

Big Picture

Biotechnology uses modern technology to manipulate and use living systems or their component parts. Two common methods used in biotechnology include gene cloning and PCR, both of which can be used to amplify target DNA fragments. Biotechnology has many applications in medicine and agriculture and plays important roles in our society today.

Key Terms

Biotechnology: Use of technology to change the genetic makeup of living things in order to produce useful products.

Gene Cloning: Process of isolating and making copies of a gene.

Vector: DNA molecule used to transfer genetic material to a target cell.

Recombinant DNA: DNA that contains genetic material from more than one source.

Genetic Engineering: The use of modern technology to modify an organism's genome.

Polymerase Chain Reaction (PCR): The replication of a DNA segment using a machine.

DNA Primer: Short DNA segment necessary for DNA replication.

Transgenic Crop: Crop that has been genetically modified with new genes that code for traits useful to humans.

The Science of Genetic Engineering

Biotechnology methods include **gene cloning** and **polymerase chain reaction**.

Gene Cloning

There are four steps in gene cloning: isolation, ligation, transformation, and selection.

- In isolation, a restriction enzyme is used to isolate the target fragment of DNA.
- In ligation, the target fragment of DNA is inserted in a **vector**. If bacteria is the host organism, the vector is a circular molecule of DNA, typically a plasmid. The plasmid with the inserted DNA fragment is an example of **recombinant DNA**.

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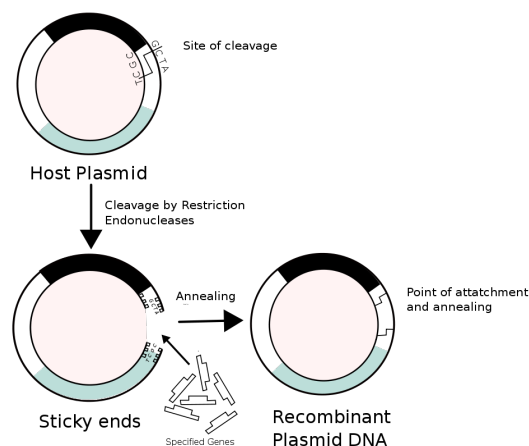


Figure: Example of recombinant DNA.

- In transformation, the recombinant DNA is inserted into the host. Heat and electric shock can make the host more receptive to the foreign plasmid. This is an example of **genetic engineering**.
 - Transformation is not 100% effective and not all the host cells will have the recombinant DNA.
- In selection, the transformed host is grown up in culture and only the host cells containing the desired DNA fragment are lysed, releasing the target DNA fragment.

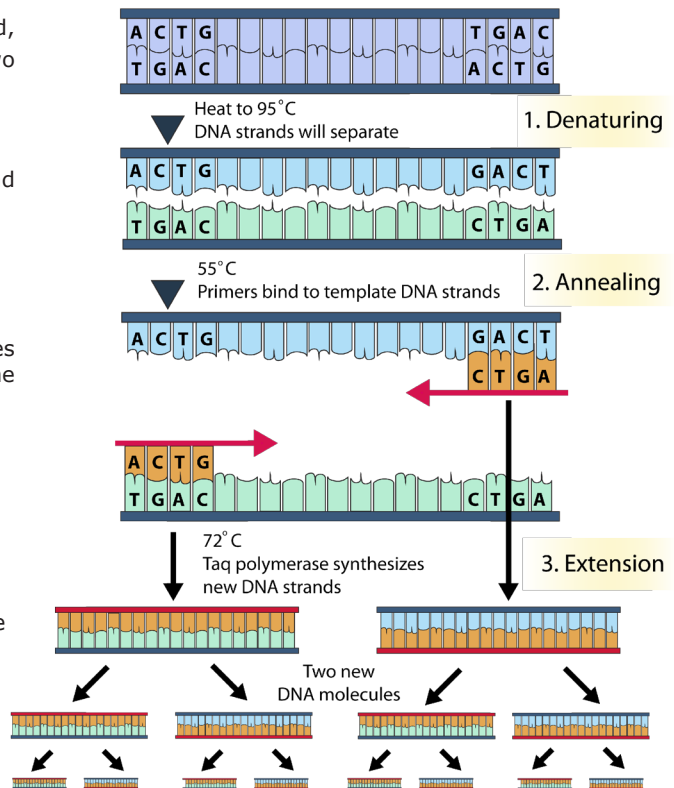
BIOTECHNOLOGY CONT.

The Science of Genetic Engineering (cont.)

Polymerase Chain Reaction

Polymerase chain reaction (PCR) is able to make many copies of a gene or DNA segment. It has three steps: denaturation, annealing and extension.

- In denaturation, the fragment of DNA is heated, causing the DNA double helix to unwind and the two strands to come apart.
- In annealing, complementary **DNA primers** will bind to the DNA fragment.
- In extension, the enzyme DNA polymerase elongates the complementary fragments of DNA, starting at the primer.



These three steps are repeated many times to make many copies of the gene/DNA segment.

Applications

Medicine

- Gene therapy: Using recombinant DNA in a vector, typically a virus, to deliver beneficial DNA to patients. A possible way to treat genetic disorders.
- Producing protein: Gene cloning can be used to synthesize human proteins. If the host organism is left to express the DNA that produces the desired protein, the protein product of its expression can be isolated by the researcher.
 - Insulin is an example of a human protein produced by gene cloning.
- Pharmacogenomics: Due to the little differences in DNA, individuals react differently to medication. This has led to new practices of personalized medicine that tailor drug administration on the basis of an individual's genetic profile.

Agriculture

- **Transgenic crops** have been engineered to express foreign DNA that afford the crop new and beneficial traits.
 - For example, many beet crops have been genetically modified for pesticide resistance.

Notes
