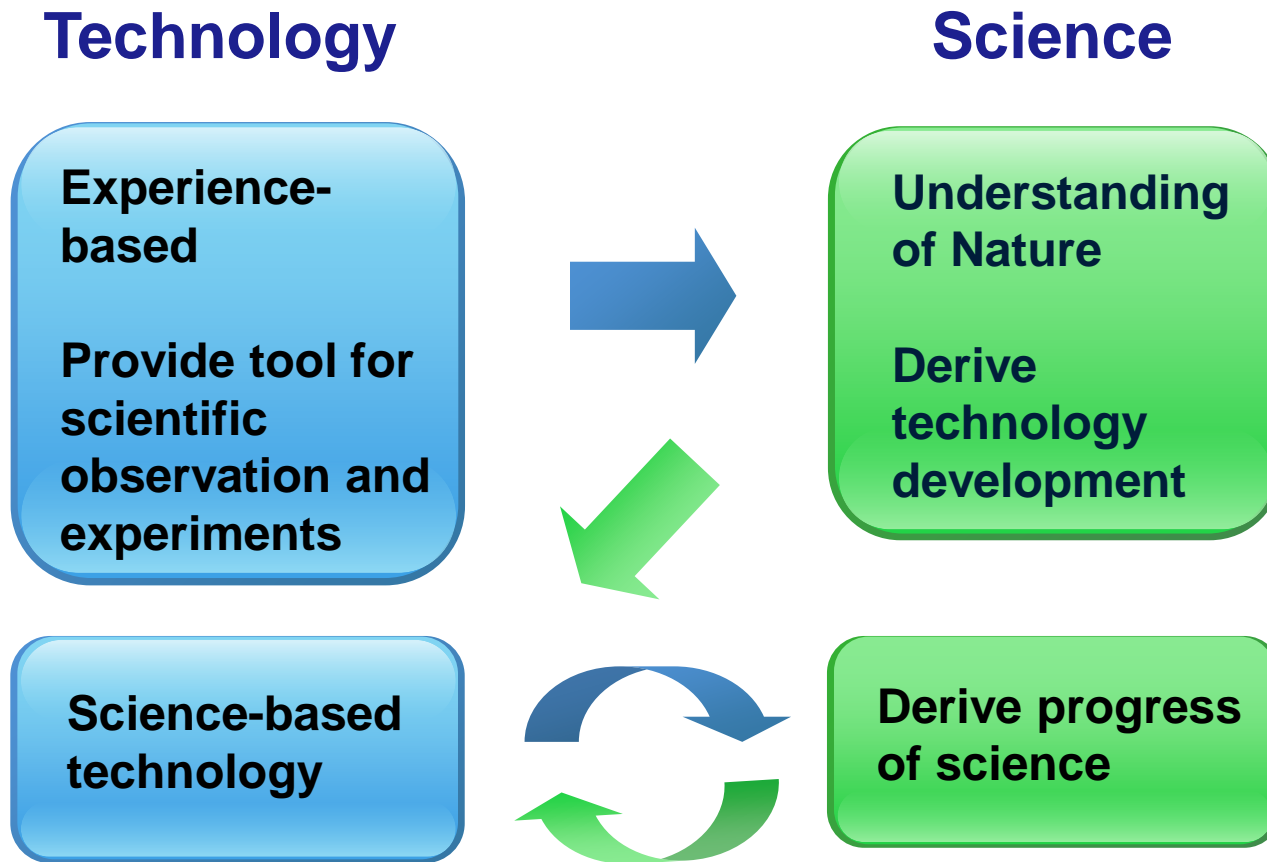




# Biotechnology

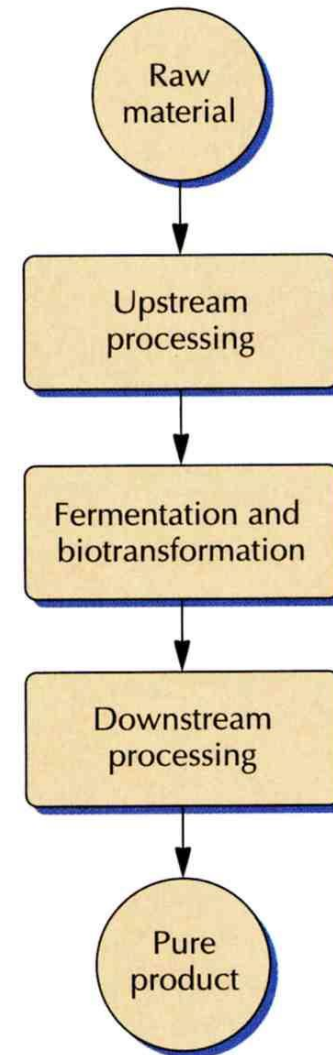
# The Relationship Between Science and Technology



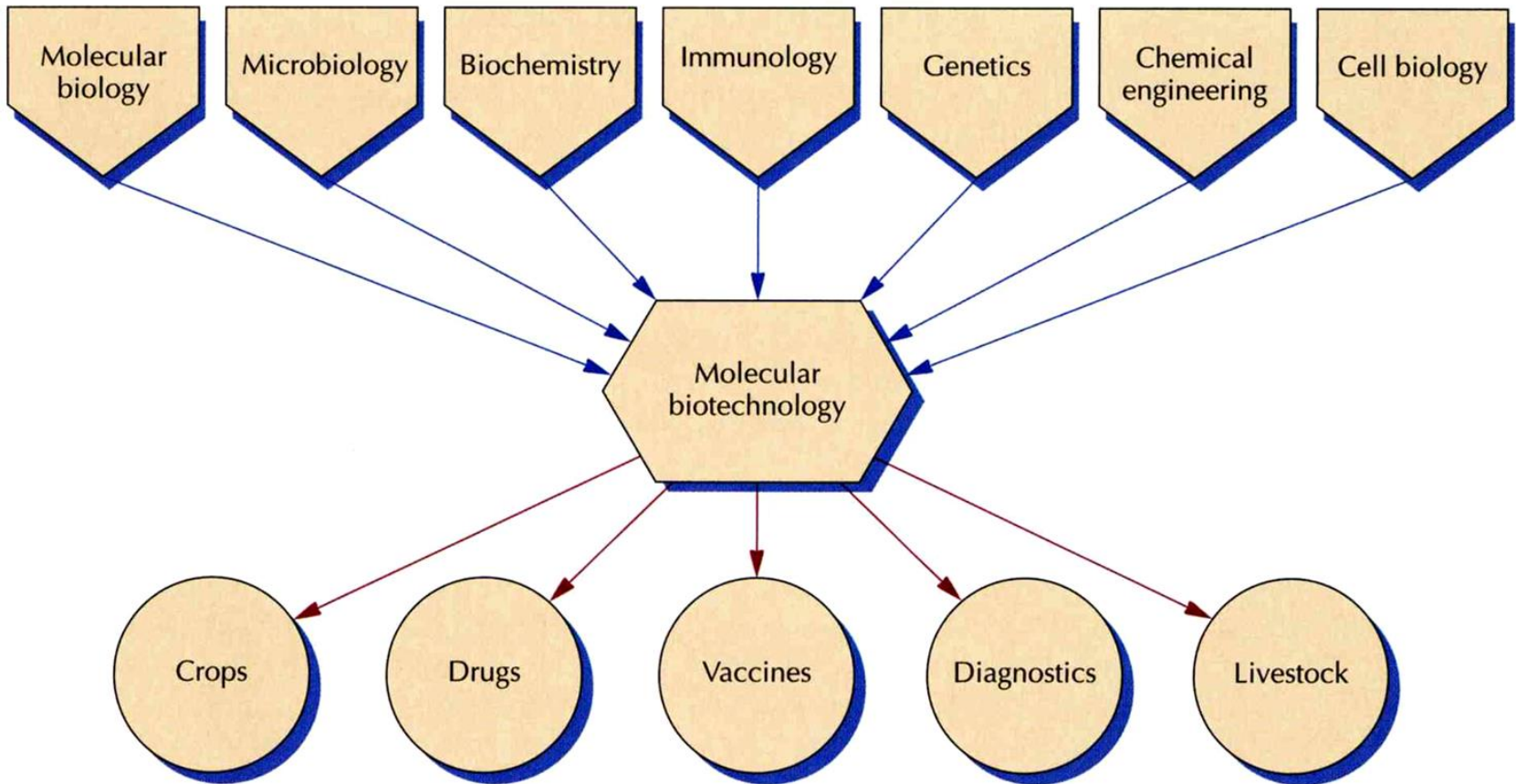
**Acceleration of technological change**

# Biotechnology

- Creation of the term 'Biotechnology'
  - Karl Ereky, 1917, Hungarian
  - All lines of works by which products are produced from raw materials with the aid of living things
- Establishing the definition of 'Biotechnology'
  - Carl Goran Heden, 1961
  - The industrial production of goods and services by processes using biological organisms, system, and processes



# Molecular Biotechnology



# History of Molecular Biotechnology (1)

- 1917 Karl Ereky coins the term biotechnology
- 1943~1952 Identification of DNA as genetic material
- 1953 Watson and Crick determine the structure of DNA
- 1961~1966 Entire genetic code deciphered
- 1970 First restriction endonuclease isolated
- 1973 Boyer and Cohen establish recombinant DNA technology
- 1977 Development of DNA sequencing methods, Walter Gilbert, Allan M. Maxam , and Frederick Sanger
- 1978 Genentech produces human insulin *in E. coli*

# History of Molecular Biotechnology (2)

- 1983 Kary Mullis Invents PCR method (1993 Nobel prize)
- 1990~2003 Human genome project
- 1996 First recombinant protein, erythropoietin, exceeds \$1 billion in annual sales
- 1996 Commercial planting of genetically modified crops
- 1997 Nuclear cloning of a mammal-a sheep-with a differentiated cell nucleus
- 2000 Monoclonal antibodies exceed \$2 billion in annual sales
- 2009 FDA approves first drug produced in genetically engineered animal (goat)

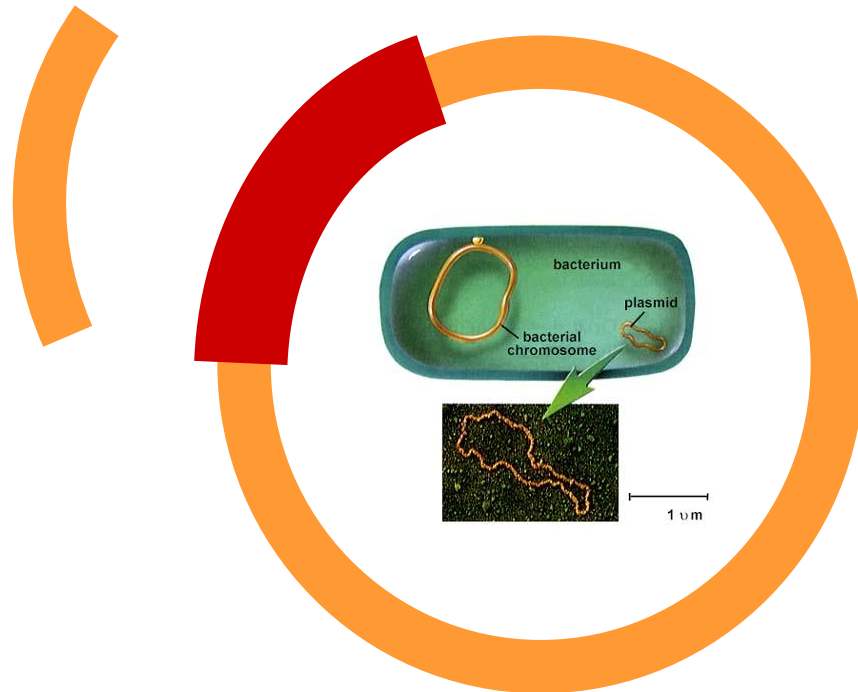


# Biotechnology & Bioindustry

- **Egypt, Fermentation**  
**(bread, cheese, wine, beer)**
- **1850s, Pure Cultures of Microorganisms**
- **1940s, Random mutation**
- **1973, Recombinant DNA technology**

# Recombinant DNA Technology

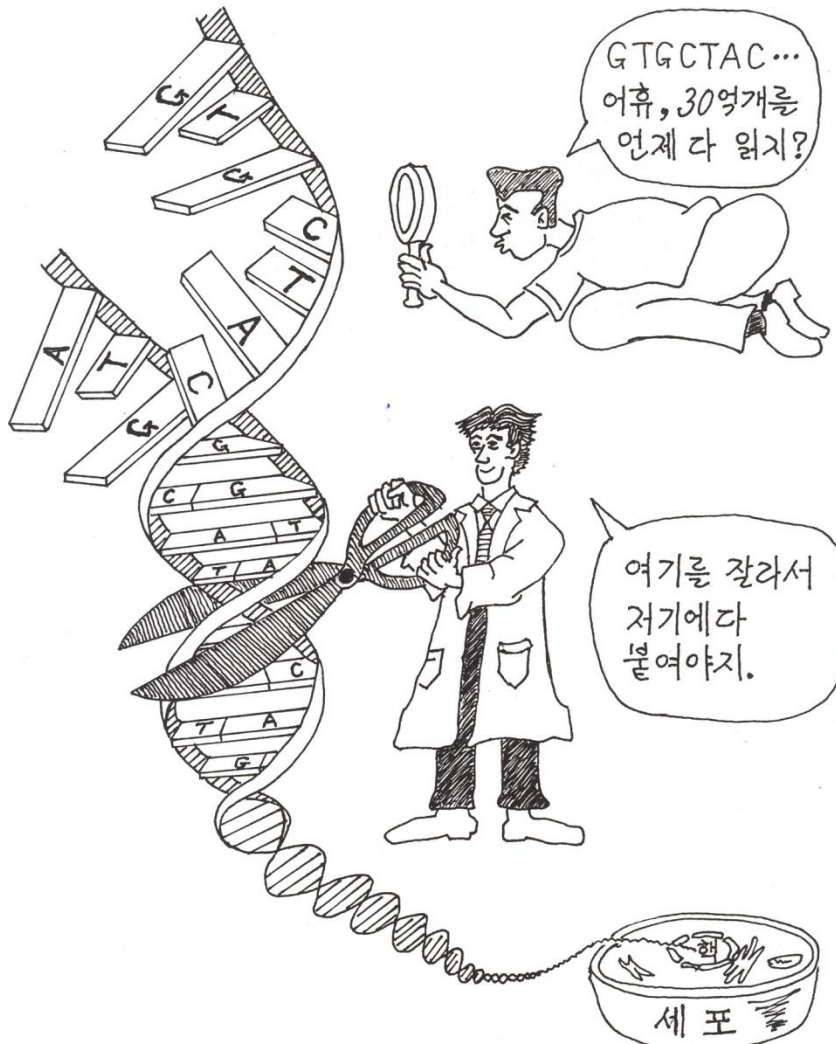
- Discovery of restriction enzyme and ligase
- Development of recombinant DNA technology
  - Herbert Boyer and Stanley Cohen (1973)



**Cutting and  
Joining DNA  
Molecules**



# Recombinant DNA Technology



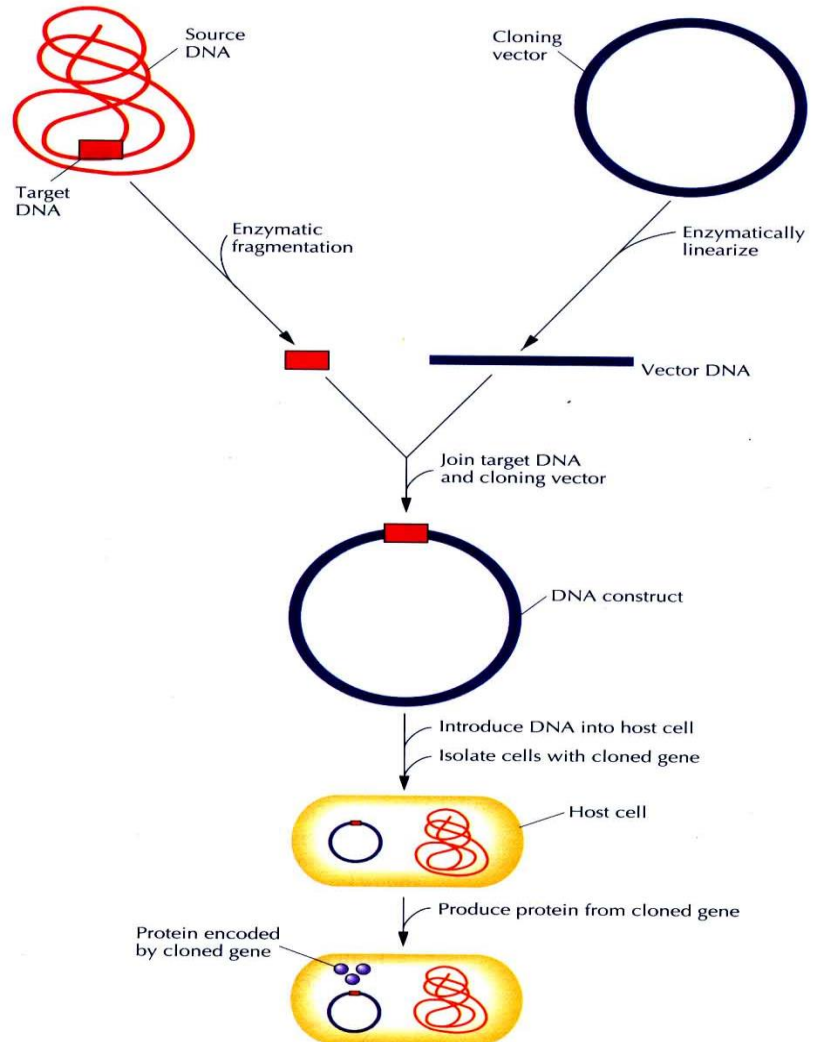
- 가위:  
Restriction Enzyme
- 풀:  
DNA ligase

# Recombinant DNA Technology

- Conference in Honolulu (1972. 11)

- Herbert Boyer (UCSF)
    - Restriction enzyme

- Stanley Cohen (Stanford Univ.)
    - Plasmid



# Commercialization of Molecular Biotechnology

## ■ Genetech (1976)

- The first biotech company based on recombinant DNA technology
- 1978: production of human insulin in *E. coli*

## ■ Today

- ~1,500 biotech companies in US, more than 8,000 worldwide
  - Amgen, Biogen, Calgene, Engenics, Genes, Cangene
  - Tissue engineering, drug delivery, vaccine, gene therapy, antisense drugs, microarray detection systems, diagnostics, genomics, proteomics, agricultural biotechnology, drug discovery
- Using molecular biotechnology in major pharmaceutical companies
  - Monsanto, Du Pont, Pfizer, Eli Lilly, GlaxoSmithKline, Merck, Novartis, Hoffmann-LaRoche

# Types and Applications of Biotechnology

## Biotechnology

- Bioprocessing
- Cell culture
- Recombinant DNA
- Monoclonal antibody
- Biosensor
- Microarray
- Protein engineering
- ...



## Industry

- Human health care
- Agricultural production
- Food and beverages
- Enzyme industry
- Chemical manufacturing
- Energy
- Waste treatment