Continuity of Life

Overview

Your family is in the dog breeding business. Currently the most popular dog in the nation is the Labrador retriever. As one of the most respected dog breeders in Pennsylvania, you have been selected to breed the best Labrador retriever possible. Your competition is Hardy Weinburger, and he is just randomly mating dogs. You have decided to look at the evolution of dogs, their genetics, and how reproduction works at the cellular level in order to produce the most lookedfor dog for families. Throughout this project, you will identify what traits are the most desirable, how to predict them, and which dogs to choose to mate together to get your perfect pups!

Task 1 Where do puppies come from?

You decide to look at reproduction to get your basis for genetics. Everyone loves puppies, but where do they come from? Like all living things, dogs are made of cells! Cells are the basic units of life, but dogs aren't made of just one cell. They are made of millions, even trillions of cells. But, how do dogs get so many cells?

Remember that cells divide for three main reasons:

- *Growth: Growth is a result of mitosis. Dogs start out as one cell, but by the time they are puppies, they have trillions of cells.*
- *Repair: Repair is the result again of mitosis. Repair is important for dogs to repair skin cells, bone cells, and hair cells that have died. Dogs' skin cells last less than a month!*
- *Reproduction: Reproduction is the result of meiosis. There are two types of reproduction: Sexual which has DNA from two parents, and asexual where the DNA is genetically identical from the parent. Dogs reproduce through sexual reproduction.*

Activity 1: Cells are dividing

In order to determine the characteristics you want your puppies to have, you must be able to describe the types of cell division and reproduction. Breeders want to be able to determine the physical and personality characteristics of their puppies so they are appropriate for the families who will adopt them.

You must compare the processes and outcomes of mitotic meiotic cellular divisions using the T- chart below. It will provide you with an understanding of how cells divide and the reproduction process. In completing the chart, provide at least three examples of each.

Remember that cell division and reproduction can occur in two ways:

- *Review Mitosis*

- *Review Meiosis*
- *View a side by side comparison*

Mitosis	Meiosis

Activity 2: Sell the Cells

To fully understand the processes in Activity 1, you must be able to describe the cell cycle. Describe the events that occur during the cell cycle in the table below. You must use the following terms, interphase, prophase, metaphase, anaphase, telophase, and cytokinesis.

Cell Cycle Phase	Description for each phase
Interphase	
Cell division	
Cytokinesis	

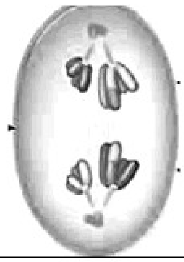
Review the cell cycle.

Activity 3: Meiosis

Remember that you will be breeding puppies for specific characteristics. The cells in a puppy will continue to divide as the puppy grows. One type of cell division is called meiosis.

Meiosis is a process where the parent cell divides into four daughter cells. During meiosis, the parent cells divide like a cell in mitosis, but does not go through cytokinesis. When the parent cell is going through meiosis, the cells are haploid cells. After the germ cell goes through meiosis, a sperm cell and an egg will combine and make a zygote. Each of these different cells contains different alleles that also determine traits and characteristics.

Label the steps of meiosis below, then use the picture to complete and answer the questions



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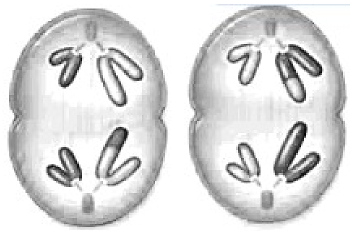

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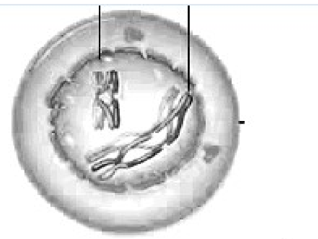

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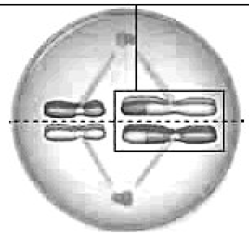

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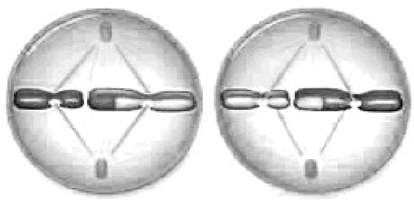

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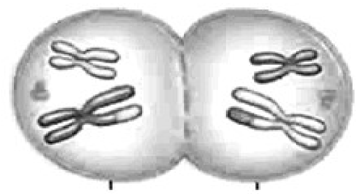

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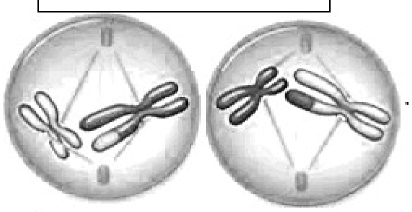

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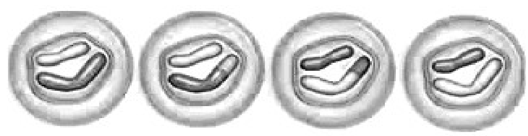


8.

Questions:

1. Which stage of meiosis is shown in picture 6?

2. In which picture is “crossing over” occurring?

3. What type of cell results at the end of meiosis?

Activity 4: Doggy Diploids

All dogs have 78 chromosomes. This is important because you will want to match the mother and father of the puppies so you will get the dogs with the physical and personality traits your families have requested. To further understand the genetic processes in breeding, answer the questions below.

1. What would the haploid and diploid numbers be for dogs?

   Haploid

   Diploid

2. How many chromosomes would you find in a dog's blood cell?

3. How many chromosomes would you find in a dog's sperm cell?

4. Use your understanding of meiosis and mitosis to compare sexual and asexual reproduction. Compare how genetic variation differs as a result of sexual and asexual reproduction.

Activity 5: Fido's DNA

Before you can create the perfect pup, you need to understand how genetic information is inherited. The process of DNA replication results in the transmission and conservation of genetic material. Answer the questions below to demonstrate an understanding of DNA replication that demonstrates how characteristics are passed from the parents to the pups.

Review DNA.

Review the steps of DNA Replication and answer the questions about DNA replication below:

1. What is the purpose of DNA replication?

   What is the end result of DNA replication?

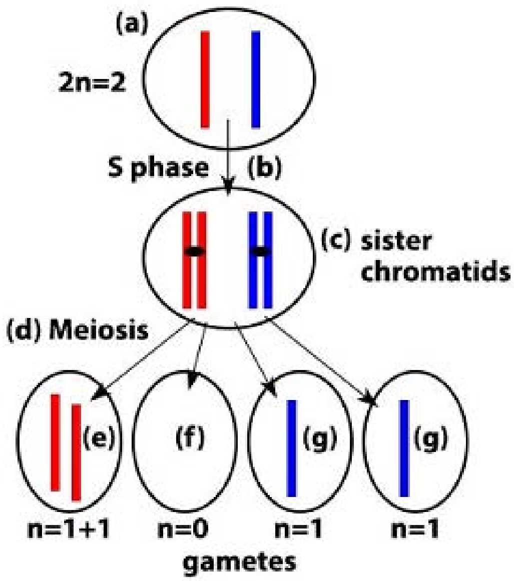
2. In DNA Replication:

   Adenine pairs with

   Cytosine pairs with

3. Some processes can alter the genetic “make up” or the number of chromosomes. What could happen if one of the dog’s chromosomes fails to separate during meiosis?

4. Sometimes genetic mutations occur during meiosis, which is something that you cannot control. Look at the diagram below. In the box after the diagram, state the genetic mutation that occurred during meiosis.



In the box below, state the genetic mutation that occurred during meiosis.

Task 2: Doggone Perfect!

Now that you know how cells reproduce and DNA replicates, you can start to examine how DNA can express specific traits and build the perfect dog for your customers.

Activity 1: Picking Out a Coat

An example of how you can control a characteristic of a puppy through the breeding of the mother and father is determining the color of the coat of the puppy. In this simulation, you will examine a hypothetical DNA sequence of a Labrador retriever by going through the process of protein synthesis. The Labrador retriever's coat colors are black, yellow, and brown. Your job is to analyze the genes of its DNA and determine the coat color as well as other traits the dog could have.

Labrador Retriever DNA AND TRAITS

tRNA triplet	Amino Acid Number
ACC	20
AGC	16
CGA	2
AAC	4
CGC	3
GGG	5

Amino Acid Sequence	Trait
20-11-13	Yellow coat color
20-12-13	Brown coat color
20-21-21	Long nose
13-14-15	Short nose
16-2-5	Long legged
16-4-5	Short legged

AGG	7
AAA	8
UUU	9
GGU	12
UAU	13
CCC	1
AUC	6
CUA	10
GGA	11

12-7-8	very heavy
5-7-8	not heavy
9-8-8	long tail
9-4-8	short tail
11-3-2	brown eyes
11-3-3	hazel eyes
6-6-10	male
6-6-14	female

Observations and Analysis of Labrador retriever DNA: You are given a hypothetical chromosome from a Labrador retriever with the sequence as illustrated in the chart below. In this case, each gene has only 3 amino acids. Your job is to determine the sequence of amino acids for your specimen. Write the complimentary mRNA, tRNA, the amino acid (A.A.) sequence it codes for and the related trait in the chart below.

	Labrador Retriever Sample DNA
DNA	A C C G G T T A T | A G C C G A G G G | T T T A A C A A A | G G A C G C C G A | G G G A G G A A A | A T C A T C C T A
mRNA	
tRNA	
A.A.	
Trait	

Questions:

1. What is protein synthesis?

2. Describe what occurs in transcription.

3. Describe what occurs in translation.

4. What is the coat color of your Labrador retriever?

5. Is your dog long legged or short legged?

6. Does your dog have a long tail or short tail?

Review Protein Synthesis.

Task 3: Punt that Square

It's time to start to *build* the customer's ideal dog. Hardy is still not having any luck randomly mating his dogs. You have decided to consult a dog specialist to give you some background regarding the requests from your customers for their perfect dog's qualities. You start by learning about genetic crosses. The following website tutorial will help you with this process.

Activity 1- Predicting genetic crosses

In Dalmatian dogs, the gene for black spots (B) is dominant to the gene for brown spots (b). As you breed your puppies, you will want to control what the puppies look like as much as possible. This is an example of breeding Dalmatians, which will be similar to what you will need to do with your puppies.

1. A heterozygous black Dalmatian produces gametes through the process of meiosis. What possible alleles could this dog pass on through its gametes?

2. What is the probability that the heterozygous dog passes on the black (B) allele?

3. Use the Punnett square below to predict the possible outcomes if the heterozygous black dog mated with another heterozygous black dog.

	Mother	
Father		

4. What is the probability of a puppy from this cross having black spots?

5. What is the probability of a puppy from this cross having brown spots?

Sometimes a breeder has a black spotted dog whose ancestry is unknown. The breeder cannot tell by looking at the dog if it is homozygous or heterozygous, but the breeder will want to find its genotype. So, the breeder performs a test cross by breeding the black spotted dog with a brown-spotted dog. Approximately half of the puppies from this cross have brown spots.

6. What is the genotype of the black dog?

7. Fill in the Punnett square below that represents the test cross.

[Use this resource.]

[Use this resource.]

Activity 2: Build –a –dog

With what you have learned about genetics, it's now time to think about breeding Labradors. A dog breed specialist tells you that the coat color for Labrador retrievers is determined by two genes with two possible alleles for each gene. One gene determines if the coat color will be brown or black. The allele for this gene is "B" black which is dominant. The allele "b" for brown is recessive. The other gene also has two alleles: "E" the dominant determines if there is pigment in the hair shaft. The "e" recessive prevents the pigment from being in the hair shaft. Therefore, a Labrador that is homozygous recessive for this "ee" gene will have no color (the protein melanin) deposited in its coat and will be yellow due to its absence of color. For example, a Labrador with the genotype "BBEE" is black and a Labrador with the genotype "BBee" or "Bbee" will be yellow.

See the pictures below to gain an understanding.


B_E_


bb_E


_ _ ee

1. How many genes control the coat color of Labrador retrievers?

2. How many alleles occur for each gene? List each allele and the corresponding trait.

3. Complete the table below to illustrate the different possible phenotypes and corresponding genotypes of Labrador retrievers. There are 9 total genotypes that you need to include.

Phenotypes	Black	Brown	Yellow
Genotypes			

4. How does yellow differ from black and brown in terms of pigment?

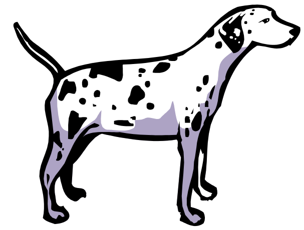
5. You decide to breed Labrador retriever dogs. From your research, you have learned that brown Labradors are the most valuable. You already know that Labradors come in three different coat colors: black, brown and yellow. Suppose you were given a mating pair of black Labradors and bred the pair. The litter resulted in 6 black Labradors, 2 brown Labradors and 2 yellow Labradors. Are the parents homozygous or heterozygous? How can you tell if the parents are homozygous or heterozygous?

6. You were happily surprised when the litter produced brown puppies. In order to fulfill the need for brown puppies, you decide to breed the two from your previous litter. To your surprise, not all of the puppies were brown. What must the genotypes be of the brown parents?

7. You wondered what genotype two parent dogs would result in brown puppies 100% of the time. What genotype must the parents exhibit in order to guarantee brown puppies?

Activity 3: Spots, dots, and solids…a lesson in types of dominance

As you continue to become an expert in genetics for your business, Hardy comes to you for advice. He tells you that he bred three different dogs and had some strange outcomes. You've decided to help Hardy with this mystery.



1. Hardy bred a white dog and a black dog and the puppies were all spotted. You explain to Hardy that his is an example of a specific type of dominance known as ________

2. Next, he tells you that he bred the same white dog but this time with a different black dog. He expected to have more dogs with spots, but to his surprise, they were all grey! You explain to Hardy that there are many patterns of inheritance. This type of inheritance is known as ________ .

Task 4: Wolves of Evolution

Now that you understand the processes that determine genetic sequences for dog traits and how the genetic information expressed, you need to start to think about dogs as a species. You wonder what types of ancestors dogs have and how they earned the title: "Man's best friend." Where did the Labrador retriever even come from?

The many forms of dogs that exist today were all created through selective breeding from the dog's ancestor, which you know as the wolf. In a span of less than 10,000 years, breeders have changed traits and body shapes of dogs by artificial selection-for example, emphasizing different aspects of hunting and herding behavior.

But dogs are so different from wolves that it seems difficult to imagine how one species led to another. You want to find out more about how an organism evolves as a result of natural selection before you think about how the dog could have evolved from the wolf.

Natural selection was proposed by Charles Darwin to explain how new species evolve. As we know, dogs have evolved from wolves and those specific wolves continued to survive in certain environments. Your task is to explain how natural selection can impact allele frequencies of a population; for this example, you will use the evolution of dogs from wolves.

Activity 1- Evolution of Dogs from Wolves

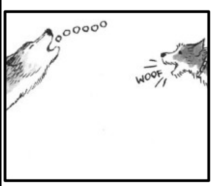
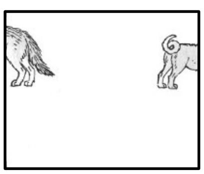
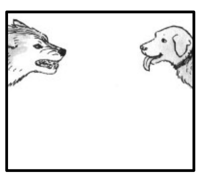
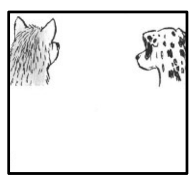
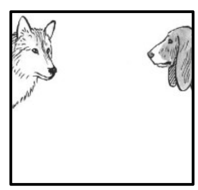
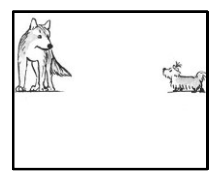
Part 1- Results of a simulation of inherited traits

The domestication of dogs has occurred over a long period of time. They are not as aggressive as wolves in the wild. An example of how this has happened is illustrated in the simulation below. You will find the results of a simulation of 24 wolves which were bred for 20 generations under two different conditions (condition A and condition B)

Within the population of the 24 wolves, each wolf has an initial temperament as indicated by a value of aggressiveness. For this simulation, the assumption has been made that the temperament is inherited.

Aggressiveness is indicated by a number between 5 and 10. A low value represents an animal with high aggressiveness; a high number represents a tamer animal.

As a breeder, you will want to control the aggressiveness level of your dogs for their prospective owners.

					
5	**6**	**7**	**8**	**9**	**10**
Most aggressive/ Least tame		Aggressiveness scale			Least aggressive Most tame

Wolf	Aggressiveness Level 5 most aggressive 10 most tame
Wolf 1	7
Wolf 2	10
Wolf 3	8
Wolf 4	5
Wolf 5	8
Wolf 6	9
Wolf 7	7
Wolf 8	8
Wolf 9	9
Wolf 10	8
Wolf 11	10
Wolf 12	9
Wolf 13	6
Wolf 14	6
Wolf 15	8
Wolf 16	9
Wolf 17	7
Wolf 18	6
Wolf 19	7
Wolf 20	8
Wolf 21	7
Wolf 22	5
Wolf 23	6
Wolf 24	7
Average Aggressiveness Level	7.5

1. Looking at table above, what is the average value of the initial temperament in your wolf population?

2. Check the box next to the correct letter that represents the level of aggressiveness of the average.

- ◯ Very aggressive
- ◯ Neither very aggressive nor very tame
- ◯ Very tame

Part 2: Subjecting the wolves to different environments

For the next simulation, assume the following:

- The 24 wolves are mating randomly as they produce each generation of offspring.
- There are random mutations occurring over the 20 generations, which will change the aggressiveness level of individual wolf offspring.

In the simulation, the wolves are subjected to two different environments (A and B)

Wolf Group Environment A – 24 Wolves	Due to selective pressures, the wolves with the most aggressive genes do not survive.
Wolf Group Environment B – 24 Wolves	Due to selective pressures, the wolves with the most aggressive and most tame genes do not survive.

Results from a Sample Simulation		
	Population Averages for Wolves in Population A	Population Averages for Wolves in Population B
Initial Population Average	**7.5**	**7.5**
Population average after 5 generations	6.9	9.6
Population average after 10 generations	6.2	12
Population average after 20 generations	6.15	19.4

Note: An aggressiveness level above 10 represents animals that are less aggressive (more tame) than any of the wolves in the original wolf populations A and B.

Questions

1. What kind of animal does the initial average of Population A reflect? What kind of animal does the average of Population A reflect after 20 generations?

2. What kind of animal does the initial average of the Population B reflect? What kind of animal does the average of Population B reflect after 20 generations?

3. What happened to the temperament of wolf Population B over time?

4. Which population (A or B) represents wolves in the wild and which population (A or B) represents dogs that have evolved from wolves? Explain your answer.

5. The two population (A and B) have been genetically isolated from each other for the entire simulation (20 generations). Explain what this means in terms of real life.

6. What do you predict would happen to the tameness of dogs if wolves and dogs were allowed to regularly interbreed?

7. Why would the genetic isolation of wolves and dogs be important for dogs to become different from wolves?

8. Describe how the variation of aggressiveness of wolves contributes to the development of the modern dog, by choosing one of the following concepts; isolating mechanisms, genetic drift, founder effect and migration.

Task 5 Meet the Professionals

Now that you have been visiting the experts, gathering genetic information, and learning about reproduction, you decide to visit the professionals at the Westminster Dog Show in Madison Square Garden in New York City, to gather information about dog breeds and their traits.

You can watch this video about dog breeding for more information, before you continue.

Dogs belong to a single species, *Canis familiaris*, but that species is comprised of about 400 different breeds. Since they are a single species, they can mate and have viable offspring. Recognized dog breeds take generations to establish through selective breeding or artificial selection. Many of the breeds we have today are the result of a desire to have dogs with specific features that make them suitable for performing particular tasks, such as retrieving, protection, assistance, hunting, and companionship. The process of breeding a new type of dog often involves identifying desired features, finding dogs with those features, and then breeding dogs to produce offspring with the appropriate combination of traits. After a number of generations, a new breed may be established.

Activity 1: Define your roles

Read the descriptions of the five different breeds to determine which breed of dog is best adapted to each task. Using the information form this chart, complete the chart below.

BREED A	BREED B	BREED C	BREED D	BREED E
				
• nasal chambers (where scents are identified) are larger than those of most other breeds. • large, long ears help prevent wind from scattering scents while the dog's nose is on the ground • folds of wrinkled flesh under the lips and neck catch stray scent particles in the air	• long-bodied and muscular, short, stubby legs. • front paws are unusually large and paddleshaped. • a deep chest that provides increased lung capacity for stamina. • Snout is long with an increased nose area that absorbs odors	• very wide head and shoulders. • thick folds of skin on its brow • short muzzle with characteristic folds above the nose. • hanging skin under the neck • drooping lips and pointed teeth • coat is short, flat, and sleek	• long, powerful legs • deep chest • flexible spine • slim but muscular build. • large heart • the highest percentage of fasttwitch muscle of any breed.	• double coat. • undercoat has an oily and woolly texture and can be as thick as two inches. • The outer guard coat is coarse and stands off the body. • heavy and powerful, with great endurance.

Task	Breed Best Suited	Evidence
Digging and tunneling to hunt for small mammals		
Running at great speeds		
Pulling sleds in cold snowy conditions		
Using scent to track down prey		

Activity 2: Lets go hunting

Part 1

1. A dog breeder asks you to help her create a new breed of dog that will be a good all-purpose hunting dog. Name your new breed and fill in the following chart to identify the traits that would be valuable in a hunting dog. Use values from 1 to 5, with 1 being the lowest, and 5 the highest.

Name of breed

Traits	Desired Value
Sight	
Smell	
Speed	
Hearing	
Trainability	
Friendliness (1 =aggressive, 5 = friendly)	

2. What is a polygenic trait?

3. Parent dogs exhibit the extreme versions of a polygenic trait: One is very friendly and the other is very aggressive. If these dogs have puppies, describe what temperament you would expect most of the puppies to express and explain why.

Part 2

Examine the dog breeds chart below and select the two breeds of dogs that you will breed to create the ideal hunting dog. Remember that the traits are polygenic so the offspring are going to be an "average" of the two parent's traits.

Dog Breed Chart					
	BREED A	BREED B	BREED C	BREED D	BREED E
Traits					
Sight	3 (average)	3 (average)	1 (poor)	5 (good)	3 (average)
Smell	5 (good)	3 (average)	3 (average)	3 (average)	3 (average)
Speed	3 (average)	3 (average)	1 (poor)	5 (good)	3 (average)
Hearing	3 (average)	3 (average)	3 (average)	1 (poor)	3 (average)
Trainability	5 (good)	5 (good)	3 (average)	1(poor)	5 (good)
Friendliness	3 (average)	1 (aggressive)	3 (average)	5 (friendly)	3 (average)

To begin breeding dogs, you will start by identifying the two parents for the dogs you will be breeding from the chart above.

Parent 1 ________

Traits	Desired Value
Sight	
Smell	
Speed	
Hearing	
Trainability	
Friendliness (1 =aggressive, 5 = friendly)	

Parent 2 ________

Traits	Desired Value
Sight	
Smell	
Speed	
Hearing	
Trainability	
Friendliness (1 =aggressive, 5 = friendly)	

Offspring ___________________________

Traits	Desired Value
Sight	
Smell	
Speed	
Hearing	
Trainability	
Friendliness (1 =aggressive, 5 = friendly)	

4. Were you able to achieve all of the desired values that you selected for your new breed at the beginning of the activity?

5. Why or why not?

6. If you decide that your new breed is not fast enough, what would you do next to improve the speed of your dog breed?

Activity 3: Relationships are Complicated

While at the dog show, you notice many vendors selling products designed to protect dogs from things like fleas, ticks, and heartworms. These organisms live in or on dogs and feed off of them. The dogs are often seriously harmed if not treated.

1. What type of symbiosis does this exemplify?

Use the table below to compare and contrast the different types of symbiotic relationships

Interaction	Type of symbiosis	Explain HOW/WHY the interaction demonstrates the relationship you identified
Heartworms enter a dog's bloodstream from the bite of an infected mosquito. The worms mature in the dog's heart, growing in length and clogging the heart. This causes illness and even death to the dog		
Dogs and humans live closely together and help one another. The dogs get shelter and food while humans get companionship, protection, and other services		
On a hot sunny day, many dogs will seek the shade provided by a nearby tree. The dog gets to cool off in the shade, but the tree is unaffected		

Task 6- Wolves in the Wild

A fellow breeder mentioned that he read an article regarding the re-introduction of wolves into the wild. With all you already know, you are eager to learn more regarding this concept. You know that what you've learned to this point will probably be similar to the role of wolves in the wild. Understanding the vital role of the wolf in the wild will help you gain better knowledge of the way that their traits affect the different breeds of modern dogs.

Watch this clip before you continue for additional help.

Activity 1: Return of the Wolf

The ecosystem of Yellowstone National Park is radically different than in the recent past. The songbirds were disappearing, the beaver population was also decreasing to very low levels, and the variety and amount of vegetation (including various willow trees and the aspen trees), were also declining. The only populations of animals that had increased were bison and, in particular, elk. The management of Yellowstone National Park faced the alarming question of how to reverse this shocking trend and return Yellowstone National Park to its pristine state.

1.Why might people be upset about the wolf being reintroduced back into the Yellowstone?

2.Describe how the wolf positively affected the ecosystem of Yellowstone.

3. Why is this important that the beaver is a prey species of the wolf?

4. Describe how the absence of the wolf acted as a limiting factor to various populations of Yellowstone Park.

Activity 2: Time to eat

Understanding how animals interact and are how they are affected by their environment is vital to the survival of the organism - in this case, the wolf. Answer the following questions to demonstrate your understanding of the interactions between organisms and their environment. See resources below for a review.

1. Specific factors determine if an item/organism is biotic or abiotic. Given the list below, indicate if the item/organism is biotic or abiotic.

Organism	Biotic or Abiotic
Grass	
Water	
Glucose	
Worm	

2. Given the following list of "levels of organization" terms, list them in order from smallest to largest.

    a. Community, Biosphere, Population, Biome, Ecosystem, Organism

___________→ ___________→___________→___________→ ___________→___________

3. Use the following article about Yellowstone to find organisms that the article/video mentioned. List one producer and four consumers.

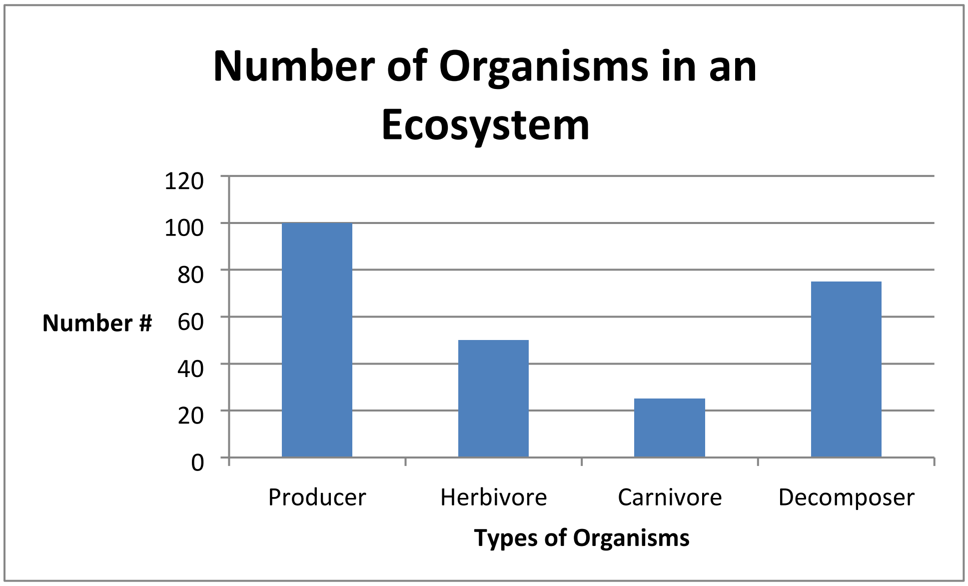
For the consumers, indicate if they are herbivores, carnivores, or omnivores.

Organism	Herbivore or Carnivore or Ominivore
Producer	N/A
Consumer 1	
Consumer 2	
Consumer 3	
Consumer 4	

4. What is a trophic level?

5. Explain why all the energy stored in each trophic level is not passed on to the next level.

Use the following graph to answer the questions below.



6. Using the graph above, what is a conclusion you can make regarding energy in an ecosystem.