Essential Question: How can humans influence the natural genetic make-up of the organisms around us?
What types of organisms have had their natural genetic make-up changed by humans?

List as many as you can come up with
Methods of Genetic Change – not the result of chemical/modern manipulation of DNA
Selective Breeding

• Taking advantage of naturally occurring genetic variation to pass on desired traits
• Sometimes referred to as “artificial breeding”

• How do humans use selective breeding?

• How has selective breeding helped human culture through time?

Brassica oleracea
Designer Reptiles and Amphibians

Advice on purchase and selective breeding of color morphs that display unusual patterns in boa constrictors, pythons, milk snakes, king snakes, lizards, turtles, crocodilians, amphibians, and many others.

BARRON'S
Hybridization

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

- What are the potential problems or limitation?

- What are the benefits?
Horse X Donkey = Mules

Horses have 64 chromosomes, while donkeys have 62. When horses and donkeys are mated, the mule offspring have 63 chromosomes and are sterile.
Better Beef!

**Brahman cattle:**
Good resistance to heat but poor beef.

**English shorthorn cattle:**
Good beef but poor heat resistance.

**Santa Gertrudis cattle:**
Formed by crossing Brahman and English shorthorns; has good heat resistance and beef.
Inbreeding

• Continued breeding of individuals with similar characteristics (usually they are related to one another)
• Most “breeds” of animal or plant are the result of inbreeding.

• What are the problems associated with this?
Problems with Inbreeding

• Elevated incidence of recessive genetic diseases
• Reduced fertility both in litter size and in sperm viability
• Increased congenital defects such as heart defects, skeletal abnormalities.
• Fluctuating asymmetry (such as crooked faces, or uneven eye placement and size).
• Lower birth weight
• Higher neonatal mortality
• Slower growth rate
• Smaller adult size, and
• Loss of immune system function.
Increasing Genetic Variation

• Inducing genetic mutation with chemicals
  • Changes the DNA, or prevent chromosome division

• May result in desirable mutation
  • In individual genes  or
  • In chromosome number
Triploid Shellfish

1/3 more meat = more money for aquaculturists
Examples of polyploid crops

**Triploid crops**: banana, apple, ginger, watermelon, citrus

**Tetraploid crops**: macaroni wheat, cotton, potato, cabbage, leek, tobacco, peanut, kinnow, Pelargonium

**Hexaploid crops**: chrysanthemum, bread wheat, triticale, oat, kiwifruit

**Octaploid crops**: strawberry, dahlia, pansies, sugar cane
Benefits of Triploid Fish

Looking for that perfect "trophy-size" trout? Looking to minimize potential impacts on wild populations? Look no further than triploid trout from Troutlodge for your stocking program. Troutlodge is proud to serve as the primary supplier for the State of Washington’s popular "trophy trout" program each year.

Triploid trout are also known as 3N or sterile trout. Some of the many benefits of utilizing triploid trout in your stocking program include:

- Fish are suitable for release without genetic impact, as they cannot breed with native populations
- Better growth to large sizes as all energy is transferred to growth rather than reproduction
- Comparable growth to diploid populations early in the life cycle
- Better flesh quality as compared to diploids

Troutlodge has been a pioneer in the development of triploid technology and processes for the salmonid industry. Thanks to this extensive experience, Troutlodge achieves +99% induction rates in the triploid process. All triploid fish sold by Troutlodge are all-female.
Recombinant DNA

- Inserting the genes of dissimilar organisms into the DNA of another organism using an infectious bacteria
Classical VS Transgenic Breeding
DNA Finger Printing

Essential Question: How can the universal code of DNA be used to identify individual organisms?
DNA Finger Prints

- DNA
  - is obtained from an individual's blood cells, hair fibers, skin fragments, or other tissue.
DNA Finger Prints

- DNA
  - extracted DNA is digested with enzymes
  - Creates smaller fragments of DNA

![Diagram showing DNA fingerprinting with EcoRI, PstI, and SmaI enzymes]
DNA Finger Prints

- DNA
  - resulting fragments are separated by electrophoresis.

![Diagram showing DNA molecules of different lengths separating in an electrophoresis chamber, with the shortest moving farthest away from the anode.](image-url)
Gel Electrophoresis

• a process in which electrical charges separate DNA fragments according to size.

http://phschool.com/atschool/phbio/active_art/gel_electrophoresis/index.html
AGAROSE GEL ELECTROPHORESIS METHOD

1. Plasmid Vector DNA

2. Add DNA Sample onto Agarose Gel Lane #2 (DNA Ladder is in Lane #1)

3. Electric Current
   - DNA Bands are separated by size
   - NEGATIVE ELECTRODE
   - Electric Current
   - POSITIVE ELECTRODE

4. Dye Added Binds to DNA

5. DNA Bands are Exposed on Film
   - 1kb
   - 500 bp
   - 200 bp

Under UV Light DNA is Visible

Copyright 2008 MolecularStation.com
Reading the Gel

• Comparisons are made from left to right
• When all bands match up, there is a DNA match between the two individuals being tested
• In paternity cases, ____ of the bands match.
• In crime scene situations, multiple donors may occur in the same sample.
Parental DNA

- Compare the bands between the child and the parents
- $\frac{1}{2}$ of each parent's DNA should occur in the child
- IF NOT, they are not the parents
Sibling DNA – Which ones are identical twins?

Which father? – F1 or F2?
Crime Scene DNA
Digesting DNA with more than one enzyme (Probe) helps to verify results.

**Schematic of DNA Fingerprinting**

- **Probe 1**: E S1 S2
- **Probe 2**: E S1 S2
- **Probe 3**: E S1 S2
- **Probe 4**: E S1 S2

**Conclusion:** Excludes Suspect 1…Includes Suspect 2
Essential Question: How can we take knowledge of the universal genetic code and use it to create new and useful organisms?
How can we modify the DNA of a cell?

• Recombinant DNA

• Cell Transformation

• Transgenic Organisms
Cutting Up DNA for Recognition and Extraction of Genes

- To sequence DNA, it must be cut into smaller consistent fragments.
- Many enzymes can do this, but not predictably.
- **Restriction enzymes** are DNA-cutting enzymes found in bacteria, commonly referred to as restriction endonucleases.
Benefits of Restriction Enzymes
Types of Restriction Enzymes

• Restriction enzymes cut at very specific locations
• Each enzyme is named for the bacteria it is harvested from.

Alul: 5’...AGCT...3’
     3’...TCGA...5’

HaeIII: 5’...GGCC...3’
       3’...CCGG...5’

BamHI: 5’...GGATCC...3’
       3’...CCTAGG...5’

HindIII: 5’...AAGCTT...3’
       3’...TTCGAA...5’

EcoRI: 5’...GAATTC...3’
       3’...CTTAAG...5’

Alul and HaeIII produce blunt ends
BamHI, HindIII, and EcoRI produce “sticky” ends
Recombinant DNA

- DNA that has been created artificially by combining two or more sources is incorporated into a single molecule.
How do you get the new DNA into a cell?

• By taking advantage of a natural process
• Artificially induced in the laboratory
Cell Transformation

• Transformation
  • The process by which prokaryotes (bacteria) are able to take up plasmids from their surroundings
  • Plasmids are small pieces of DNA
    • Generally contain a few genes, including genes for making more of themselves and inserting into other cells DNA
Bacterial Transformation:
Definition, Process and Genetic Engineering of E. coli
Usefulness of Transformation

• Plasmids are easily cut apart and manipulated
• Bacteria can take up engineered DNA and transfer it to
  • Other bacterial cells
  • Plant cells
  • Animal cells
Transformed Cells

• If plasmid is taken up and combined with the host DNA then the new DNA is termed RECOMBINANT DNA

• The new organisms are GMOs (genetically modified organisms)
Why Recombinant DNA?

• Why would we want to be able to insert a single gene into a bacteria, plant or animal cell?

• What types of information could be replaced or added to a host cells DNA?
Transgenic Organisms (GM)

- Trans = across or between
- Genic = of the genome (genes)
  - Organisms that have had genes removed or added through genetic engineering

http://learn.genetics.utah.edu/content/science/gmfoods/
Practical Applications

• What are the practical applications of transgenic organisms?

• What are some of the fears associated with transgenic organisms?
Cloning Basics

• Let’s do an online activity! We’re going to clone mice.

CLICK AND CLONE

Using what you know about Somatic Cell Nuclear Transfer, let’s try it out!

Your mission is to create a genetically identical clone of Mimi, a brown female mouse.

Click on Mimi to begin!
History of Animal Cloning

“Lost in the midst of all the buzz about cloning is the fact that cloning is nothing new: its rich scientific history spans more than 100 years.”

http://learn.genetics.utah.edu/content/cloning/clonezone/

Let’s look at the highlight from the timeline and you can explore more on your own.
Brief History of Cloning

• 1885 - First-ever demonstration of artificial embryo twinning
• 1902 - Artificial embryo twinning in a vertebrate
• 1928 - The cell nucleus controls embryonic development
• 1952 - First successful nuclear transfer
• 1958 - Nuclear transfer from a differentiated cell
Brief History of Cloning

• 1975 - First mammalian embryo created by nuclear transfer
• 1984 - First mammal created by nuclear transfer
• 1987 - Nuclear transfer from embryonic cell
• 1996 - Nuclear transfer from laboratory cells
• 1996 - Dolly: First mammal created by somatic cell nuclear transfer
Brief History of Cloning

• 1997 - First primate created by embryonic cell nuclear transfer
• 1997 - Nuclear transfer from genetically engineered laboratory cells
• 1998-1999 - More mammals cloned by somatic cell nuclear transfer
• 2001 - Endangered animals cloned by somatic cell nuclear transfer
Brief History of Cloning

- 2007 - Primate embryonic stem cells created by somatic cell nuclear transfer
- 2013 - Human embryonic stem cells created by somatic cell nuclear transfer
Cloning 101 – DNA Learning Center

• [https://www.youtube.com/watch?v=q0B9Bn1WW_4](https://www.youtube.com/watch?v=q0B9Bn1WW_4)

• How is cloning different from a transgenic organism?

• Can you clone a transgenic organism?

• Why would a clone be better than a naturally breed organism?