Ch. 9 Frontiers of Technology

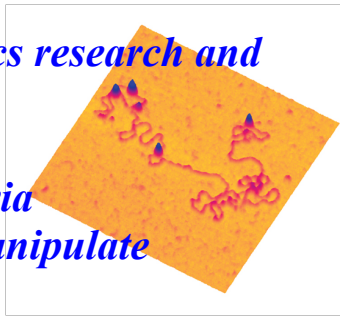
Section 9.1 Manipulating DNA

I. Biotechnology relies on cutting DNA at specific places.

A. **Scientists use several techniques to manipulate DNA.**

-***Chemicals, computers, and bacteria*** are used to work with DNA.

-Scientists use these tools in ***genetics research and biotechnology.***



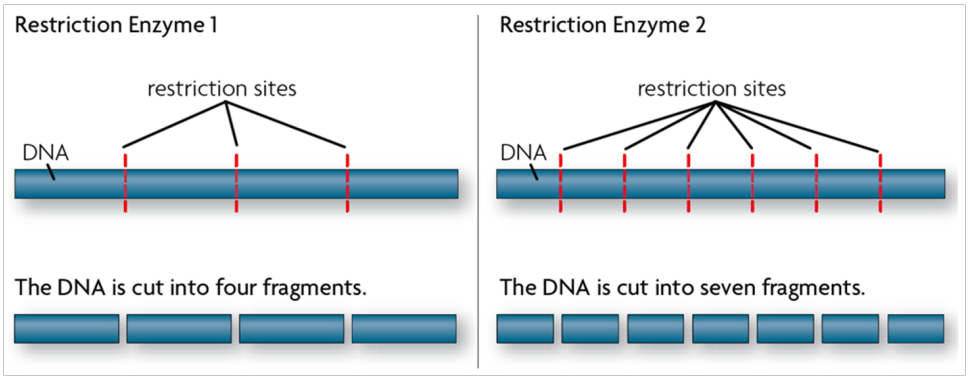
B. **Restriction enzymes cut DNA.**

-Enzymes come from various types of ***bacteria***

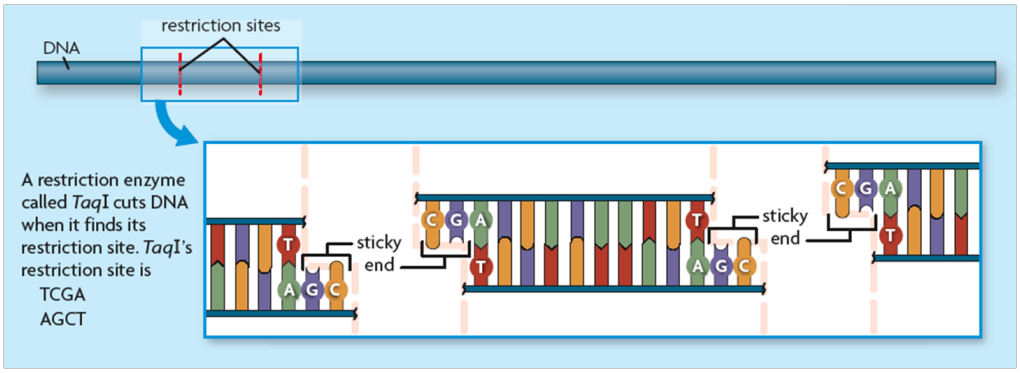
-allow scientists to more easily study and ***manipulate genes***

-cut DNA at a specific nucleotide sequence called a ***restriction site***

- ***Different*** restriction enzymes cut DNA in different ways.
- ***Each enzyme*** has a different restriction site



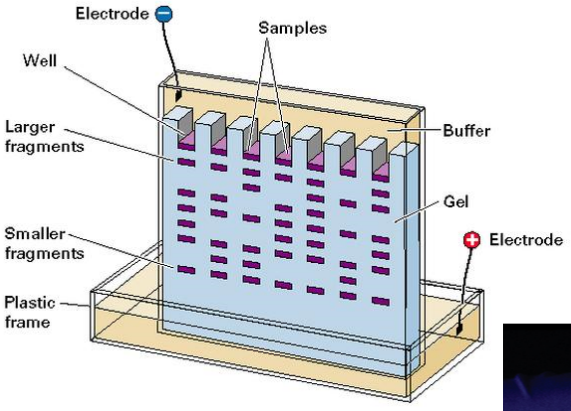
- Some cut straight across and leave ***"blunt ends"***
- Some make staggered cuts and leave " ***sticky ends*** "
- A ***palindrome*** is the pattern used to create these sticky ends.

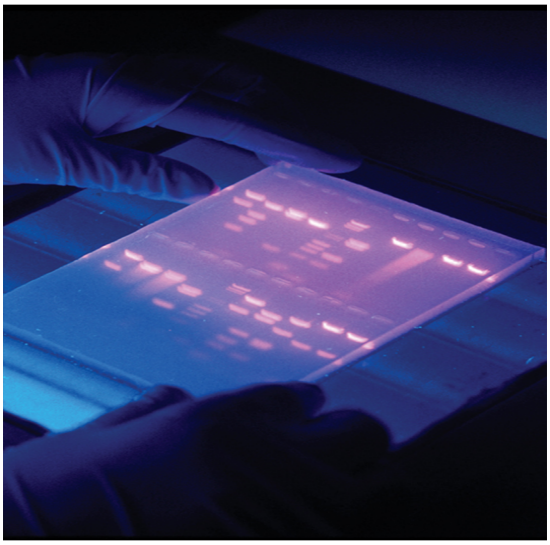


C. Restriction maps show the lengths of DNA fragments.

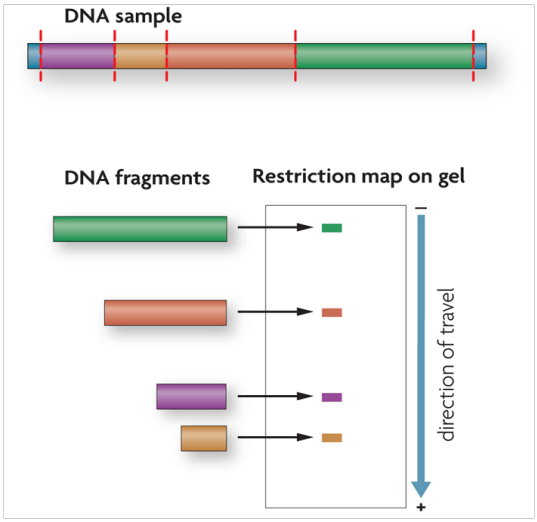
- ***Gel electrophoresis*** is used to separate DNA fragments by size.
- A DNA sample is ***cut*** with restriction enzymes.
- ***Electrical current*** pulls DNA fragments through a gel.
- ***Smaller fragments move faster*** and travel farther than larger fragments.
- Fragments of ***different sizes appear as bands*** on the gel.

Gel Electrophoresis





- A ***restriction map*** shows the lengths of DNA fragments between restriction sites.
- fragments only ***indicate size***, not DNA sequence
- useful in ***genetic engineering***
- used to study ***mutations***



Section 9.2 Copying DNA

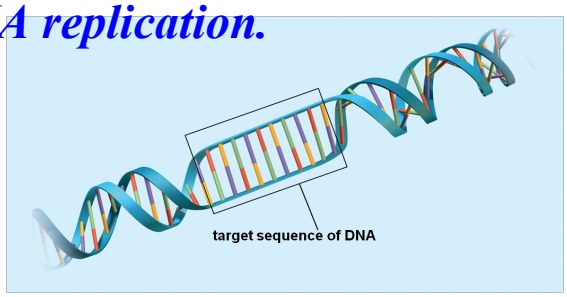
II. The *polymerase chain reaction* rapidly copies segments of DNA.

A. PCR uses polymerases to copy DNA segments.

-PCR makes many copies of a ***specific DNA sequence*** in a few hours.

-PCR ***amplifies*** DNA samples.

-PCR is similar to ***DNA replication.***



B. PCR is a three-step process.

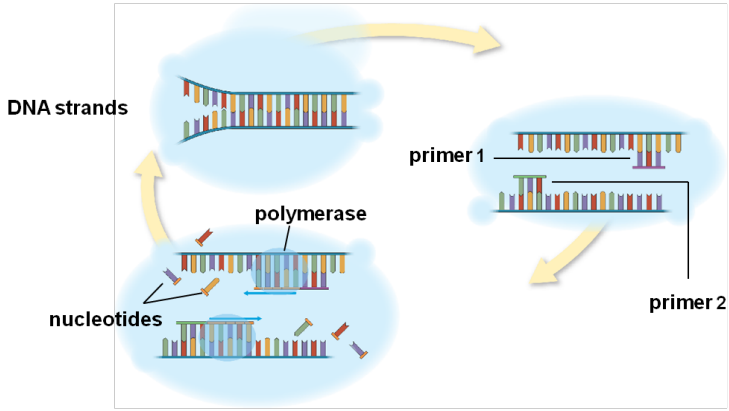
- PCR uses four materials.

-DNA to be copied

-DNA polymerase

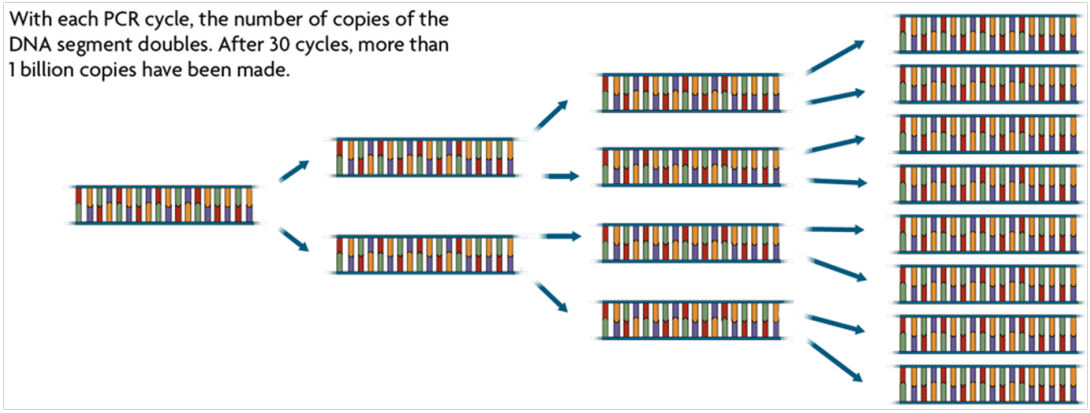
-A, T, C, and G nucleotides

-two primers

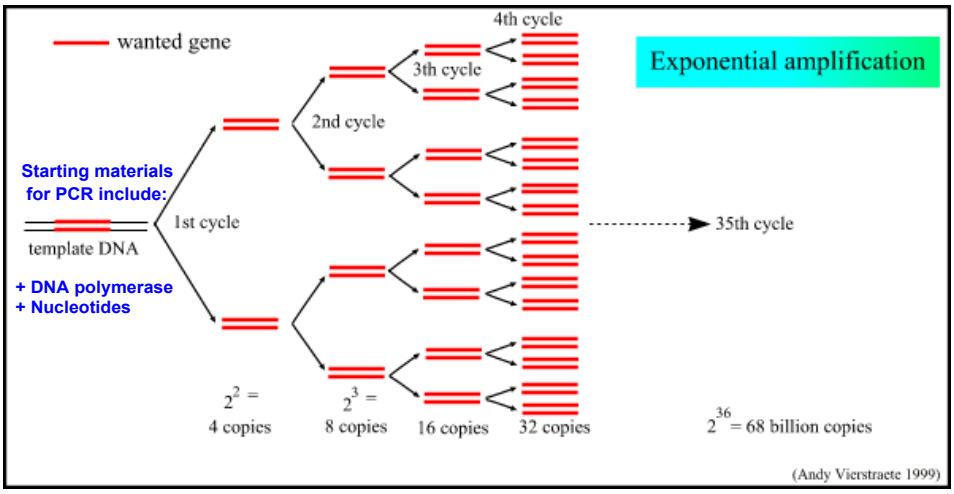


C. The three steps of PCR occur in a cycle.

- ***heat is used to separate*** double-stranded DNA molecules
- ***primers bind*** to each DNA strand on opposite ends of the segment to be copied
- ***DNA polymerase*** binds nucleotides together to form new strands of DNA



- Each PCR ***cycle doubles*** the number of DNA molecules.



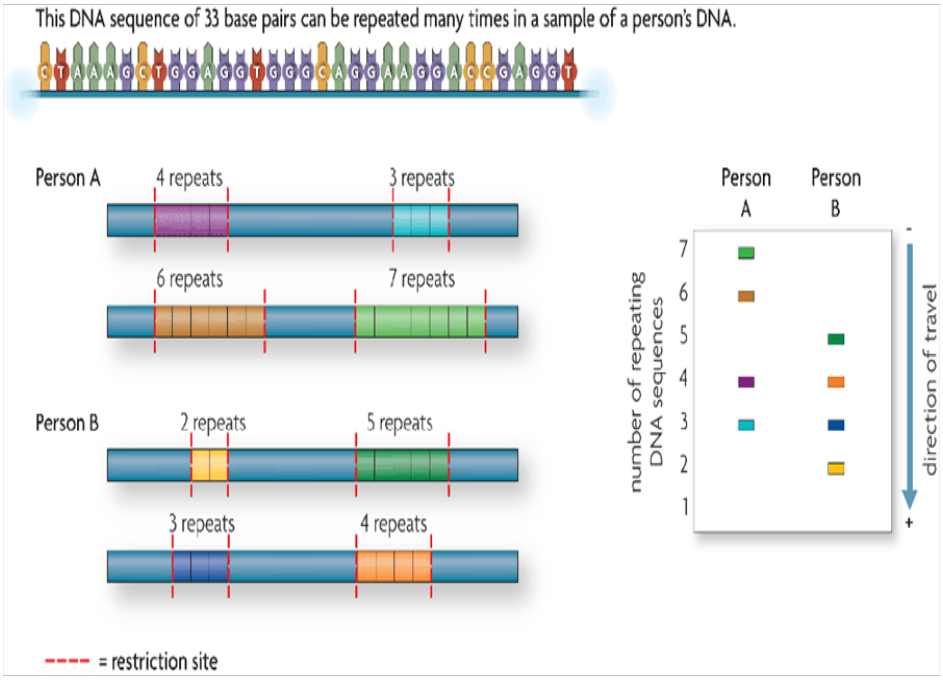
Ch. 9.3 DNA Fingerprinting

DNA fingerprints identify people at the molecular level.

A. DNA fingerprint is a type of restriction map.

-***DNA fingerprints*** are based on parts of an individual's DNA that can by used for identification.

1. based on ***noncoding regions*** of DNA
2. noncoding regions have ***repeating DNA*** sequences
3. number of repeats ***differs*** between people
4. ***banding pattern*** on a gel is a DNA fingerprint



B. DNA fingerprinting is used for identification.

- DNA fingerprinting depends on the ***probability*** of a match.
  1. Many people have the ***same number of repeats*** in a certain region of DNA.
  2. The probability that two people share identical numbers of repeats in several locations is ***very small***.

3. Individual probabilities are ***multiplied*** to find the overall probability of two DNA fingerprints randomly matching.

$$\frac{1}{500}\quad\frac{1}{90}\quad\frac{1}{120}\quad\frac{1}{5{,}400{,}000} =$$ **1 chance in 5.4 million people**

4. Several ***regions of DNA*** are used to make DNA fingerprints.

C. DNA fingerprinting is used in several ways.

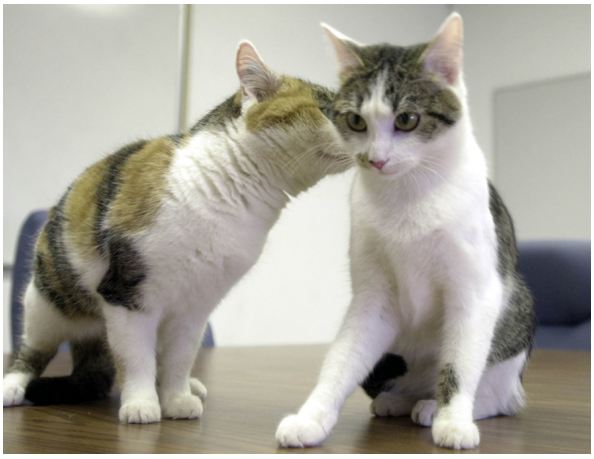
1. ***evidence*** in criminal cases
2. ***paternity*** tests
3. ***immigration*** requests
4. ***studying*** biodiversity
5. ***tracking*** genetically modified crops

Ch. 9.4 Genetic Engineering

DNA Sequences of Organisms can be changed

A. Entire organisms can be cloned.

-A clone is a ***genetically identical copy*** of a gene or of an organism.

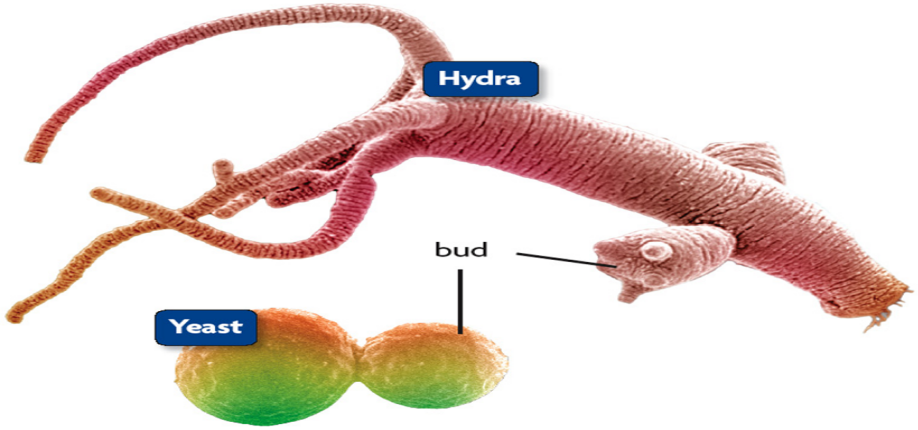


-Cloning occurs in nature.

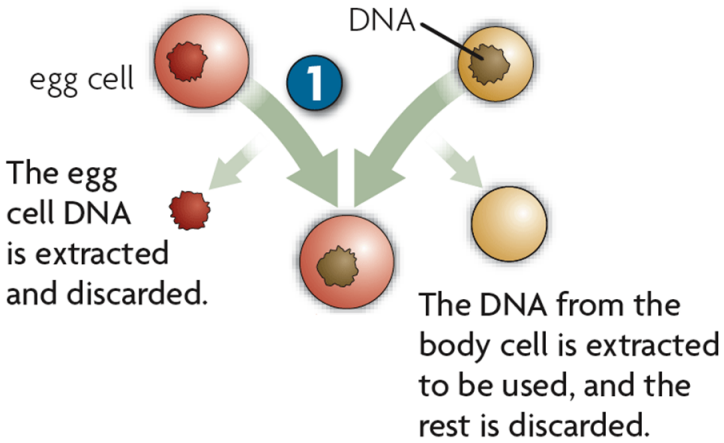
bacteria (***binary fission***)

some plants (from roots)

some simple animals (***budding, regeneration***)



- **Mammals can be cloned through a process called nuclear transfer.**
  - > nucleus is removed from an ***egg*** cell
  - > nucleus of a cell from the animal to be cloned is ***implanted*** in the egg



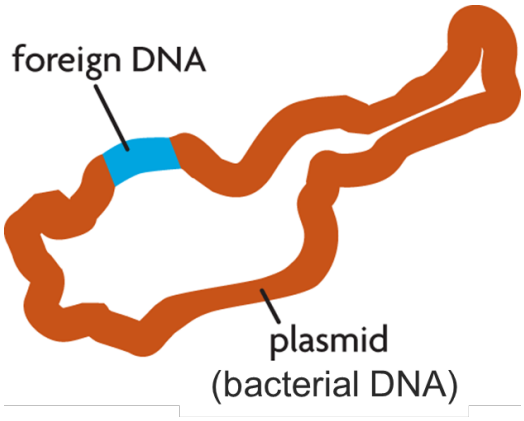
- **Cloning has potential benefits.**
  - > ***organs for transplant*** into humans
  - > ***save endangered*** species

- **Cloning raises concerns.**
  - > ***low success rate***
  - > clones "***imperfect***" and less healthy than original animal
  - > ***decreased biodiversity***

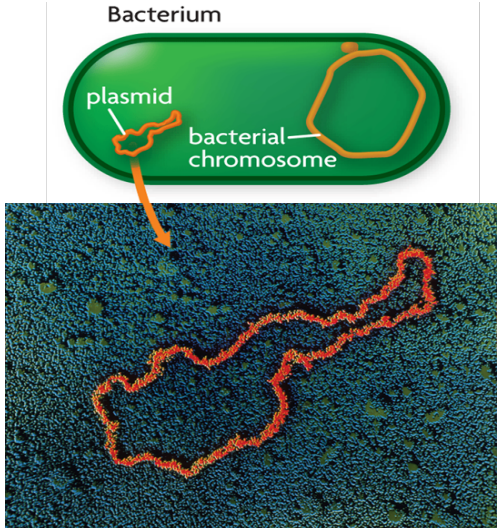
B. New genes can be added to an organism's DNA.

-***Genetic engineering*** involves changing an organism's DNA to give it new traits.

- Genetic engineering is based on the use of ***recombinant DNA.***
- Recombinant DNA contains genes from ***more than one*** organism.

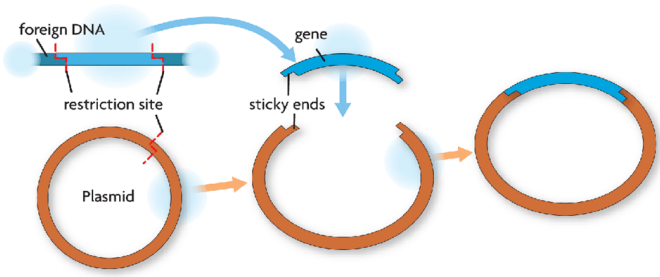


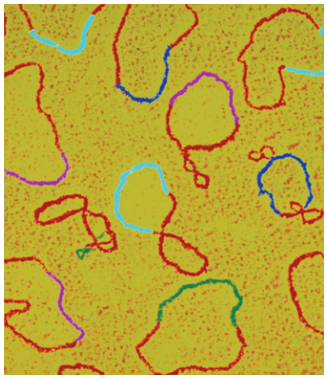
- **Bacterial plasmids are often used to make recombinant DNA.**
  - > ***plasmids*** are loops of DNA in bacteria
  - > ***restriction enzymes*** cut plasmid and foreign DNA
  - > foreign gene ***inserted*** into plasmid



C. Genetic engineering produces organisms with new traits.

- A ***transgenic organism*** has one or more genes from another organism inserted into its genome.



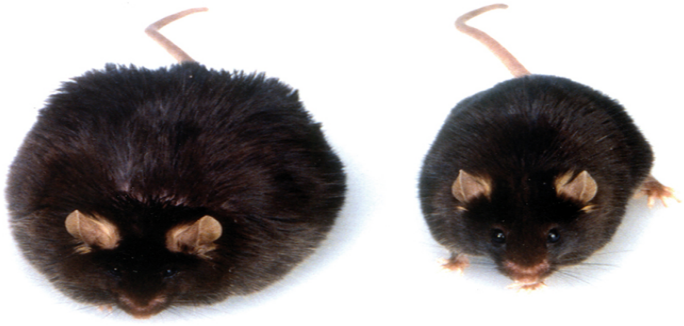


- **Transgenic bacteria can be used to produce human proteins.**
  - > ***gene inserted*** into plasmid
  - > ***plasmid inserted*** into bacteria
  - > ***bacteria express*** the gene

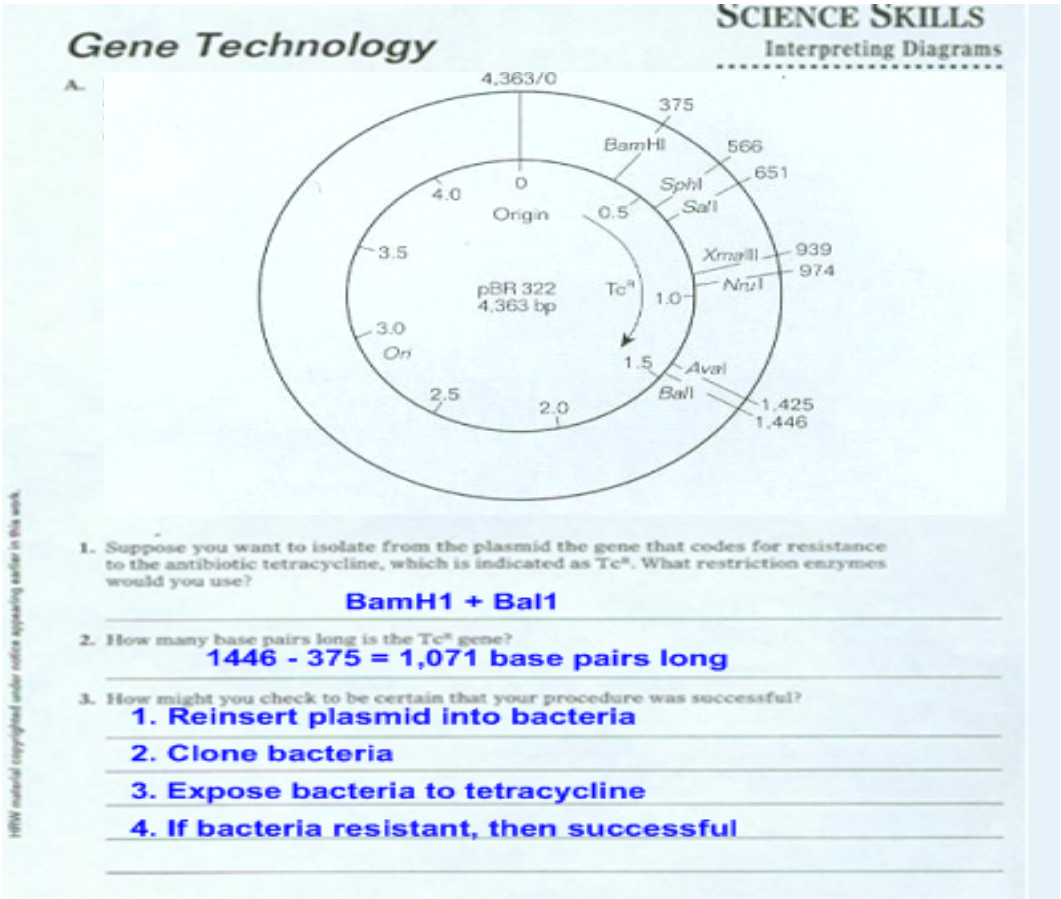
- **Transgenic plants are common in agriculture.**
  - > ***transgenic bacteria*** infect a plant
  - > ***plant expresses*** foreign gene
  - > many crops are now ***genetically modified (GM)***

- **Transgenic animals are used to study diseases and gene functions.**
  - > transgenic mice used to ***study development and disease***
  - > ***gene knockout*** mice used to study gene function

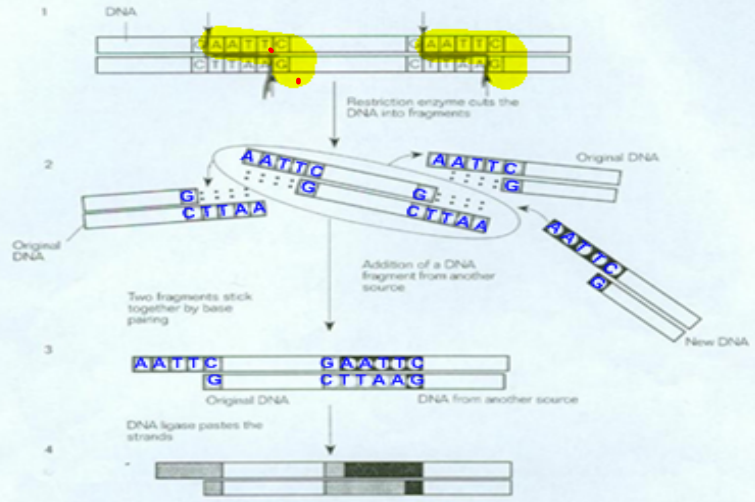
(A **gene knockout** is a genetic technique in which one of an organism's genes is made **inoperative** ("knocked out" of the organism).)



- **Scientists have concerns about some uses of genetic engineering.**
  - > possible ***long-term health effects*** of eating GM foods
  - > possible effects of GM plants on ***ecosystems and biodiversity***



B. Restriction enzymes recognize certain short nucleotide sequences in DNA, such as those shown below, and cut them at specific points called restriction sites. The restriction enzyme *Eco*R1 will cut the DNA in Figure 1 at the restriction sites where the bases A and G lie next to each other.



4. In Figure 2, fill in the boxed circles of the original DNA fragments with the correct nucleotides.
5. A second piece of DNA cut by the same restriction enzyme forms hydrogen bonds with the original DNA in Figure 3. What nucleotide sequence must this second piece of DNA have? Fill in the boxed circles of the original and new DNA fragments on Figure 3 with the correct nucleotides. A A T T C / G
6. What is the final outcome of this process, as shown in Figure 4?
   Recombinant DNA

Pharming

A combination of the words ***farming*** **and** ***pharmaceutical***, refers to plants and animals that have been genetically engineered to express genes they would not otherwise express.

Some examples of drugs currently being tested are antithrombin III and tissue plasminogen activator to treat blood clots, erythropoietin for anemia, **blood clotting factors VIII and IX for hemophilia,** and alpha-1-antitrypsin for emphysema and cystic fibrosis.

Genomics

Genomics is the study of genomes.

- can include the sequencing of the genome
- comparisons of genomes within and across species

- ***Gene sequencing*** is determining the order of DNA nucleotides in genes or in genomes.

- The genomes of several different organisms have been sequenced.

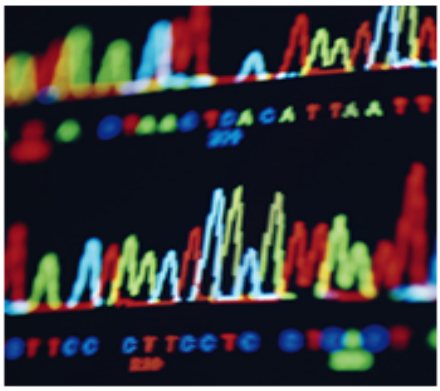
FIGURE 9.13 COMPARING GENOME SIZES

Organism	Approximate Total DNA (millions of bases)
E. coli	4.6
Fruit fly	165
Yeast	12.1
Banana	873
Chicken	1200
Humans	3000
Vanilla	7672
Crested newt	18,600
Lungfish	139,000

Human Genome Project

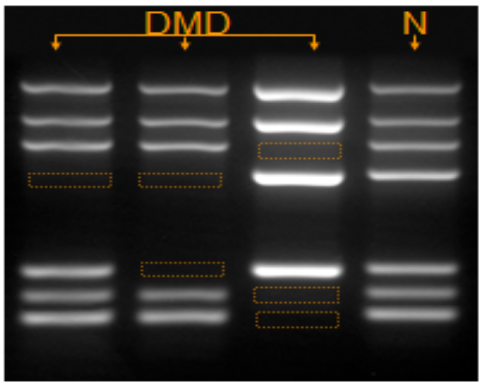
A project that has sequenced all of the DNA base pairs of ***human chromosomes***.

- analyzed DNA from a few people
- still working to identify and map human genes



Genetic Screening

The process of testing DNA to determine a person's risk of having ***or passing on a genetic disorder***



Genetic screening can be used to detect Duchenne's muscular dystrophy (DMD). Notice the missing bands on the gel (boxes) for three people with DMD as compared with a person without the disorder (N).

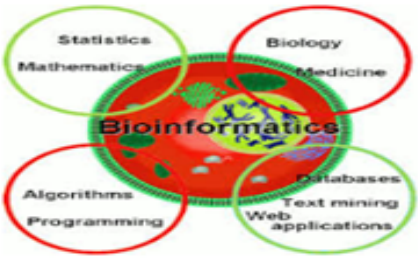
Used to test for genes related to an ***increased risk*** of cancer, heart disease, etc.

An example of a disease-causing gene is the BRCA1 that has been linked to breast cancer.

Gene therapy

The **replacement** of ***defective or missing*** **genes**, or the addition of ***new*** **genes**, into a person's genome to treat a disease.

- ***Bioinformatics***
  - The use of computer databases to organize and analyze biological information



- ***Proteomics*** – the study and comparison of all the proteins that result from an organisms genome.