Biology and Biotechnology

- Part I : Perspective
  - Science, Technology, and Society
- Part II: The foundational Science
  - The Cell
  - Molecular components of cells
  - Expression of genetic information
  - Protein structure and function
  - Cell metabolism
  - Cells maintain their internal environments
  - Cells respond to their external environments
  - Cells grow and reproduce
  - Cells differentiate
  - Ecological interaction

Biology and Biotechnology

- Part III: Biotechnology Applications

Research applications

- The biotechnology toolbox
- Biotechnology in the research laboratory

Commercial applications

- Health care applications
- Environmental sustainability and biotechnology

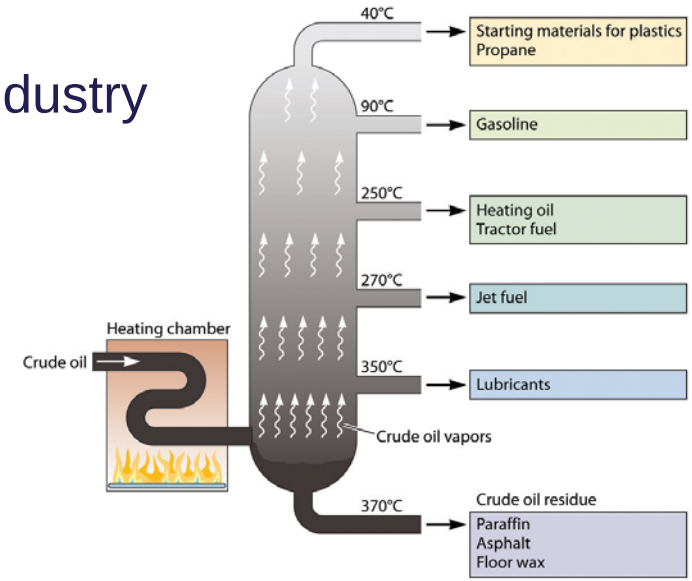
Chapter 1

Science, Technology, and Society

Contents

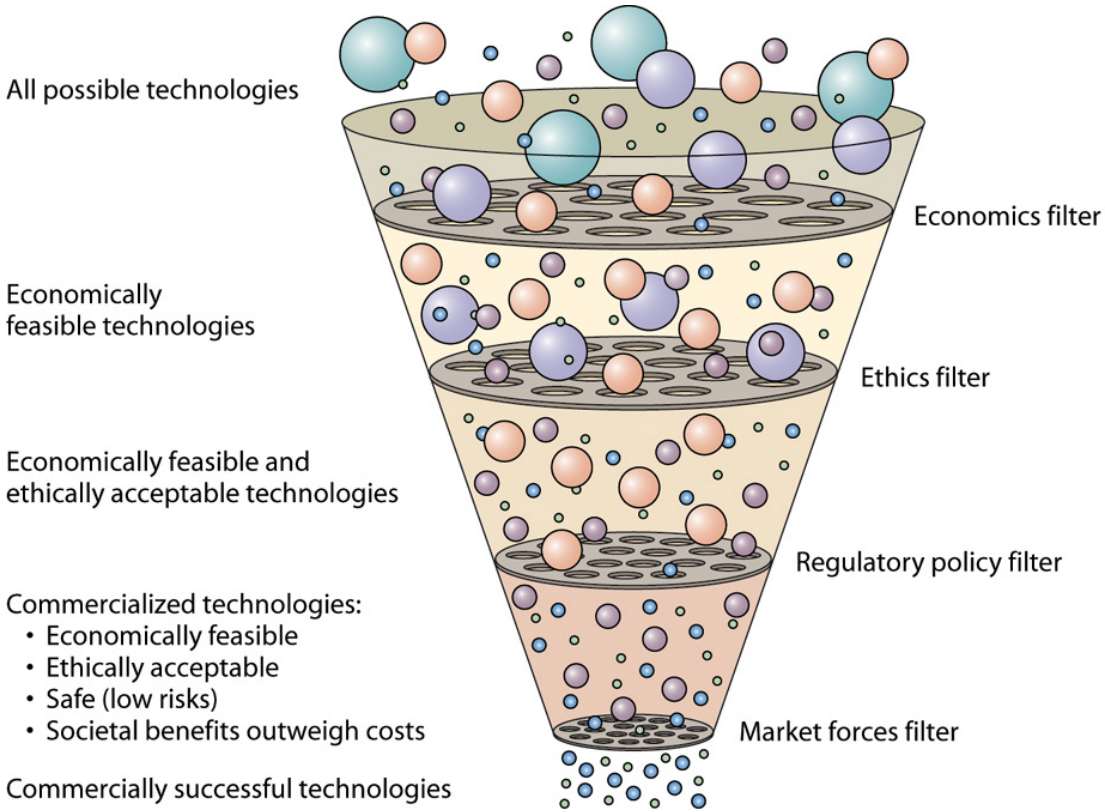
Technology and Society

- Technology
  - The totality of means employed to provide objects necessary for human sustenance and comfort
  - Changes the environment and society
    - Automobile
      - Development of petroleum industry
      - Social impacts
      - Pollution and global warming



Technology and Society

- Society
  - Creates filters for technology



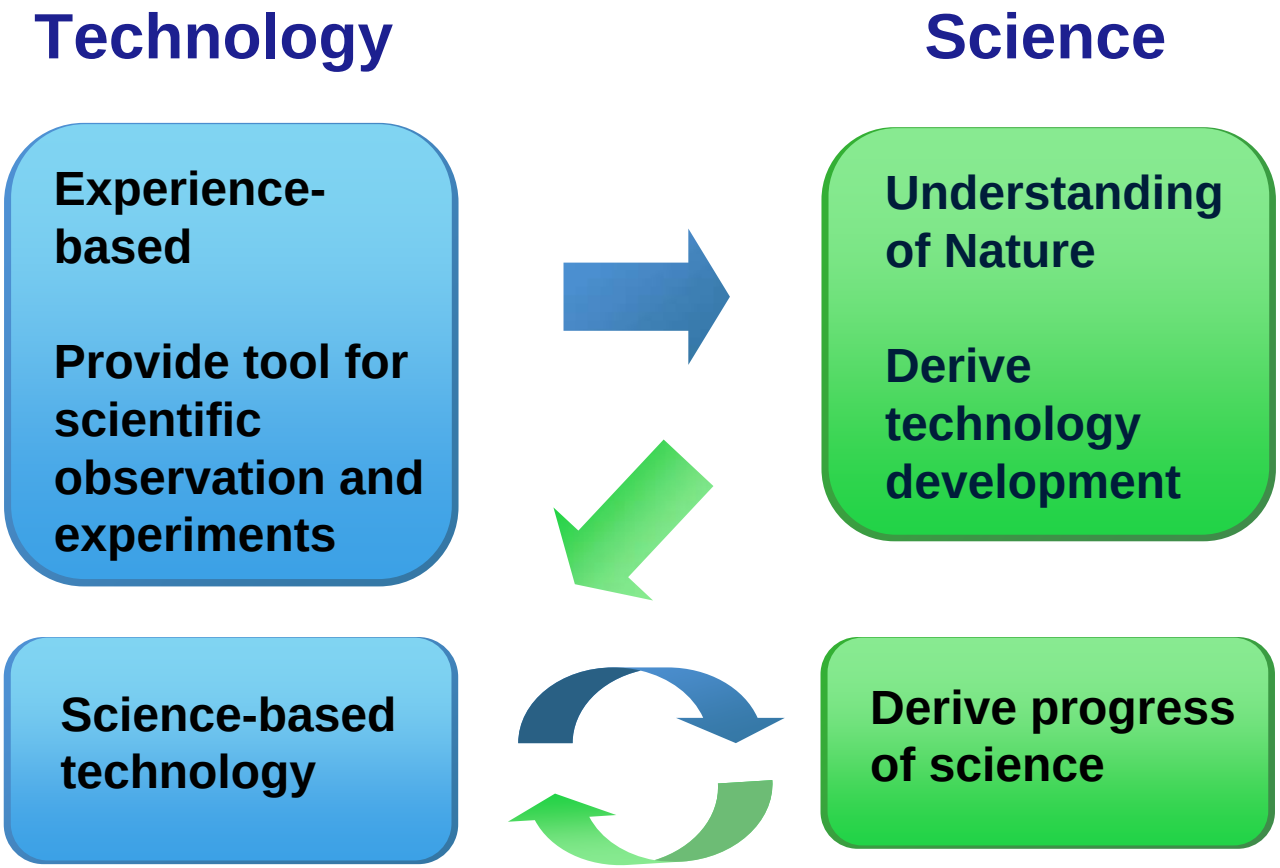
Science and Technology

- **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 application of knowledge
  - Way of adapting ourselves to the physical world
  - Process of finding solutions to human problems to make lives easier and better

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 control the physical world
  - Evaluated by how well it works
  - Limited by financial cost and safety concerns
  - Advances give rise to scientific discovery

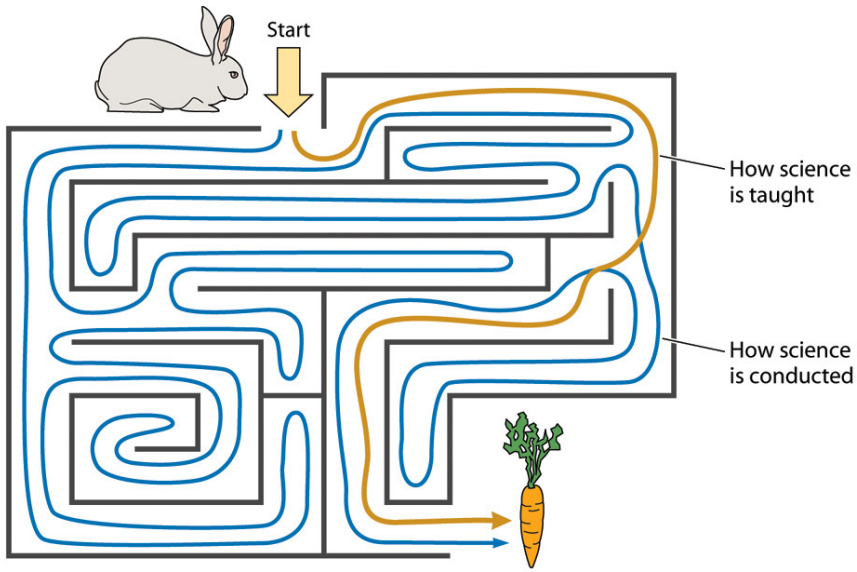
The Relationship Between Science and Technology

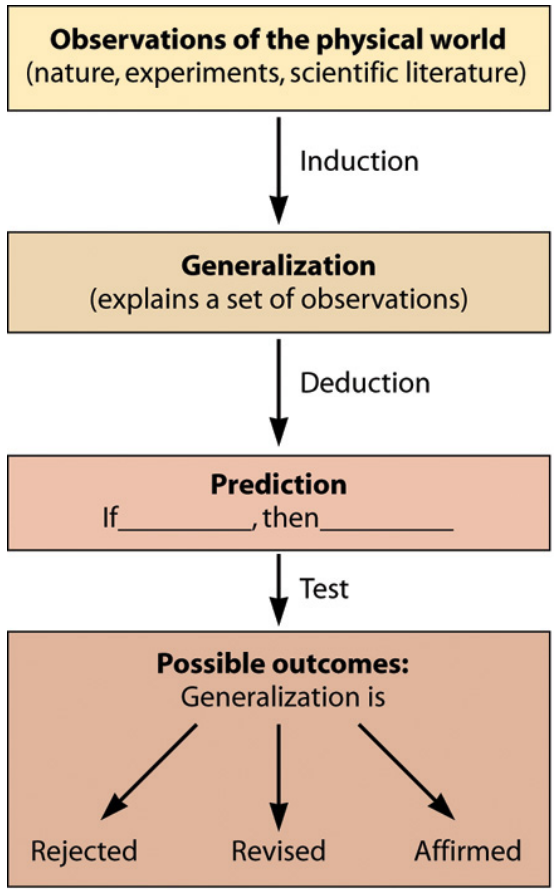


Acceleration of technological change

The Nature of Science

- Science is a process, not a list of discoveries
- Science can prove a generalization is not true, but cannot prove that is true
- Influenced by society





Biotechnology

- Definition
  - The use of living organisms or life processes to solve problems or make useful products
- Ancient biotechnology
  - Started from 10000 years ago
    - Domestication of plants and animals
    - Fermented foods
  - Trial and error-based

Bread,3000 BC

Wine, 2500 BC

- Modern biotechnology
  - Technology using cells and biological molecules or cellular and biomolecular processes
    - Specificity, precision, and predictability
    - Unity and flexibility
    - Reproduction and renewable resources

Types and Applications of Biotechnology

Biotechnology

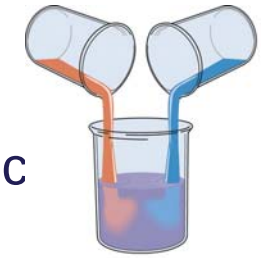
- Bioprocessing
- Cell culture
- Recombinant DNA
- Monoclonal antibody
- Biosensor
- Microarray
- Protein engineering
- Antisense technology

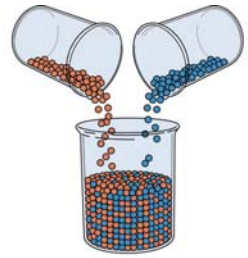
Industry

- Human health care
- Agricultural production
- Food and beverages
- Enzyme industry
- Forestry/pulp and paper
- Textiles
- Chemical manufacturing
- Energy
- Waste treatment

The History of Crop Genetic Modification

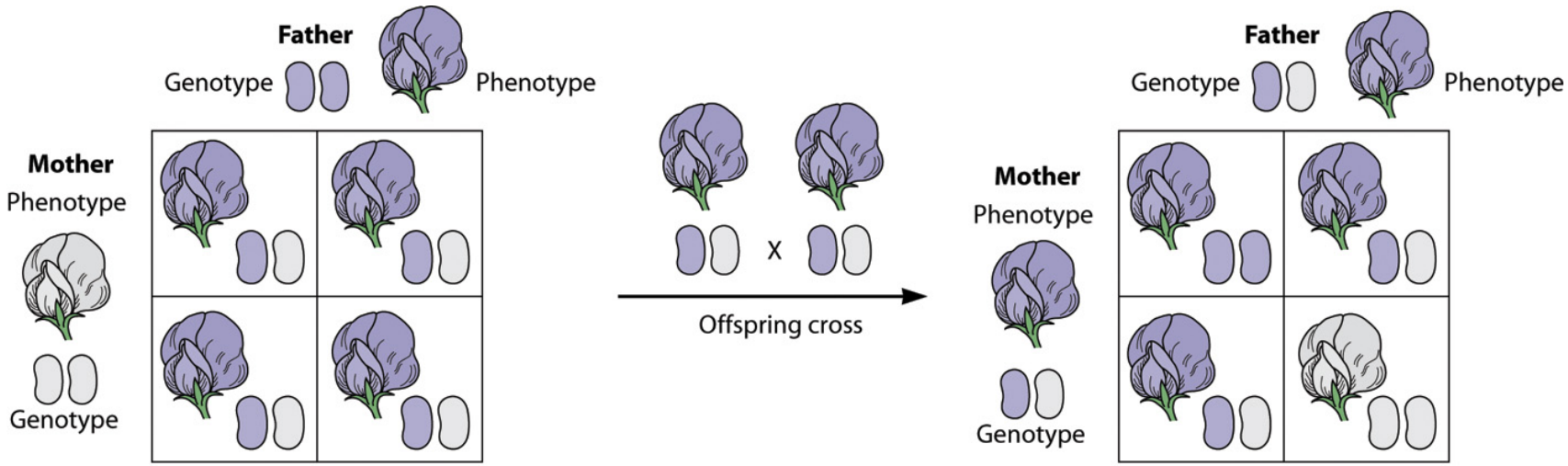
- Stage1
  - Genetic modification through seed selection
- Stage 2
  - Genetic modification through plant breeding and selection
  - Models of inheritance
    - Fluid-blending model
    - Medel's theory of inheritance (1865, proved in 1900)
      - Discrete-particle (now known as gene) model
- Stage 3
  - Science-based plant breeding
- Stage 4
  - Discovery of the nature of genetic inheritanc
  - Plant genetic engineering


Fluid blending


Discrete particle

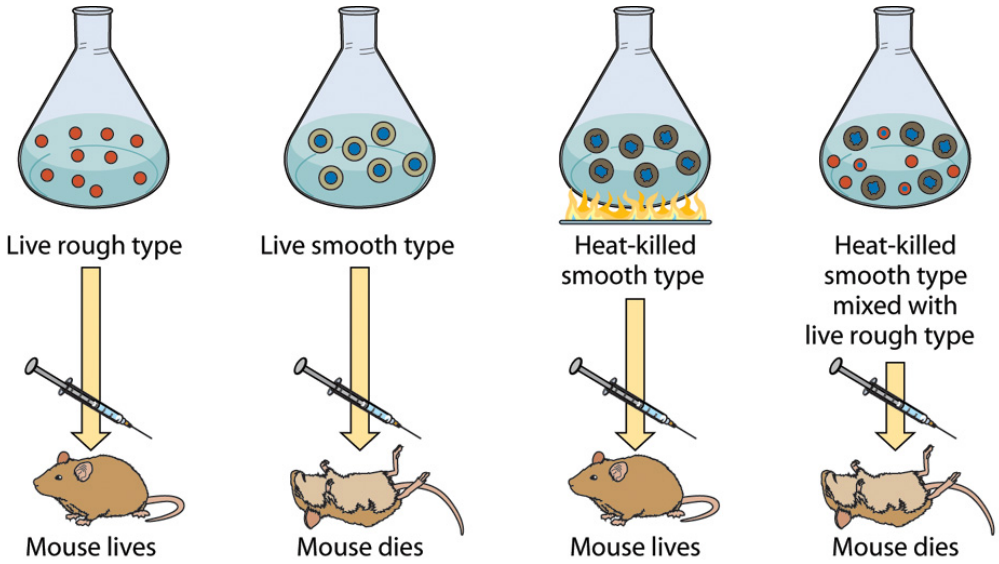
Mendel's Theory of Inheritance

- Dominant and Recessive
- Genotype and Phenotype



The Nature of Genetic Material

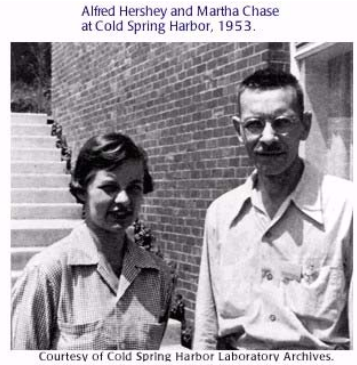
- DNA as genetic material
  - Frederick Griffith (1928)
    - ‘Transforming factor’ transferred from dead smooth virus to rough virus

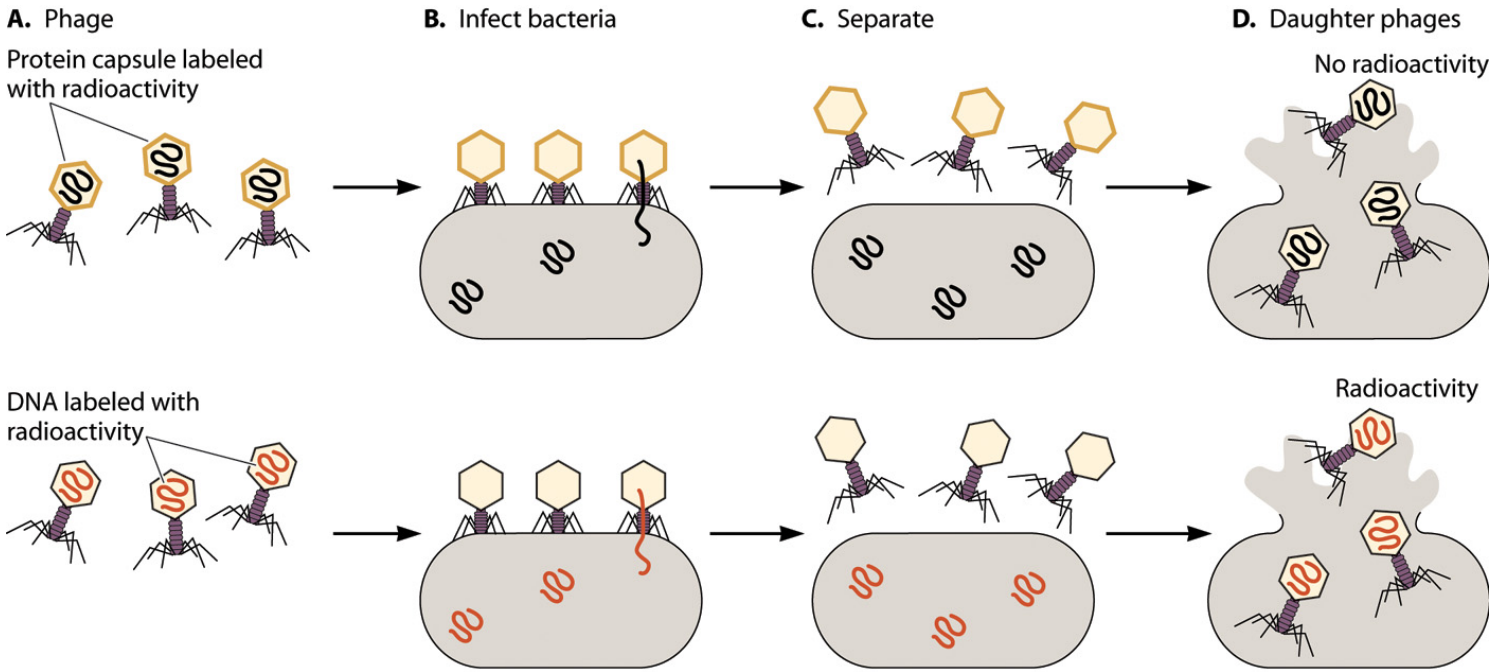


  - O.T. Avery (1943)
    - Identification of the ‘Transforming factor’ as DNA

The Nature of Genetic Material

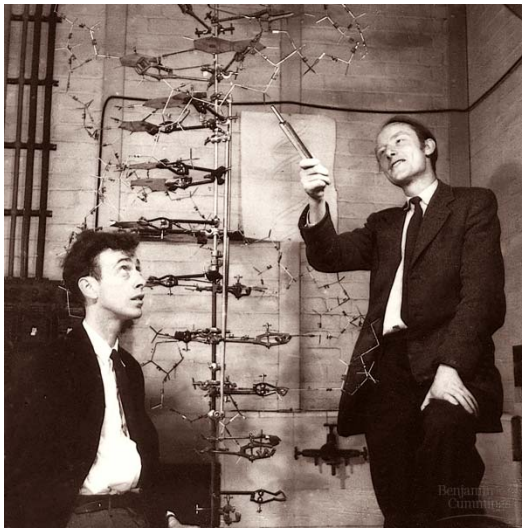
- DNA as genetic material
  - Alfred Hershey and Martha Chase (1952)
    - Identification of DNA as genetic material
    - Protein labeled with ^{35}S, and DNA with ^{32}P

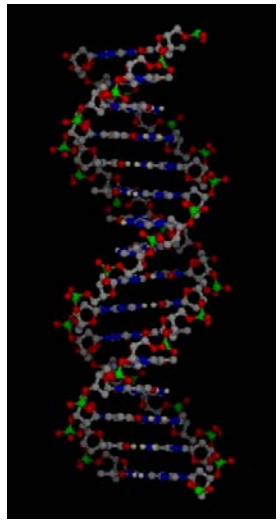


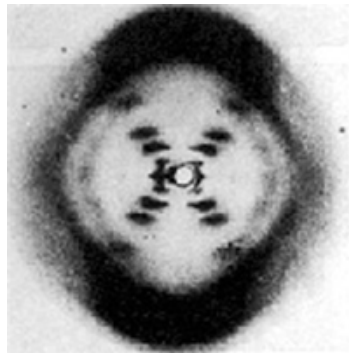


The Nature of Genetic Material

- 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

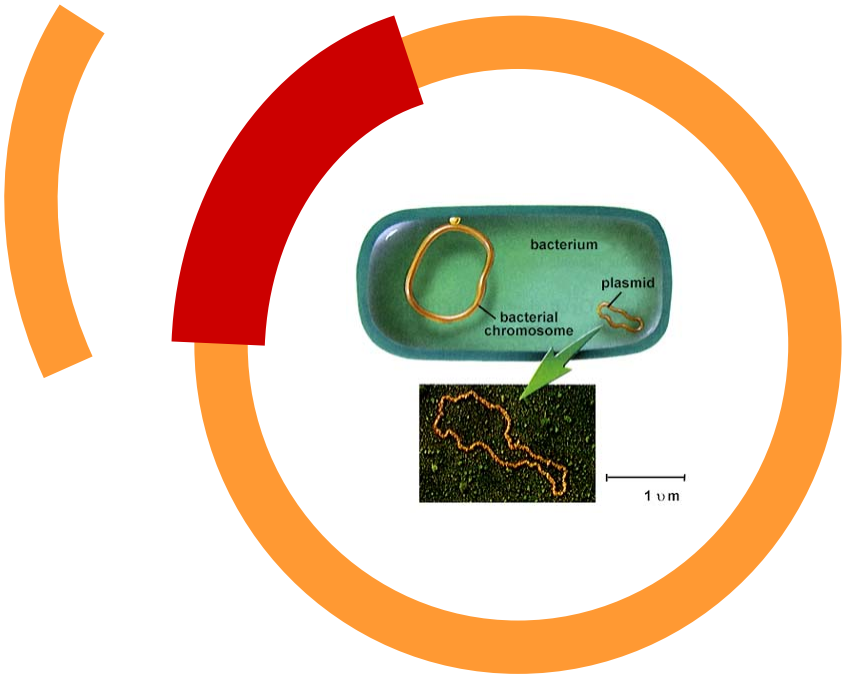






Recombinant DNA Technology

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



Cutting and Joining DNA Molecules

Molecular Biotechnology

- The last great technological revolution of the 20th century