Biotechnology

- “bio” and “technology”
- The use of living organisms to solve problems or make useful products.
- Biotechnology has been practiced for the last 10,000 years.
  - Selective breeding
  - Use of microbes (bacteria & yeast)

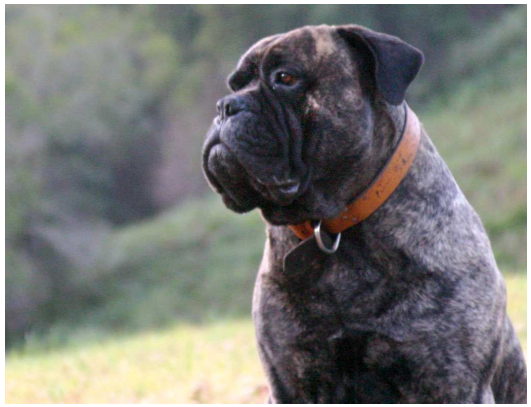
Selective Breeding

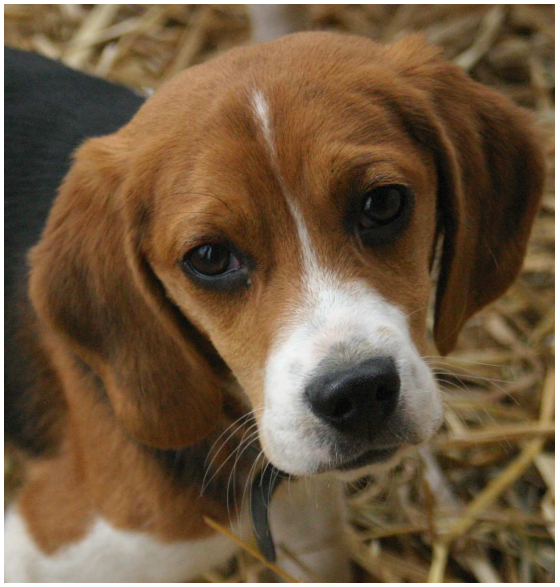
- A technique in which only those animals and plants with the most desirable traits are allowed to produce the next generation.
- Humans use selective breeding to pass desired traits on to the next generation of organisms.
- Examples: domestic animals & crop plants

Selective Breeding

Great Dane

Teacup Yorkie





Selective Breeding

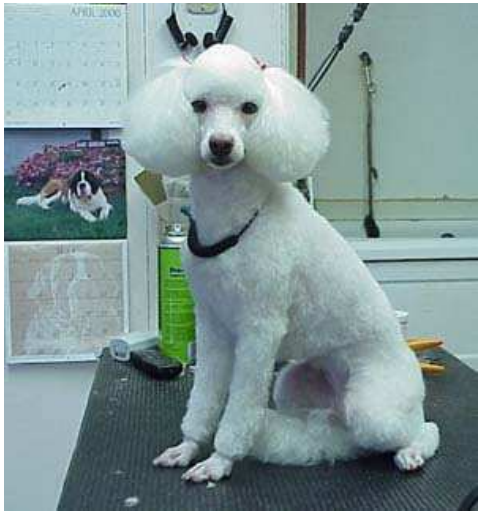


Figure 22.11b Artificial selection: diverse vegetables derived from wild mustard

Figure 22.11a Artificial selection: cattle breeders of ancient Africa

New Biotechnology

- The use of cells and biological molecules to solve problems or make useful products.
- Biological molecules that are used:
  - Nucleic acids – DNA & RNA
  - Proteins – enzymes, hormones, etc.
- Genetic Engineering – making changes in the DNA code of living organisms.

Special

Have been isolated to manipulate DNA and RNA molecules.

Enzymes – The tools of Genetic Engineering

- DNA polymerase (1955)
  - Replicates (copies) DNA molecules
- DNA ligase (1966)
  - Attaches two or more pieces of DNA to one another
- First Restriction Enzyme (1968)
  - breaks DNA molecules into fragments
  - Today more than 900 restriction enzymes have been isolated

DNA Enzymes

- These enzymes make it possible to create entirely new kinds of DNA molecules and, equally important, to manipulate the functioning of the genes located on these new molecules.

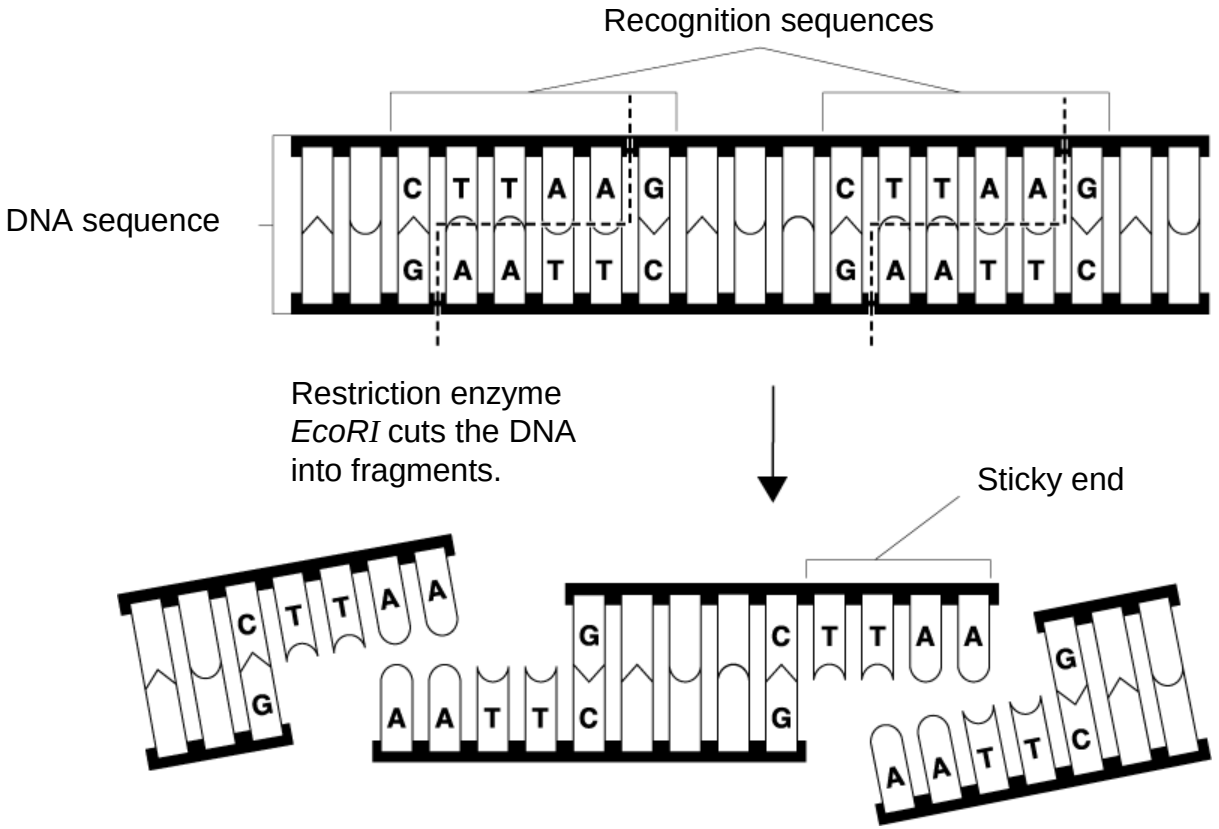
Restriction Enzymes

- Enzymes that cut DNA at specific sites
- Each type has a recognition sequence
  - Example

EcoRI

- They occur naturally in bacteria and have been isolated for genetic engineering

Restriction Enzymes

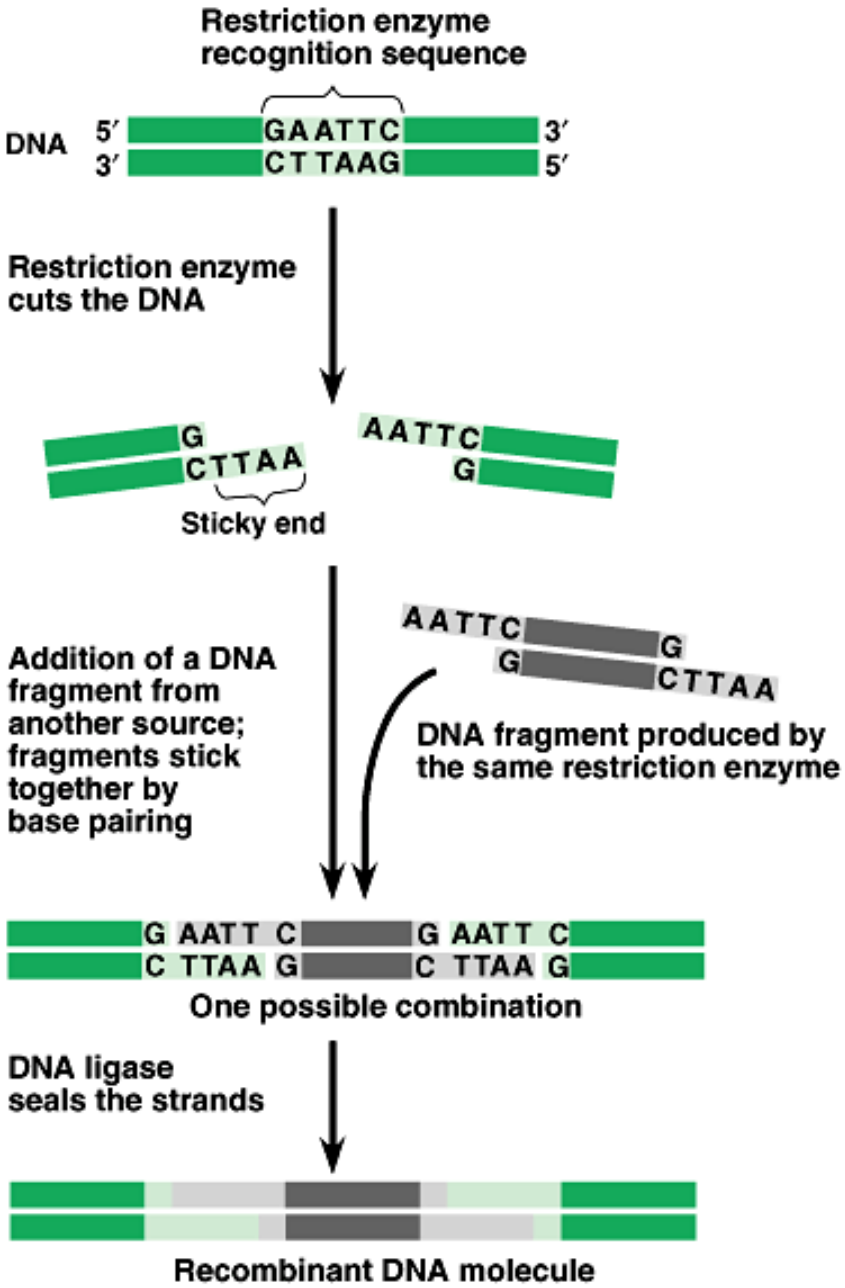


I’m a restriction enzyme and I’m here to say
That I cut DNA in a specific way
If my cuts are staggered then I make sticky ends
But if I cut straight across I make a blunt end my friends
When I make a cut it’s specific and precise
I find my recognition sequence and I make the slice
I was isolated from bacteria which is not new news
The new news is in the way I’m used
Genetic engineering yes it’s here to stay
And I’m one main tool that humans use on DNA

I’m a restriction enzyme and I’m here to say
That I cut DNA in a specific way

Cha, Cha, Cha!

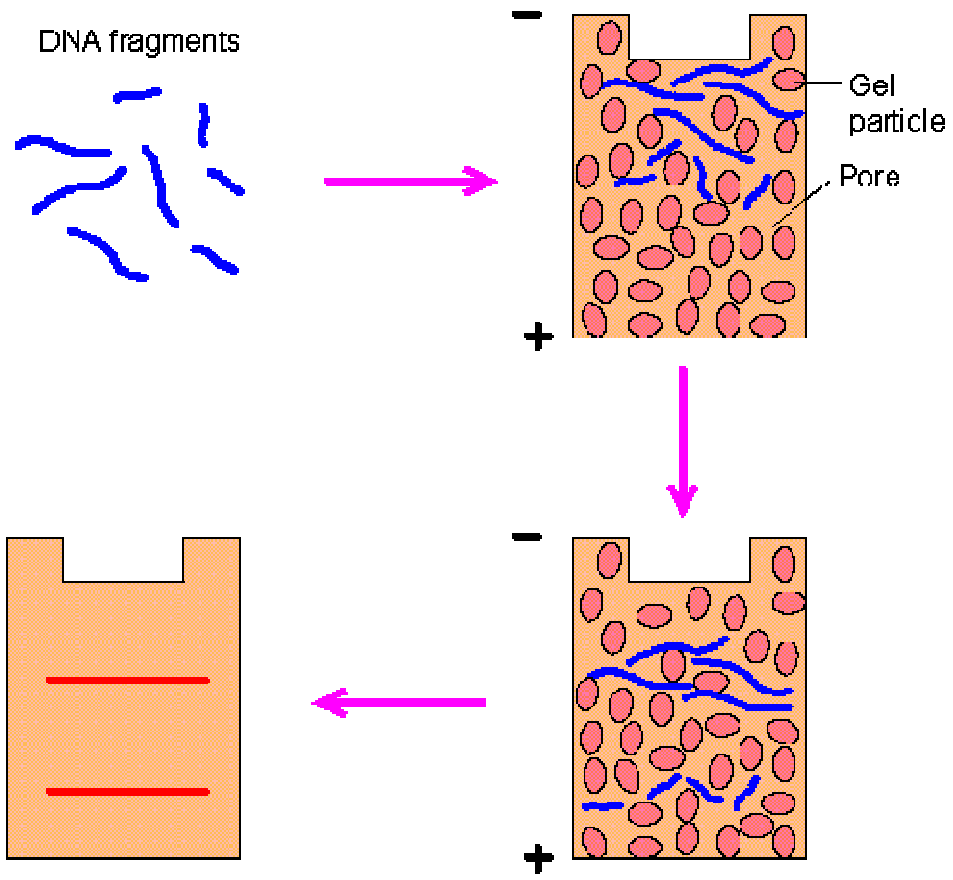
Figure 20.2 Using a restriction enzyme and DNA ligase to make recombinant DNA

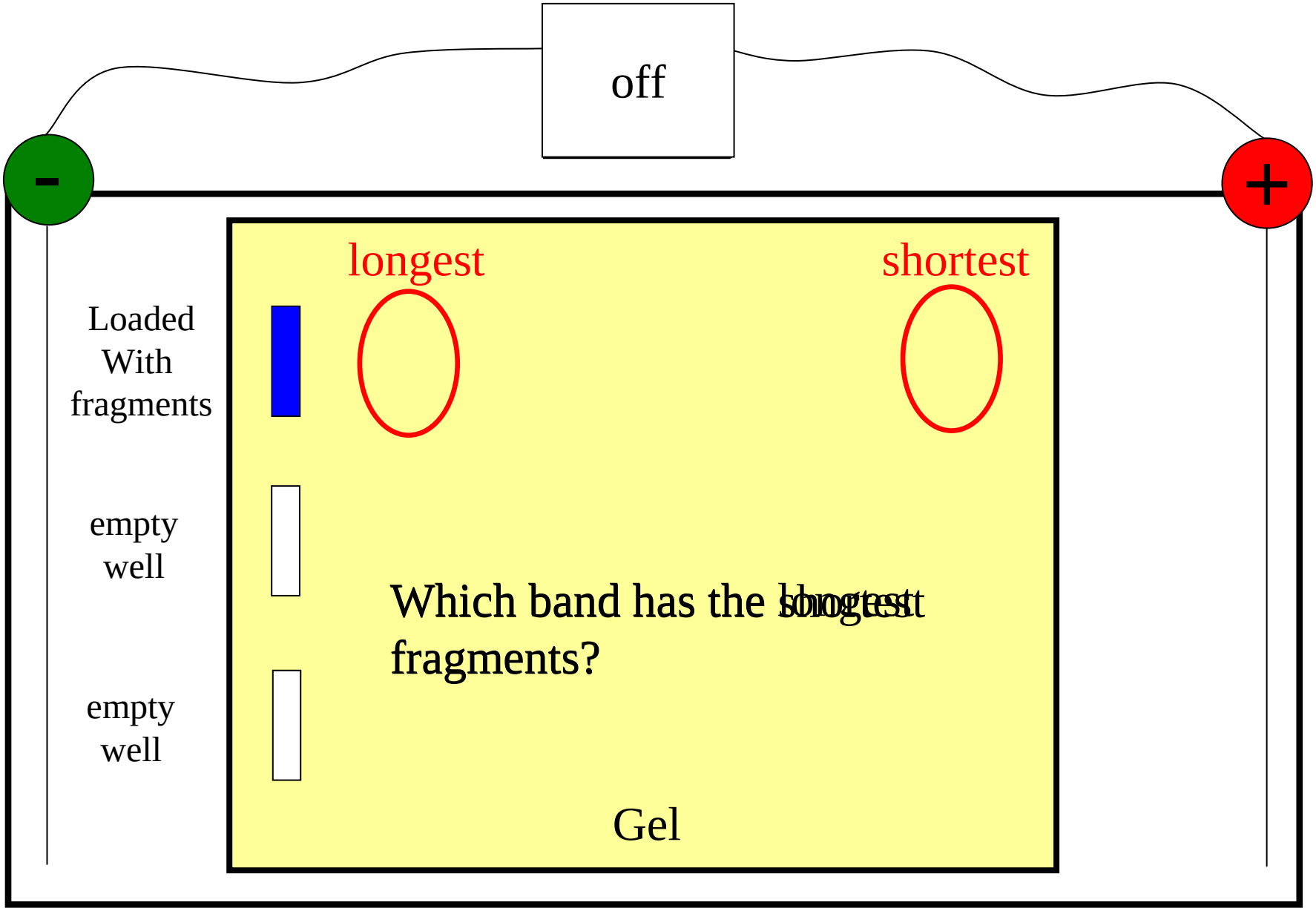


Gel Electrophoresis

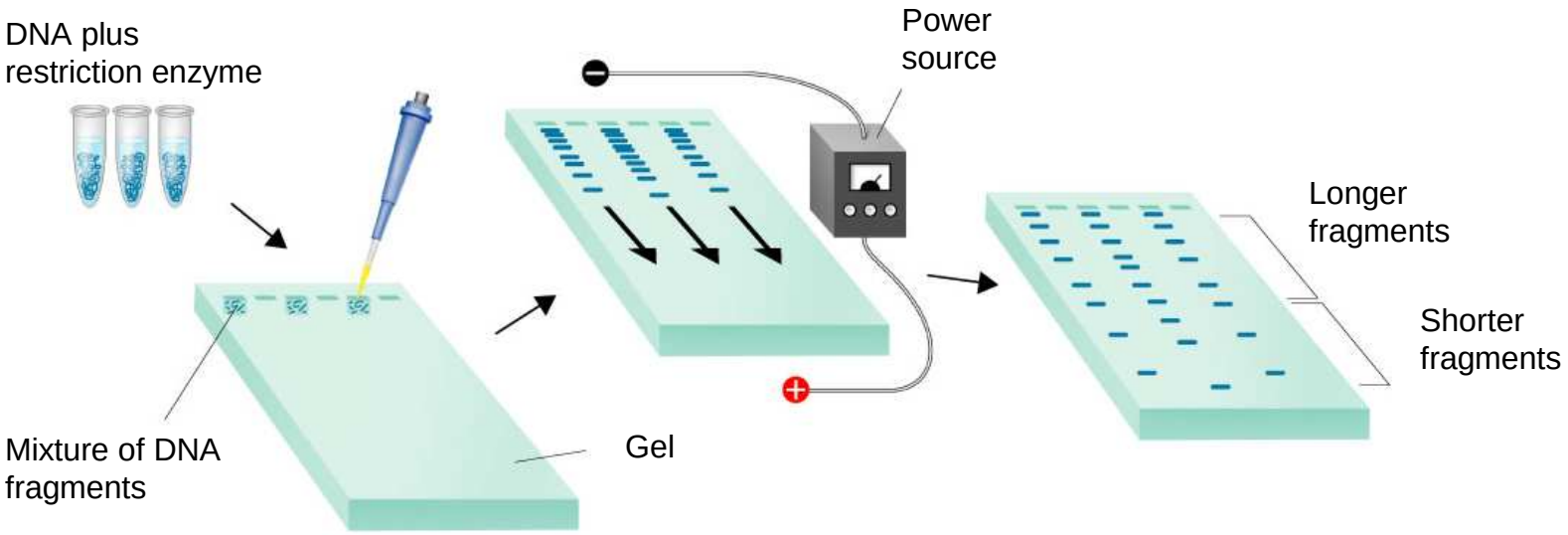
- Important tool in genetic engineering.
- Separates DNA fragments (or proteins) based on size.
- An electrical current is used to move fragments through a gel matrix.
- Short fragments move through the gel faster than longer fragments.

How fragments move in gel



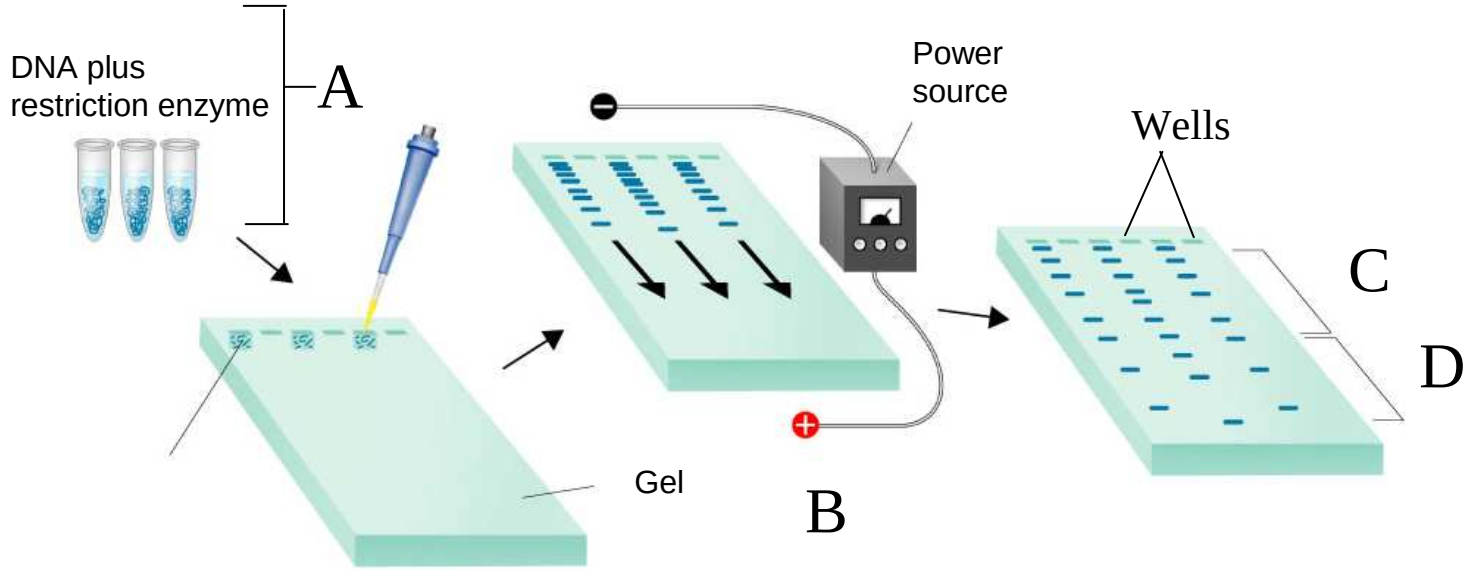

off
-
+
longest
shortest
Loaded
With
fragments
empty
well
empty
well
Which band has the longest fragments?
Gel

Gel Electrophoresis



DNA fragments are separated by size

Gel Electrophoresis

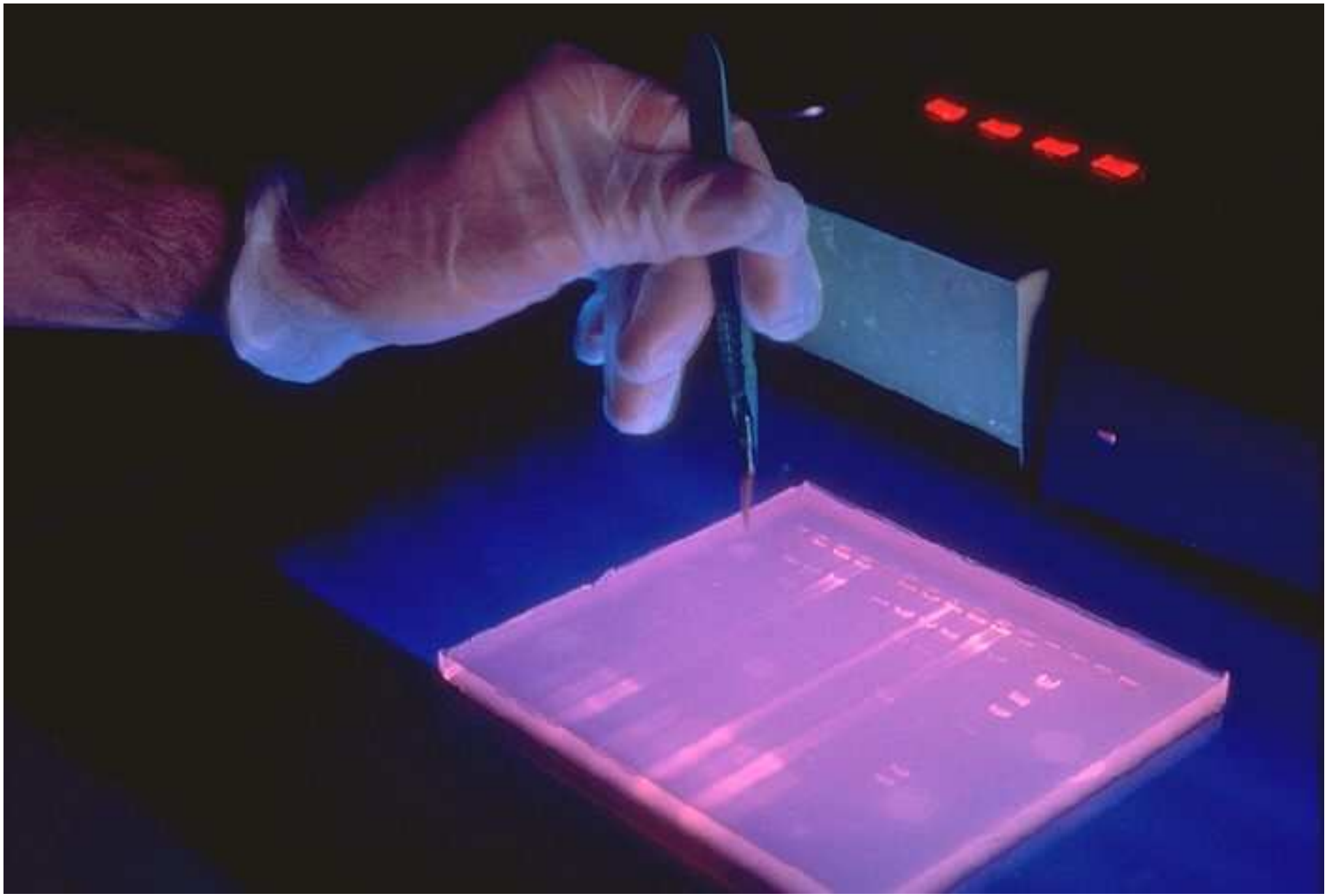


What is occurring in A?

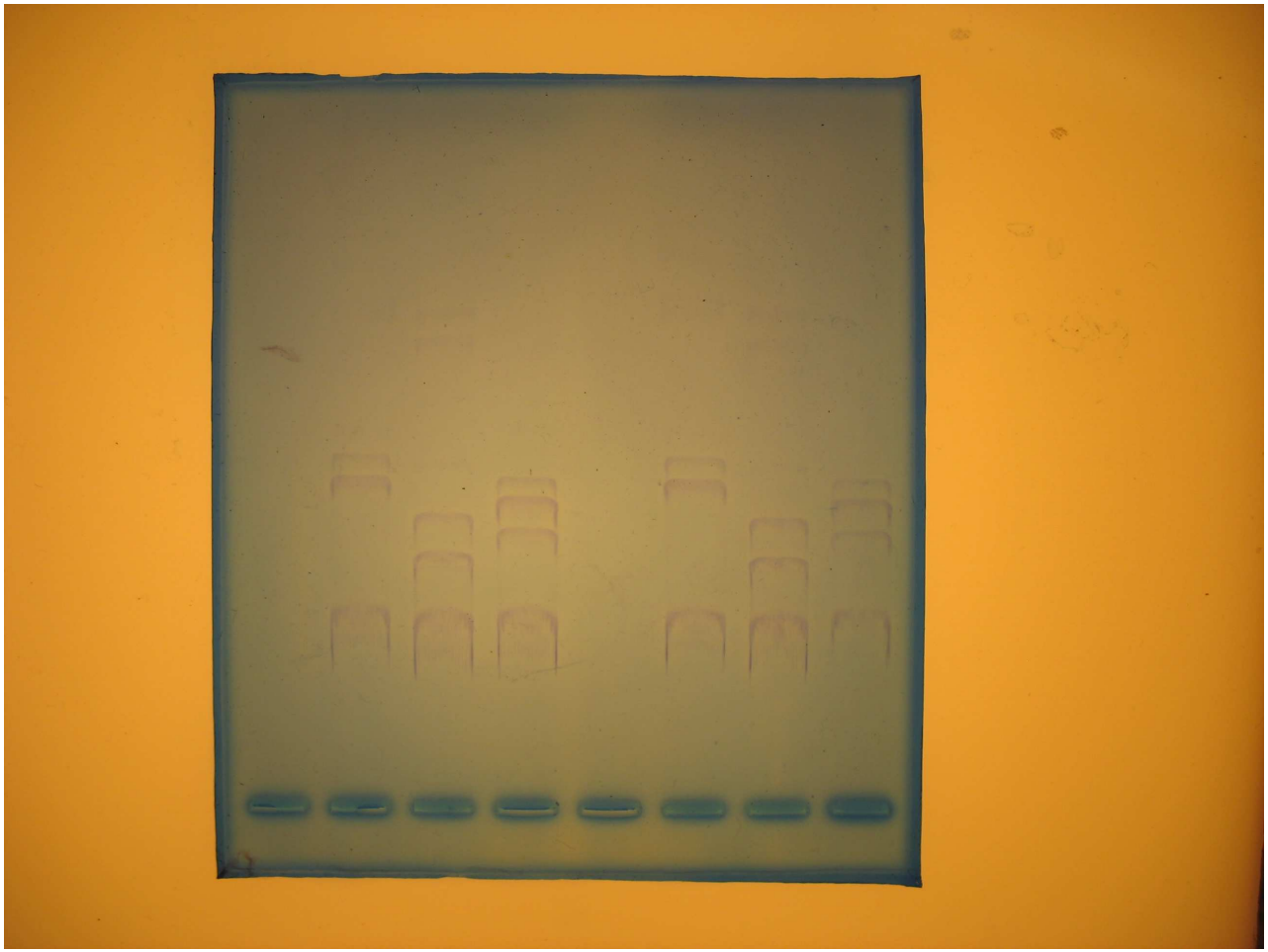
Which group of bands moved faster, C or D? Why?

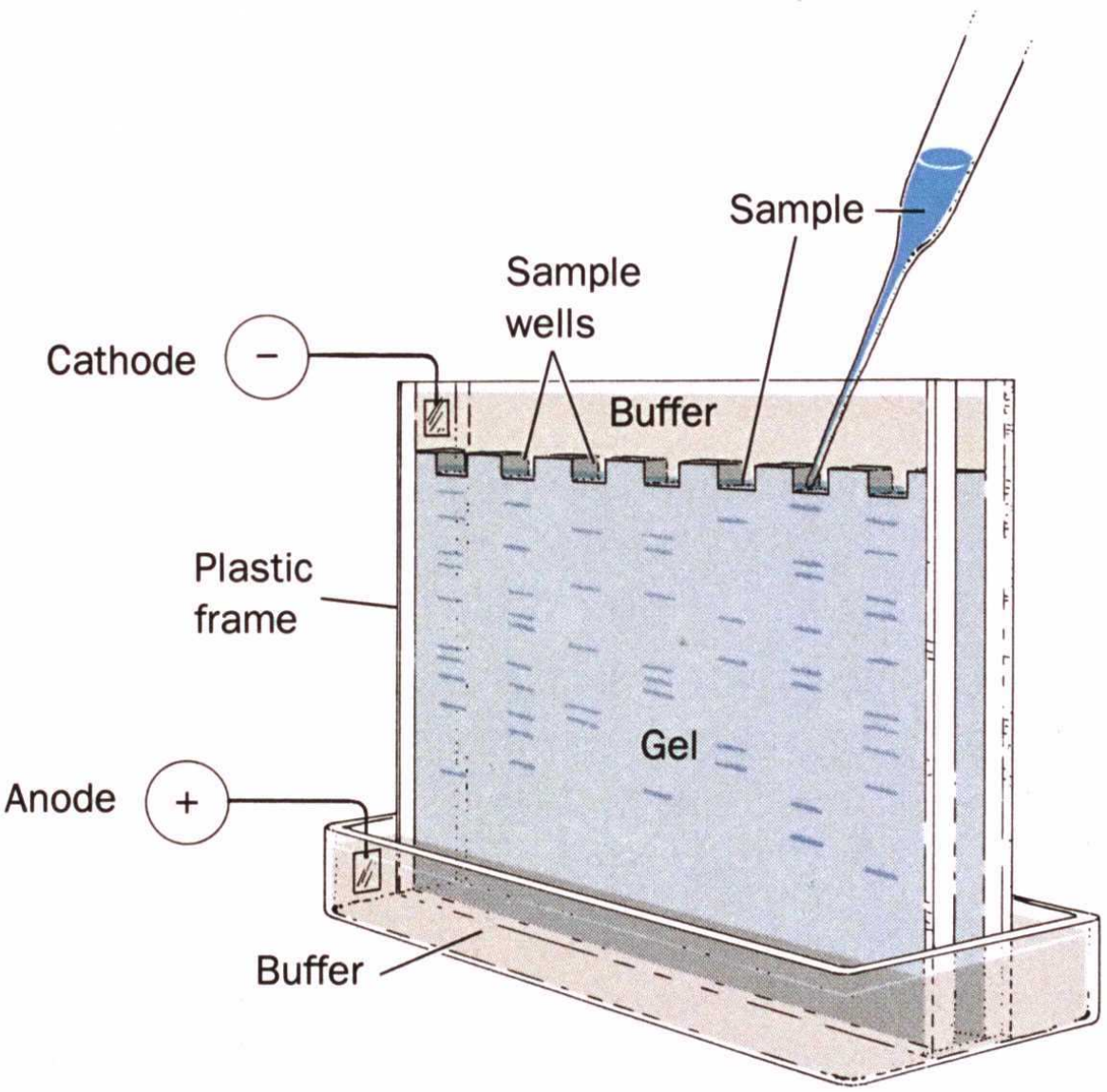
What do the bands in B consist of?

Figure 20.x1a Laboratory worker reviewing DNA band pattern



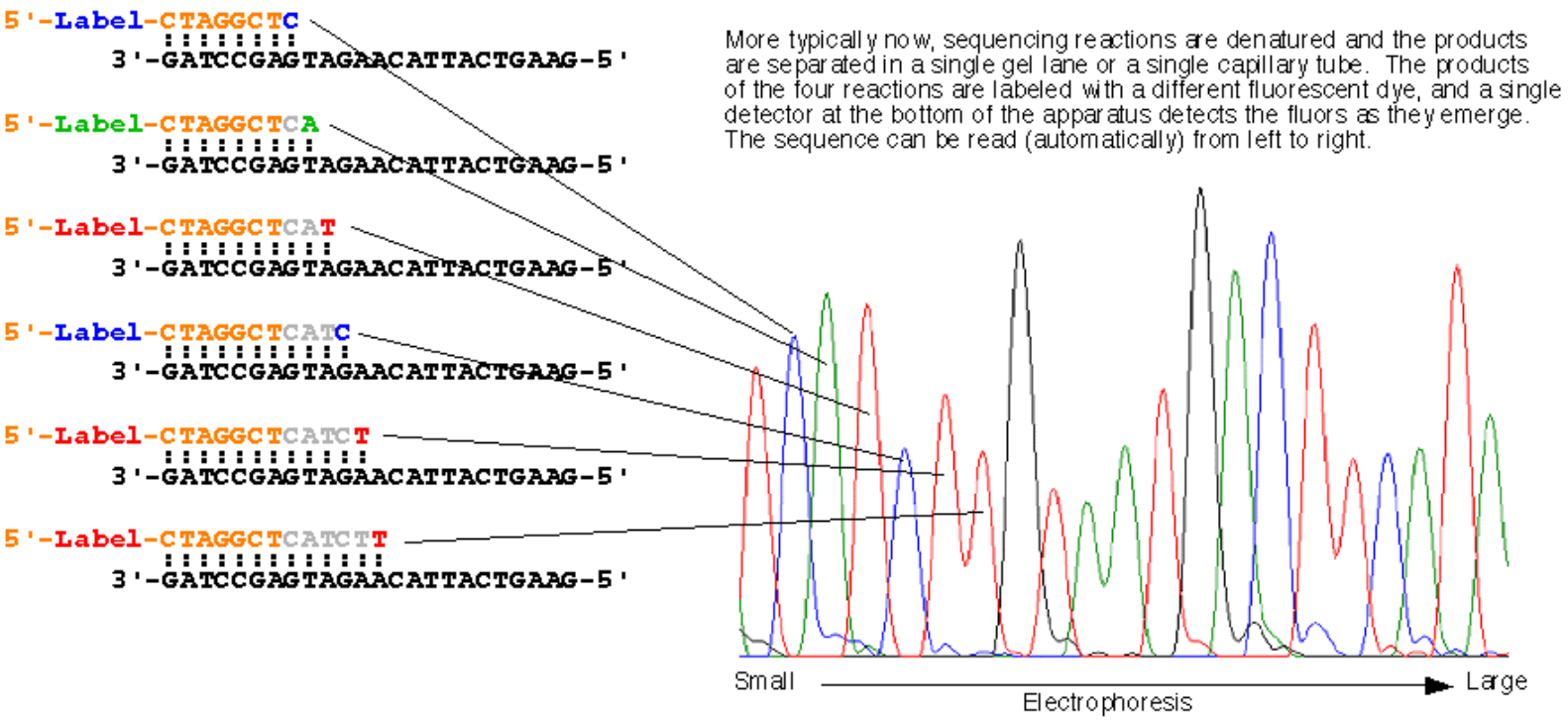
Lamda DNA cut by EcoR I and Hind III

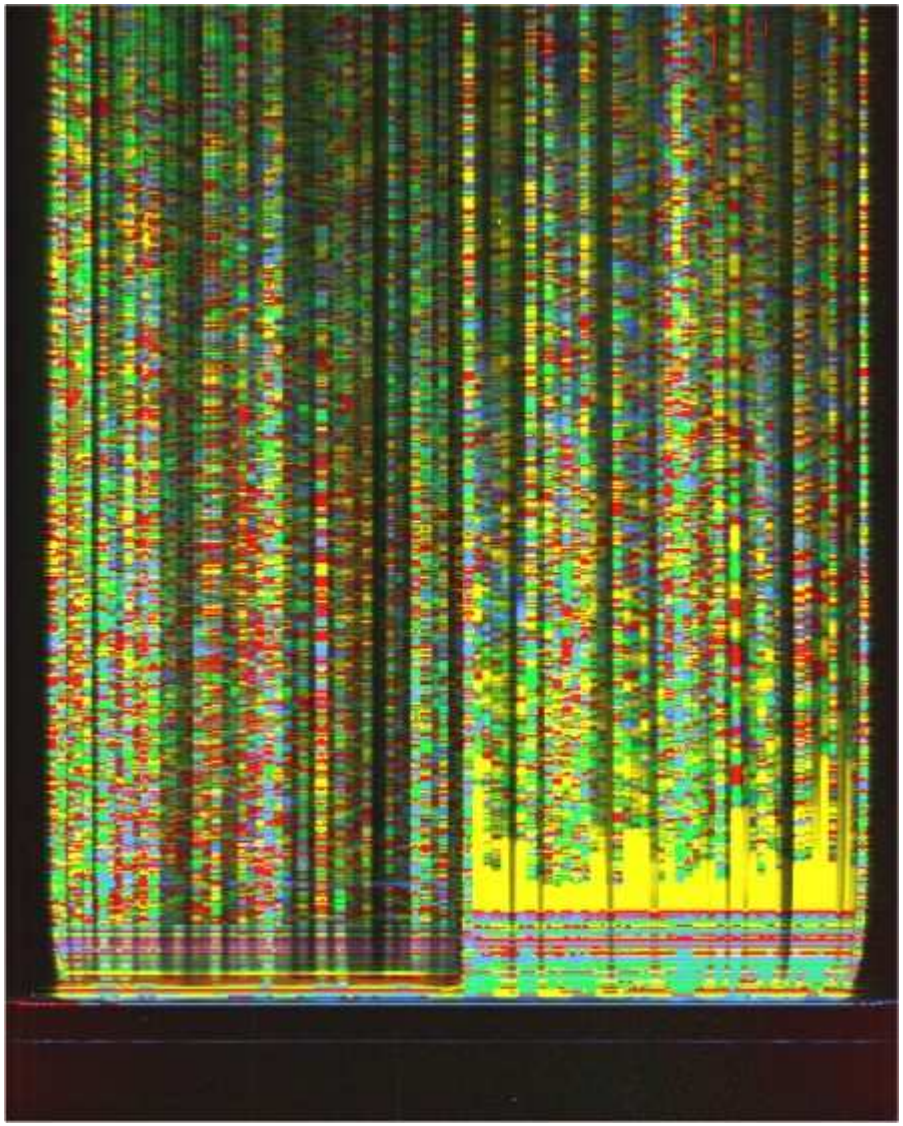



Sample
Sample wells
Cathode
−
Buffer
Plastic frame
Gel
Anode
+
Buffer

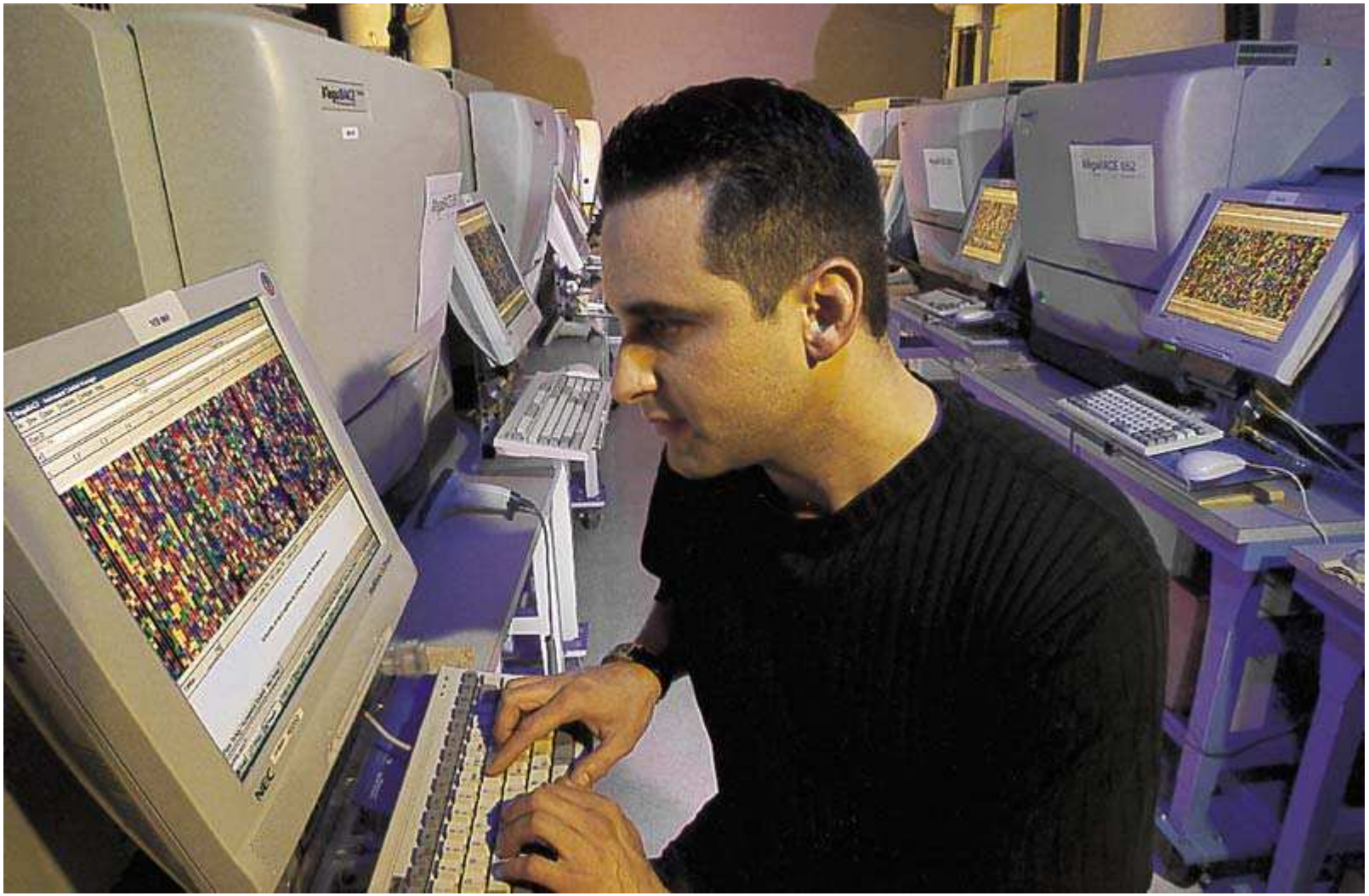
large electrophoresis equipment used in DNA sequencing

Automated DNA sequencing





- Chain terminators with florescent dies are used
- Each type of nucleotide (A,T,G,C) is represented by a different color.
- The photo to the left shows many lanes of a large gel.



Automated gene sequencing

Figure 20.8 Gel electrophoresis of macromolecules

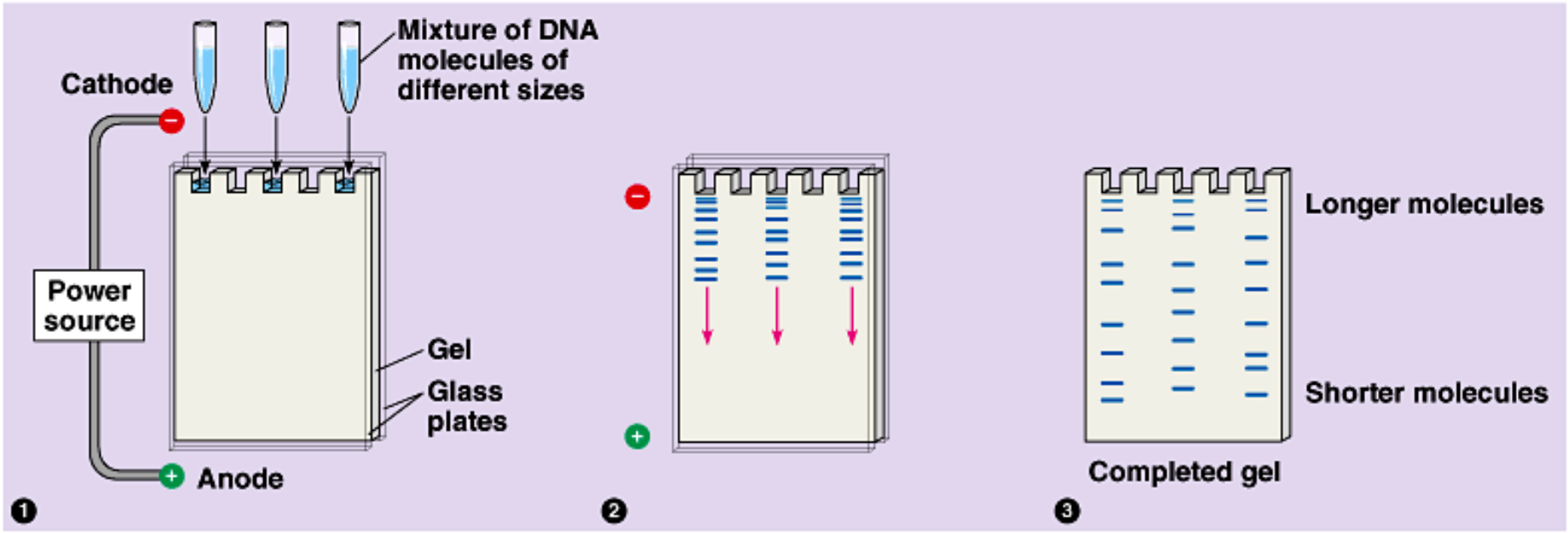
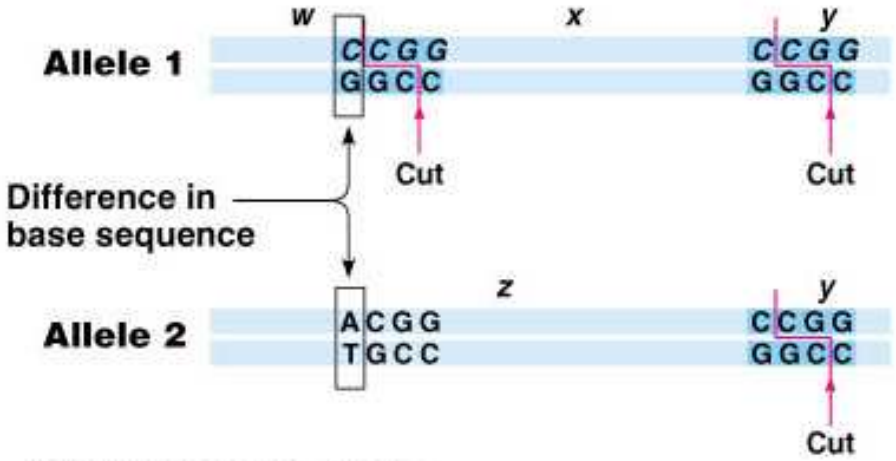
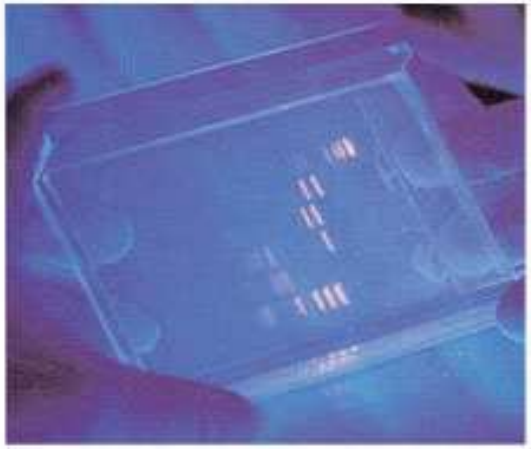


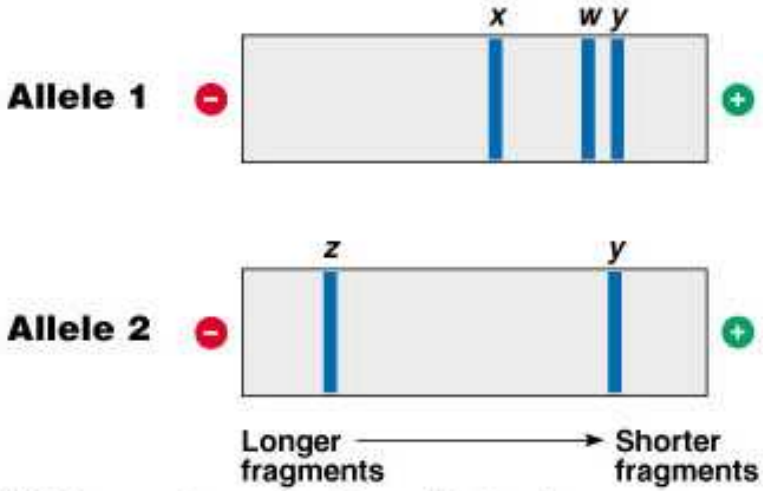
Figure 20.9 Using restriction fragment patterns to distinguish DNA from different alleles



(a) DNA from two alleles



(c) Completed gel



(b) Electrophoresis of restriction fragments

Locating Genes

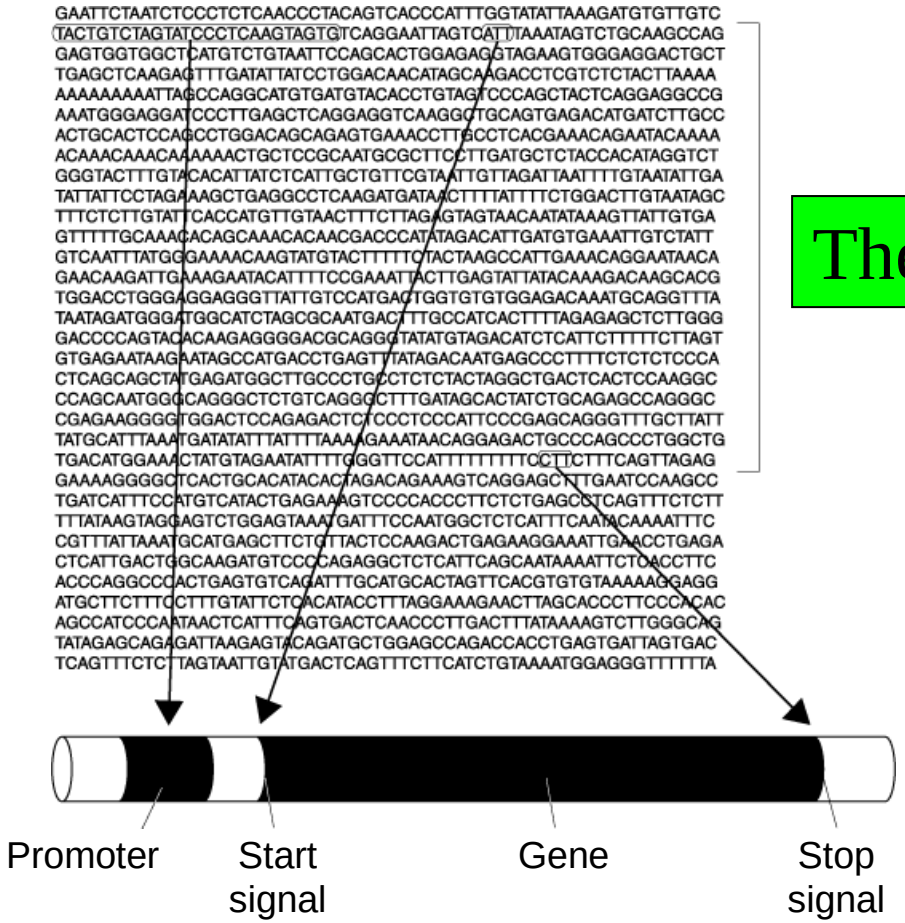


Table 20.1 Genome Sizes and Numbers of Genes

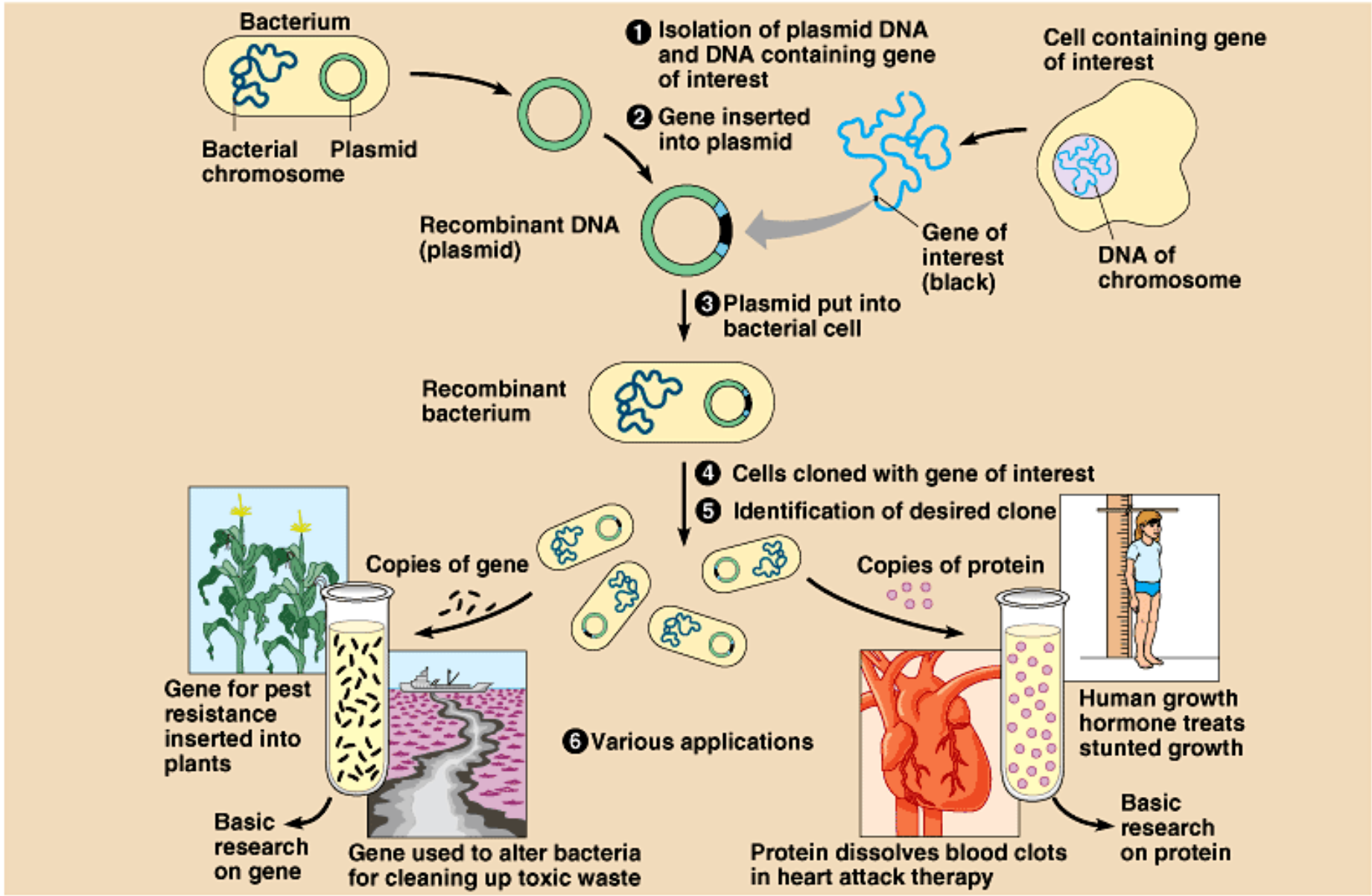
Organism	Genome Size	Estimated Number of Genes	Genes per Mb*
H. influenzae (bacterium)	1.8 Mb*	1,700	950
S. cerevisiae (yeast)	12 Mb	6,000	500
C. elegans (nematode)	97 Mb	19,000	200
A. thaliana (plant)	100 Mb	25,000	200
D. melanogaster (fruit fly)	180 Mb	13,000	100
H. sapiens (human)	3,200 Mb	30,000–40,000	10

*Mb = million base pairs

Transformation

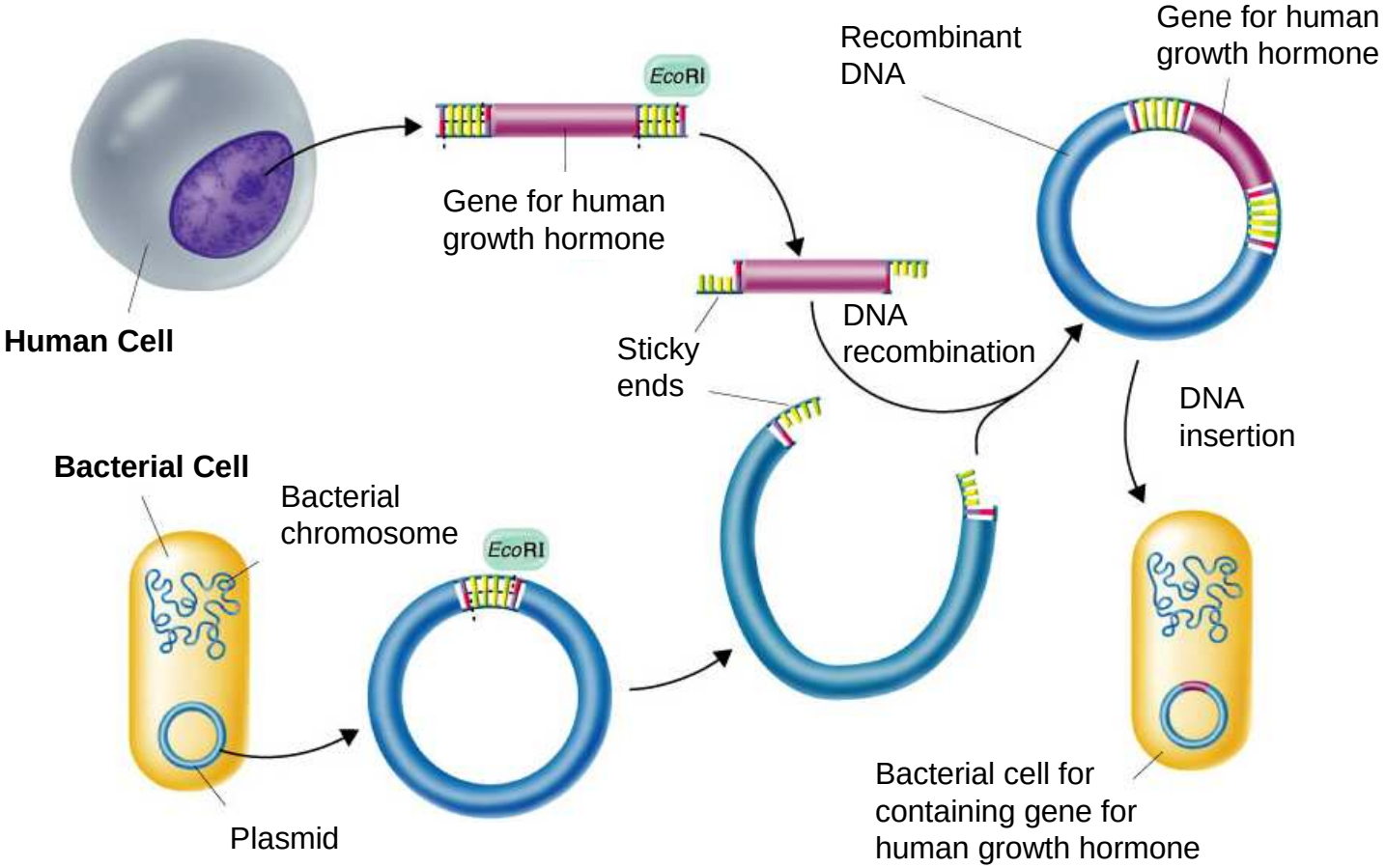
- When a cell takes in DNA from outside the cell and it becomes part of the living cell.
- This can be done with many types of cell using different techniques.
- Bacteria – are good at taking up pieces of DNA. They are often used in Genetic Engineering.

Figure 20.1 An overview of how bacterial plasmids are used to clone genes



Cell Transformation

making recombinant DNA



Plant cell transformation

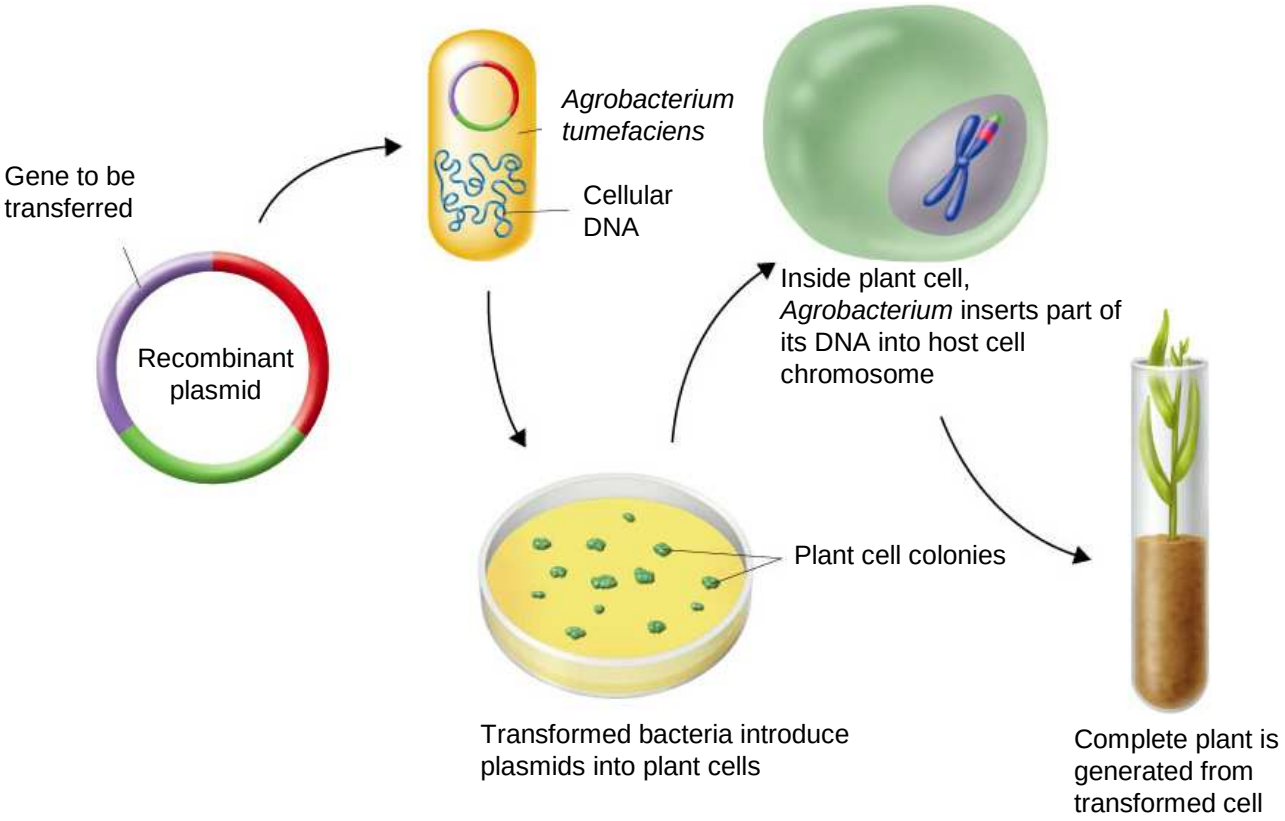
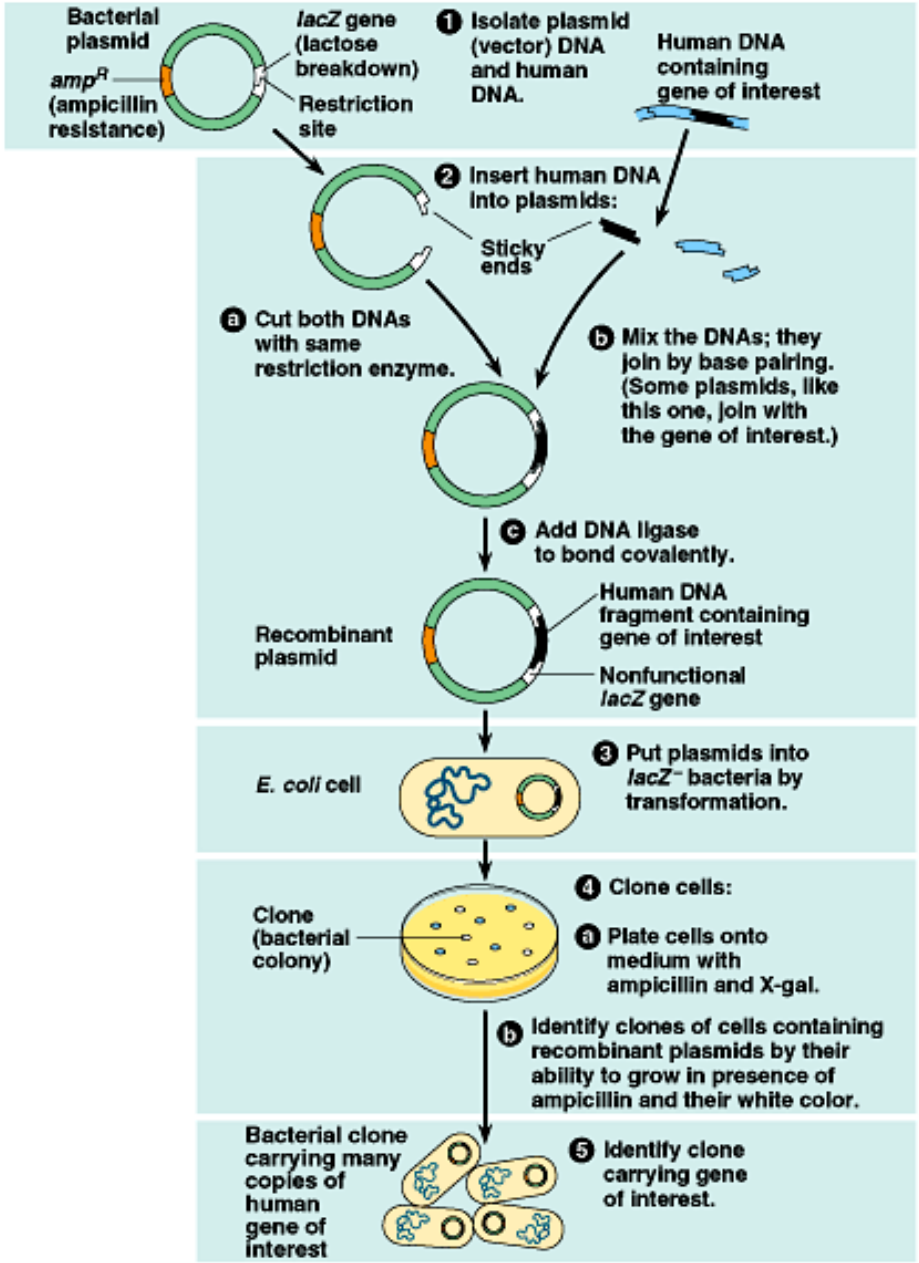


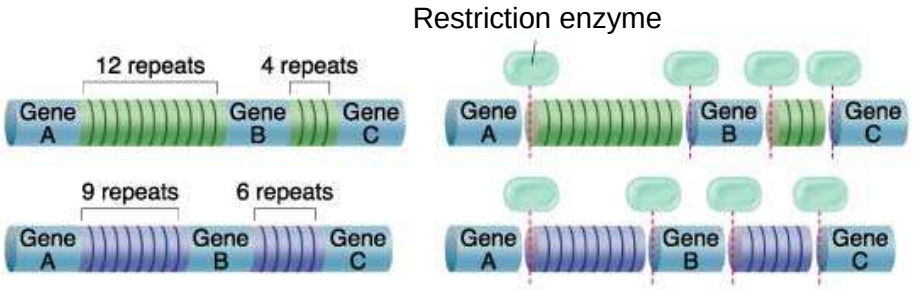
Figure 20.3 Cloning a human gene in a bacterial plasmid: a closer look (Layer 3)

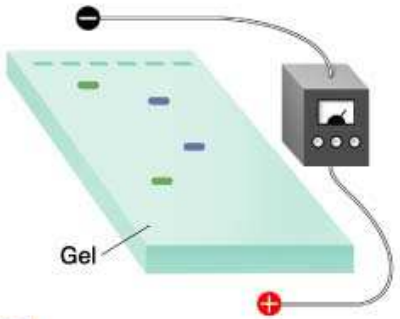


DNA Fingerprints

- Used to identify individuals like an actual fingerprint.
- DNA is cut with restriction enzymes and then the fragments are separated using gel electrophoresis.
- Every individual has a unique band pattern

DNA Fingerprinting



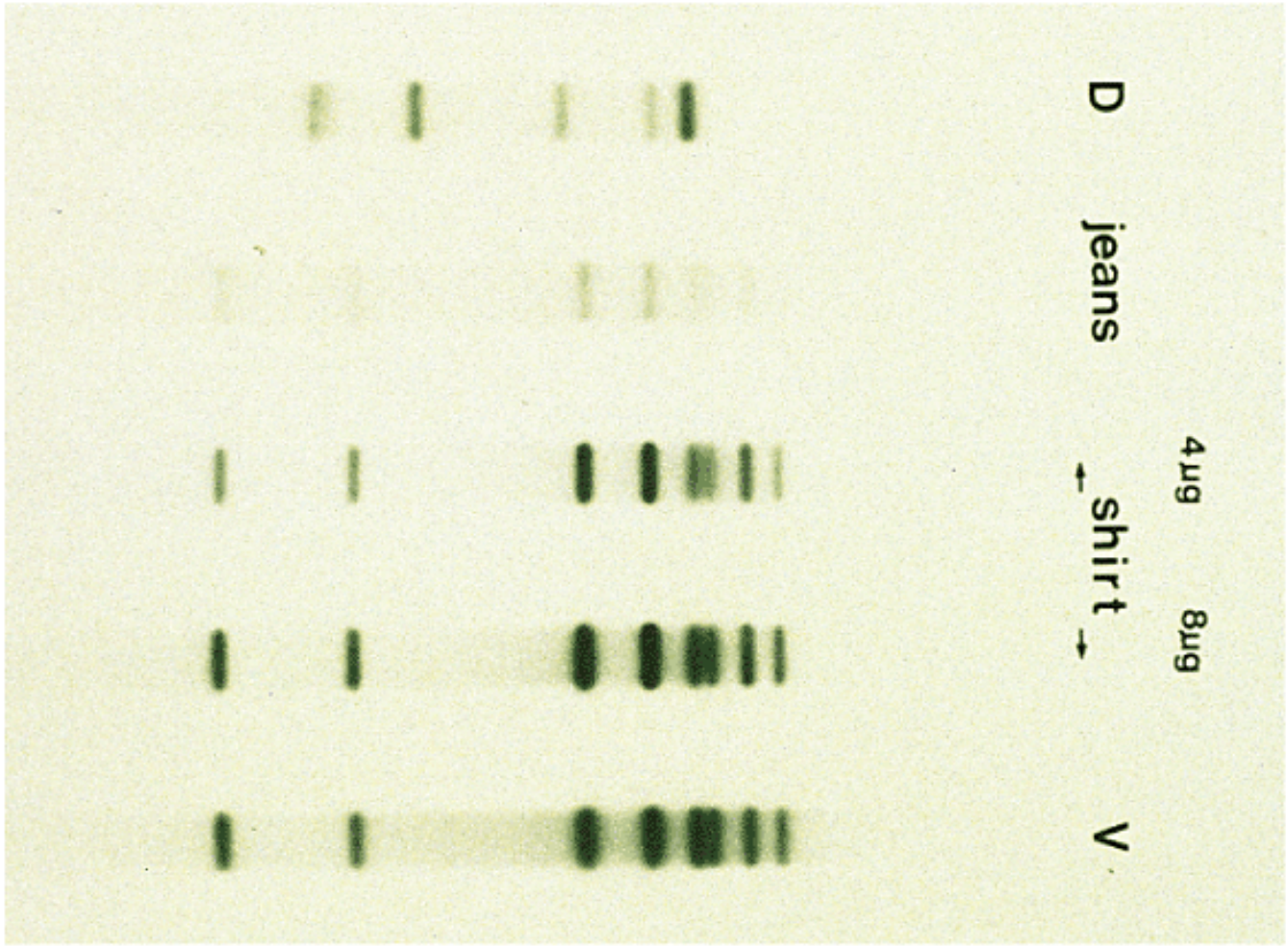


A Chromosomes contain large amounts of DNA called repeats that do not code for proteins. This DNA varies from person to person. Here, one sample has 12 repeats between genes A and B, while the second sample has 9 repeats.

B Restriction enzymes are used to cut the DNA into fragments containing genes and repeats. Note that the repeat fragments from these two samples are of different lengths.

C The DNA fragments are separated according to size using gel electrophoresis. The fragments containing repeats are then labeled using radioactive probes. This produces a series of bands—the DNA fingerprint.

Figure 20.17 DNA fingerprints from a murder case



Cloning

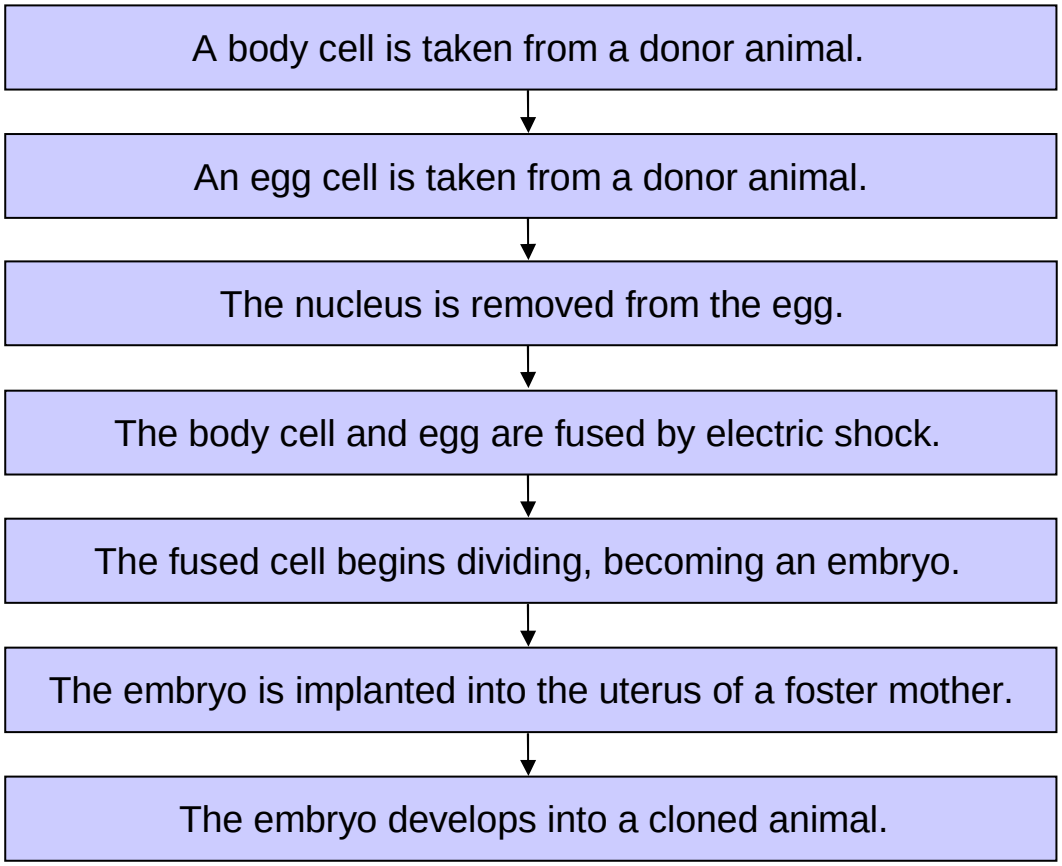
- A clone is a cell or a group of cells that are genetically identical to each other.
- It is easy to make colonies of bacteria and other microorganisms that are clones.
- It is more difficult to clone multicellular organisms.
- Many scientists thought it would be impossible to clone mammals.

Cloning II

- In 1997, Scottish scientists cloned a sheep
- Something that was thought impossible was done.

How?

Cloning


A body cell is taken from a donor animal.
An egg cell is taken from a donor animal.
The nucleus is removed from the egg.
The body cell and egg are fused by electric shock.
The fused cell begins dividing, becoming an embryo.
The embryo is implanted into the uterus of a foster mother.
The embryo develops into a cloned animal.

Cloning of the first mammal

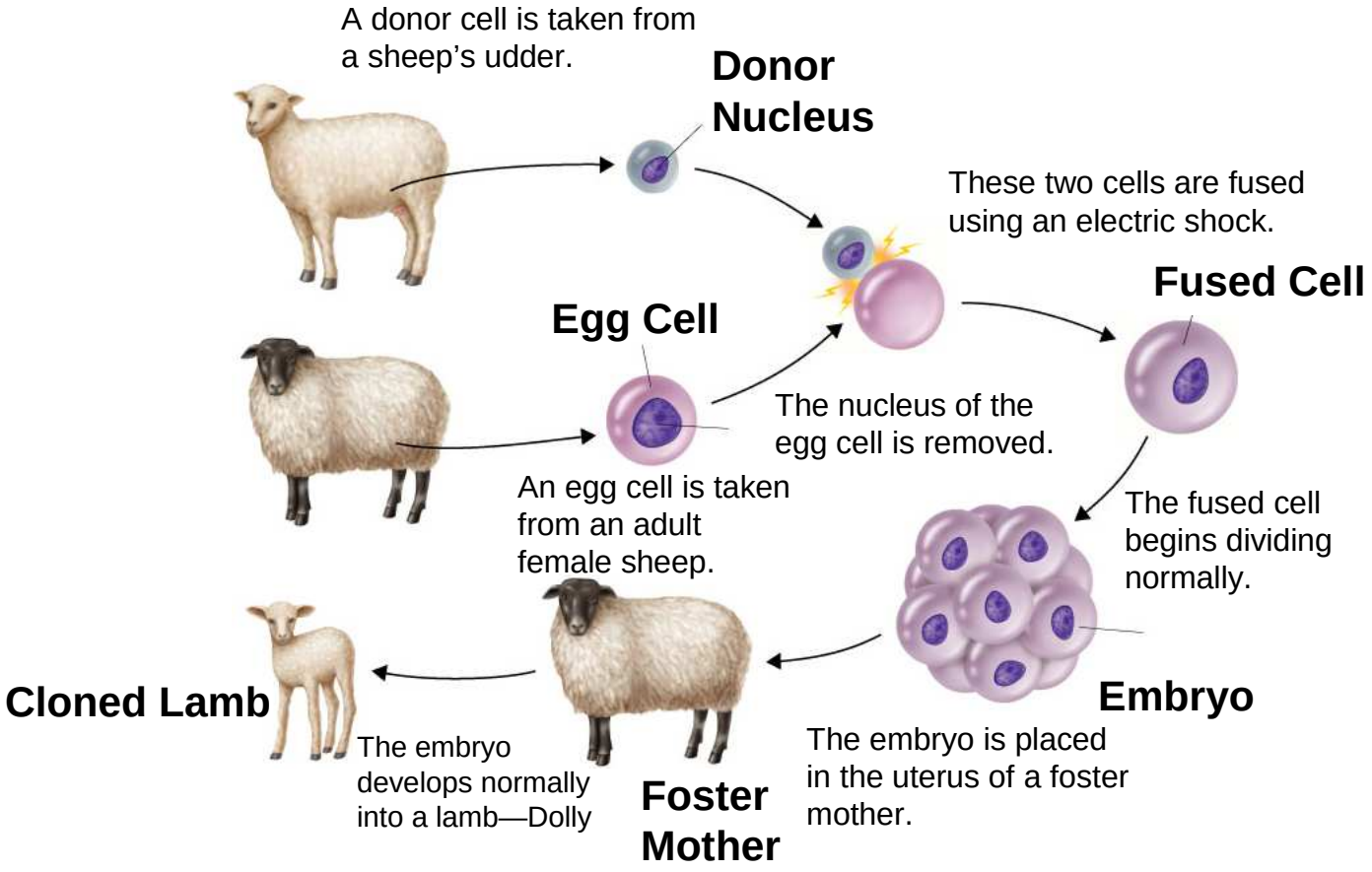
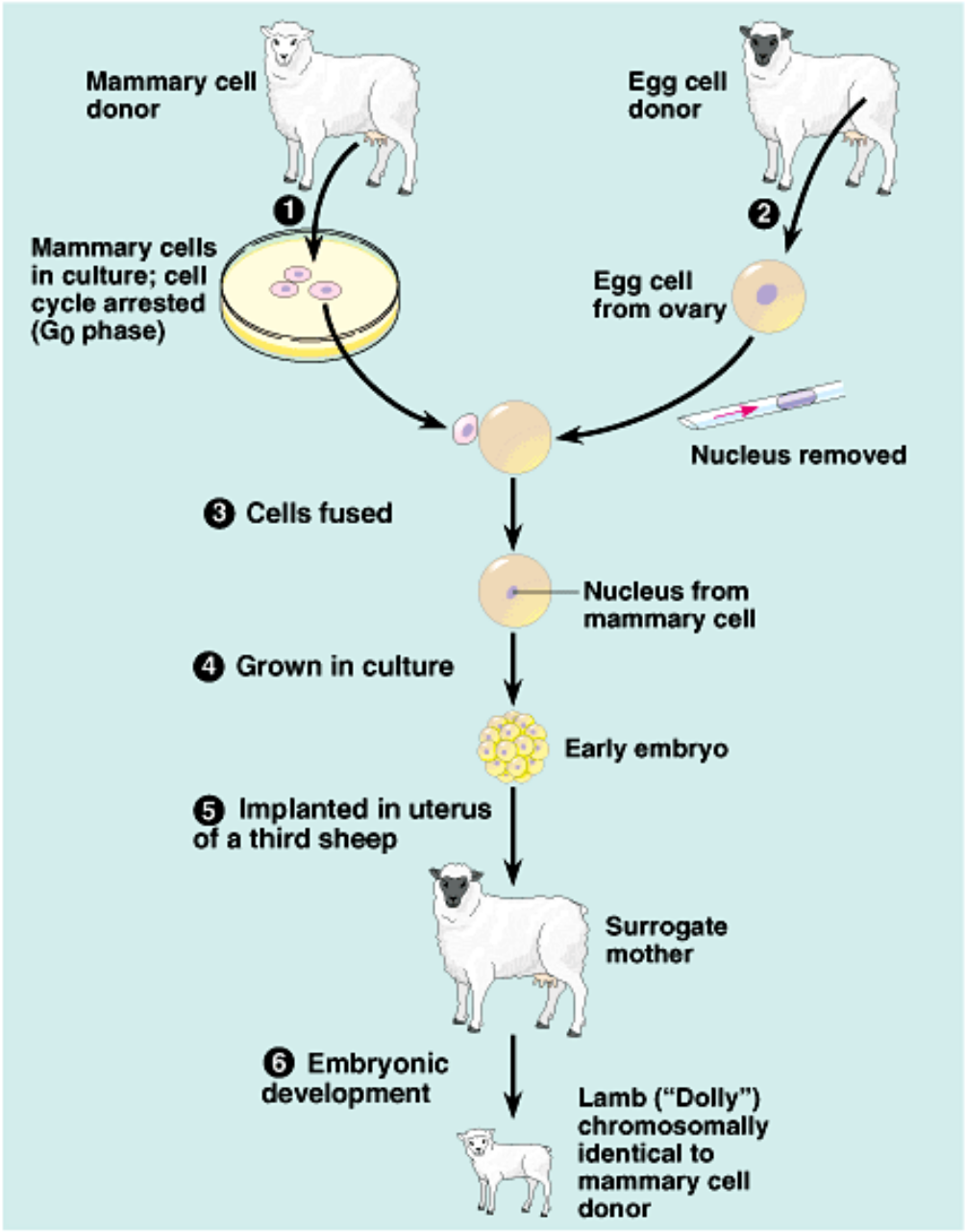


Figure 21.7 Cloning a mammal



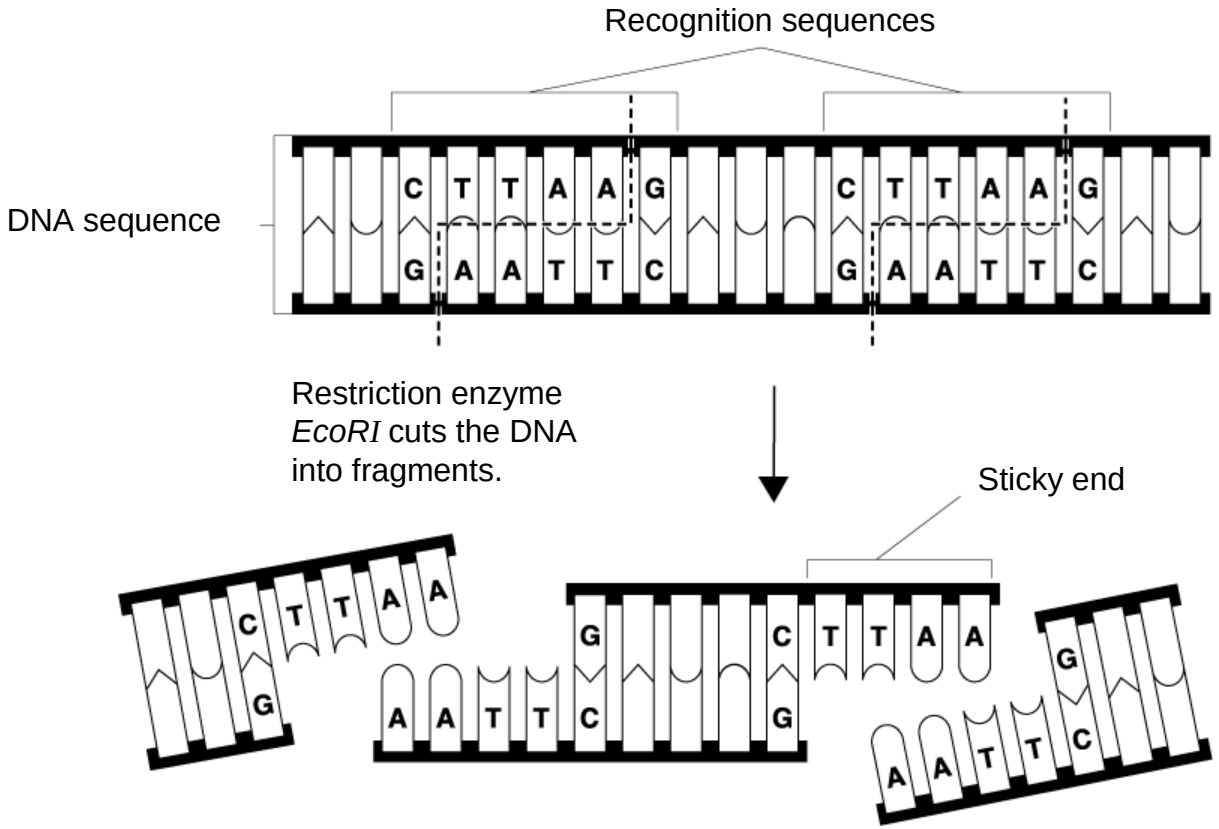
Dolly

Flash Presentations of advanced Genetic Engineering Topics

- Restriction Enzymes
- Gel Electrophoresis
- DNA Sequencing - Sanger Method
- DNA Sequencing - Florecent Dye Type
- PCR
- Model Organisms
- Transformation 1
- Transformation 2

Review for Quiz

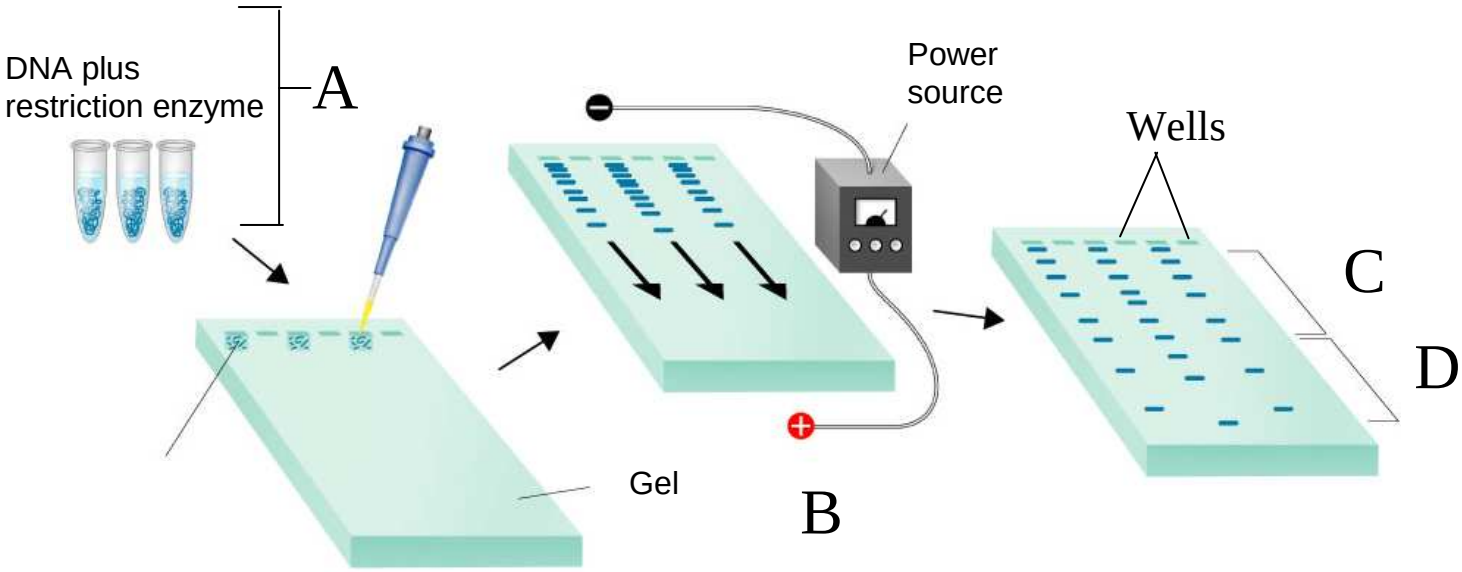
- What types of organisms have been influenced using selective breeding?
- What does selective breeding produce in offspring?
- Is selective breeding a new form of biotechnology?



- What is shown in the figure above?
- Between which nucleotides is the DNA cut?

Review Questions

- What is the function of gel electrophoresis?
- What is involved in genetic engineering?
- In gel electrophoresis DNA fragments are pulled toward what end of the gel?
- What happens during transformation?



- What do the bands in B consist of?
- Which group of bands moved faster, C or D? Why?
- What is occurring in A?

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1. 4
2. 1
3. 1
4. 1
5. 1
6. 1
7. 3
8. 2
9. 3
10. 1
11. 1