Biotechnology Overview


SECRETLY, HUMAN RESEARCH CONTINUED...
Cloning
Vegetarians
WASSERMAN
BOSTON GLOBE

What is Biotechnology?

The use of living organisms to solve problems or make useful products

Early Biotechnology

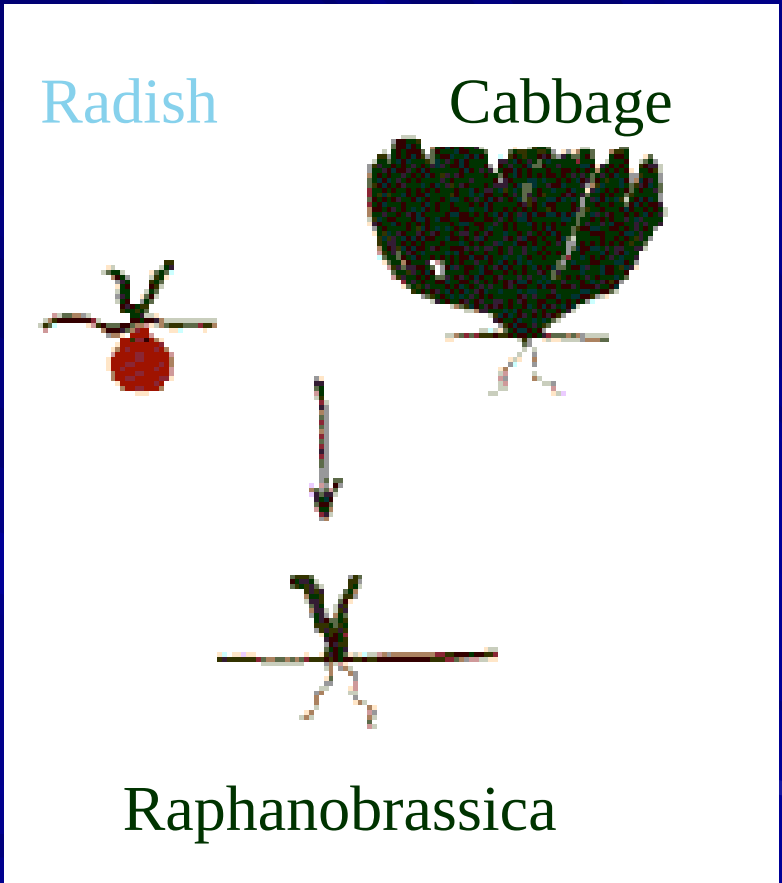
- Microbes such as yeast and bacteria to make useful food products – bread, wine, cheese
- Antibiotics and vaccines from microbes
- Enzymes from microbes for use in manufacturing processes
- Selective breeding of plants to obtain new characteristics

Early Biotechnology

A Russian scientist named Vavelov promised Stalin that he could double productivity by crossing a cabbage with a radish

Instead Vavelov introduced a brand new species to science and went to Siberia for his efforts!!

Traditional crossbreeding selection, mutation breeding, and wide crosses allow no control at the genome level and it may take years of backcrossing to remove unwanted effects.



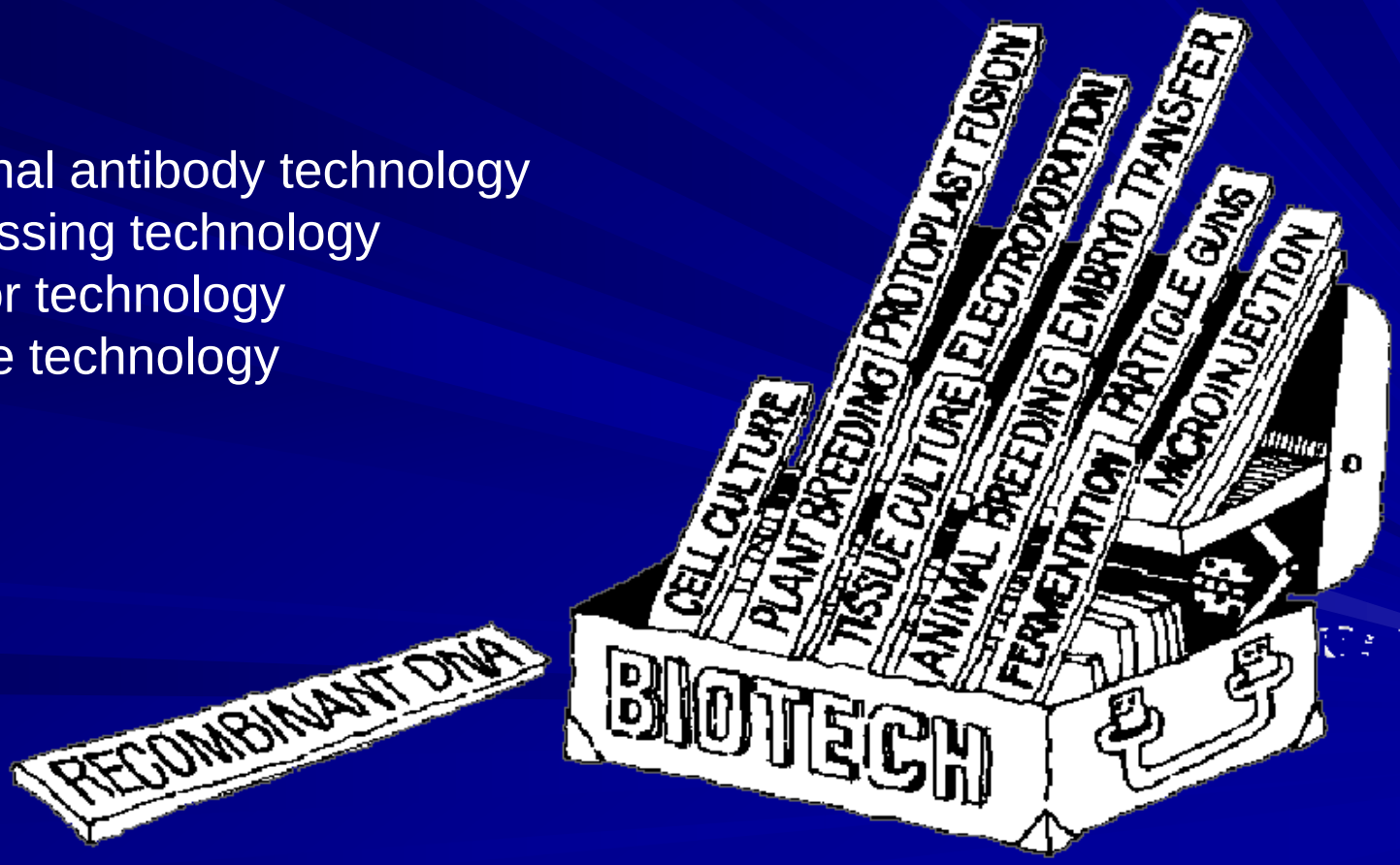
Biotechnology Revolution

- Before, we manipulated whole organisms to our advantage, now we use their cells and biological molecules...
- Modern definition - Biotechnology is the application of technologies, such as recombinant DNA techniques, that use living organisms or its products, to solve problems or make useful products
- Biological molecules: nucleic acids such as DNA, RNA, and proteins
- Cells and molecules are extraordinarily specific in their interactions. Because of this specificity, the tools and techniques of biotechnology are quite precise

Biotechnology: A Collection of Technologies

Also:

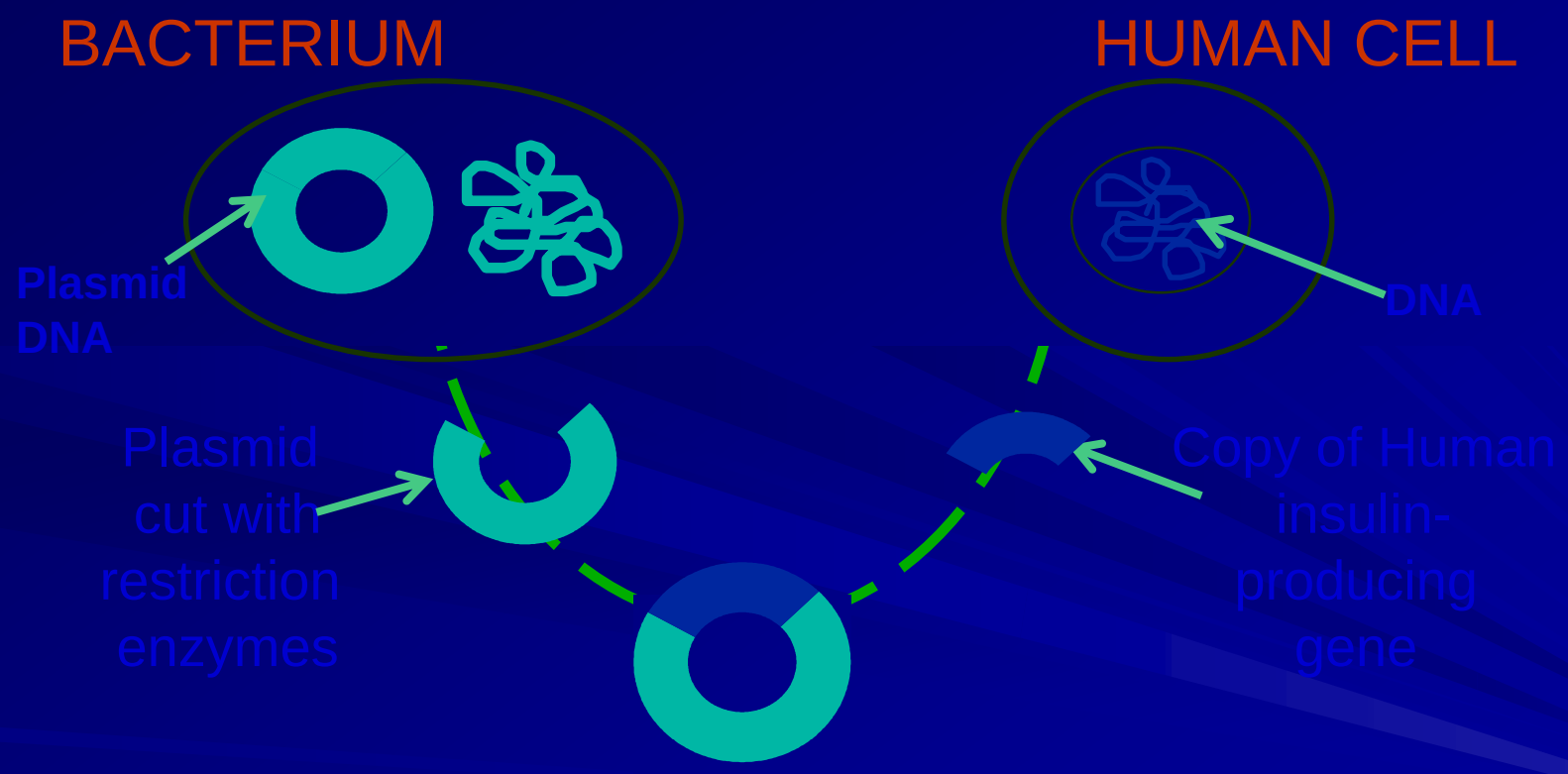
- Monoclonal antibody technology
- Bioprocessing technology
- Biosensor technology
- Antisense technology



Biotechnology Applications: Medical

- Diagnostics:
  Monoclonal antibodies, nucleic acid probes
- Therapeutics:
  Designer drugs, stem cells, recombinant vaccines, gene therapy
- Genomics:
  Information source for preventative medicine, therapeutics, diagnostics, gene therapy
- Tissue Engineering
- Biomaterials, nanotechnology

Human Insulin From Biotechnology



Bacterial plasmid; human gene inserted

Other Examples

Herceptin (Trastuzumab)
An antibody that is an approved treatment for HER2 protein overexpressing metastatic breast cancer.

Rituxan® (Rituximab)
A monoclonal antibody approved for the treatment of relapsed or refractory low-grade or follicular, CD20-positive B-cell non-Hodgkin's lymphoma, a cancer of the immune system.

Avonex
Genetically engineered interferon beta 1-alpha from Biogen
Treats relapsing forms of multiple sclerosis

Biotechnology Applications: Animal

- Recombinant vaccines and therapeutics, e.g rabies
- Diagnostics
- Marker assisted selection
- Improved nutrition – supplements
  - Phytase
  - Carbohydrases
- Transgenics
  - disease resistance
  - productivity
  - improved growth rates
  - reduced fat
- Medical applications
  - produce valuable proteins in milk, blood, or urine
  - xenotransplantation
  - disease and developmental models

Nexia's lead products are biomaterials and pharmaceuticals used to treat life-threatening disease. Nexia produces these recombinant proteins in the milk of transgenic BELE® goats from which they are extracted. Nexia will further process the milk to purify recombinant products. BioSteel™ filaments are environmentally friendly and will be used in applications where strength and flexibility are required, such as medical devices or body armor.

Biotechnology Applications: Plants

- Disease resistance
- Improved nutritional content
- Factories for materials such as plastics
- Edible vaccines
- Phytoremediation

Example: Papaya ringspot virus in Hawaii

Aerial view of transgenic field trial in Puna that was started in October 1995. The solid block of green papaya trees are 'UH-Rainbow' while the surrounding papaya trees that are nearly dead are nontransgenic papaya trees severely infected by PRSV.

Field trial of transgenic 'UH Rainbow' and 'UH SunUp' was established in Puna in October 1995. Slides show the progress of the disease caused by PRSV in rows of nontransgenic papaya (left in picure) as compared to the resistance in rows of 'UH Rainbow' (right in picture).

Example: Phytoremediation

University of Georgia genetically engineered yellow poplar trees giving them the ability to absorb toxic mercury from soil, convert the toxin to a relatively inert form, and release the converted matter as a vapor into the atmosphere

Engineered the poplars with a gene, merA, from a mercury-resistant bacteria. The bacteria are soil-borne and thrive at sites polluted with heavy metals. Resulted in 10X increase in Mercury removal

Societal Issues

- Ethics of genetic modification (interfering with nature)
- Safety of food and of introducing genetically engineered organisms into the environment
- Possible negative impacts on employment or small farms
- Genetic screening and genetic privacy issues
- Trust or lack of trust of government regulatory agencies
- Enhancement of corporate power and ownership of intellectual property
- Negative Globalization - Possible exploitation of developing countries
- Possible mistreatment of animals

We have recently advanced our knowledge of genetics to the point where we can manipulate life in a way never intended by nature.

We must proceed with the utmost caution in the application of this new found knowledge.

Luther Burbank, 1906