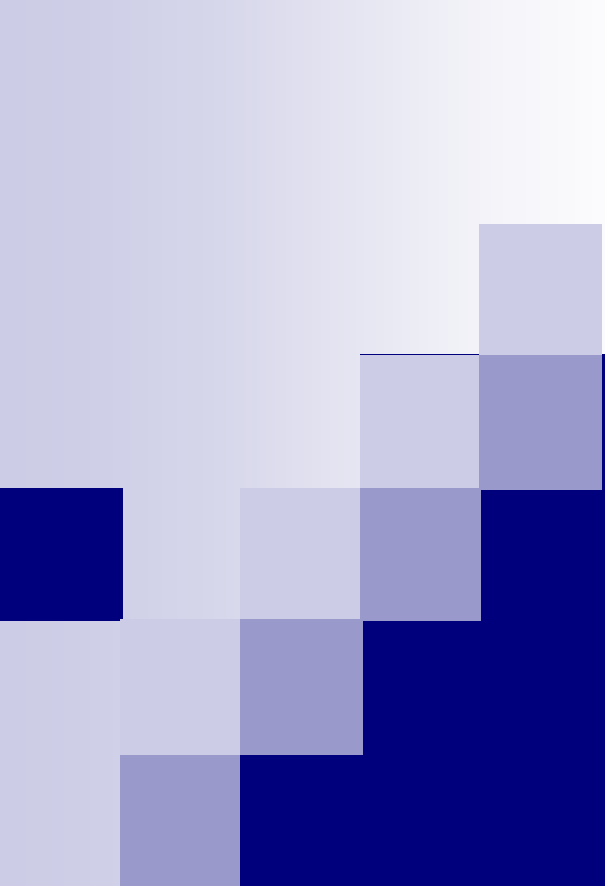




# Molecular Biotechnology

Principles and applications of  
recombinant DNA



# Chapter 1. The Molecular Biotechnology Revolution

# Science and Technology

## ■ Science

- Search for knowledge
- Way of understanding ourselves and the physical world
- Process of asking questions and finding answers, then creating broad generalizations

## ■ Technology

- Practical \_\_\_\_\_ of knowledge
- Way of \_\_\_\_\_ ourselves to the physical world
- Process of finding solutions to human problems to make lives \_\_\_\_\_ and \_\_\_\_\_

# Science and Technology

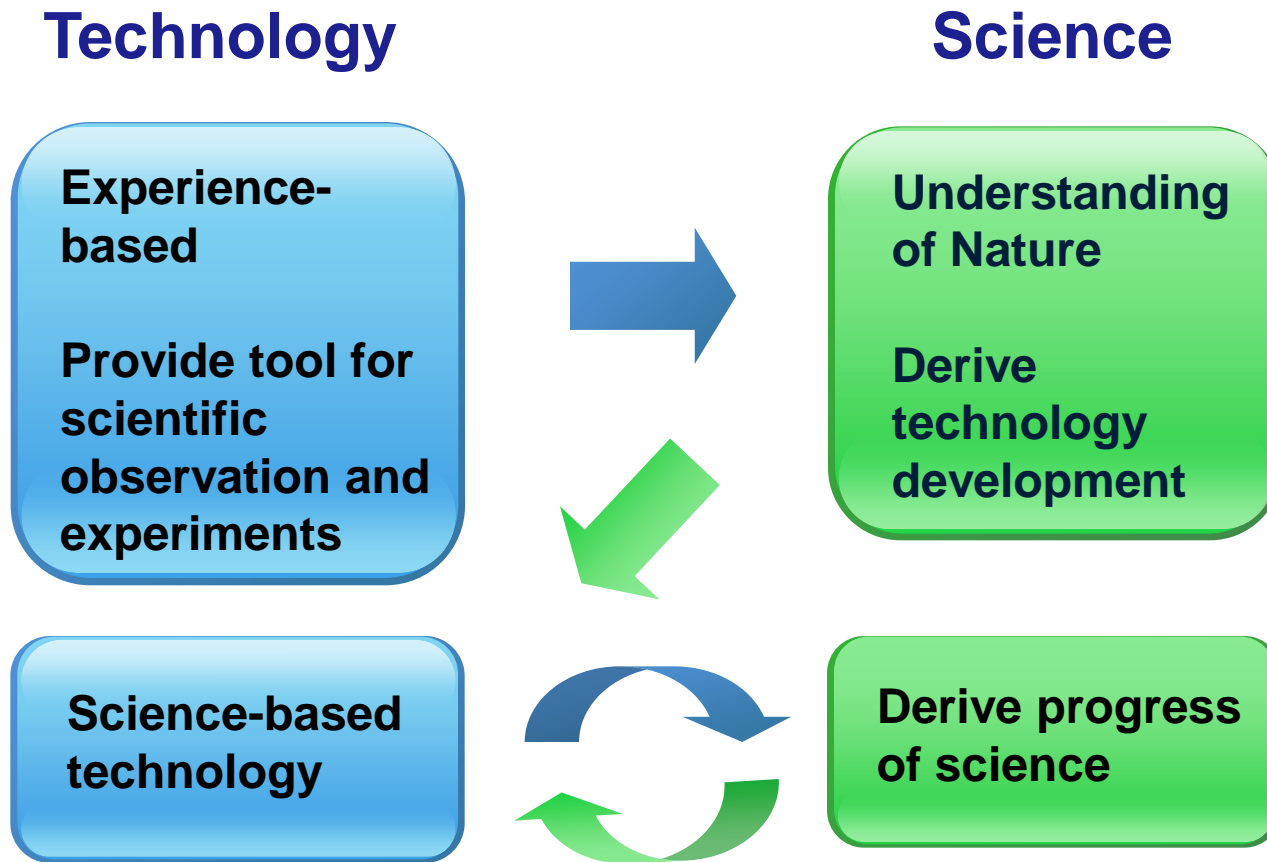
## ■ Science

- Looks for order or patterns in the physical world
- Evaluated by how well the facts support the conclusion or theory
- Limited by the ability to collect relevant facts
- Discoveries give rise to technological advances

## ■ Technology

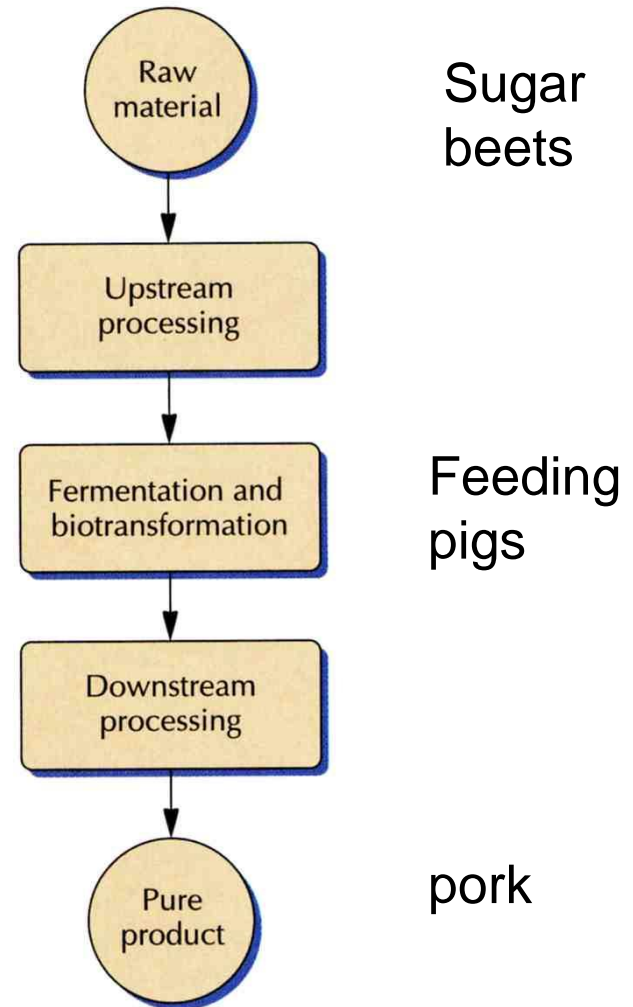
- Looks for ways to \_\_\_\_\_ the physical world \_\_\_\_\_
- Evaluated by how well it \_\_\_\_\_
- Limited by \_\_\_\_\_ and \_\_\_\_\_ concerns
- Advances give rise to \_\_\_\_\_ \_\_\_\_\_

# The Relationship Between Science and Technology



# Biotechnology

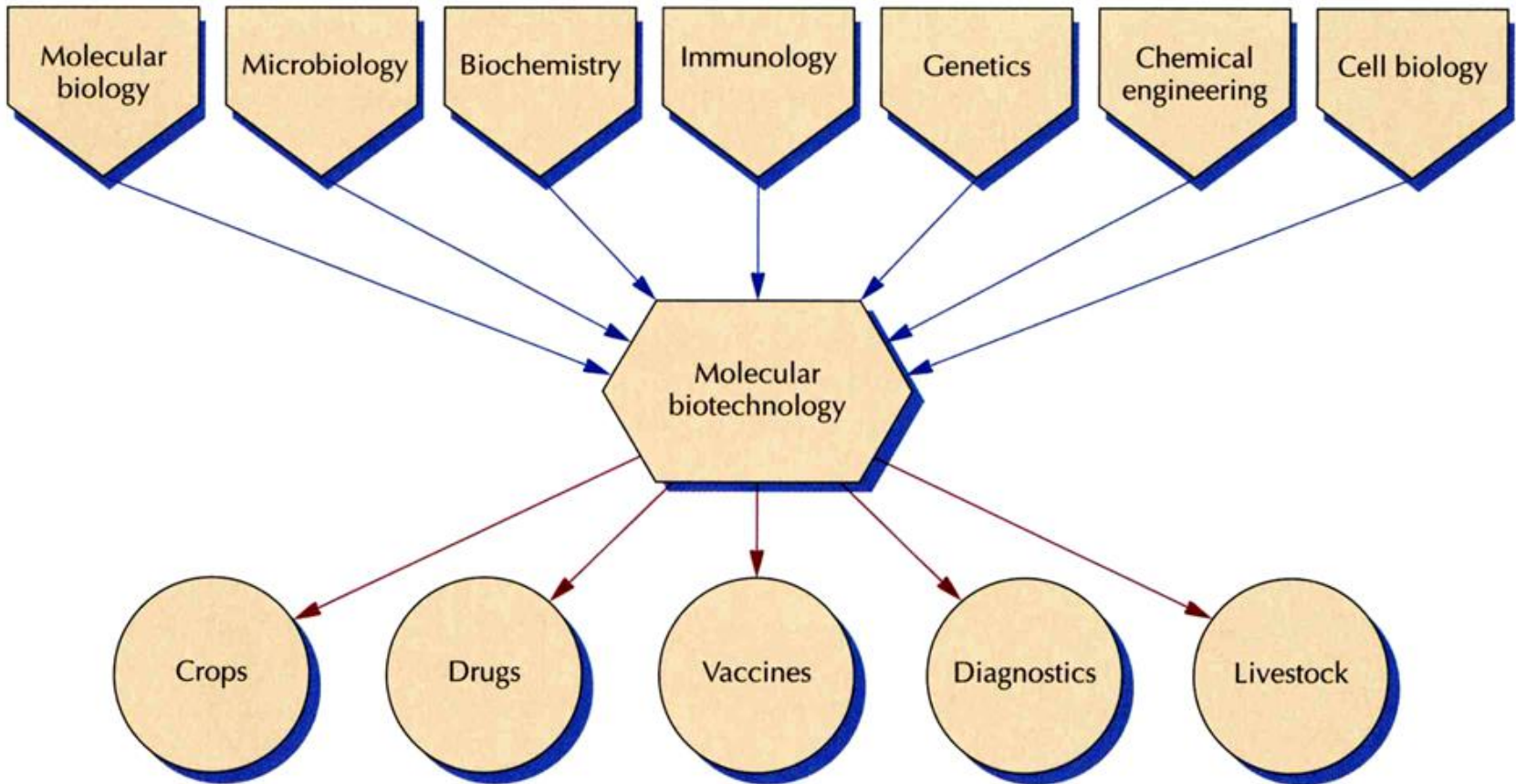
- Creation of the term 'Biotechnology'
  - Karl Ereky, 1917, Hungarian
  - All lines of works by which products are produced from raw materials with the aid of living things
- Establishing the definition of 'Biotechnology'
  - Carl Goran Heden, 1961
  - The industrial production of goods and services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



# Biotechnology Process

- Upstream processing
  - Preparation of raw materials to feed microorganism
- Fermentation and transformation
  - Fermentation: growing cells
  - Biotransformation: microbial production of desired product
    - Using natural strains
    - Induced mutagenesis and selection
    - **Molecular biotechnology revolution**
      - Recombinant DNA technology
      - Biological factories for the production of foreign proteins
- Downstream processing
  - Purification of the desired compound

# 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*

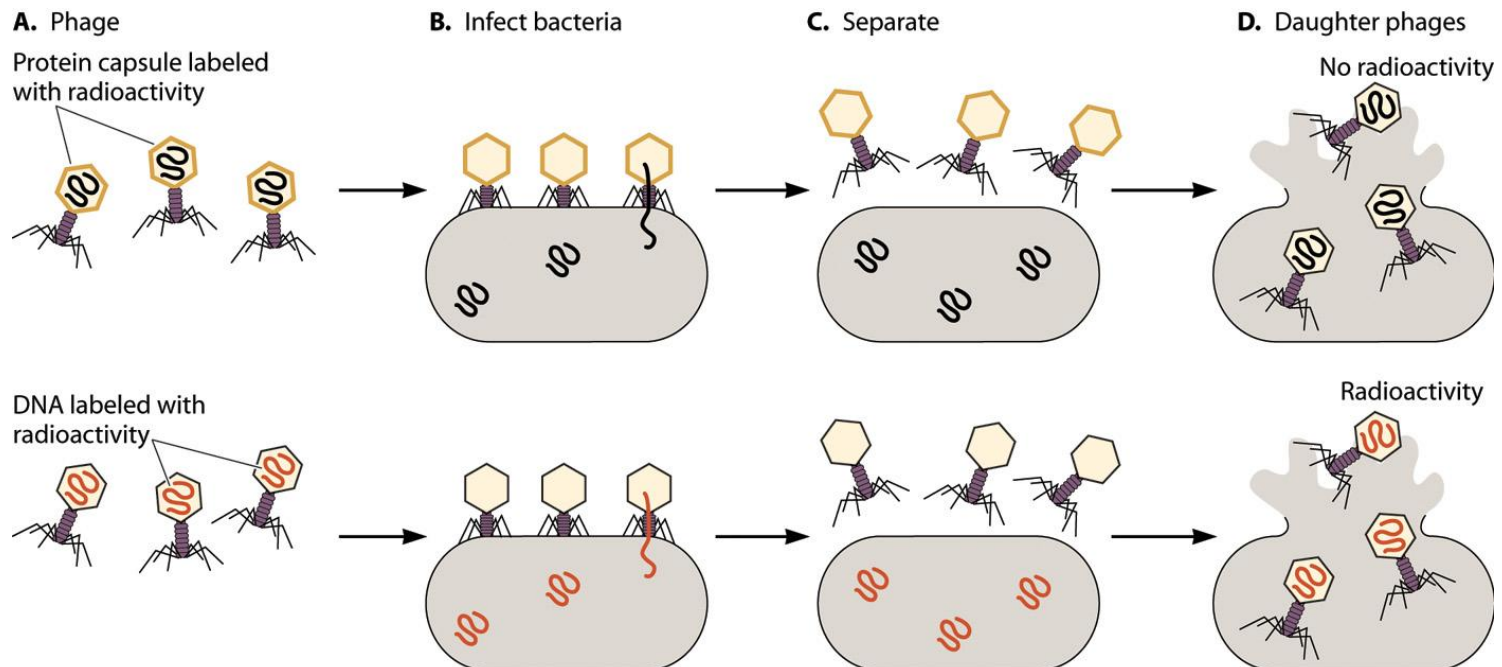
# The Nature of Genetic Material

- DNA as genetic material
  - Alfred Hershey and Martha Chase (1952)
    - Identification of DNA as genetic material
    - Protein labeled with  $^{35}\text{S}$ , and DNA with  $^{32}\text{P}$

Alfred Hershey and Martha Chase  
at Cold Spring Harbor, 1953.



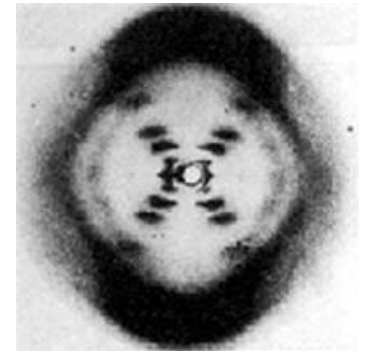
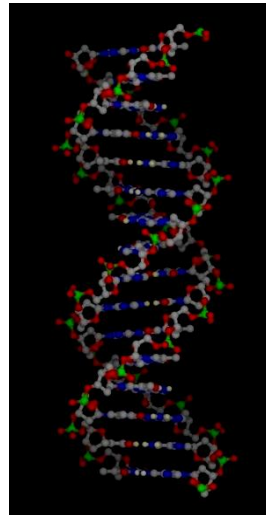
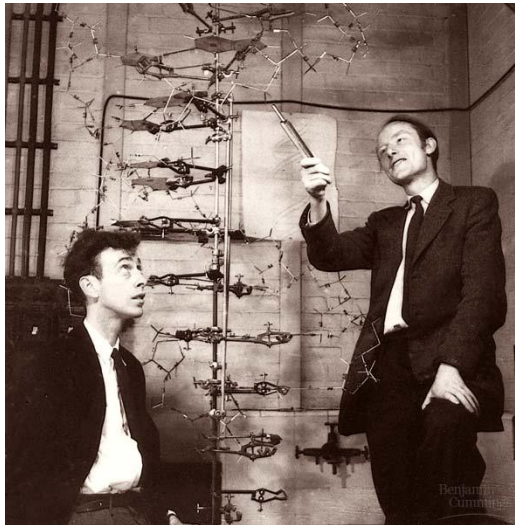
Courtesy of Cold Spring Harbor Laboratory Archives.



# The Nature of Genetic Material

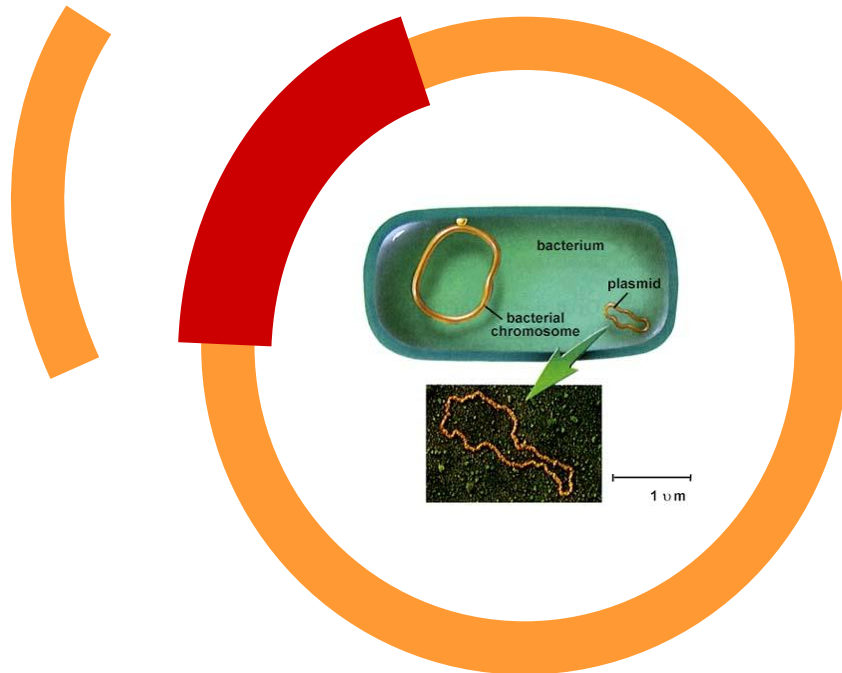
## ■ Structure of DNA

- Linus Pauling, Erwin Chargaff, Maurice Wilkins, Rosalind Franklin (1948-1951)
  - Identification of chemical properties and X-ray diffraction images of DNA
- Frances Crick and James Watson (1953)
  - Determination of DNA structure



# 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

# 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 Complete DNA sequencing of yeast *Saccharomyces cerevisiae*
- 1996 Commercial planting of genetically modified plant
- 1998 FDA approves first antisense drug
- 1999 FDA approves recombinant fusion protein (diphtheria toxin-interleukin-2) for cutaneous T-cell lymphoma
- 2005 Over 60 billion dollars revenue by biotech companies

# Commercialization of Molecular Biotechnology

## ■ Genetech (1976)

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

## ■ Today

- ~1,300 biotech companies in US, 2,500 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, Pharmacia, 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**

# Molecular Biotechnology

- The last great technological revolution of the 20<sup>th</sup> century

