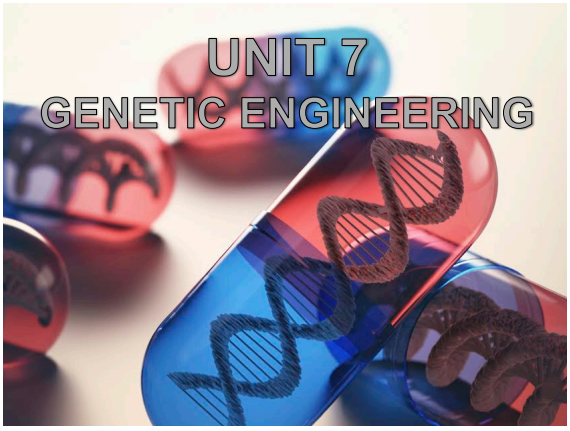
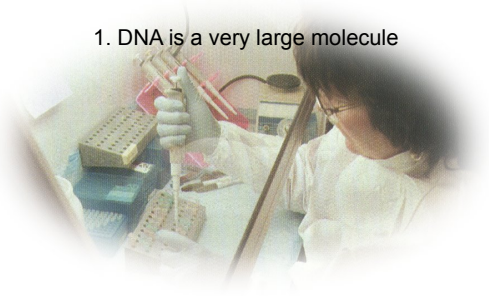


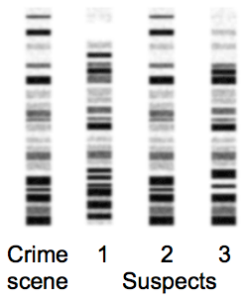
I. Manipulating DNA (9.1)

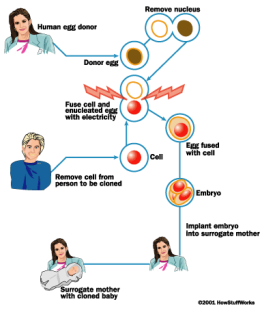
A. Scientists use several techniques to manipulate DNA

1. DNA is a very large molecule



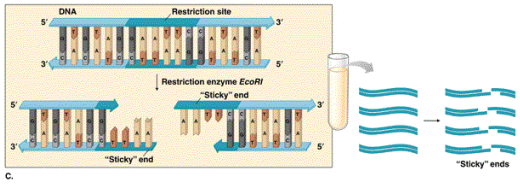
3. Led to many biotechnology applications- genetic engineering, DNA fingerprinting, cloning, etc.)





B. **Restriction Enzymes** cut DNA

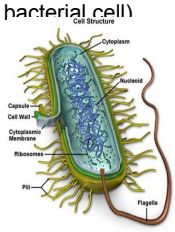
1. Scientists use enzymes as “scissors” to cut slice chromosomes into pieces for study



2. Enzymes which slice apart DNA come from many different **bacteria**

a. Bacteria use enzymes to combat viruses DNA that invade their cells

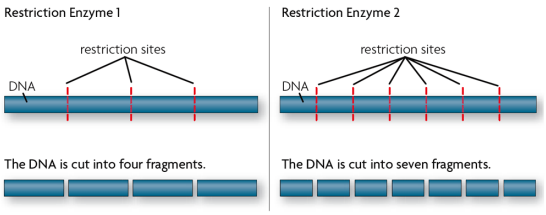
b. Called **Restriction Enzymes** (restrict or decrease the effect of virus on bacterial cell)



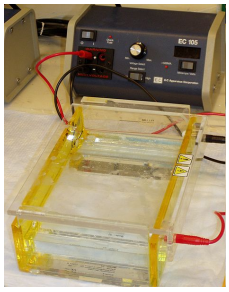
3. Restriction enzymes **cut** DNA at <u>specific</u> **sites**

a. Look for special <u>sequence</u> of **nucleotides** and cuts the DNA at that point

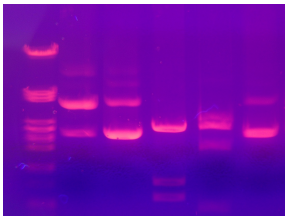
b. Different number of **fragments** and different **lengths** result



C. Restriction maps show the **lengths** of **DNA fragments**

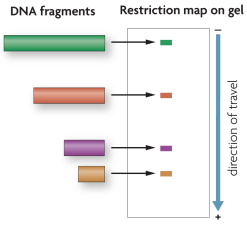


1. **Gel electrophoresis**- technique using electric current to separate mixture of DNA fragments from each other



2. **Restriction Maps**- pattern of bands on gel show lengths of fragments

a. Comparison of restriction maps can help diagnose **disease**.

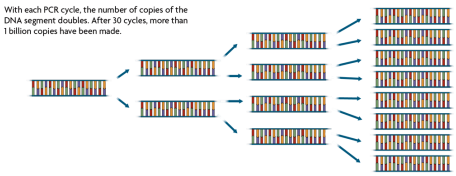


b. A **mutation** could change a restriction site and result in different **fragments**.

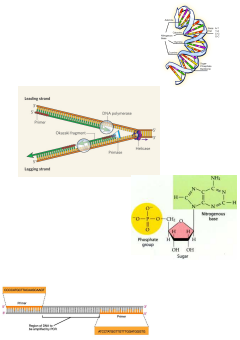
II. Copying DNA (9.3)

A. **PCR** uses polymerases to copy DNA segments

1. **Polymerase chain reaction (PCR)**- technique used to make copies of specific DNA sequence.
2. Adapted the process of DNA replication in cell to be used in test tube.



B. PCR uses just <u>four</u> materials



1. The **DNA** to be copied,

2. **DNA polymerases** (enzymes)

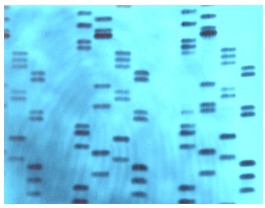
3. **DNA nucleotides**

4. two **primers** (a short sequence of DNA acting as starting point for new strand)

III. DNA Fingerprinting (9.3)

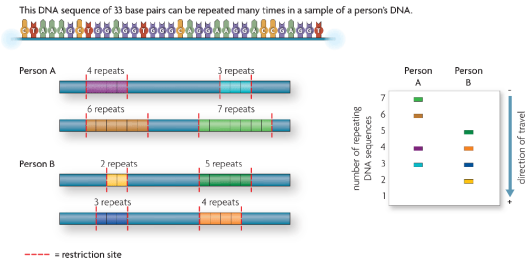
A. A **DNA fingerprint** is a type of restriction map

1. Every individual (except identical twins) has a **unique** set of **DNA**



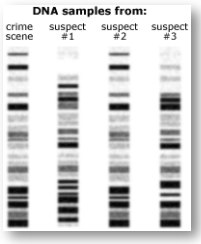
2. A DNA fingerprint is a representation of parts of individuals DNA that can be used to identify a person a nuclear level

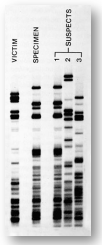
a. Use sequences of DNA that **vary greatly** from one individual to another
b. Restriction enzymes cut into **fragments**
c. **Gel electrophoresis** used to look for different **number** and **sizes** of fragments



B. DNA fingerprinting is used for **identification**

1. Chance of having same DNA fingerprint is **one chance in 5.4 million people**
2. DNA fingerprinting used in legal cases (crimes, paternity cases, studying genetic diversity)





IV. **Genetic Engineering** (9.4)

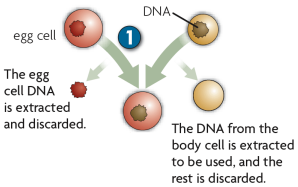
A. Entire organisms can be cloned

1. **clone**- genetically identical copy of gene or of an organism
2. Some simple animals can essentially clone themselves by **regeneration** (sea star)

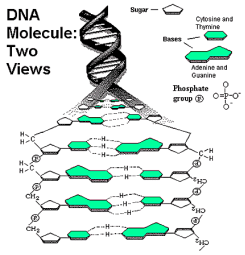
First cloned dog

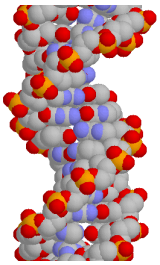
*3. In **mammals**- scientists swap DNA between cells*

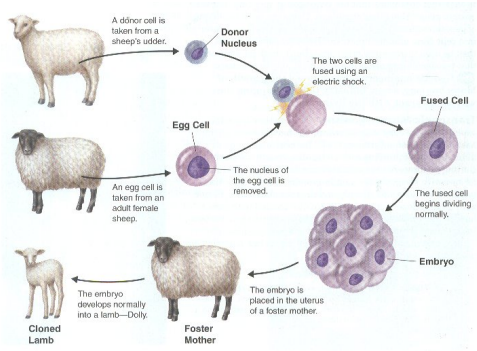
a. Unfertilized egg taken from animal
b. Eggs nucleus removed
c. nucleus of animal to be cloned in implanted into egg
d. After embryo grows for a couple days is transplanted into female



2. Still to small to see or work with directly
   a. Scientist work with DNA without being able to handle it directly
   b. Use Chemicals, computers, and bacteria as tools to study DNA







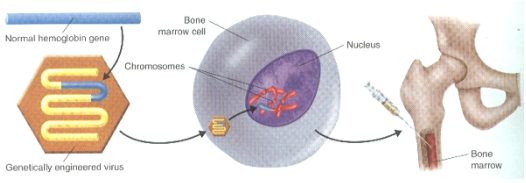
4. **Dolly** became first cloned mammal (sheep)

a. Led to cloning of pigs, dogs and mice

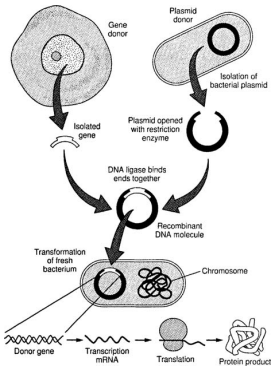
b. Clone may not look like original (many factors influence expression of gene- i.e. **environment**)

B. New genes can be added to organisms DNA

1. **Genetic engineering**- changing of an organisms DNA to give new trait



a. Based on use of Recombinant DNA technology



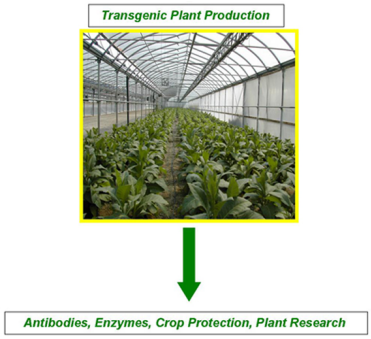
1). **Recombinant DNA**- is DNA that contains genes from more than one organism.

2). Being used by scientist to make medicines, vitamins, vaccines, etc.

2. Genetic engineering produces organisms with new traits

a. **Transgenic organisms**- has one or more genes from another organism inserted into its genome.

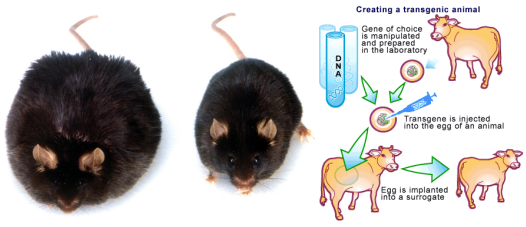
*1). **Transgenic plants**- provides resistance to frost, disease, and insects, and increase crops yields.*

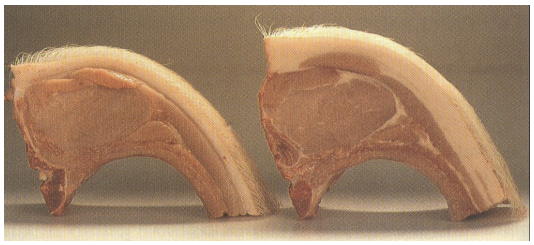


*2). **Transgenic animals-** much harder to produce*

a). Will pass on transgenic trait to offspring

b). Transgenic animals used in research

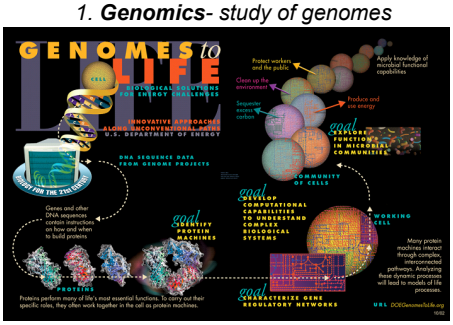




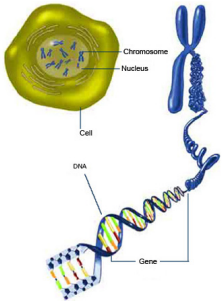
A transgenic pig with higher levels of growth hormone produced the meatier pork chop.

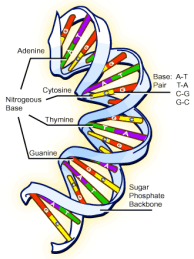
4. Concerns about genetic engineering
   a. **Ethical** concerns-
   b. **Environmental** concerns- long term effects
   c. Decrease in **genetic diversity**- leave crops vulnerable to new disease or pests

V. Genomics and Bioinformatics (9.5)
   *A. **Genomics** involves the study of genes, gene functions, and entire genomes.*
      *1. **Genomics**- study of genomes*



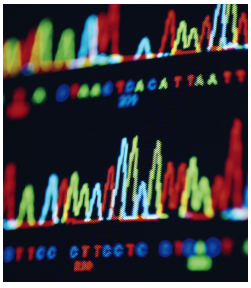
a. All studies of genomics begin with **gene sequencing-** determining the order of DNA nucleotides in genes or genomes



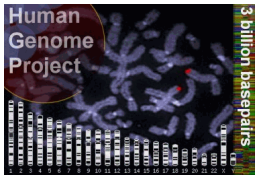


b. **Human Genome Project**-

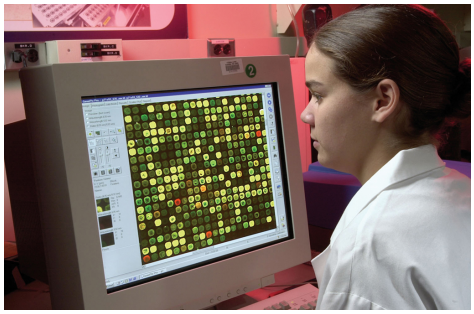
1). Completed mapping and sequencing of human DNA in 2003



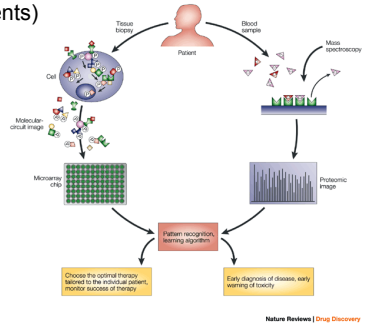
2). Still working on identifying genes in the sequence



B. **Bioformatics**- use of computer databases to organize and analyze biological data



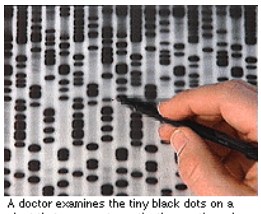
C. **Proteomics**- study and comparison of all the proteins that result from an organism's genome (used to study shared ancestry, disease, potential treatments)



VI. Genetic Screening and Gene Therapy (9.6)

A. Genetic screening can detect genetic disorders

*1. **Genetic screening**- process of testing DNA to determine risk of having or passing on a genetic disorder.*

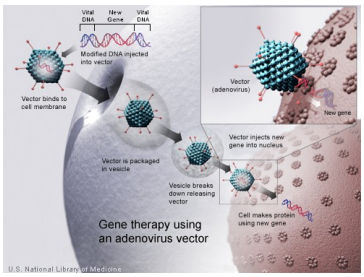


A doctor examines the tiny black dots on a chart that represent a patient's genetic code.

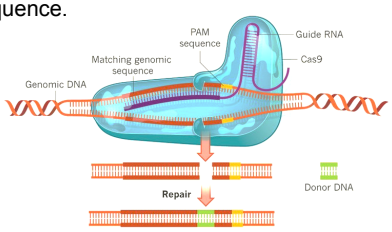
2. Used to help save lives and make tough choices

B. **Gene therapy** is the replacement of faulty genes

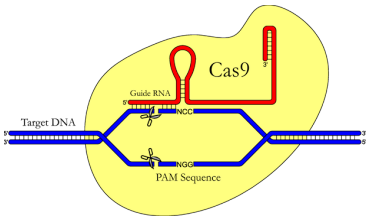
1. Can replace defective gene or add new gene into person's genome
2. Has great potential and requires much more research.



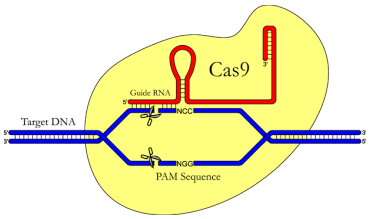
3. **CRISPR** -Clustered regularly interspaced short palindromic repeats (pronounced crisper)
   a. **CRISPR-Cas9 system** is a unique technology that enables geneticists and medical researchers to edit parts of the genome by removing, adding or altering sections of the DNA sequence.

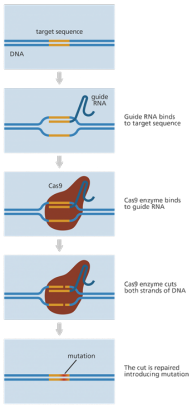


b. The CRISPR-Cas9 system consists of <u>two</u> key molecules that introduce a change (mutation) into the DNA.
   1). An **enzyme** called **Cas9**. This acts as a pair of 'molecular scissors' that can cut the two strands of DNA at a specific location in the genome so that bits of DNA can then be added or removed.

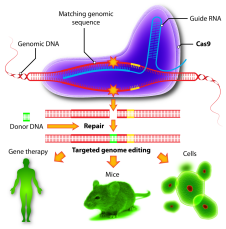


2). A piece of **RNA** called **guide RNA (gRNA)**. This consists of a small piece of pre-designed RNA sequence (about 20 bases long) located within a longer RNA scaffold. The scaffold part binds to DNA and the pre-designed sequence 'guides' Cas9 to the right part of the genome. This makes sure that the Cas9 enzyme cuts at the right point in the genome.





3). The guide RNA is designed to find and bind to a specific sequence in the DNA. The guide RNA has RNA bases that are complementary to those of the target DNA sequence in the genome.



c. What are the applications and implications of CRISPR-Cas9 system?

1). Has a lot of potential as a tool for treating a range of medical conditions that have a genetic component, including cancer.

2). Many of the proposed applications involve editing the genomes of somatic cells but there has been a lot of interest in and debate about the potential to edit germline (reproductive) cells.