CHAPTER 9:
GENETIC ENGINEERING

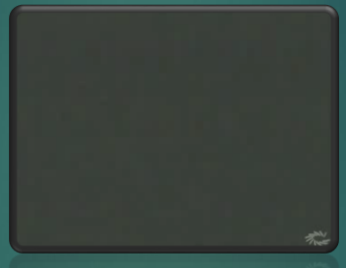
DR. BERTOLOTTI

Essential Question

How and why do scientists manipulate DNA in living cells?

What is selective breeding used for?

Application of Genetic Engineering



Video:
Dog breeding

- **Selective breeding** is the method of breeding that allows only those individual organisms with desired characteristics to produce the next generation.
  - Humans use selective breeding, which takes advantage of naturally occurring genetic variation, to pass wanted traits on to the next generation of organisms.
  - Example: Dog breeds, development of corn, etc.
- **Hybridization** is a breeding technique that involves crossing dissimilar individuals to bring together the best traits of both organisms
  - Hybrids are often better than their parents

Animal breeding



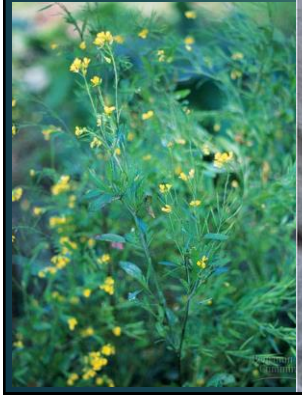


Breeding food plants

Evolution of modern corn (right) from ancestral teosinte (left).

Breeding food plants

- "Descendants" of the wild mustard
  - the "Cabbage family"



An example of Hybridization

Polyploid Plants

- Drugs that prevent the separation of chromosomes during meiosis are very useful in plant breeding. These drugs can produce cells that have many times the normal number of chromosomes.
  - Plants grown from these cells are called polyploid because they have many sets of chromosomes.
    - Polyploidy is usually fatal in animals, but plants are much better at tolerating extra sets of chromosomes.
    - Polyploidy can quickly produce new species of plants that are larger and stronger than their diploid relatives.
    - A number of important crop plants, including bananas, have been produced in this way.

Polyploid Crops

Plant	Probable Ancestral Haploid Number	Chromosome Number	Ploidy Level
Domestic oat	7	42	6N
Peanut	10	40	4N
Sugar cane	10	80	8N
Banana	11	22, 33	2N, 3N
Cotton	13	52	4N

- **Inbreeding** is the continued breeding of individuals with similar characteristics to maintain the desired characteristics of a line of organisms
  - Helps to ensure that the characteristics that make each breed unique will be preserved
  - Most members of a breed are genetically similar and so the probability of a genetic defect is higher in this population, ex. Joint deformities in German Shepherds

QUESTION AND ANSWER

What is selective breeding used for?

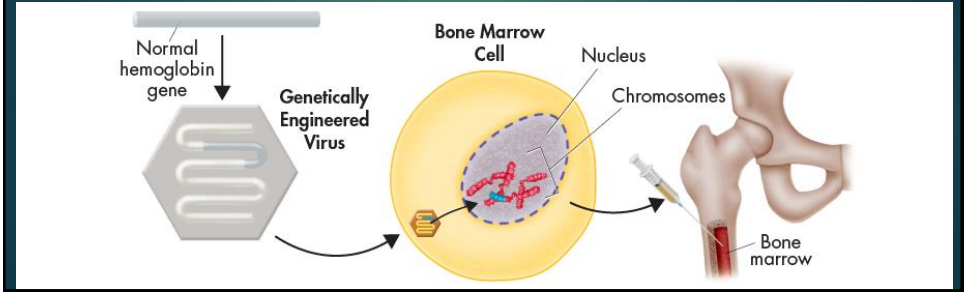
How do people increase genetic variation?

- Breeders can increase the genetic variation in a population by inducing mutations, which are the ultimate source of genetic variability
  - Mutations can be induced by using radiation and chemicals
  - Most mutations however are harmful
- When scientists manipulate the genetic makeup of an organism, they are using biotechnology.
  - **Biotechnology** is the application of a technological process, invention, or method to living organisms.

How can recombinant DNA technology benefit humans?

Treating Disease - One Example of 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.
  - The DNA containing the therapeutic gene is inserted into the modified virus.
  - To deliver therapeutic genes to target cells researchers engineer a virus that cannot reproduce or cause harm.



Can we mix genes from one creature to another?

YES!

Mixing genes for medicine…

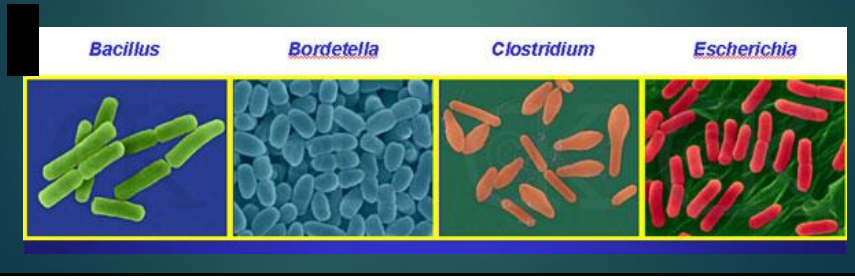
- Allowing organisms to produce new proteins
  - bacteria producing human insulin
  - bacteria producing human growth hormone

Humulin®

- **Recombinant DNA** is DNA produced by combining DNA from different sources
  - Recombinant DNA technology- joining together DNA from two or more sources- makes it possible to change the genetic composition of living organisms.

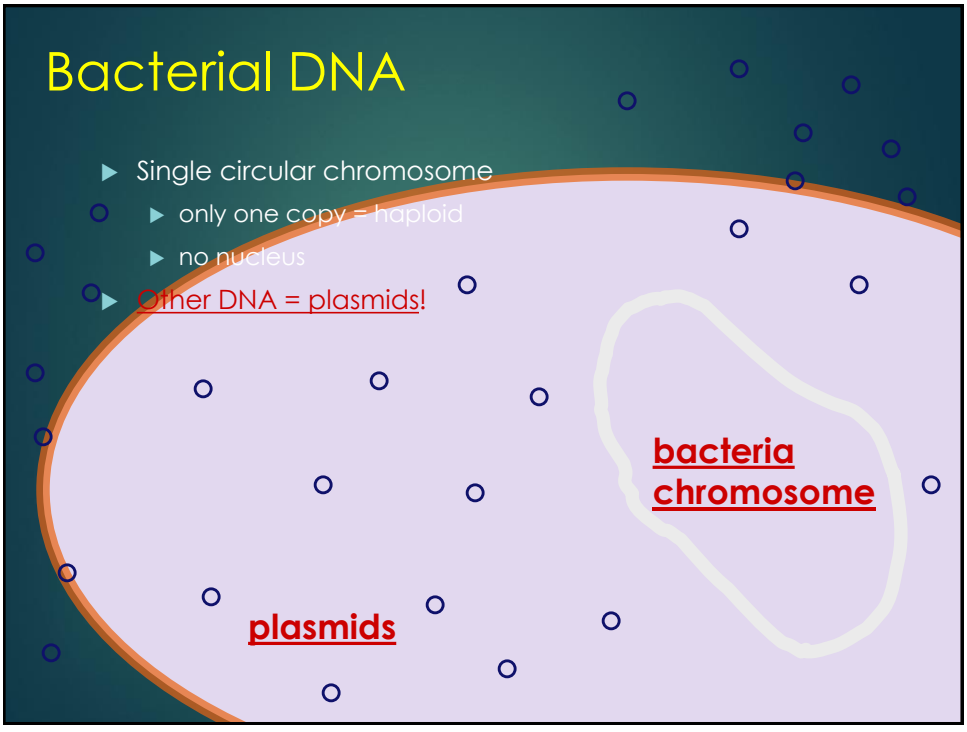
Bacteria

- Bacteria are great!
  - one-celled organisms
  - reproduce by mitosis
    - easy to grow, fast to grow
      - generation every ~20 minutes



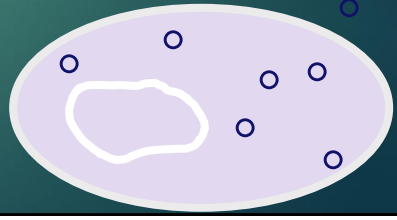
Bacterial DNA

- Single circular chromosome
  - only one copy = haploid
  - no nucleus
- Other DNA = plasmids!



There's more…

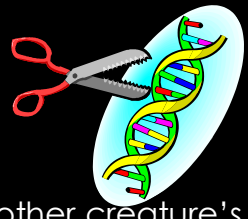
- Plasmids
  - small extra circles of DNA
  - carry extra genes that bacteria can use
  - can be swapped between bacteria
    - bacterial sex!!
    - rapid evolution = antibiotic resistance
  - can be picked up from environment



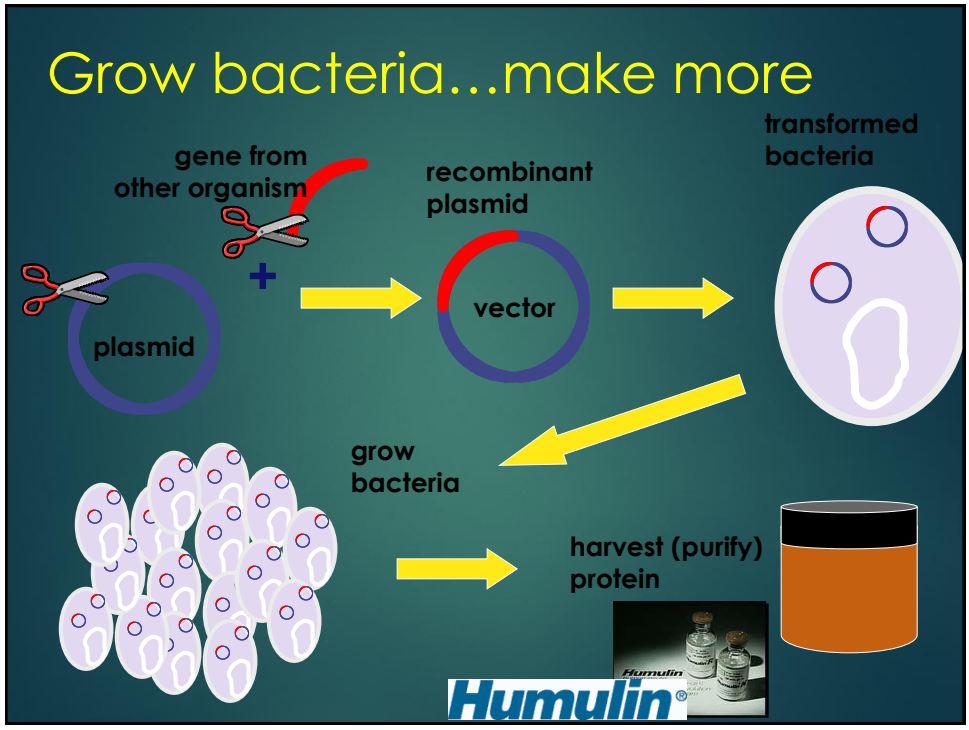
Cell transformation

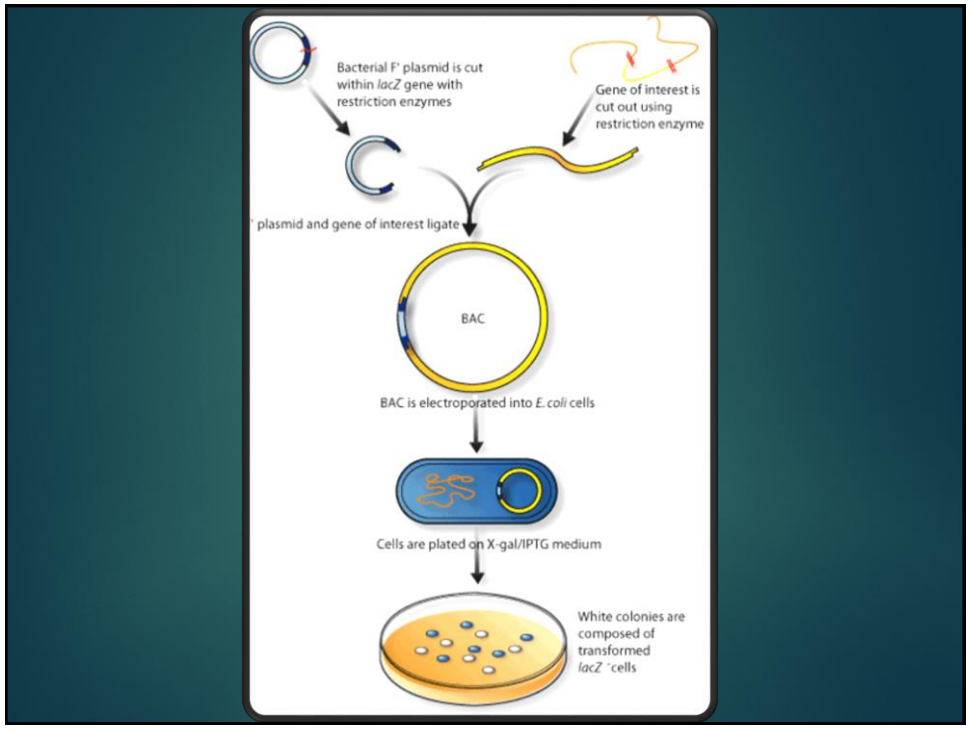
- During transformation, a cell takes in DNA from outside the cell. This external DNA becomes a component of the cell's DNA
  - If transformation is successful, the recombinant DNA is integrated into one of the chromosomes of the cell
- **Plasmid** is a small circular piece of DNA
  - Naturally found in bacteria
  - Useful to transfer DNA
  - Has a genetic marker is a gene that makes it possible to distinguish bacteria that carry a plasmid with foreign DNA from those that don't

How do we do mix genes?

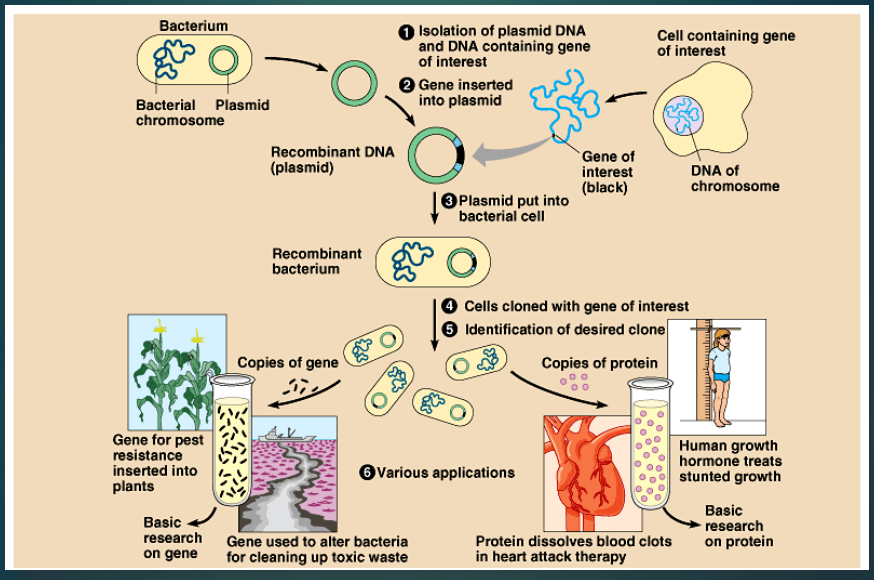


- Genetic engineering
  - find gene
  - cut DNA in both organisms
  - paste gene from one creature into other creature's DNA
  - insert new chromosome into organism
  - organism copies new gene as if it were its own
  - organism reads gene as if it were its own
  - organism produces NEW protein:
    Remember: we all use the same genetic code!

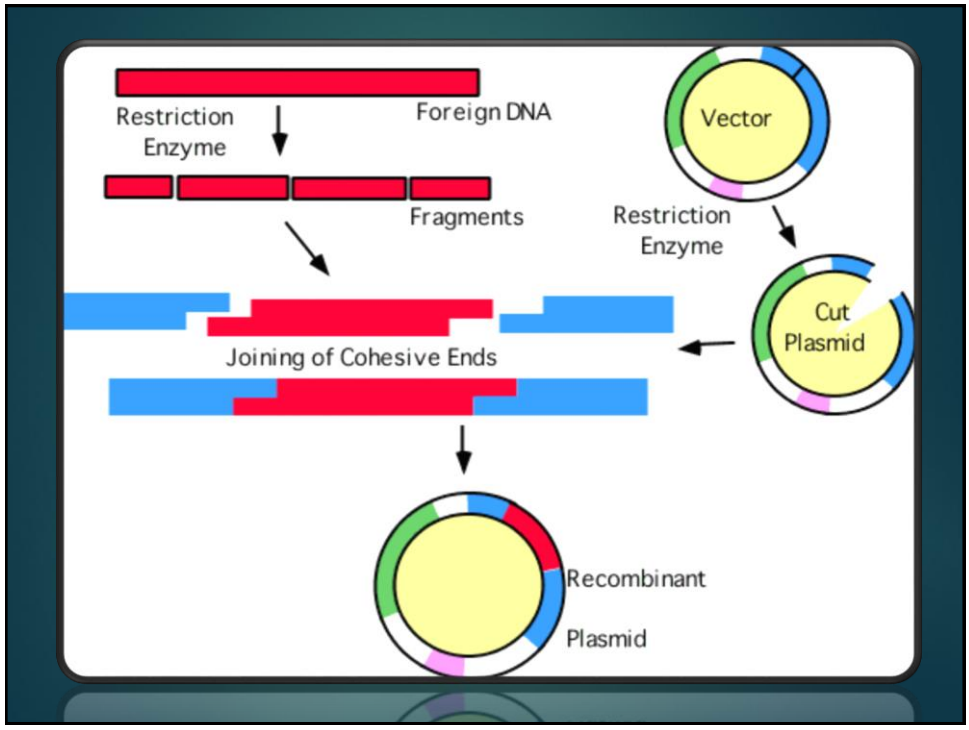

Grow bacteria…make more
gene from other organism
recombinant plasmid
transformed bacteria
plasmid
vector
grow bacteria
harvest (purify) protein
Humulin


Bacterial F' plasmid is cut within lacZ gene with restriction enzymes
Gene of interest is cut out using restriction enzyme
plasmid and gene of interest ligate
BAC
BAC is electroporated into E. coli cells
Cells are plated on X-gal/IPTG medium
White colonies are composed of transformed lacZ⁻ cells

Applications of biotechnology



- Plasmids also contain a **genetic marker-** a gene that makes it possible to distinguish bacteria that carry the plasmid from those that don't
  - These markers serve as identifiers- a way of finding the cell
- Both plant and animal cells can be successfully transformed so that recombinant DNA is integrated into one of the chromosomes of the cell



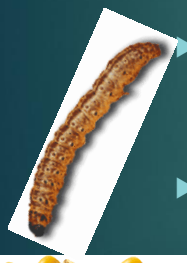
QUESTION AND ANSWER

How can recombinant DNA technology benefit humans?

How can genetic engineering benefit humans?

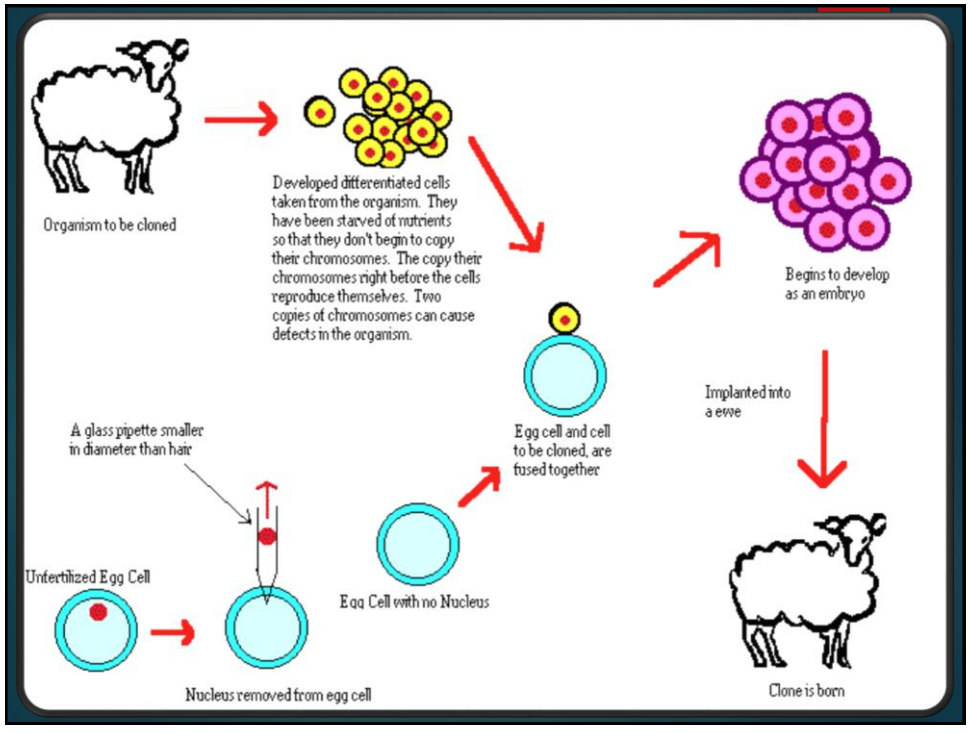
Uses of genetic engineering

- Genetically modified organisms (GMO)
  - enabling plants to produce new proteins
    - **Protect crops from insects**: BT corn
      - corn produces a bacterial toxin that kills corn borer (caterpillar pest of corn)
    - **Extend growing season**: fishberries
      - strawberries with an anti-freezing gene from flounder
    - **Improve quality of food**: golden rice
      - rice producing vitamin A improves nutritional value

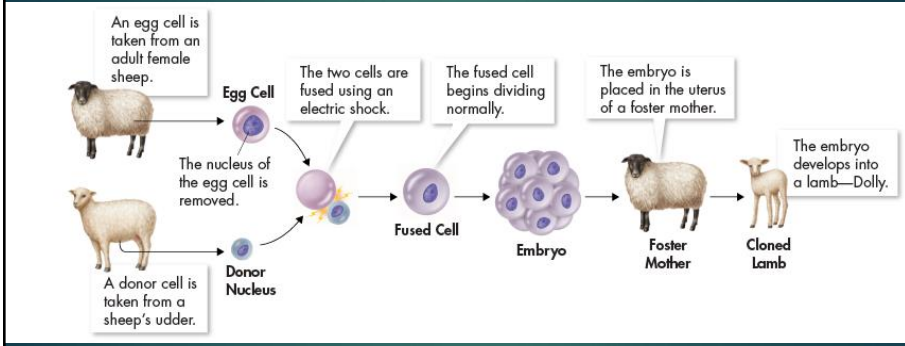


Applications of genetic engineering

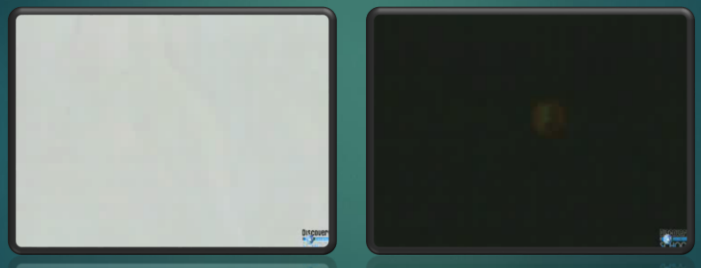
- **Transgenic organisms** refers to an organism that contains genes from other organisms
  - Ex. Transgenic bacteria produce insulin, growth hormone in a cheap and abundant manner
- **Clones** are members of a population of genetically identical cells produced from a single cell – cloned colonies of bacteria are easy to grow but the same is not the case for multi-cellular organisms
  - Ex. Dolly, the sheep



Cloning



Cloning



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