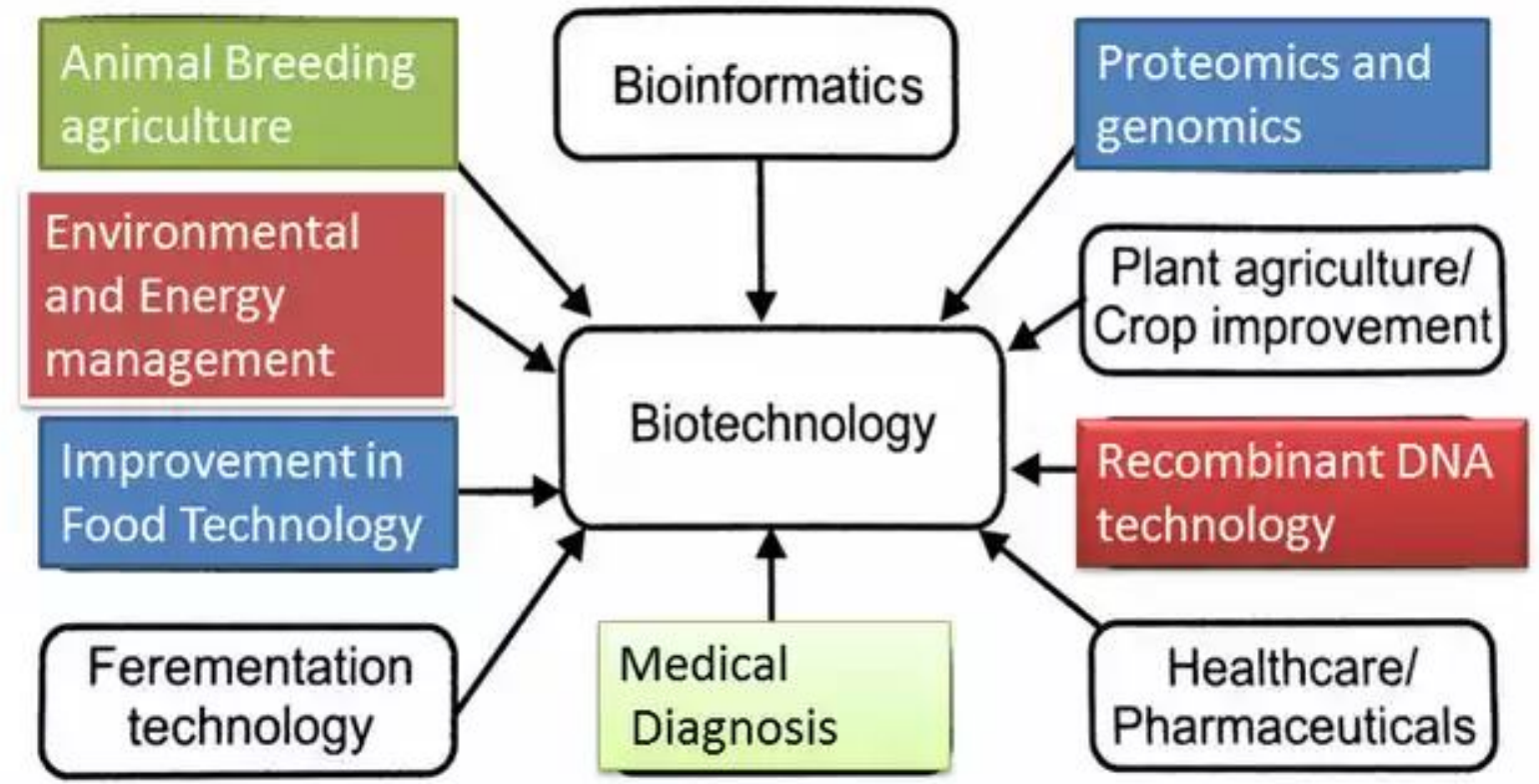


Branches of Biotechnology

Basically biotechnology classified in to four major categories including red, white, green, and blue.

- **Red biotechnology:** involves medical processes (healthcare) such as getting organisms to produce new drugs, or using stem cells to regenerate damaged human tissues and perhaps re-grow entire organs.
- **White (also called gray) biotechnology:** The technology that use microorganisms to make many industries more efficient and environmentally friendly and to reduce the waste, energy consumption and greenhouse gas emissions.
- **Green biotechnology:** applies to agriculture and involves such processes as the development of pest-resistant grains or the accelerated evolution of disease-resistant animals.
- **Blue biotechnology:** rarely mentioned, encompasses processes in marine and aquatic environments, such as controlling the proliferation of noxious water-borne organisms.

Major Applications of Biotechnology



Question time