MAINIDEA

Researchers use genetic engineering to manipulate DNA.

K *What I Know*	**W** *What I Want to Find Out*	**L** *What I Learned*

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Essential Questions

- What are the different tools and processes used in genetic engineering?
- How does genetic engineering manipulate recombinant DNA?
- What are the similarities between selective breeding and genetic engineering?
- How can genetic engineering and biotechnology be used to improve human life?

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Vocabulary

Review

- DNA

New

- genetic engineering
- genome
- restriction enzyme
- gel electrophoresis
- recombinant DNA
- plasmid
- DNA ligase
- transformation
- cloning
- polymerase chain reaction
- transgenic organism

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Genetic Engineering

- Genetic engineering is technology that involves manipulating the DNA of one organism in order to insert the DNA of another organism.
- The inserted DNA of another organism is known as exogenous DNA.

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Genetic Engineering

- Genetically engineered organisms are used to:
  - Study the expression of a particular gene
  - Investigate cellular processes
  - Study the development of a certain disease
  - Select traits that might be beneficial to humans

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DNA Tools

- Genetic engineering can be used to increase/decrease the expression of specific genes in selected organisms.
- An organism's genome is the total DNA in the nucleus of each cell.
- DNA tools can be used to manipulate DNA and to isolate genes from the rest of the genome.

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DNA Tools

Restriction enzymes

- Restriction enzymes are proteins that recognize and bind to specific DNA sequences and cleave the DNA within that sequence.
- They are used as a defense mechanism by bacteria against viruses.
- Scientists use restriction enzymes as powerful tools for isolating specific genes or regions of the genome.

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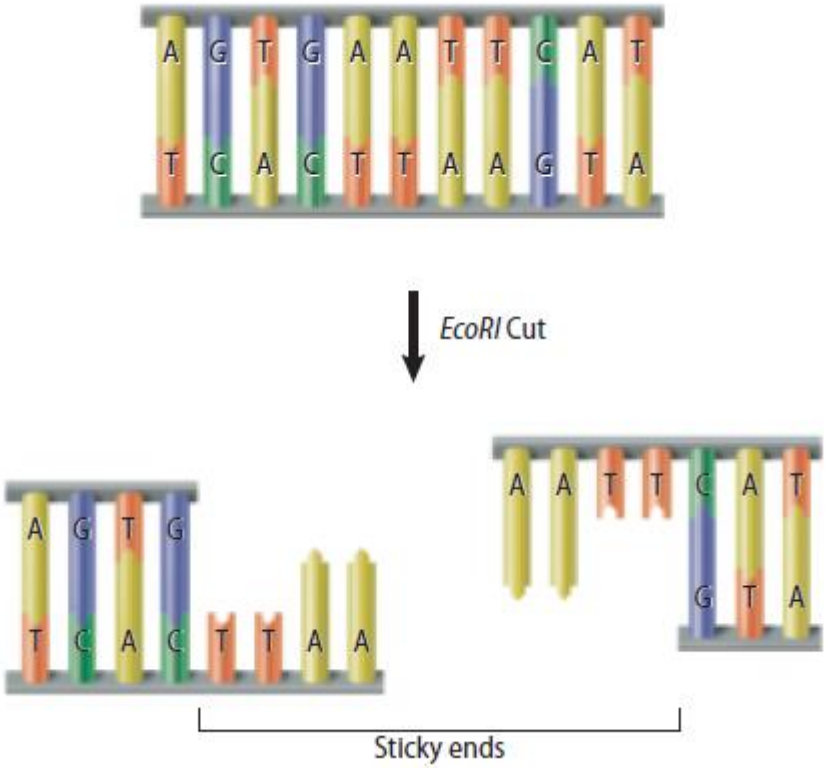
DNA Tools

*EcoR*I

- *EcoR*I is a restriction enzyme that specifically cuts DNA containing the sequence GAATTC.
- Sticky ends are single stranded DNA sequences at the end of fragments.
- Can be reattached to complementary strands



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Restriction Enzymes

Animation

FPO

Add link to animation from page 364 (Figure 4) here.

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DNA Tools

Gel electrophoresis

- An electric current is used to separate DNA fragments according to the size of the fragments in a process called gel electrophoresis.
- When an electric current is applied, the DNA fragments move toward the positive end of the gel.
- The smaller fragments move farther faster than the larger ones.
- The unique pattern created based on the size of the DNA fragment can be compared to known DNA fragments for identification.

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Recombinant DNA Technology

- DNA fragments from different sources can be combined to make new DNA molecules.
- The newly generated DNA molecule with DNA from different sources is called recombinant DNA.

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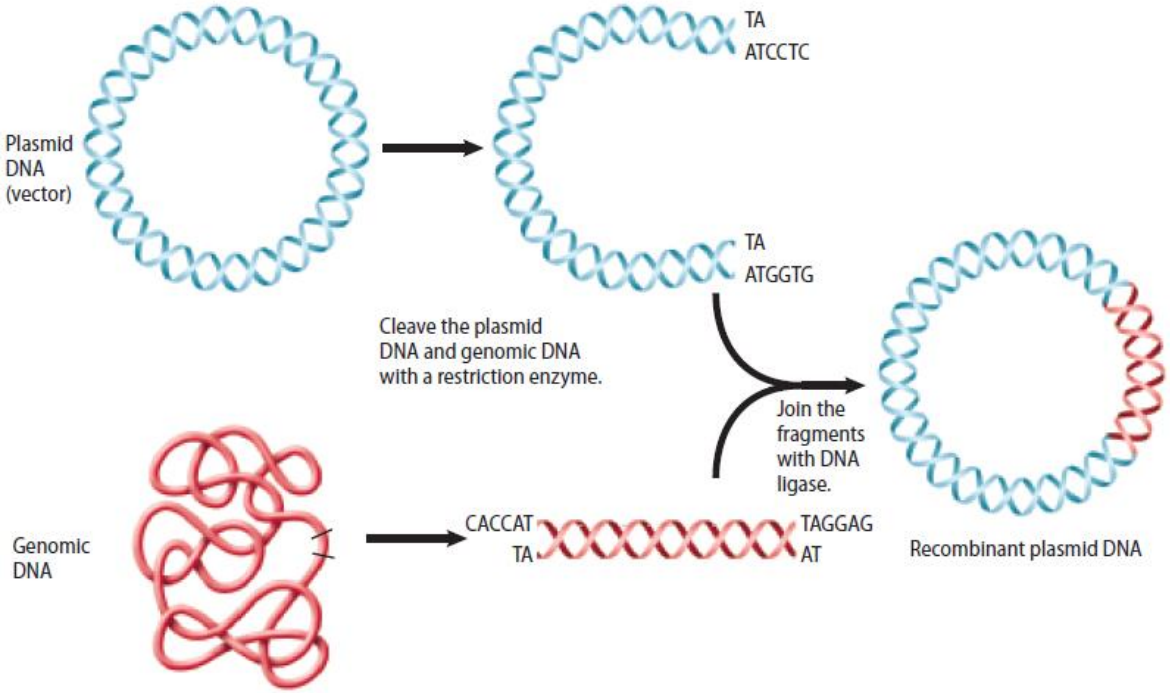
Recombinant DNA Technology

- Recombinant DNA is placed into bacterial cells for study via a carrier.
- Common carriers include viruses and plasmids – small, circular, double-stranded DNA molecules that occur naturally in bacteria and yeasts.
- DNA ligase, a cellular repair enzyme, attaches the recombinant DNA to the plasmid.



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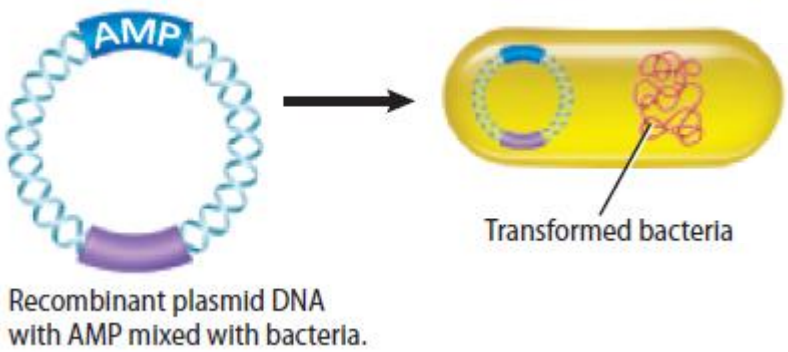
Recombinant DNA Technology

Gene cloning

- To make a large quantity of recombinant plasmid DNA, bacterial cells are mixed with recombinant plasmid DNA.
- Some of the bacterial cells take up the recombinant plasmid DNA through a process called transformation.



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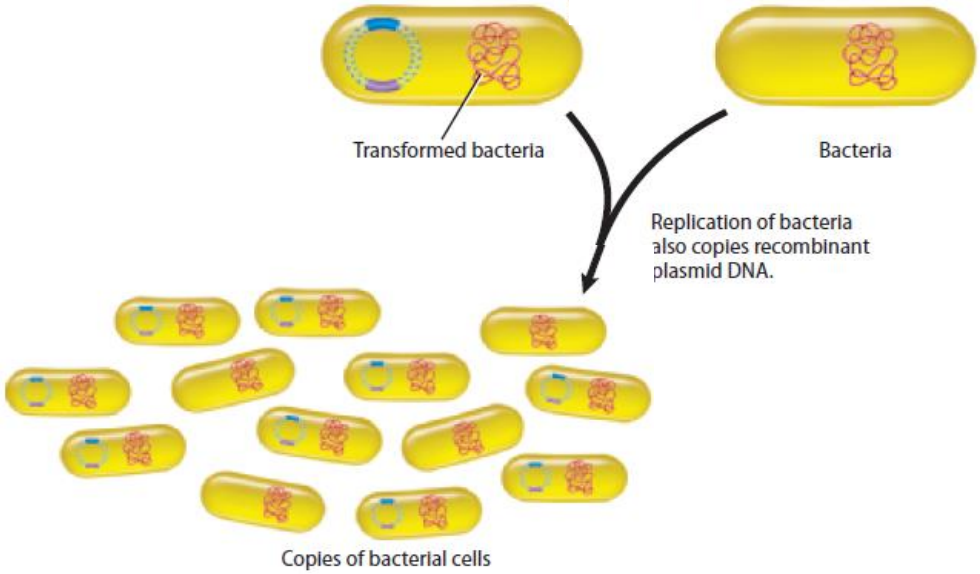
Recombinant DNA Technology

Gene cloning

- Bacteria that take up the plasmid make copies of the recombinant DNA during cell replication.
- Large numbers of identical bacteria containing recombinant DNA can be produced through this process called cloning.



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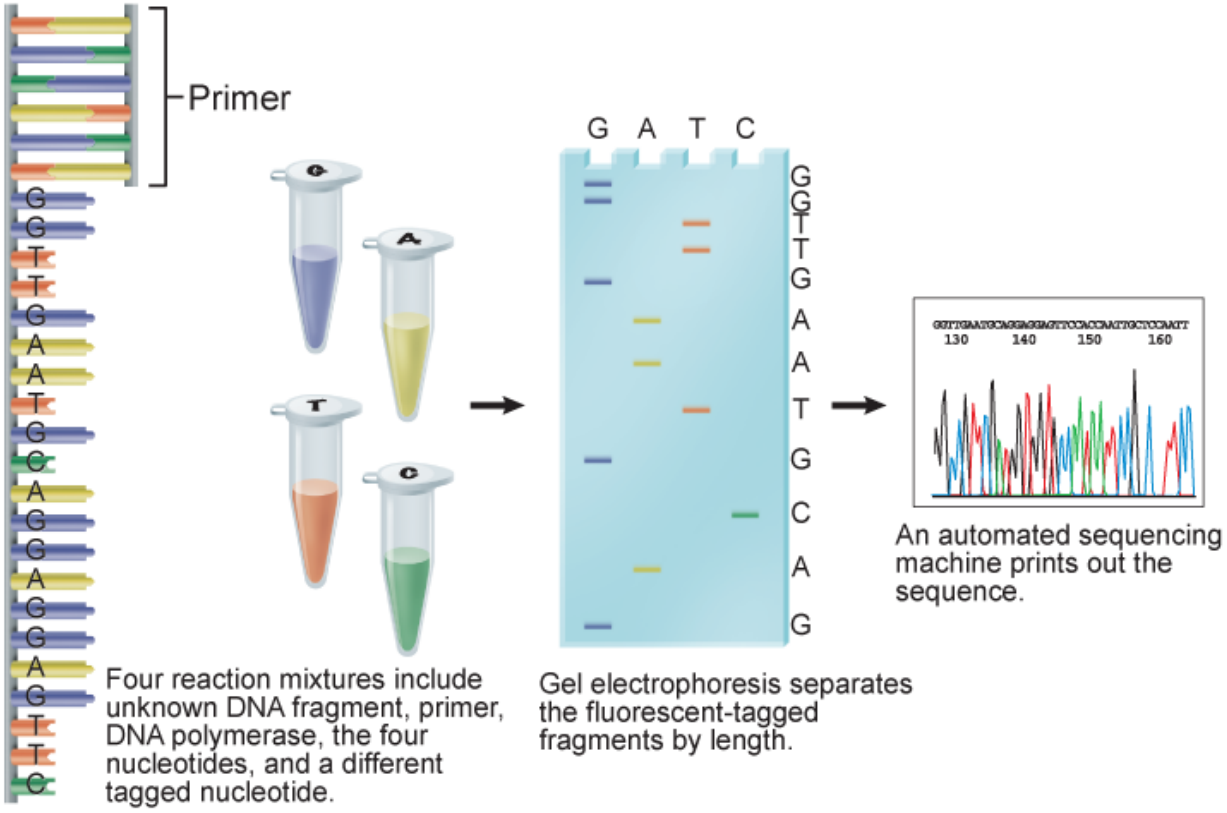
Recombinant DNA Technology

DNA sequencing

- Scientists study DNA sequences with DNA fragments, DNA polymerase, fluorescently labeled nucleotides, and gel electrophoresis.



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Recombinant DNA Technology

Polymerase chain reaction

- Once the sequence of a DNA fragment is known, a technique called the polymerase chain reaction (PCR) can be used to make millions of copies of a specific region of a DNA fragment.
- PCR can copy or amplify a single DNA molecule numerous times for use in analysis.

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Polymerase Chain Reaction

Animation

FPO

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Genetic Engineering

Interactive Table

FPO

Add link to interactive table from page 370 (table 1) here.

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Biotechnology

- Biotechnology is the use of genetic engineering to find solutions to problems.
- Organisms with genes from other organisms are called transgenic organisms.
- Transgenic animals, plants, and bacteria are used for research, medicine, and agriculture.

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Biotechnology

Transgenic animals

- Scientists produce most transgenic animals in laboratories for biological research.
- They are used to:
  - Study diseases
  - Improve food supply
  - Improve human health
  - Be potential sources of organs for transplant

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Biotechnology

Transgenic plants

- Frequently genetically engineered for resistance against insect or viral pests.
- Other transgenic plants are designed to:
  - Reduce allergic reactions in humans
  - Contain increased vitamin and mineral content
  - Resist extreme weather
  - Produce vaccines or biodegradable plastics

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Biotechnology

Transgenic bacteria

- Transgenic bacteria can:
  - Produce insulin and growth hormones
  - Slow the formation of ice on crops
  - Clean up oil spills
  - Decompose garbage

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Review

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