



**Mutations,
Genetic Testing
and
Engineering**

Objectives



- Describe how techniques such as DNA fingerprinting, genetic modifications, and chromosomal analysis are used to study the genomes of organisms (TEKS 6H)

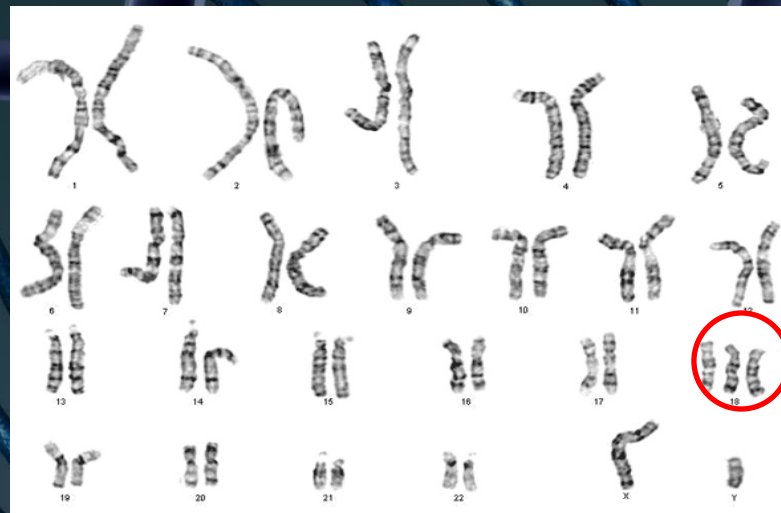
Genetic Testing

Chromosome Painting - The technique known as chromosome painting is used to mark the locations of genes on human chromosomes with fluorescent tags. It is also possible to apply this technique to the chromosomes of many different species. Chromosome painting allows for a comparison of the genomes of different species.



Genetic Testing

Chromosomal analysis - Chromosome analysis is the microscopic examination of chromosomes in dividing cells. Such analysis can detect changes in chromosomal number and structure. Deletions (eg, partial monosomy), duplications (eg, partial trisomy), and structural abnormalities such as translocations, inversions, and rings can be detected.



Can you spot what's wrong with this individual?

Karyotypes are a form of chromosomal analysis where an organism's entire genome (all their chromosomes) can be visualized

Genetic Testing

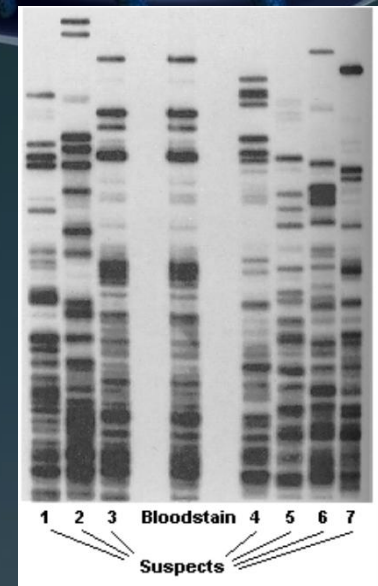
DNA Fingerprinting - a technique employed by forensic scientist to assist in the identification of individuals by their respective DNA profiles.

DNA profiling should not be confused with full genome sequencing. It is used in, for example, parental testing and criminal investigation.

Although 99.9% of human DNA sequences are the same in every person, enough of the DNA is different to distinguish one individual from another, unless they are identical twins.

DNA profiling uses repetitive ("repeat") sequences that are highly variable, called variable number tandem repeats (VNTRs), particularly short tandem repeats (STRs).

VNTR loci are very similar between closely related humans, but so variable that unrelated individuals are extremely unlikely to have the same VNTRs.



Genetic Engineering

= making changes in the DNA code of a living organism



HETEROZYGOATS

Just allele uneven.

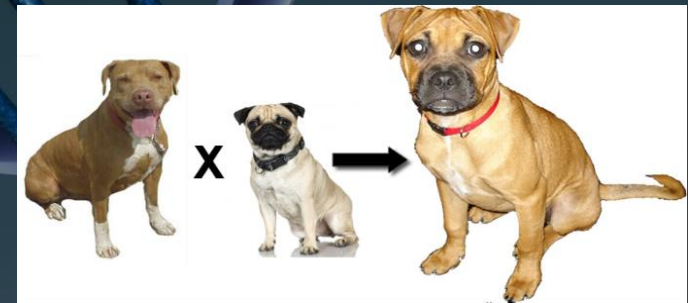
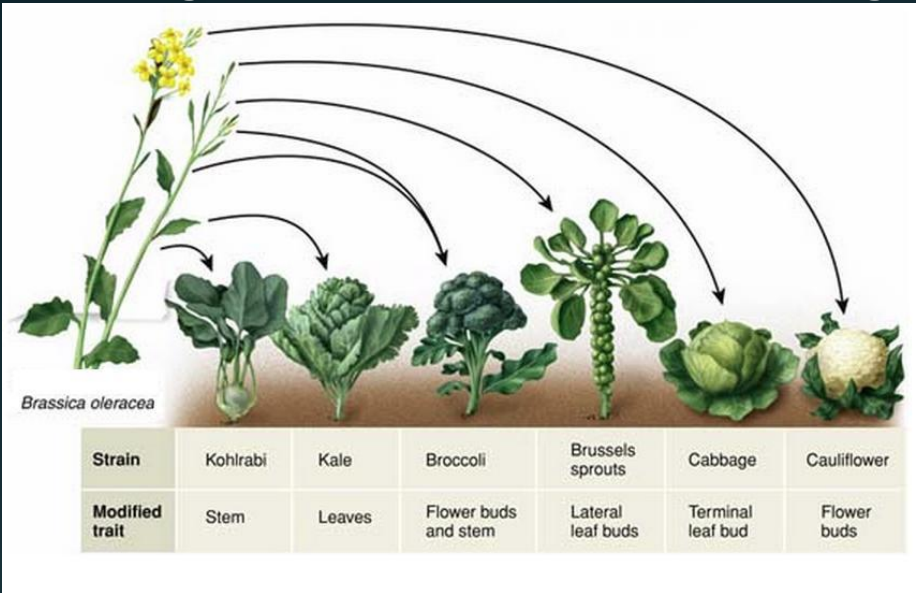


GENETIC ENGINEERING

SOMEONE ALWAYS HAS TO SUFFER.

Selective Breeding - breeding or crossing of organisms with favorable traits. This is a natural form of genetic engineering.

Choosing the "best" traits for breeding



Hybridization - Crossing dissimilar individuals to bring together the best traits of both organisms

Produces **hybrids**

* Hybrids can be different species crossed together or different types within the same species.



Genetic Engineering



How are changes made to DNA?

Scientists use their knowledge of the structure of DNA & its chemical properties to study & change DNA molecules.

Different techniques are used. Most techniques involve:

- extracting DNA from cells (you did this in class!)
- cutting DNA into smaller pieces (restriction enzymes)
- identifying the sequence of bases in a DNA molecule (gel electrophoresis)
- making unlimited copies of DNA (PCR)

A.) DNA extraction - simple chemical process to get DNA out of cell; cells are opened & DNA is separated from other cell parts (you did this in class!)

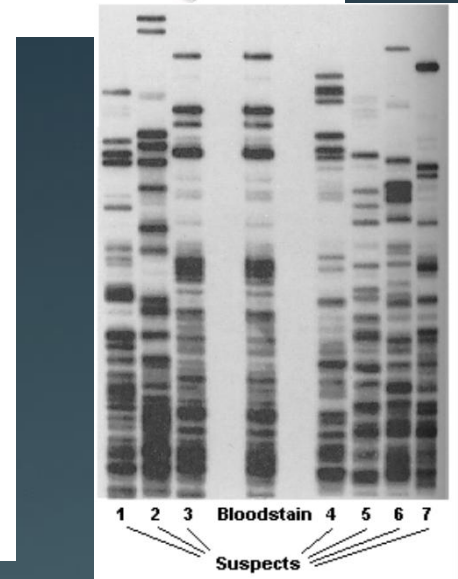
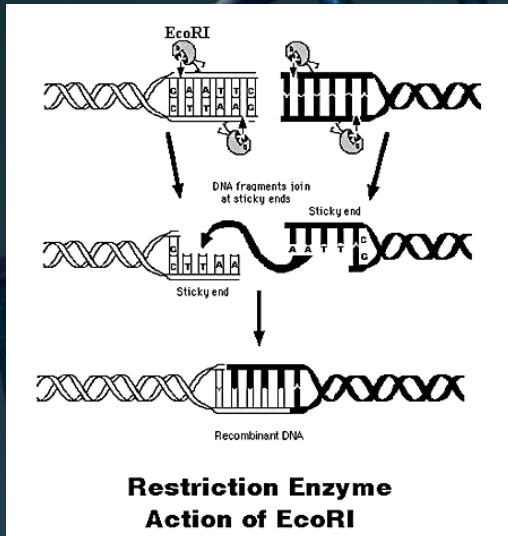
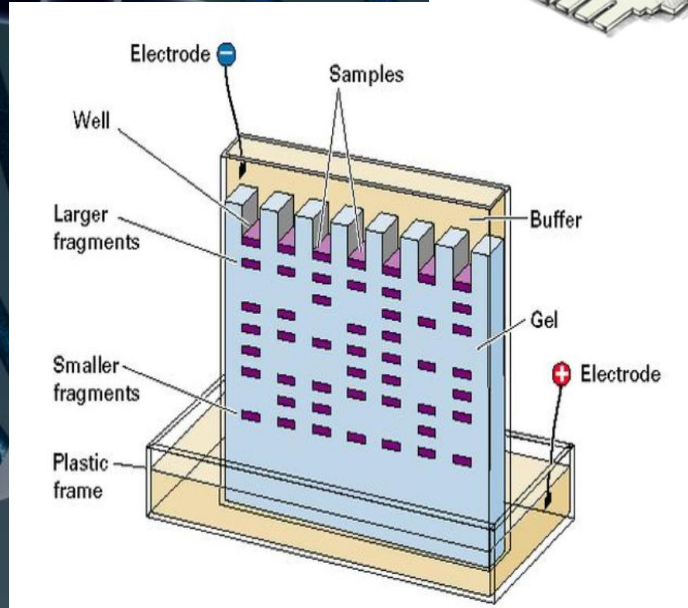
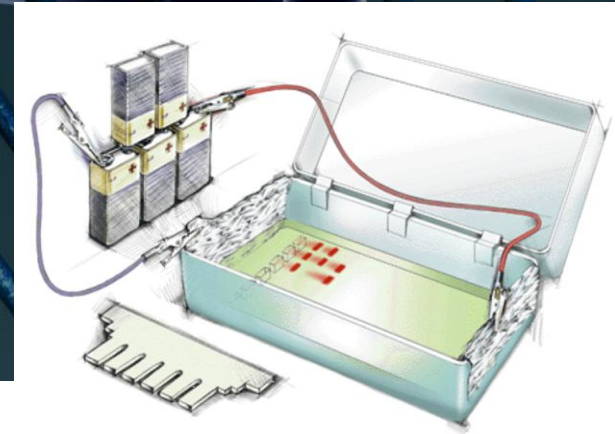
B.) cutting DNA - restriction enzymes are used to cut DNA at specific sequences of nucleotides

C.) separating & analyzing DNA

Scientists use gel electrophoresis =

-DNA fragments are put at one end of a gel

- electric current is applied to gel
- DNA molecules move

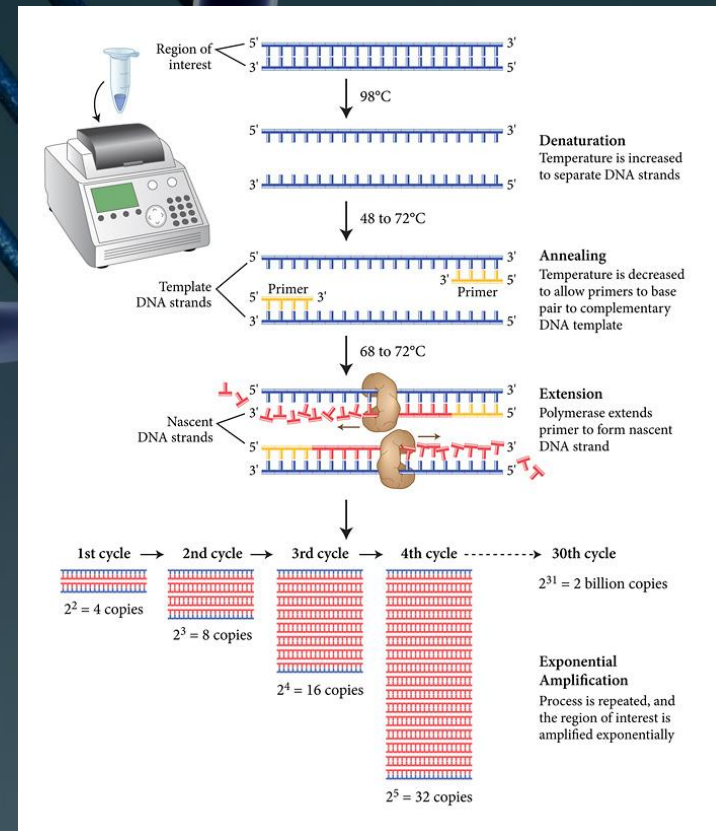
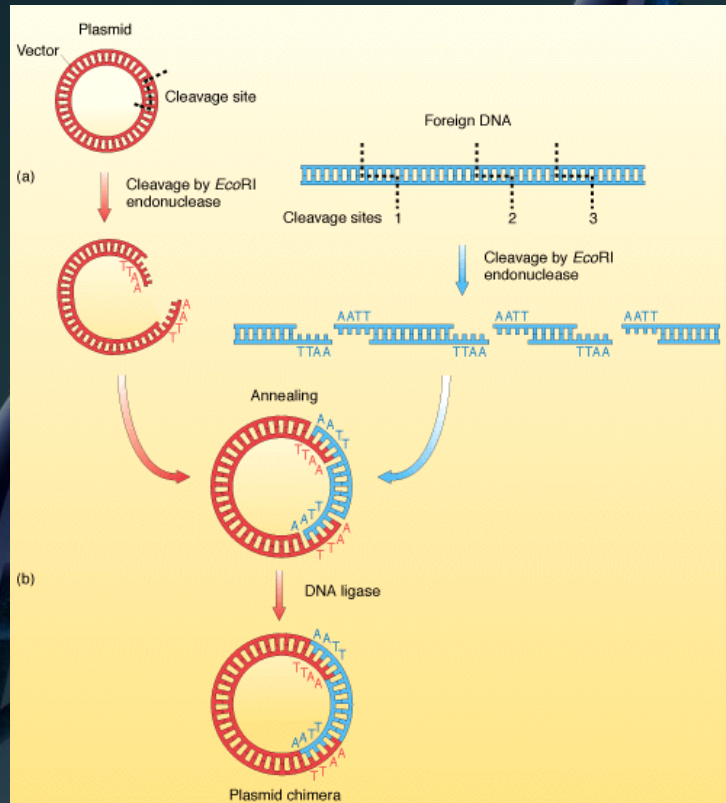


D.) recombinant DNA - DNA produced by combining DNA from different sources

E.) making copies

Polymerase chain reaction (PCR)

used to make multiple copies of genes



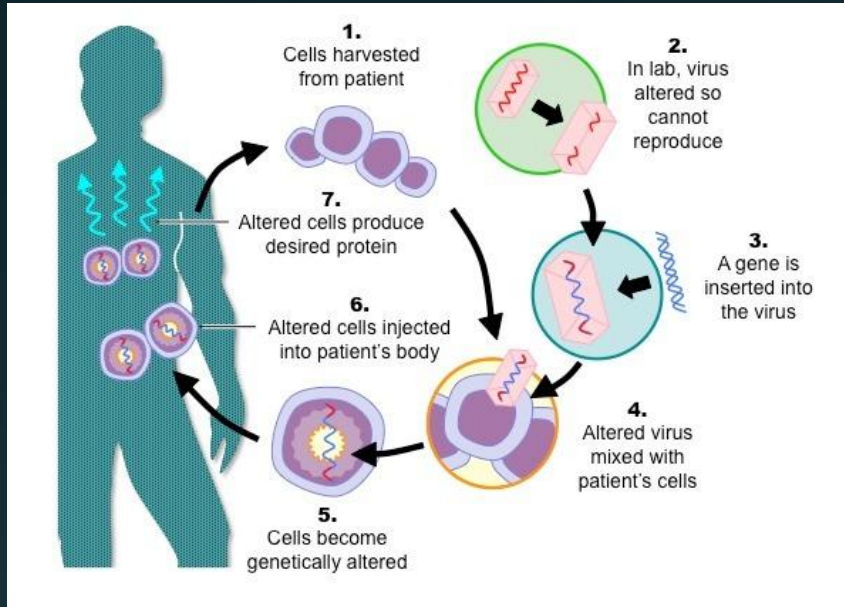
Transgenic Organisms

Contains genes from other species



Gene causes these mice to glow in the dark. Normally, the gene is found in jellyfish.

Gene Therapy



Gene therapy is the process of changing a gene to treat a medical disease or disorder. In gene therapy, an absent or faulty gene is replaced by a normal, working gene. This process allows the body to make the protein or enzyme it needs, which eliminates the cause of the disorder.

Genetic diseases caused by mutations in single genes are good candidates for gene therapy, whereas diseases involving many genes (or entire chromosomes) and/or environmental factors are poor candidates.

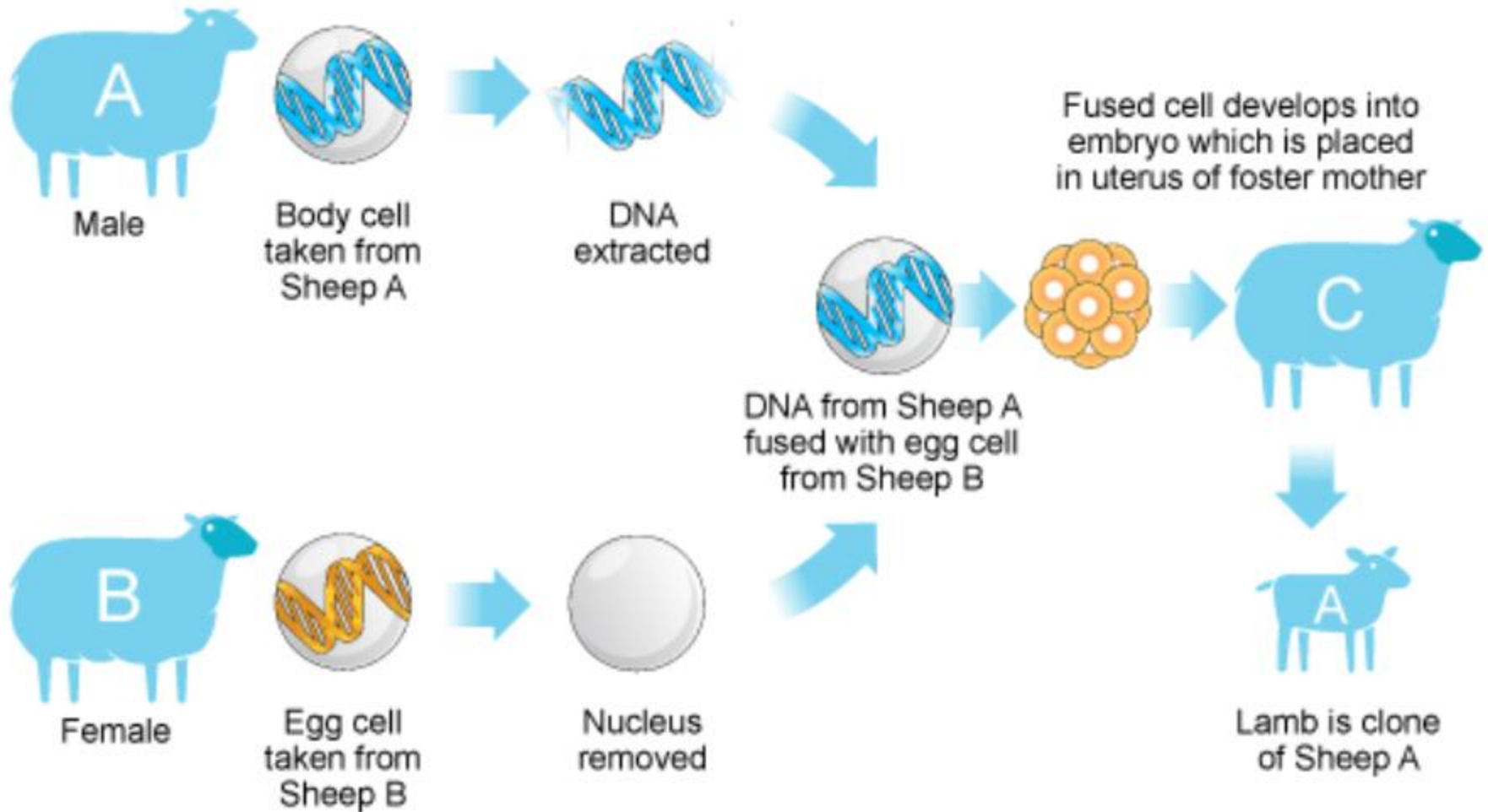
Although gene therapy is a promising treatment option for a number of diseases, the technique remains risky and is still under study to make sure that it will be safe and effective. It is currently only being tested for the treatment of diseases that have no other cures.

Cloning

- member of a population of genetically identical cells produced from a single cell
- easy to clone *single cell* organisms
- multicellular organisms more difficult to clone
- An identical twin is a natural clone
- 1997 Dolly the sheep cloned, 1st mammal



How to Clone a Sheep





CC



Rainbow

Photos courtesy TAMU, College of Veterinary Medicine

CC was the first cloned cat (Rainbow is the original). CC is short for "Carbon Copy". What is interesting is the color pattern for the clone is different from the original.

The reason is that the genes for color randomly turn on or off for the skin cells, creating random coloration even on the cloned cat.



How Can Cloning Be Useful?

1. Save endangered species by storing DNA and cloning
2. Make multiple copies of a useful gene (insulin for diabetics)
3. Clone spare parts, like organs or bone marrow
4. Create experimental groups for studying (animals)
5. Clone "special" animals, pets or horses



Bioethics

Where do we draw the line with genetic engineering?

1. I would use genetic engineering to remove a harmful gene from my unborn child, such as the gene that causes cystic fibrosis.
2. I would use genetic engineering to remove an abnormal (but not necessarily harmful) gene from my unborn child; such as the gene that causes dwarfism.
3. I would use genetic engineering to remove a gene that is not desirable, such as the gene that causes baldness.
4. I would use genetic engineering to change a gene in my unborn child, such as their hair color or eye color.
5. I would use genetic engineering to add a gene to my child that is not human - such as a gene from another organism that could improve sight or running ability.