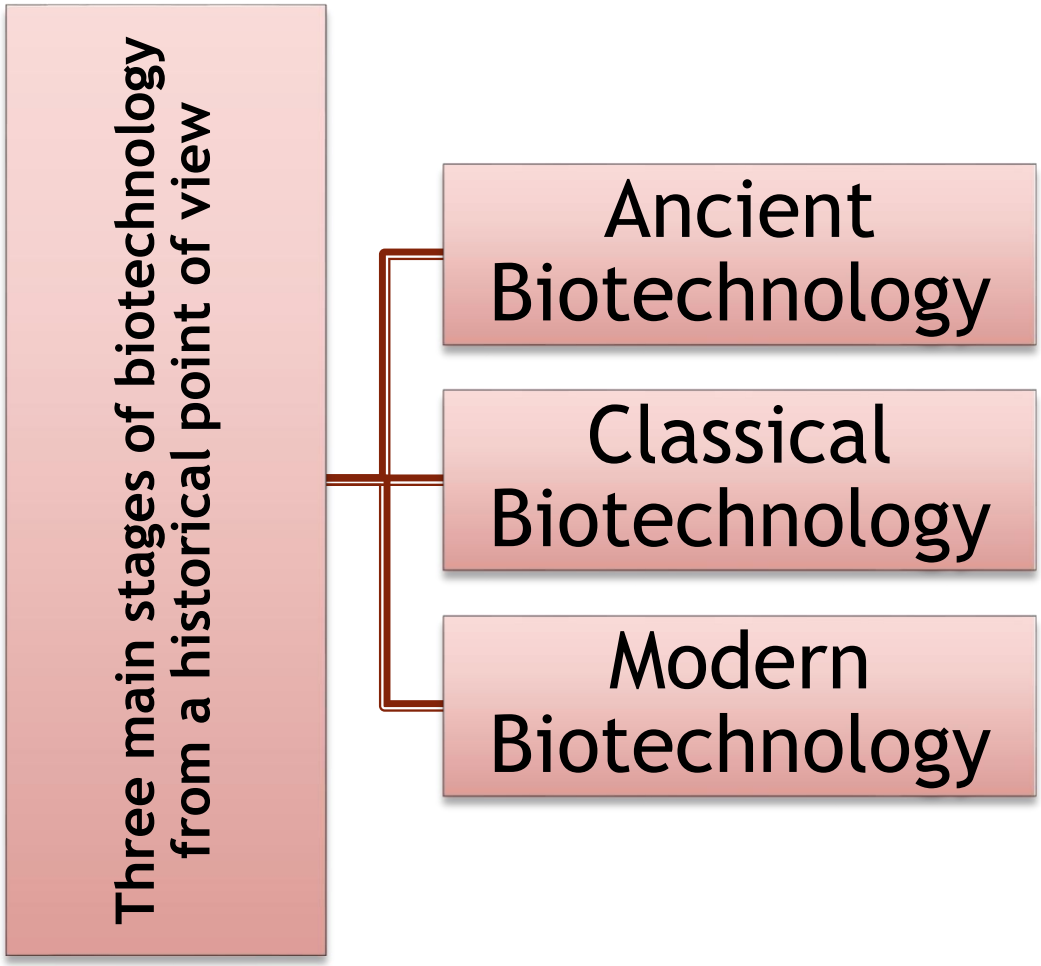
FDE 330
FOOD BIOTECHNOLOGY

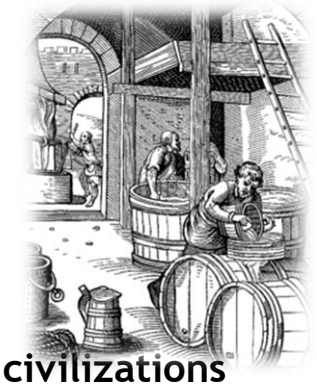
- HISTORY OF BIOTECHNOLOGY
- MAIN AREAS OF APPLICATION OF BIOTECHNOLOGY
- FOOD BIOTECHNOLOGY

History of Biotechnology

Periods of Biotechnology History



1. Ancient Biotechnology



- The roots of biotechnology can be traced back to the prehistoric civilizations between 5000 and 10,000 BC, when Egyptian and Indus Valley Civilizations initiated the domestication and selection of plants and animals for better taste, high-yield, and disease resistance.
- Various sexual and vegetative propagation methods were used to produce these plants.
- There was also the use of microorganisms to produce cheese, bread, beer, and wine and the use of herbal remedies for the treatment of wounds and ailments.
- This period in the history of biotechnology is described as ancient biotechnology.
- Early civilizations used traditional biotechnology techniques in a trial and error manner, apparently without understanding the underlying scientific principles.
- Their activities are typically referred to as discoveries rather than developments as they came about based on observations of nature.

2. Classical Biotechnology

- The second phase in the history of biotechnology, referred to as classical biotechnology or traditional biotechnology, charts the development of fermentation technology between the mid-19th century and the 1970s.

- During this period, there was the widespread use of methods from ancient biotechnology, especially fermentation, and their adaptation to the industrial production of enzymes, antibiotics, and various types of organic acids such as vinegar, citric acid, amino acids, and vitamins.

- Koch, Pasteur, and Lister founded institutes with the mandate of investigating fermentation along with other microbial processes.

- By the end of the 19th century, Mendel's work on the basic principles of heredity revolutionized genetics and led to the beginning of controlled plant breeding experiments.

3. Modern Biotechnology

- The discovery of the structure of DNA in the 1950s marks the era of modern biotechnology.
- Two techniques contributed greatly to the transition, namely recombinant DNA (rDNA) technology and monoclonal antibody or hybridoma technology.
- rDNA technology is the field of molecular biology in which DNA from two or more sources is "edited" to form new synthetic molecules.
- Hybridomas are the hybrid cells of myeloma cells with antibody-producing cells.
- rDNA technology enables the transfer of genetic material from one species to another, and thus the production of food crops and animals with traits that are different from those obtained using traditional breeding techniques.
- The hybridoma technology enabled the generation of unlimited quantities of monospecific antibodies directed against any antigen.
- Both technologies rapidly found industrial applications and led to the rapid development of diagnostic procedures in the fields of parasitology, virology, and cancer as well as biopharmaceuticals (e.g., the production of insulin in recombinant *Escherichia coli* and *Saccharomyces cerevisiae*).

- Although the discovery of the structure of DNA and rDNA technology is regarded as a huge driver for the recent developments in modern biotechnology, two other influences have contributed to the growth and development of the field.
  1) the need to replace fossil resources and move to renewable raw materials
  2) the need for green or clean processes, where efficient use is made of the energy during production

- All three drivers, rDNA technology, **renewable raw materials**, and **environmental impact**, are shaping biotechnology growth.

- The history of biotechnology is still being written and will continue to be written as new uses are realized.

The Historical Development of Biotechnology

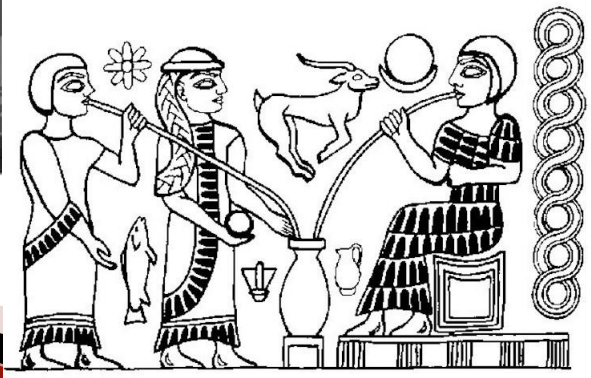
Karl Ereky

- The term "biotechnology" was coined by a Hungarian engineer, **Karl Ereky in 1919**, meaning the production of products from raw materials with the aid of living organisms. He is regarded by some as the "father" of biotechnology.

- This definition was similar to the traditional biotechnological applications at that time. Because in those years the biotechnological systems were used without any modification. The main reason of this was the non-development of technology.

The Historical Development of Biotechnology

- 6000 BC: Yeast was used to make beer by Sumerians and Babylonians.
- 4000 BC: The Egyptians discovered how to bake leavened bread using yeast.
- 3500 BC: There is evidence of wine production.



The Historical Development of Biotechnology

Louis Pasteur

- 1673: Antonie van Leeuwenhoek (1632-1723) was the first scientist to describe protozoa and bacteria and to recognize that such microorganisms might play a role in fermentation.

- 1856: Louis Pasteur (1822-1895) asserted that microorganisms are responsible for fermentation.

The Historical Development of Biotechnology

- **1977-Present:** The Dawn of Biotech. Genetic engineering became a reality when a man-made gene was used to manufacture a human protein in a bacteria for the first time. Biotech companies and universities were off to the races, and the world would never be the same again. In 1978, in the laboratory of Herbert Boyer at the University of California at San Francisco, a synthetic version of the human insulin gene was constructed and inserted into the bacterium *Escheria coli*. Since that key moment, the trickle of biotechnological developments has become a torrent of diagnostic and therapeutic tools, accompanied by ever faster and more powerful DNA sequencing and cloning techniques.

- **1977:** Genetic engineering studies began. Genentech, Inc., reports the production of the first human protein manufactured in a bacteria: somatostatin, a human growth hormone-releasing inhibitory factor. For the first time, a synthetic, recombinant gene was used to clone a protein. Many consider this to be the advent of the Age of Biotechnology.

- 1978: RECOMBINANT INSULIN Genentech, Inc. and The City of Hope National Medical Center announced the successful laboratory production of human insulin using recombinant DNA technology.

The Historical Development of Biotechnology

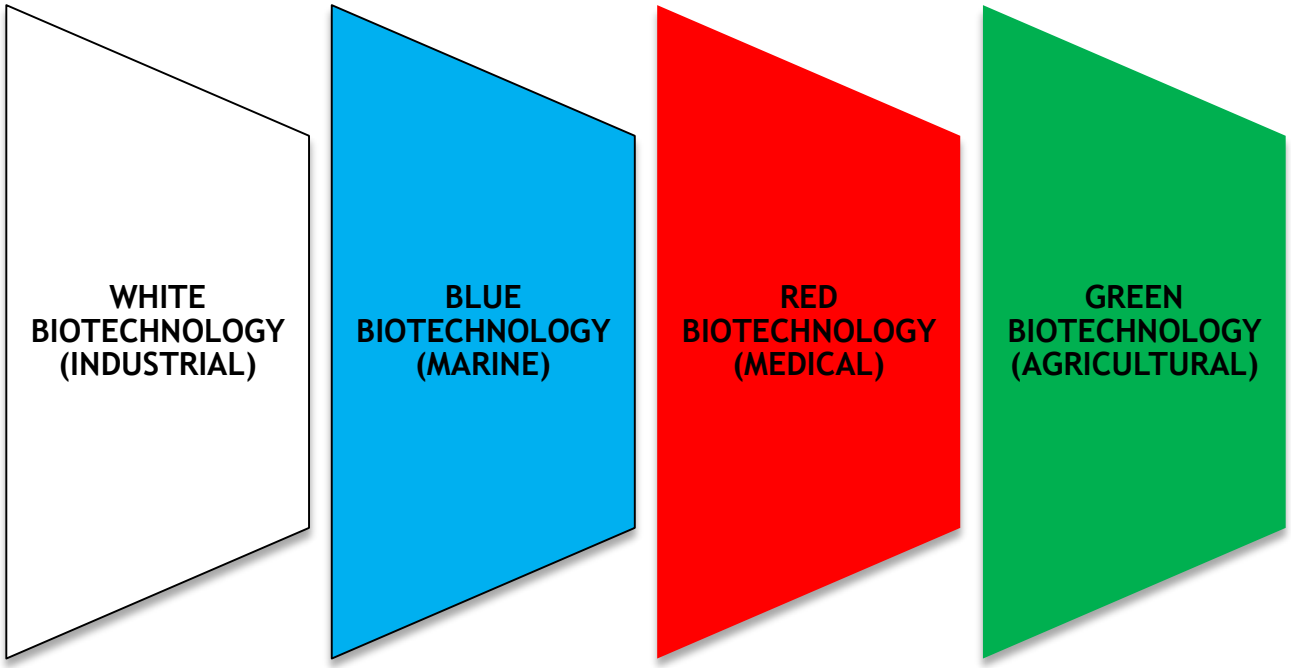
- **1986:** The FDA granted a license for the first recombinant vaccine (for hepatitis) to Chiron Corp.
- **1988:** Harvard molecular geneticists Philip Leder and Timothy Stewart awarded the first patent for a genetically altered animal, a mouse that is highly susceptible to breast cancer.
- **1990:** First federally approved gene therapy treatment is performed successfully on a young girl who suffered from an immune disorder.
- 1993: Kary Mullis won the Nobel Prize in Chemistry for inventing the technology of polymerase chain reaction (PCR).
- **1994:** The United States Food and Drug Administration approves the first GM food: the "Flavr Savr" tomato.

- Herbert Boyer and Stanley Cohen made the first genetically modified organism in 1973, a bacteria resistant to the antibiotic kanamycin.
- The first genetically modified animal, a mouse, was created in 1974 by Rudolf Jaenisch, and the first plant was produced in 1983.
- In 1994 the Flavr Savr tomato was released, the first commercialized genetically modified food.
- The first genetically modified animal to be commercialized was the GloFish (2003).
- The first genetically modified animal to be approved for food use was the AquAdvantage salmon in 2015.

Main Areas of Application of Biotechnology

Biotechnology in Color/Types of Biotechnology

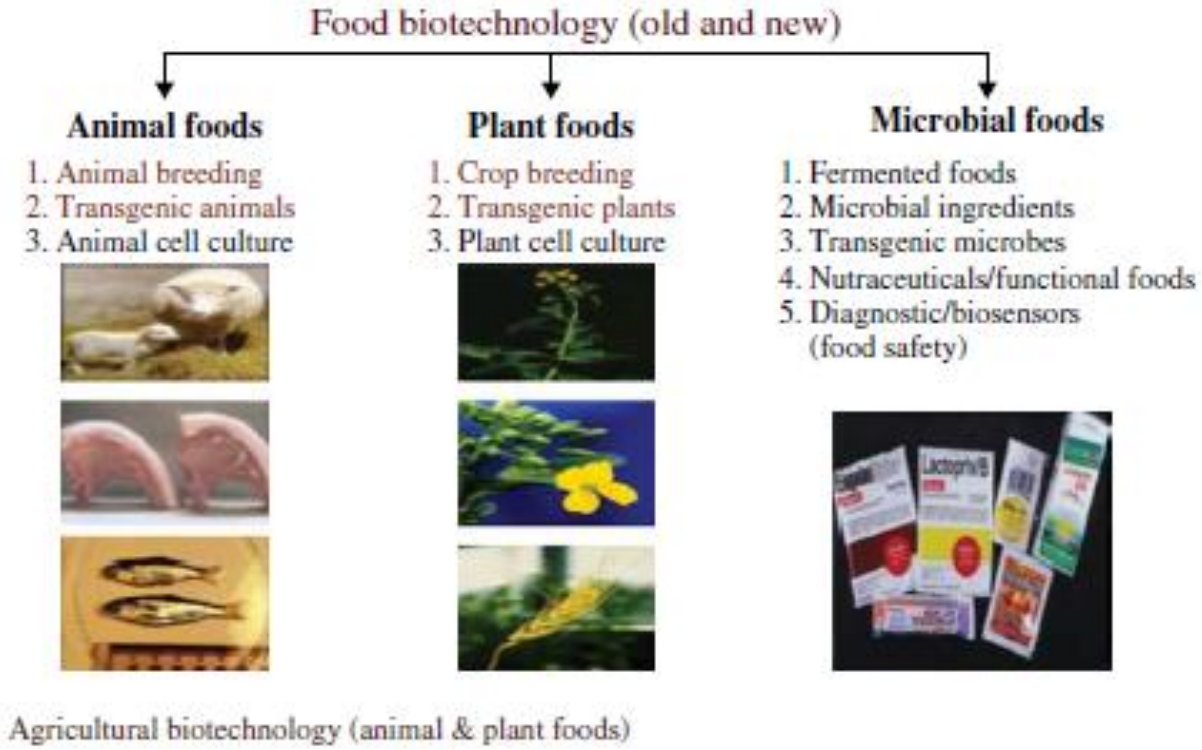
There are four main topics of biotechnology being explored to date:



Food Biotechnology

What is food biotechnology?

- Food biotechnology has been defined as **"the application of biological techniques to food crops, animals and microorganisms to improve the quality, quantity, safety, ease of processing and production economics of food**. It thus includes the traditional manufacturing processes used for bread, beer, cheese and various fermented milk products" (IFST 2004).



Concept of Food Biotechnology

Important Food Biotechnology Products

Food Product	Raw, Semi-finished and Finished material	Organism
Bread	Cereal flour	*Saccharomyces cerevisiae*
Beer	Malt	*S. cerevisiae*
Brandy/Whiskey	Wine/Cereal	*S. cerevisiae*
Hard cheese	Milk	*Lactococcus*, *Lactobacillus* species
Blue cheese	Milk	*Penicillum camemberti*, *P. roqueforti*
Coffee	Coffee bean	Lactic Acid Bacteria
Kefir	Milk	*Candida kefir*, *Lactobacillus kefir*
Pickled cabbage/Sauerkraut	White cabbage	*Lactobacillus plantarum*
Sausage	Beef-pork-lamb	*Lactobacillus*, *Staphylococcus*, *Micrococcus* species
Soy sauce	Soy bean	*Aspergillus oryzae*
Vinegar	Malt	*Acetobacter aceti*
Wine	Grape juice	*S. cerevisiae*
Yogurt	Milk	*Lb. bulgaricus*, *Str. thermophilus*

Major Biotechnology Products Used in Food Processing

Product	Usage	Producer Organism
Acetic acid	Pickles	*Acetobacter aceti*
Alginate	Ice-cream, meat, pudding	*Acetobacter vinelandi*
Ascorbic acid	Food enrichment	*Gluconobacter oxydans*
Beta-carotene	Food enrichment	*Blakeslea trispora*
Citric acid	Beverages, dairy products	*Aspergillus niger*
Enzymes	All-purpose	Microorganisms
Fumaric acid	Dairy and meat products	*Rhizopus* species
Glutamic acid	Flavouring compound	*Corynebacter glutamicum*

Major Biotechnology Products Used in Food Processing

Product	Usage	Producer Organism
Lactic acid	Desserts, fruit juice	*Lactobacillus delbrueckii*
Lysine	Food enrichment	*Corynebacter glutamicum*
Malic acid	Jams, gels, beverages	*Aspergillus* species
Methionine	Protein enrichment	*Corynebacter glutamicum*
Nisin	Canned food, meat and dairy products	*Lactococcus lactis*
Riboflavin	Food enrichment	Ashbya gossypii
Single cell protein	Food supplement	*Kluvyeromyces fragilis*, *Fusarium graminearum*
Tryptophan	Antioxidant	*Corynebacter glutamicum*
Xanthan	Beverages, cheese and emulsifiers	*Xantomonas compestris*