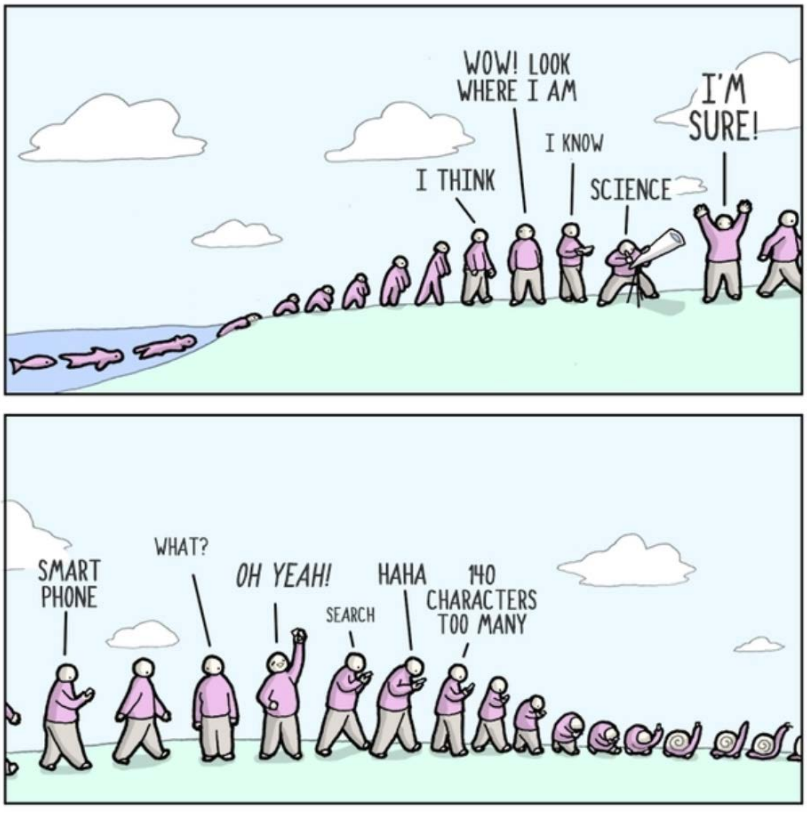
SCIENCE 10

UNIT 3: BIOLOGY



BOOK 2: MUTATIONS & EVOLUTION

NAME: Key BLOCK: _____

Amoeba Sisters | Video Recap

NAME: Amoeba Sisters Answer Key

Amoeba Sisters Video Recap: *Mutations (Updated) ANSWER KEY*

1. What is a mutation?

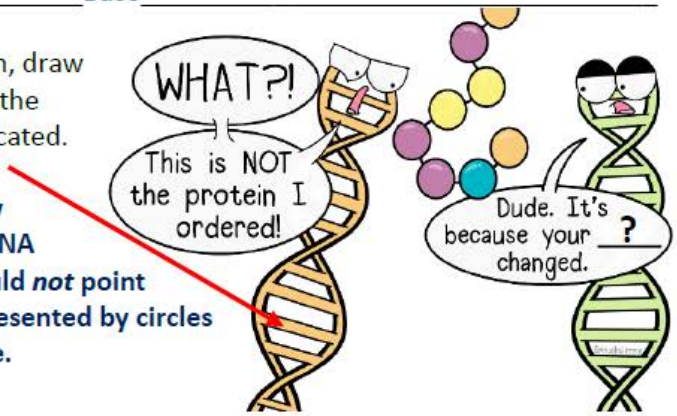
A mutation is a random change that can happen to nucleic acids (DNA or RNA).

2. A specific part of a **nucleic acid** (such as DNA or RNA) experiences a mutation that could lead to a different protein produced. View the illustration below of DNA. Which part of the DNA experiences the mutation?

Base

3. On the DNA illustration, draw an *arrow* to show *where* the answer to #2 could be located.

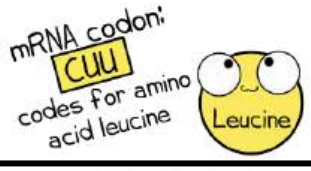
Answer Key Note: Arrow should point to where DNA bases are shown. It should *not* point to the amino acids (represented by circles at top) or DNA backbone.



Mutations can be harmful, helpful, or neutral in their effect. A **silent mutation** tends to have a neutral effect as it does not result in coding for a different amino acid. Using your mRNA chart, give another mRNA codon that this CUU could mutate to and *still* code for leucine.

4. The mRNA codon CUU could mutate to **C__UC___** and *still* code for leucine, which would not change the amino acid.

Note: Above answer from video. However, student could also write others such as CUA or CUG.



5. Which type(s) of organism(s) can experience a mutation? Mark any that apply.

_X___ Animals (this includes humans)

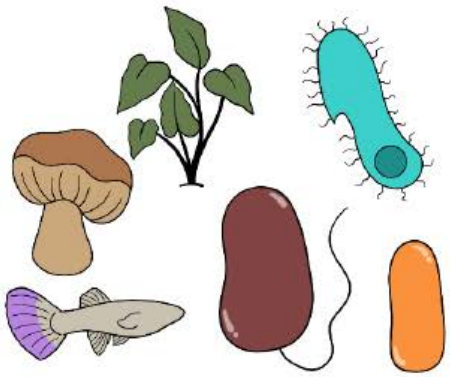
_X___ Archaea

_X___ Bacteria

_X___ Fungi

_X___ Plants

_X___ Protists



6. Even a **gene mutation** that is a **point mutation**, meaning it affects one nucleotide base, can still make a major change

Consider the below information for normal hemoglobin:

Portion of Hemoglobin DNA	GGA CTC CTC
mRNA	CCU GAG GAG
Amino Acids	Proline-Glutamic Acid-Glutamic Acid

Sickle Cell Anemia is caused by a point mutation known as a **substitution.** Show what would occur *if* the *first* T ("thymine") DNA base in the portion shown above experienced a mutation with a substitution of A ("adenine").

Sickle Cell Hemoglobin:

Portion of mutated hemoglobin DNA: GGA CAC CTC

mRNA: CCU GUG GAG

Amino Acids: Proline- Valine- Glutamic Acid

[Answer Key Note: Video clip does walk students through this portion if they struggle with this prompt.]

Amoeba Sisters | Video Recap

NAME: Amoeba Sisters Answer Key

Amoeba Sisters Video Recap: Mutations (Updated) ANSWER KEY

7. An **insertion or deletion** can result in a **frameshift mutation**. To demonstrate this, complete the following.
Note: You will need a codon chart.

Normal Strand:

DNA: GCA ATG CAC

mRNA: CGU UAC GUG

Amino Acids: Arginine- Tyrosine- Valine

Deletion (causing a frameshift):
Taking out the first "G" in the original DNA above results in:

DNA: CAA TGC AC

mRNA: GUU ACG UG

Amino Acids: Valine- Threonine- -

How did the frameshift change the amino acids that were coded?
Since the frameshift mutation deleted a base, the reading frame was shifted. This led to different coded amino acids.

8. Check your understanding! Mark any that are *correct.*

_X___Mutations are random.

_____Mutations are mostly beneficial and useful for an organism.

_X___Mutations can occur in both DNA and RNA, which are **nucleic acids**.

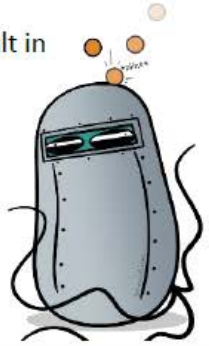
_____Mutations can only occur during **interphase**.

_X___Not all genes code for proteins.

_X___Not all genes are "turned on" at a given time.

_____**Substitution** mutations typically result in a **frameshift mutation**.

_X___Mutations can be **genetically inherited**.



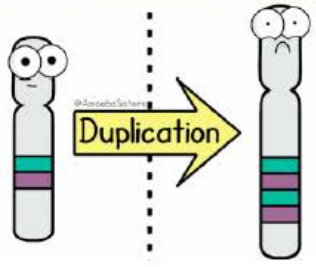
Chromosome Mutations

Sketch It!

Create illustrations to show the following chromosome mutations. Note: Chromosomes exist in both prokaryotic and eukaryotic cells, but prokaryotic chromosome structure tends to be very different from eukaryotic chromosomes.

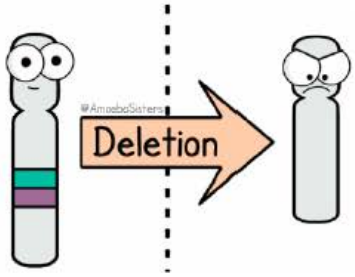
9. Duplication

Student illustrations may vary! Here is ours.



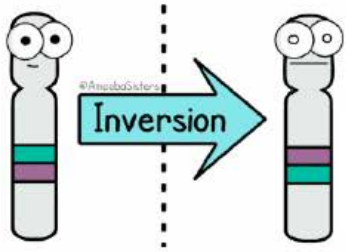
10. Deletion

Student illustrations may vary! Here is ours.



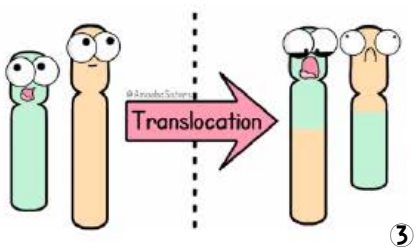
11. Inversion

Student illustrations may vary! Here is ours.



12. Translocation

Student illustrations may vary! Here is ours.

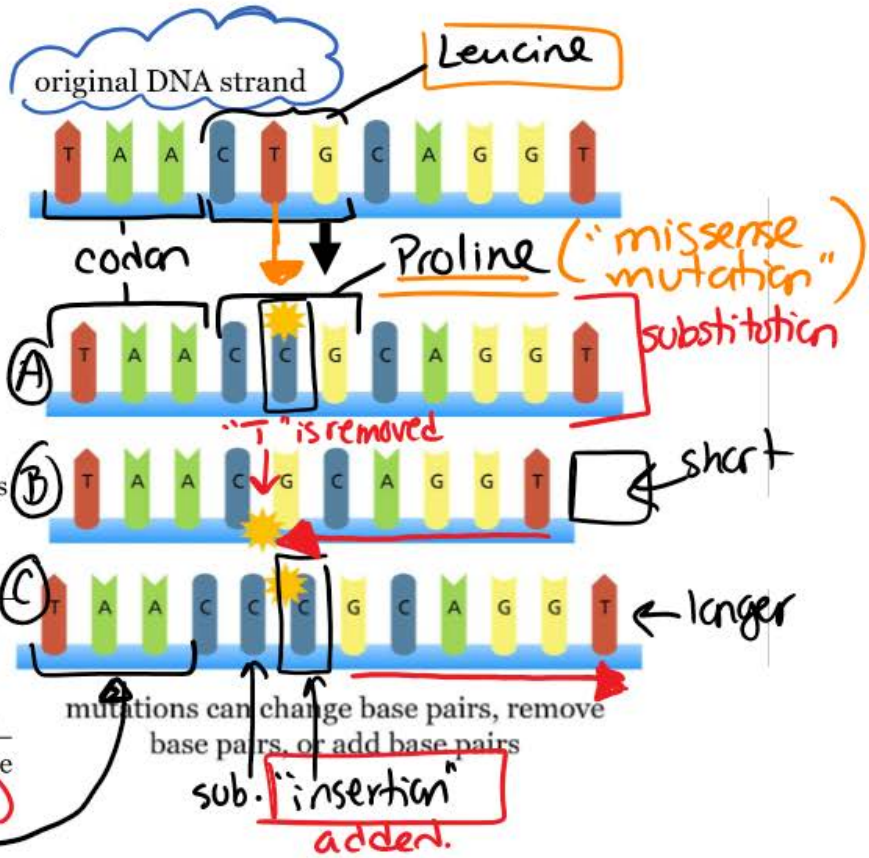


PART A - MUTATIONS

- ☐ Up to this point, we have considered DNA molecules to be permanent structures, but in nature the DNA of organisms is always changing
- ☐ Any persistent change to the sequence of bases in a DNA molecule that is passed down to new generations is called a mutation
- ☐ These changes can be small, such as single base changes, single base delete or add, or they can be large, causing multiple base changes and deletions as big as whole chromosome
- ☐ There are many different types of mutations, but some involve a change to just a nucleotide (base)
  - these types of mutations are called point - mutations
  -

1. Substitution - *a change to a single base in the codon*
   - **silent mutation** - where the altered codon still codes for the SAME amino acid
   - **missense mutation** - the altered codon now codes for a NEW (different) amino acid
   - **nonsense mutation** - the altered codon codes for a STOP code which truncates the synthesis of the protein early. ↳ stops early.

2. Frequency Mutation - a type of mutation which causes the remaining DNA sequence to "shift" left or right
   - (C) **insertion** - a nucleotide base is ADDED into the DNA code causing a frameshift to the right. (longer strand)
   - (B) **deletion**- a nucleotide base is REMOVED from the DNA code, causing a frameshift to the left (shorter strand)



A-T-C C-GG

Since codons are read in groups of 3 nucleotide bases, a frameshift mutation disrupts the normal reading frame, resulting in mutated protein products with an incorrect amino acid sequence that can be either longer or shorter than the normal protein.

(missense mutation)

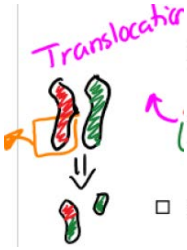
A C

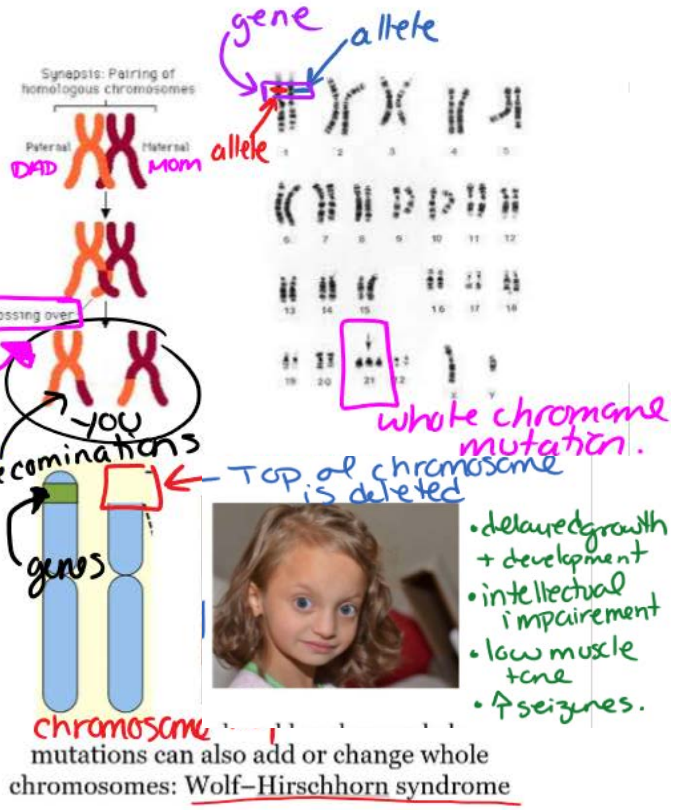
deletion

* codon is not read as 2 ... so DNA strand shifts to fill the gap

messes up the placement of the "STOP" code.

- ☐ In most organisms the rate of mutation is extremely low, perhaps as little as one or two changes per generation
- ☐ Mutation is incredibly important for evolution because it create new alleles.
- ☐ These are the building blocks for evolution as it creates genetic variation.
- ☐ ☐ *Normal cellular events,* such as "crossing-over" of homologous chromosomes during meiosis also creates new combinations and increases genetic variation.





mutations can also add or change whole chromosomes: Wolf–Hirschhorn syndrome

Chromosomal Mutations - are mutations to the whole or part of a chromosome

- ***trisomy-21*** *(down syndrome) is a translocation error resulting in an extra copy of chromosome 21 (3 copies in each cell)*
- ***Wolf-Hirschhorn Syndrome*** *a partial deletion or monosomy of chromosome 4*

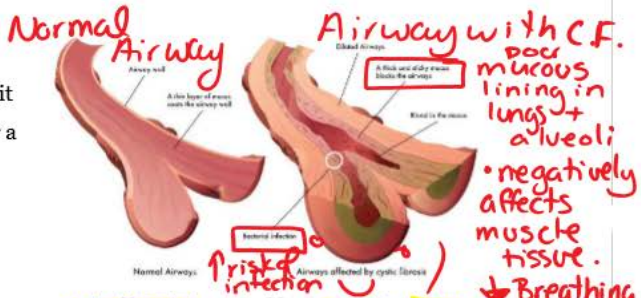
only 1 copy

Effects of Mutations

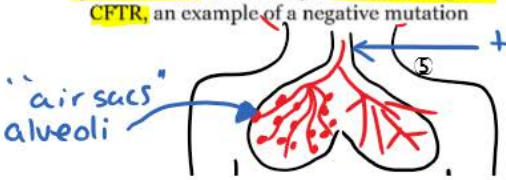
- ☐ **Positive Mutation** = any mutation that improves the function of a gene by causing it to create a BETTER protein and will give that organism an advantage over other members of its species (+ evolution of a stronger, more "fit" individual)

antibiotic resistance makes bacteria immune to an antibiotic, an example of a positive mutation

- ☐ **Negative Mutation** = any mutation that Harms the function of a gene by causing it to create a less effective protein or a protein that does not perform its job, and will give that organism a disadvantage



cystic fibrosis is caused by a mutation in gene CFTR, an example of a negative mutation



☐ **Neutral Mutation** = any mutation that do not change the function of a gene by causing it to create a protein that is less effective or more effective, provides its organism with no advantage or disadvantage.

the 'Spirit Bear' is a mutant version of the black bear

An Analogy: If the gene was a sentence, and its function (meaning) was its protein: "The old dog sit."

☐ Positive mutation: The old dog sat. The sentence has improved function

☐ Negative mutation: The old dgg sit. The sentence has reduced function

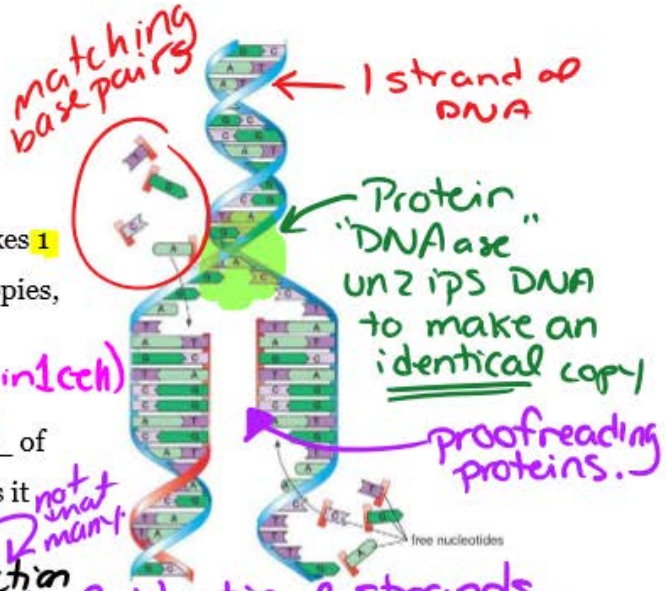
☐ Neutral mutation: the old cat sit. The sentence has identical function

Sources of Mutations

1. DNA Replication

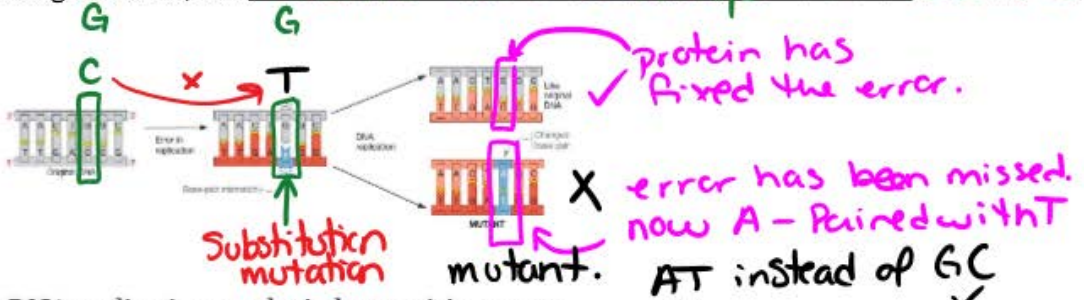
☐ The protein that replicates DNA is (DNAase) extremely accurate: it only makes 1 base pairing mistake for every 100,000 base pairs it copies, but across all 46 chromosomes this creates ~120 000 mistakes (copy DNA in1cell)

☐ The same protein that replicated DNA fixes 99% of these mistakes by proofreading the new DNA strand as it goes, leaves ~1200 mistakes (not that many)



DNA sequence → amino acids → protein → function in body

☐ Other proteins look for these mismatches and repair them, removing almost all of the remaining base pairing mistakes, but some are always left behind



DNA replication results in base pairing errors – approximately 1,200 which each copy – that can become mutations

2. Mutagen

- ☐ natural and man-made agents that can cause mutations are called "mutagens"

- ☐ nuclear radiation (alpha particles, gamma rays) and high energy light (X-rays, ultraviolet light) physically damage or break down cells

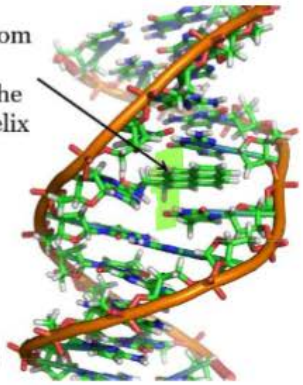
sun →

Measuring Radiation's Effects

Activity	Millirems
Typical yearly dose, all sources	360.00
Full set of dental X-rays	40.00
Chest X-ray	8.00
Flying round-trip from D.C. To Los Angeles	5.00
Living outside nuclear power plant for a year	0.10

Health risk	Expected life lost
Smoking a pack of cigarettes a day	6 years
Being 15 percent overweight	2 years
Working in construction	227 days
Working in nuclear plant (1,000 mrem/yr)	51 days
Typical annual background radiation dose (360 mrem/yr)	18 days

- ☐ Chemicals such as benzene attach themselves to DNA and cause errors during replication.



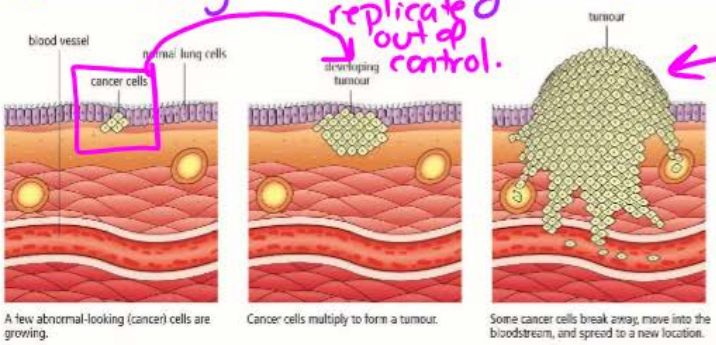
benzopyrene from cigarettes inserted into the DNA double helix

KNOWN carcinogen ("cancer-causing")

- ☐ Heavy metals such as arsenic, cadmium, iron also damage DNA and interfere with DNA repair
- ☐ Some viruses insert themselves into the DNA of the host cell, interrupting genes

Mutations and Cancer

- ☐ While some cancers are inherited, almost all of them are caused by mutations to genes that alter a cell's identity and affect normal cell division
- ☐ Agents that cause cancer, called "carcinogens", are thus mostly mutagens
- ☐ Cancer mutations result in abnormal cells with uncontrolled growth that can spread through the body to cells + tissues.



replicate out of control.

"mass" of out of control cancer cells.

7

Assignment #1: Complete the following worksheet in the space provided below

1. Identify each of the following examples as a positive, negative, or neutral mutation:

Example	Type of Mutation
a. Some plants carry a mutated gene that protects them from a fungus parasite called powdery mildew.	_____
b. Some people are born with a mutated gene that prevents the cells in their throat and lungs from making normal mucus, as a result the thick mucus accumulates and clogs the lungs (cystic fibrosis).	_____
c. The Spirit Bears of coastal British Columbia have a mutation that makes their fur white instead of black, but does not affect their survival.	_____
d. Some people have a mutation that prevents the virus HIV from infecting their cells.	_____
e. Some people have a mutation which causes blood protein involved in clotting to have a different shape, as a result they have internal and external bleeding (haemophilia).	_____

2. Which of the following can result from a DNA mutation?

   A. The protein will no longer function.
   B. The protein will have reduced function.
   C. The protein will have improved function.
   D. All of the above can occur.

3. Which of the following correctly describes a mutation?

   A. a change in the base pair sequence of a DNA molecule
   B. a change in the proteins that wrap around the DNA molecule
   C. a change in the order of sugars and phosphates in a protein
   D. a change in the structure of a protein

4. A man is sitting outside of a restaurant on a park bench smoking a cigarette, reading the newspaper. Which of the following is a mutagen that he is exposing himself to?

   A. the newspaper
   B. the cigarette
   C. the oxygen he is breathing
   D. the park bench

5. The three kinds of mutations are called:

   A. neutral, negative, and carcinogenic
   B. positive, negative, and neutral
   C. mutagens, carcinogens, and mutations
   D. complete, incomplete, co-mutant

6. A woman breaks her arm riding motocross. After checking into the hospital, she waits in the emergency room and drinks a glass of water. Eventually the doctor identifies the break with an X-ray and casts the arm. Which of the following is a mutagen that she is exposing herself to?

   A. the glass of water
   B. the hospital waiting room
   C. the chair she sits on
   D. the X-ray exam

7. Cancer results when mutations cause body cells to lose their identity and divide uncontrollably. Cancer is an example of

   A. a negative mutation.
   B. a positive mutation.
   C. a neutral mutation.

8. A mutation in a gene that creates proteins which carry fat in blood was discovered in people living in a small village in northern Italy. Blood fat can accumulate inside the walls of blood vessels, blocking blood flow and causing heart attacks and strokes. The mutation greatly reduces the accumulation of fat inside the walls of blood vessels, and so is an example of

   A. a neutral mutation.
   B. a negative mutation.
   C. a positive mutation.

9. A mutation which does not affect the function of the protein is called a

   A. positive mutation.
   B. negative mutation.
   C. neutral mutation.

10. Cats in the American Curl breed have ears that curl upwards at the tips. This does not appear to affect their hearing in any way. This mutation is an example of

    A. a neutral mutation.
    B. a positive mutation.
    C. a negative mutation.

11. The Huntingtin gene creates a protein which is found in many different body cells. In humans there is a mutant allele of this gene which results in a protein that kills many types of cells, especially brain cells. This mutation is an example of

    A. a negative mutation.
    B. a neutral mutation.
    C. a positive mutation.

12. Identify the type of mutation below (substitution, addition, or deletion). Fill in the table.

Original DNA Sequence:	TACACCTTGGCGACGACT	**Type of Mutation**
Mutated DNA Sequence #1:	TACATCTTGGCGACGACT	
Mutated DNA Sequence #2:	TACGACCTTGGCGACGACT	
Mutated DNA Sequence #3:	TACACCTTAGCGACGACT	
Mutated DNA Sequence #4:	TACACCTTGGCGACTACT	
Mutated DNA Sequence #5:	TACACCTTGGGACGACT	

13. Look at the following sequence: THE FAT CAT ATE THE RAT. Delete the first H and regroup the letters in groups of three- write out the new groups of three. Does the sentence still make sense? What type of mutation is this an example of?

ANSWERS:

1. a. positive
   b. negative
   c. neutral
   d. positive
   e. negative
2. D
3. A
4. B
5. B
6. D
7. A
8. C
9. C
10. A
11. A
12.

Original DNA Sequence:	TACACCTTGGCGACGACT	**Type of Mutation**
Mutated DNA Sequence #1:	TACA**T**CTTGGCGACGACT	substitution
Mutated DNA Sequence #2:	TAC**(added G)**ACCTTGGCGACGACT	addition
Mutated DNA Sequence #3:	TACACCTTAG**(missing G)**CGACGACT	deletion
Mutated DNA Sequence #4:	TACACCTTGGCGAC**T**ACT	substitution
Mutated DNA Sequence #5:	TACACCTTGG**(missing C)**GACGACT	deletion

13. TEF ATC ATA TET HER AT.. does not make sense. This is a NEGATIVE mutation

In Class Assignment: Peppered Moth Simulation

Objective: Simulate changes in moth population due to pollution and predation, and observe how species can change over time.

Introduction:

Charles Darwin accumulated a tremendous collection of facts to support the theory of evolution by natural selection. One of his difficulties in demonstrating the theory, however, was the lack of an example of evolution over a short period of time, which could be observed as it was taking place in nature. Although Darwin was unaware of it, remarkable examples of evolution, which might have helped to persuade people of his theory, were in the countryside of his native England. One such example is the evolution of the peppered moth *Biston betularia*.

The economic changes known as the industrial revolution began in the middle of the eighteenth century. Since then, tons of soot have been deposited on the country side around industrial areas. The soot discoloured and generally darkened the surfaces of trees and rocks. In 1848, a dark-coloured moth was first recorded. Today, in some areas, 90% or more of the-peppered moths are dark in colour. More than 70 species of moth in England have undergone a change from light to dark. Similar observations have been made in other industrial nations, including the United States.

Instructions:

Click the link below to read more information on Kettlewell's study of moths. Peppered Moth Simulation at **https://askabiologist.asu.edu/peppered-moths-game/play.html**

At the end, you will run two simulations for 5 minutes each, during this time you will play the part of a bluejay that eats moths.

After 5 minutes record the % of dark moths and light moths - you will need this information later.

Data and Analysis

Read the background information and answer the questions as you go.

Life Cycle of the Peppered Moth

1. Why are these moths called "peppered moths?"

2. What animals eat the peppered moth?

3. What is a lichen?

4. What do the larvae of the moth eat?

5. How do peppered moths spend the winter?

6. Moths that have more dark spots than the average moth are called what?

Impact of Pollution

7. Where was the virst black form of the moth found?

8. What was the Industrial Revolution?

9. What was causing the different colors in the moths?

10. What is natural selection?

11. Who suggested that peppered moths were an example of natural selection?

12. What is industrial melanism?

Kettlewell's Experiments

13. What is an entomologist?

14. How do scientists test theories?

15. Write down ONE of Kettlewell's predictions.

16. Dark moths were found in what parts of the country?

17. How did Kettlewell directly study the moths?

18. Why did dark moths have a survival advantage?

19. When Kettlewell recaptured the marked moths, what did he find?

20. Where did Kettlewell publish his findings?

Birdseye View

21. Open the simulation and play the role of the bird in both the dark and the light forest. Try to behave as a bird would behave, choosing the moths that are the most obvious. At the end of each simulation, record the percent of moths captured in the table below.

	Percent Dark Moths	Percent Light Moths
Light Forest		
Dark Forest		

Final Analysis

22. Explain how the color of the moths increases or decreases their chances of survival.

23. Explain the concept of "natural selection" using your moths as an example.

24. What would happen if there were no predators in the forest? Would the colors of the moths change over time? Defend your answer?

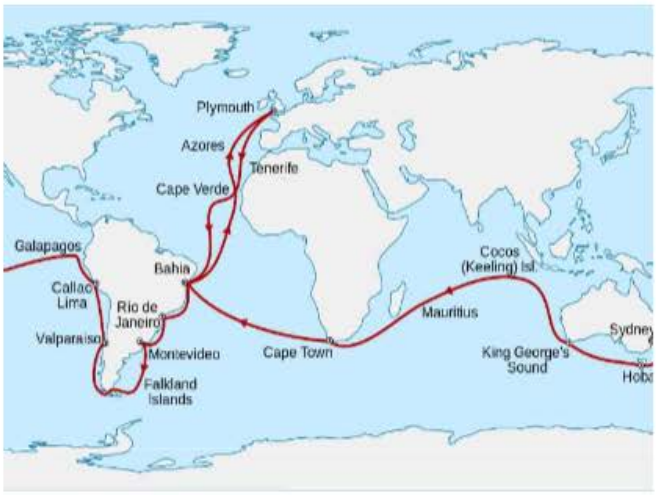
Part B - Darwin, Wallace, and Natural Selection

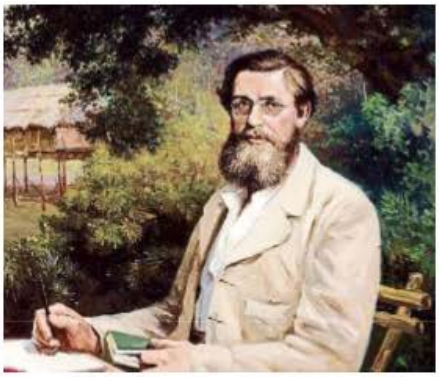
A Tale of Two Very Different Scientists

☐ Darwin (1809-1882) was born into a wealthy family, studying natural history and religion at Cambridge

☐ At 22 he was hired to join the HMS Beagle as it travelled around the world, observe + collect animal + plant specimens

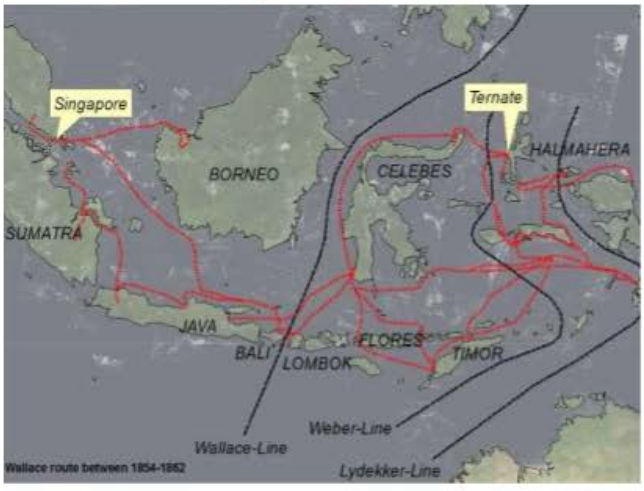
navy ship





☐ Alfred Wallace (1823-1913) was from a poor family, and after a few failed careers, inspired by Darwin, he became an explorer in Brazil and southeast Asia

☐ Wallace collected thousands of specimens, including thousands of NEW species, and began to think about why there were so many different species?



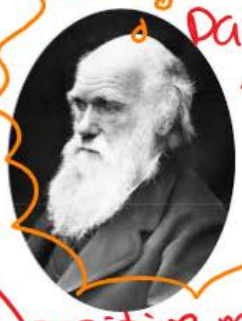
worked separately

Darwin and Wallace's Observations (Reached Independently)

1. Organisms give birth to offspring and pass on their traits. (sadly they did not yet know about Mendel's work)

2. Within every population there is variation in traits of that population (caused by mutations creating new alleles)

causes variation



3. Some variations affect an organism's survival: successful variations increases their chance of survival, and unsuccessful variations decreased survival

negative mutation

positive mutation

4. "Successful organisms live longer and reproduce more offspring. Passing on more of THEIR successful traits, and that makes the "successfull alleles" more common.

The Theory of Natural Selection

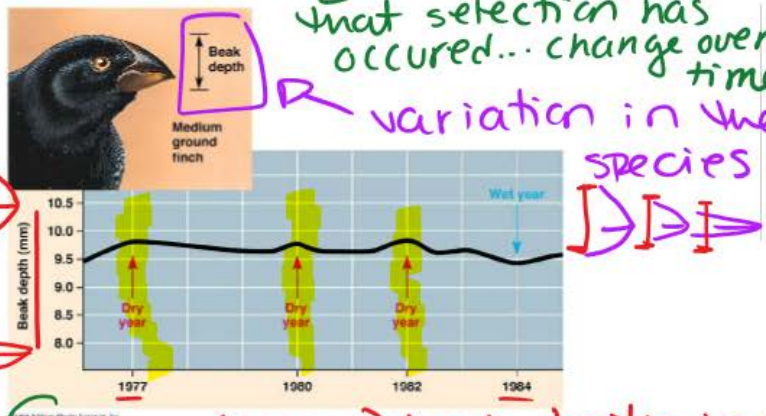
- ☐ Wallace wrote to Darwin, and it turned out that Darwin had come to the same conclusions: a theory they named Natural selection
- ☐ Nature 'selects' – by allowing them to live and reproduce – organisms with successfull alleles, and those alleles become more and more common in the population over time (loooong time)... with each generation

successful version of the gene.

- ☐ It is often thought of as "survival of the fittest" but this ignores the important role of reproduction and inheritance of successful traits.
- ☐ Natural selection is an important driving force of EVOLUTION

"to evolve" means that selection has occured... change over time.

medium ground finch.



variation in the species.

Trend in offspring

Higher (larger) beak depth in a dry year was more prevalent.
- reduced numberof seeds?
- seeds are harder to eat?

factors / things that influences or causes Natural selection.

Selection Pressures on Natural Populations

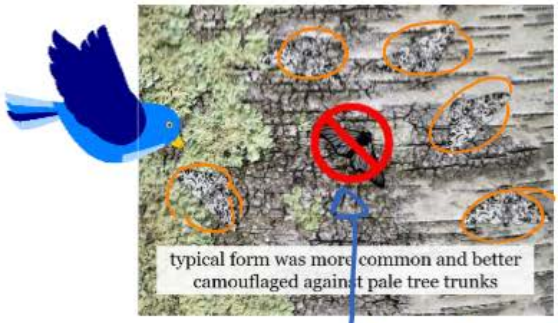
- ☐ The 'forces' that drive natural selection, called selection pressure, include anything that affects the survival of an organism in a population.
  - Competition between organisms of the same species for resources (food, habitat, and reproductive partners)
  - competition between species (predator-prey relationships)
  - Seasonal and long-term availability of resources (fluctuation in Finches drought vs wet)
  - Organisms introduced from other environments, called invasive species that increase competition for resources or act as predators + wild/rapid growth (eg. plants)

Types of Selection Pressure.

typical morph melanic morph

Two different traits in a natural population of peppered moths

2 alleles for the moth color gene

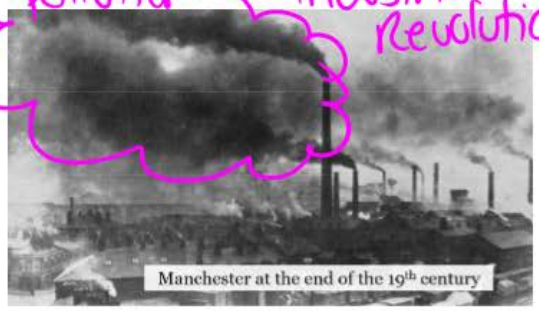


Light color moths more common

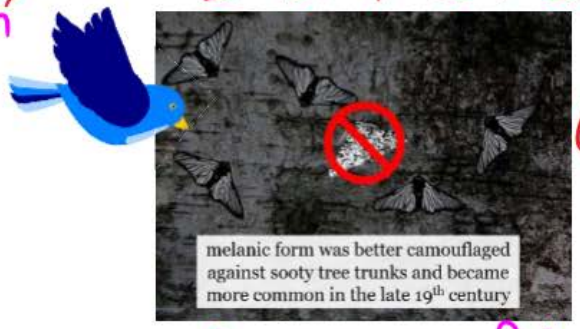
dark moth = no camouflage eaten = dead = no reproduction

VS

Pollution Industrial Revolution



↑ soot, ↓ ash = Lichen change to darker. (trees were darker)



* Natural selection was driven by the environmental changes

⇓

"selection pressure"

Now the succesful allele/trait is the dark moth

↑ dark moth population increased

↓ Light moth population decreased.

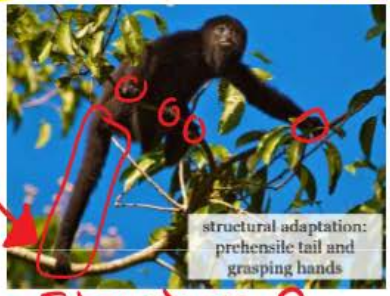
(traits) alleles for a gene → Natural selection → ↑ Number of allele in population (successful trait) → Adaptation → organism "fits its" niche (better equipt for survival)

selection pressure causes change in allele

Adaptation

- ☐ Every organism has a 'job' in its environment, which biologists call its ___niche___
- ☐ Natural selection leads to organisms ___fitting successfully___ in their niche, a process called ___Adaptation___
- ☐ Adaptations that allow organisms to be successful include ___chemical changes___ inside of cells (___physiological___), ___anatomical changes___ to cells or organs (___structural___), and ___behavioral changes___ in an organism's response to its environment
  - ↳ migration, hibernation

3 Types of Adaptations

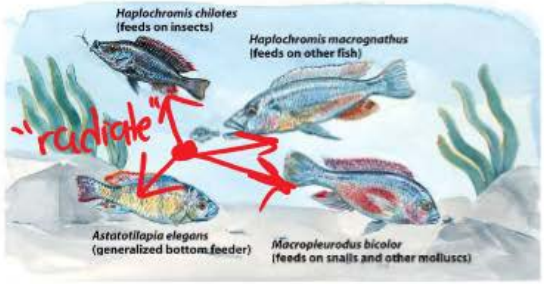


eg. Structural.

eg. Physiological

eg. Behavioral

- ☐ A special kind of adaptation occurs when a ___single species arrives in a new environment___: the species evolves into ___several new species___ to fill a ___number of different niches___ in what is called an ___adaptive radiation (spreads)___
  - ☐ Example: 300 species of cichlid fish evolved from single ancestor that entered Lake Victoria, Africa, evolving to feed in different parts of the lake



Environmental Changes

- ☐ Natural selection and adaptation are ___continuous___ (slow) processes because environments ___constantly change over time___ mutations introduce ___new alleles___, ___new species evolve___, and ___climate changes___

- ☐ Natural selection is a remorseless process, organisms which cannot adapt to their environment for any reason face ___extinction___: the ___complete loss___ of a species
  - ↳ can't reproduce and pass on genes if you're dead.
    - "unfit to survive"
    - "less successful genes"

Assignment #2: Complete the following worksheet in the space provided below

Charles Darwin developed the theory of evolution through a process called natural selection. This process of natural selction has 5 main principles:

1. Population has variations.
2. Some variations are favorable.
3. More offspring are produced than can survive.
4. Those that survive have favorable traits.
5. A population will change over time.

Read the following situations below and identify the 5 points of Darwin's natural selection in **complete sentences**.

1) 

There are 2 types of worms: worms that eat at night (nocturnal) and worms that eat during the day (diurnal). The birds eat during the day and seem to be eating ONLY the diurnal worms. The nocturnal worms are in their burrows during this time. Each spring when the worms reproduce, they have about 500 babies but only 100 of these 500 ever become old enough to reproduce.

a. What worm has natural selection selected AGAINST? _____ FOR? _____

b. Darwin's 5 points: Identify the 5 points in the scenario above.

1. Population has variations. _____
2. Some variations are favorable. _____

_____

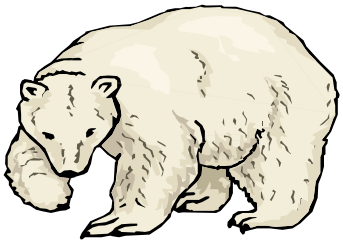
3. More offspring are produced than survive. _____
4. Those that survive have favorable traits. _____

_____

5. A population will change over time. _____

_____

2) There are 3 types of polar bears: ones with thick coats, ones with thin coats and ones with medium coats. It is fall, soon to be winter. The temperatures are dropping rapidly and the bears must be kept warm, or they will freeze to death. Many of the bears have had ~2 cubs each but due to the extreme temperatures, many mothers only have one cub left.



a. What bear has natural selection selected AGAINST? _____ FOR? _____

b. Darwin's 5 points: Identify the 5 points in the scenario above.

1. Population has variations. _____
2. Some variations are favorable. _____

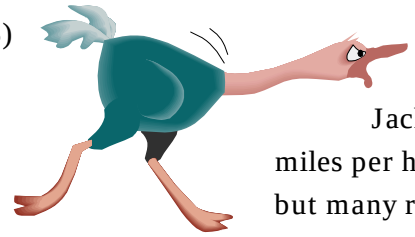
_____

3. More offspring are produced than survive. _____
4. Those that survive have favorable traits. _____

_____

5. A population will change over time. _____

_____

3) 

In ostriches, there are 2 types: ones that run fast and those that run slowly. The fast birds can reach up to 40 miles an hour. Jackals love to eat ostrich, and they can reach speeds of up to 35-40 miles per hour. A flock of ostrich will lay ~ 10 eggs (each mother only lays 1), but many rodents break into the eggs and eat the fetus before they hatch.

a. Which ostrich has natural selection selected AGAINST? _____ FOR? _____

b. Darwin's 5 points: Identify the 5 points in the scenario above.

1. Population has variations. _____
2. Some variations are favorable. _____

_____

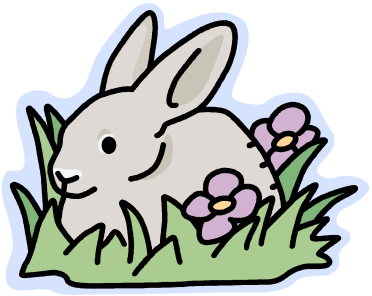
3. More offspring are produced than survive. _____
4. Those that survive have favorable traits. _____

_____

5. A population will change over time. _____

_____

4) There are two types of rabbits: those that strictly eat grass and those that strictly eat berries and flowers. A drought occurs one year, and the plants have difficulty producing any extras (flowers, berries, etc.). They can only try and keep themselves green. The rabbits have had babies all year long but many are eaten by foxes or hawks Due to the drought, many have starved to death.



a. What rabbit has natural selection selected AGAINST? _____ FOR? _____

b. Darwin's 5 points: Identify the 5 points in the scenario above.

1. Population has variations. _____
2. Some variations are favorable. _____

_____

3. More offspring are produced than survive. _____
4. Those that survive have favorable traits. _____

_____

5. A population will change over time. _____

_____

ANSWERS:

1. a. AGAINST: diurnal & FOR: nocturnal
   b. 1. The worm population has diurnal and nocturnal worms.
   2. Nocturnal worms are favoured over diurnal worms, as they are in their burrows when their predators are out.
   3. Each worm has about 500 babies, but only 100 survive.
   4. The worms that will survive at the highest rate will be the nocturnal worms.
   5. Over time, the worm population will have more nocturnal worms than diurnal worms.

2. a. AGAINST: thin coats & FOR: thick coats
   b. 1. The polar bear population has bears with thick coats, thin coats, and medium coats.
   2. In the winter, the bears with thick coats will be favoured over the bears with medium or thin coats, as it will keep them warm.
   3. Many bears have 2 cubs each, but due to the extreme temperatures, often only one survive the winter.
   4. The bears that survive the winter tend to be the ones with thick coats.
   5. Over time, the polar bear population will have more thick coats than medium or thin coats.

3. a. AGAINST: running slowly & FOR: running fast
   b. 1. There are ostriches that run slowly and ostriches that run quickly.
   2. Ostriches that run quickly are favoured over those that run slowly, as they can outrun jackals (their predator).
   3. A flock of ostrich will lay about 10 eggs, but rodents break into the eggs before they hatch, leaving less than 10.
   4. Chances are the eggs that survive belong to fast ostriches, as more of them will survive to lay eggs.
   5. Over time, the ostriches that can outrun the jackals (run fast) will lay more eggs than the ostriches that run slow, so the ostrich population will change. There will be more fast ostriches than slow ostriches.

4. a. AGAINST: rabbits that eat berries and flowers & FOR: rabbits that eat grass
   b. 1. There are rabbits that eat grass and rabbits that eat berries and flowers.
   2. During the drought, the rabbits that eat grass will be favoured over the rabbits that eat berries and flowers (since plants are not able to produce these).
   3. Many offspring that are produced get eaten by foxes or hawks.
   4. The rabbits that survive will tend to be grass eaters, since there will be more food available for them.
   5. Over time, the rabbit population will change to have more grass-eaters than berry-eaters during the drought.

Part C – Artificial Selection

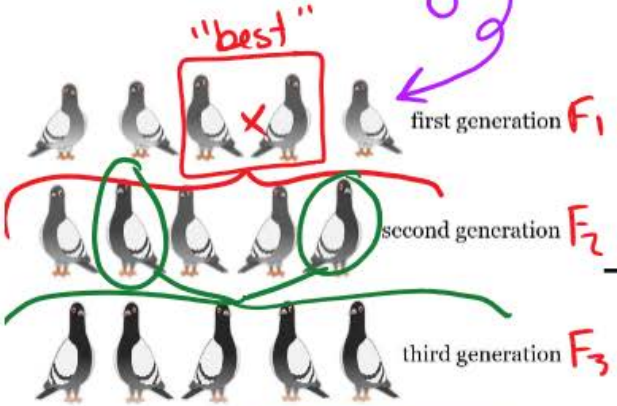
"man-made" ⇒ done by humans eg. selective breeding

Darwin and Pigeons

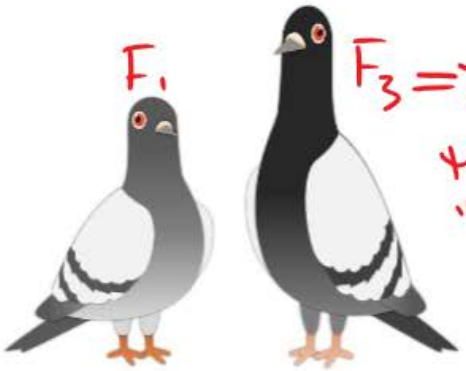
- ☐ Darwin was aware of how humans had modified animal + plant species for their own purposes because he was interested in pigeon breeding
- ☐ Pigeon breeders had selectively bred the wild rock dove (pigeon) into 100s of different breeds, some for racing, some for appearance, and some for meat
- ☐ They had done so by identify the traits they were wanted/desireable, such as the color of their feathers, and only breeding together the pigeons that BEST display that trait you "want"

many breeds of pigeon had been created

many different varieties (alleles)



this was accomplished by breeding together parents with the traits that they were interested in



F_3 ⇒ traits (alleles) that were "selected" for

within a few generations of this process the offspring are genetically different from the original population

Artificial Selection

- ☐ The process of humans selecting desireable traits in plants + animals by choosing which organisms BREED together is now called "selective breeding" (the process of artificial selection)
- ☐ Artificial selection is **similar** to natural selection in that it is differences in survival and reproduction of organisms which changes the alleles in the population
- ☐ Artificial selection also causes the alleles that are selected to become MORE common in the population over time, causing the population to change.

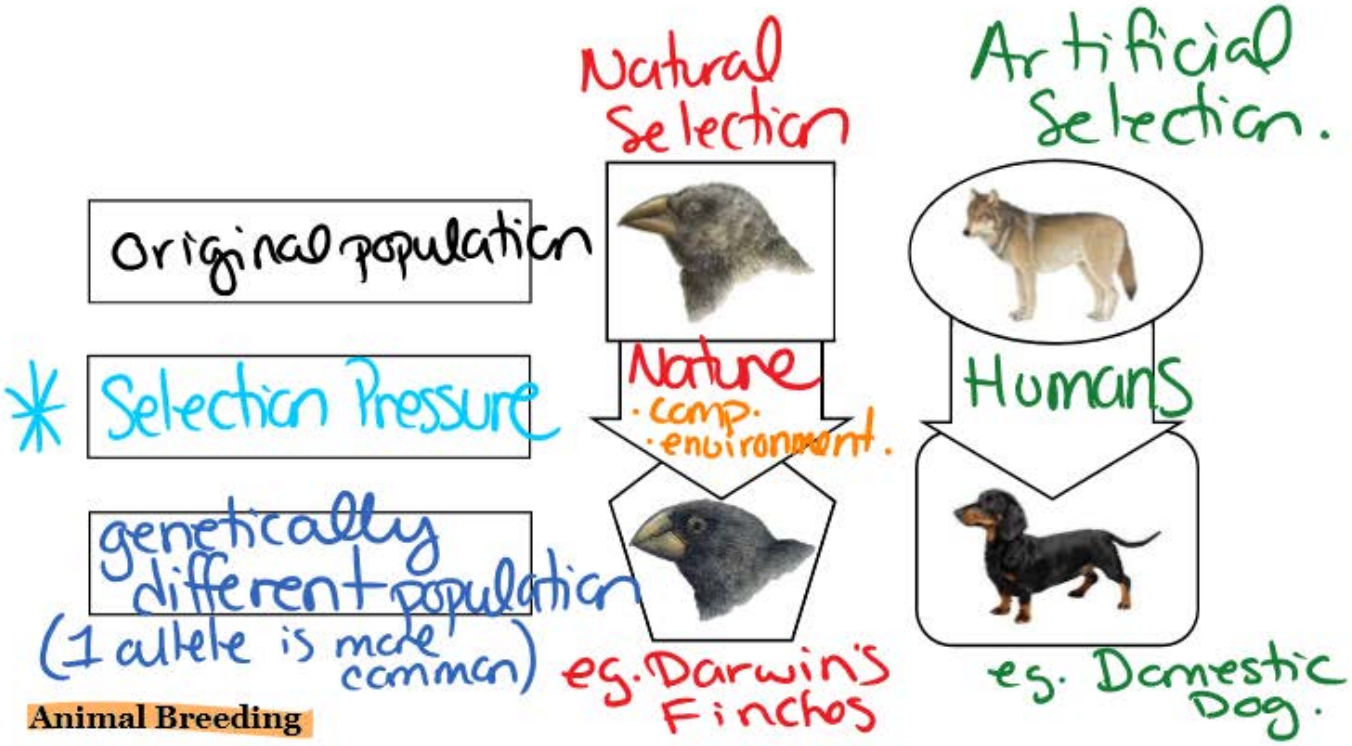
Natural Selection vs. Artificial Selection

"nature chooses" (selection pressures)

variation in alleles ⇒ 1 allele will be more common.

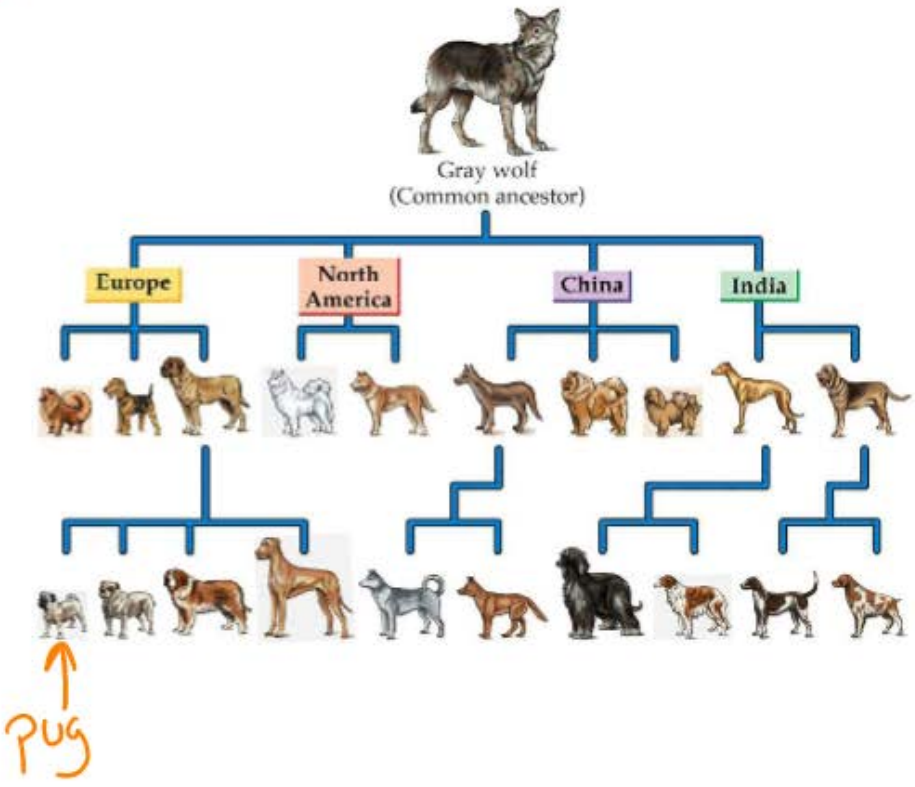
we choose

- ☐ The important **difference** between the two is that the selection pressures in artificial selection are created entirely by the desire of humans. (i.e. they are artificial) rather than by the environment.

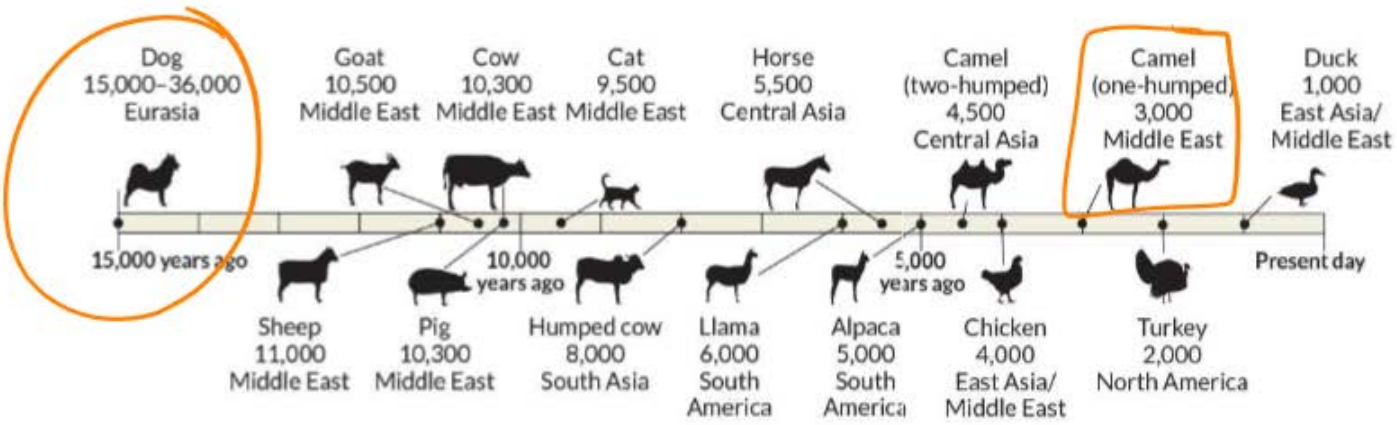


Animal Breeding

- ☐ All domesticated animals – such as dogs, cats, sheep, horses, and cows – are the products of hundreds of years of artificial selection by humans
- ☐ Dogs were the first organism to be artificially selected by humans, perhaps as early as 36,000 years ago, using a population of Eurasian gray wolves that is now extinct

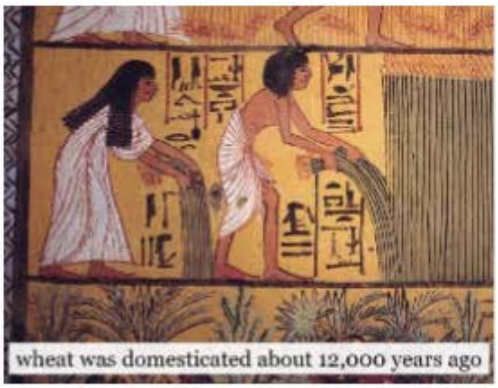


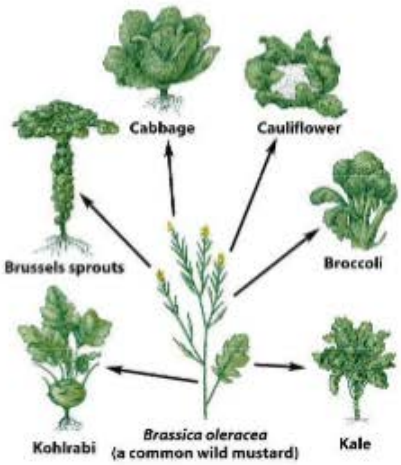
- ☐ Since that time we have domesticated other animal species for meat (cows, pigs, chickens), milk (cows), and physical labour (horses)

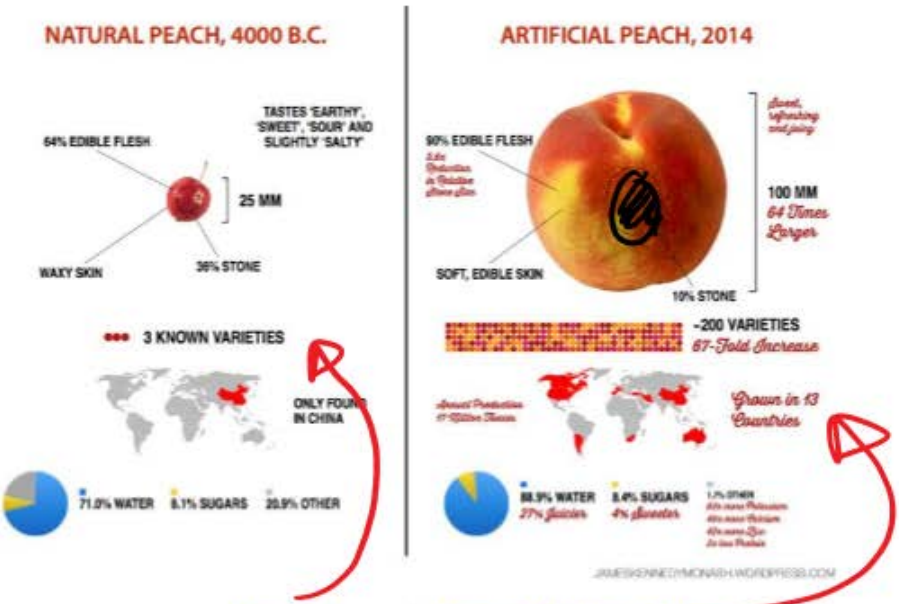


Plant Breeding

- ☐ Almost all of the plant foods that we grow are also domisticated organisms resulting from long periods of artificial selection
- ☐ Grains were probably the first plants to be domesticated by humans, around 12,000 years ago from Middle Eastern grasses
- ☐ Since then we have domesticated plants for their seeds (grains, rice, peas, beans), fruit (apples, oranges, berries), leaves (lettuce, spinach, kale), roots (onions, celery), and tubers (carrots, beets)


wheat was domesticated about 12,000 years ago





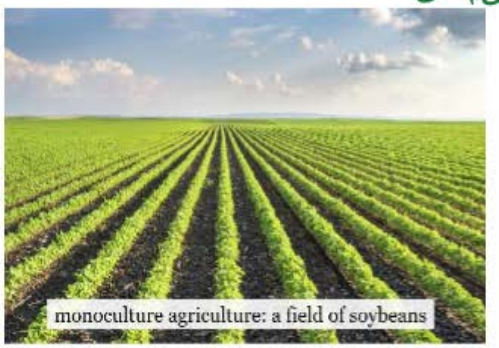
comparison of wild and domesticated peaches

eg. Apple varieties

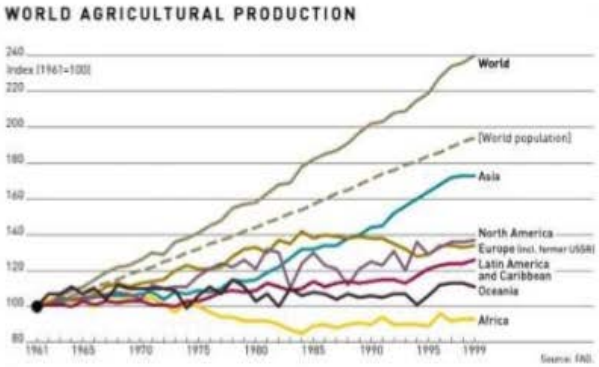
Modern Agriculture

- ☐ Modern agriculture grows huge numbers of plants or animals of the SAME kind (called a monoculture) in as little space as possible, using machines do as much of the physical labour as possible (artificially inseminate for reproduction)


modern industrial agriculture


monoculture agriculture: a field of soybeans

- ☐ This system is very efficient and produces MORE food globally than is required (sadly distribution of the food is not equal), but has several disadvantages:



Evolution "Take Home"

  - LACKS genetic diversity in our crops and animal breeds means that they are vulnerable to the same diseases (or disorders)


bananas infected with Panama disease

  - Crops and animals are selected for their efficiency, not necessarily for their nutrition value or the health of the species (eg. pug.)

(inbreeding)

  - Welfare of crops and animals is secondary to how efficiently they can be grown for human wants + needs (selfish)


industrial farming of animals

Assignment #3: Complete the following worksheet in the space provided below

1.7 Worksheet: Artificially Selecting Dogs

OVERVIEW

1. You will learn how artificial selection can be used to develop new dog breeds with characteristics that make the dog capable of performing a desirable task.
2. You will begin by examining canine features and their functions.
3. Then, you will be given a scenario that describes the type of task you need a new breed of dog to perform.
4. Next, you will select two existing breeds you feel will most likely produce a successful new breed and determine the resulting offspring's characteristics.

PROCEDURE

1. You will be trying to artificially select a new dog with certain traits by crossing two existing breeds. Look at your **Ownership Card**, and put you and your partner's name on the card. Follow the directions given in Part 1, and complete it.
2. Next, look at your **Dog Breeds Handout** and review the descriptions given for each breed. Discuss this information with your partner and select two dogs that have the features most likely to produce a breed with the features you need. In Part 2 of your **Ownership Card**, write in the breed names and reasons for your selections.
3. Now, choose which dog will be the mother and which will be the father. Circle the gender of each under the breed name in Part 2 of your **Ownership Card**. Your breeding pair will produce 3 puppies and each puppy will have a chance of inheriting traits from either the mother or father.
4. You will use a penny to determine which trait is inherited by your puppy. Keep track using the **Puppy Traits – Generation 1** table provided. You will fill in the Puppy #1 column. Flip the coin for each trait. Write in the trait that is inherited each time.
    - Heads = females (mother's) trait is inherited
    - Tails = males (father's) trait is inherited
5. Repeat step 4 again for Puppy #2 and again for the Puppy #3
6. Now, pick the puppy you feel would get you closest to your goal in another round of breeding. Record this puppy in Part 3 of your **Ownership Card**, and explain why you picked it.
7. After making your puppy selection, visit with a neighbouring group, and collect "trait" information for a puppy from that group's you feel would most likely get you closer to your goal. Record these on the "Puppy Traits – Generation 2" handout. Circle the gender of each dog under the breed name in Part 3 of your **Ownership Card**.
8. Next, repeat steps 3, 4, and 5, except now use **Puppy Traits – Generation 2** to record your data.
9. Pick the puppy from this second generation which you feel will provide a dog that can perform the assigned task, and **draw** this puppy on the **last page**, labelling the significant features of this animal.

Ownership Card

Breeders' Names: _____ Date: _____

Assignment: "You are a dog breeder. You have been contacted by a scientist who wants dogs that could be used to see and retrieve waterfowl (ducks and geese) from lakes in the area so the birds can be tagged and re---released. The birds are very skittish (scare easily) and must be retrieved unharmed and with a minimum amount of stress."

Part 1: Desired Features of the New Breed

For each feature below, circle the desired form you ideally want your dogs to have. For features that you do not think will affect your breed's ability to perform the given task, circle "any."

Physical Features	**Desired Form**			
Smell	above average	average	below average	any
Sight	above average	average	below average	any
Hearing	above average	average	below average	any
Speed	above average	average	below average	any
Endurance	above average	average	below average	any
Strength	above average	average	below average	any
Coat color	very dark	average	very light	any
Hair length	long	average	short	any
Behavioral Features	**Desired Form**			
Trainability	high	average	low	any
Disposition	vicious	compatible	meek	any
Bark	very loud	average	very quiet	any

Part 2: Dog breeds chosen to mate: _____ X _____ (Generation 1)

male or female ***male or female*** ***(circle)***

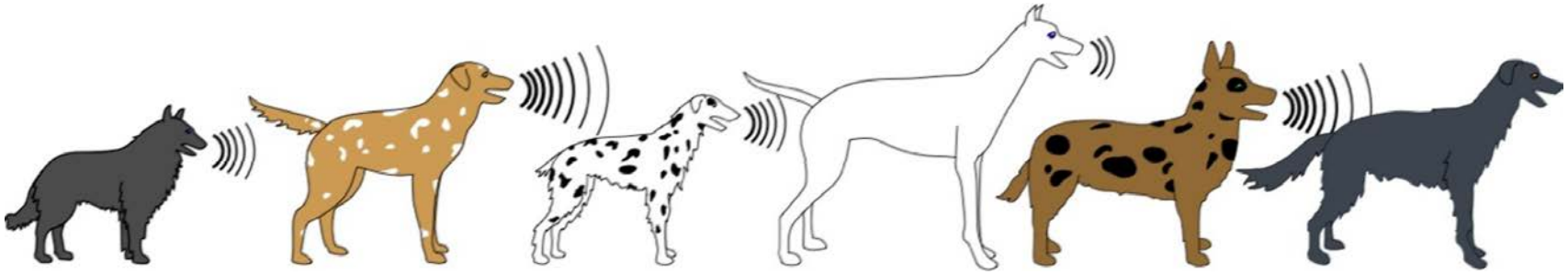
Reason:

Part 3: Dog breeds chosen to mate: _____ X *Neighbor's Puppy* (Generation 2)

male or female ***male or female*** ***(circle)***

Reason:

Dog Breeds



	Breed A	Breed B	Breed C	Breed D	Breed E	Breed F
	Tally Collie	**Floxich**	**Gootagan**	**Spalling**	**Cruxtic**	**Horvisianer**
Physical Features						
Smell:	above average	average	above average	below average	average	above average
Sight:	average	average	average	above average	average	above average
Hearing:	above average	average	average	above average	above average	average
Speed:	average	above average	above average	above average	below average	average
Endurance:	below average	average	above average	average	above average	below average
Strength:	above average	above average	average	below average	average	below average
Coat color:	black	brown	white	white	brown	black
Hair length:	long	medium	long	short	medium	long
Behavioral Features						
Trainability:	average	average	high	high	low	high
Disposition:	meek	meek	vicious	meek	compatible	vicious
Bark:	average	very loud	average	very quiet	very loud	average

Puppy Traits - Generation #1

Physical Features	Puppy #1	Puppy #2	Puppy #3
Smell			
Sight			
Hearing			
Speed			
Endurance			
Strength			
Coat color			
Hair length			
Behavioral Features			
Trainability			
Disposition			
Bark			

Puppy Traits - Generation #2

Physical Features	Neighbouring Puppy Traits	Puppy #1	Puppy #2	Puppy #3
Smell				
Sight				
Hearing				
Speed				
Endurance				
Strength				
Coat color				
Hair length				
Behavioral Features				
Trainability				
Disposition				
Bark				

Drawing of your Best Artificially Selected Puppy