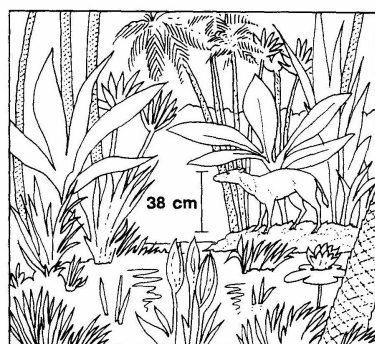


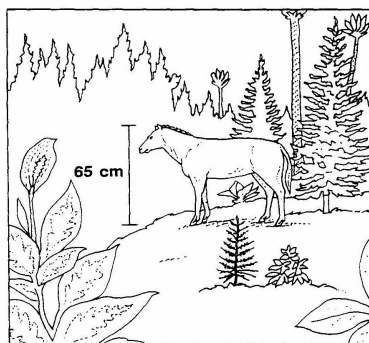
Name: _____ Block: _____ Date: _____

Evidence for Evolution

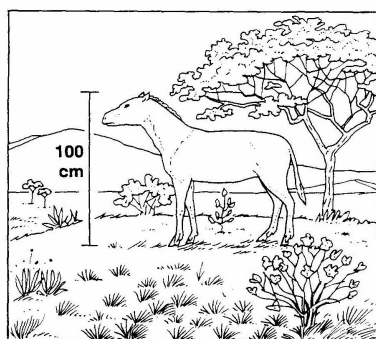
Fossils:



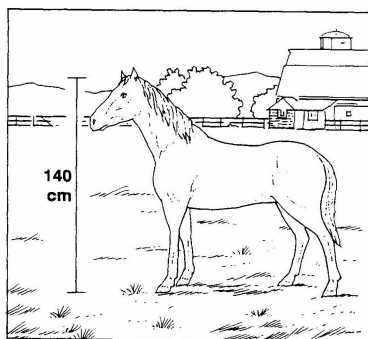
Hyracotherium
55 million years ago



Miohippus
30 million years ago



Merychippus
13 million years ago



Equus
Today

FIGURE 1. Evolution of the horse

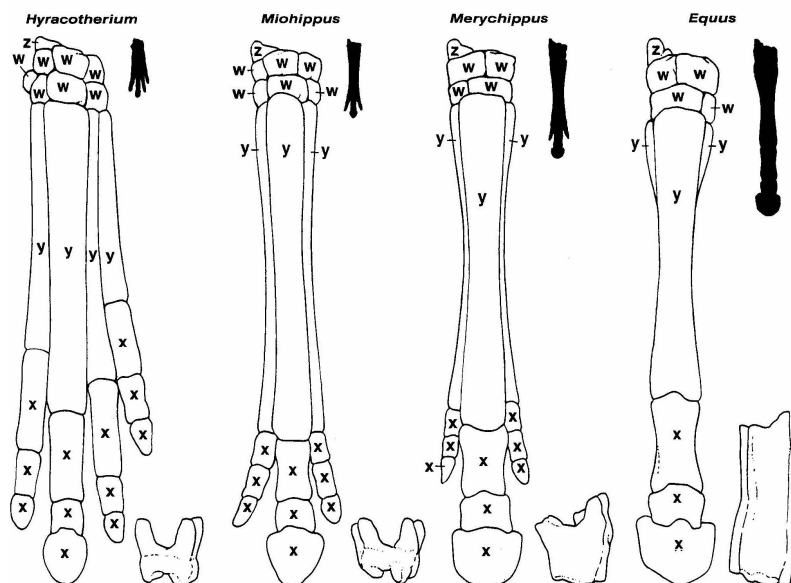


FIGURE 2. Forefoot bones and teeth of horses

Study the images of horses and horse fossils to the left and answer the following questions.

1. What changes occurred in the environment of horses from *Hyracotherium* to *Equus*?

2. As the environment (surroundings) changed, what happened to the teeth of the horse?

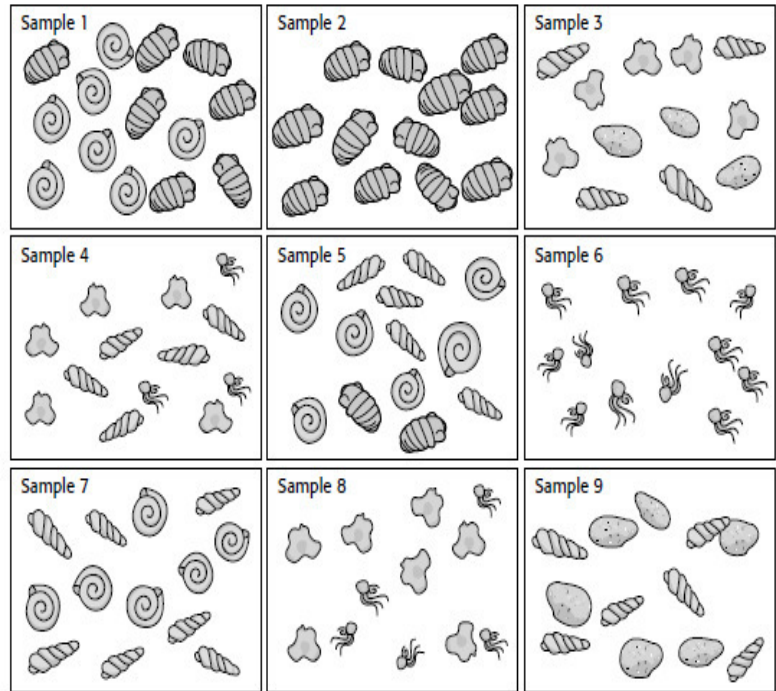
3. Describe the overall change in the foot of the horse over time.

4. How would natural selection have caused the changes in teeth and feet?

The pictures to the right represent nine different samples of fossils taken from layers of rock in a specific area. Sample 2 is the oldest. As organisms go extinct, they don't appear in younger layers of rock.

5. List the samples in order from oldest to youngest.

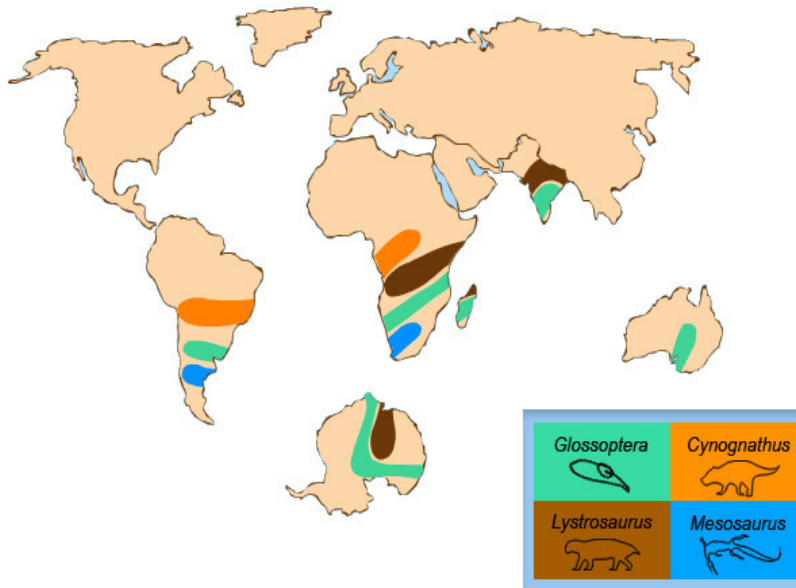
6. According to the pictures, circle the organism you think was most successful in this area? Why?



To the left is map that shows where various fossils have been found.

7. How does this show evidence that the continents were once connected?

8. What happened to various species once the land separated?



Geographical Distribution:

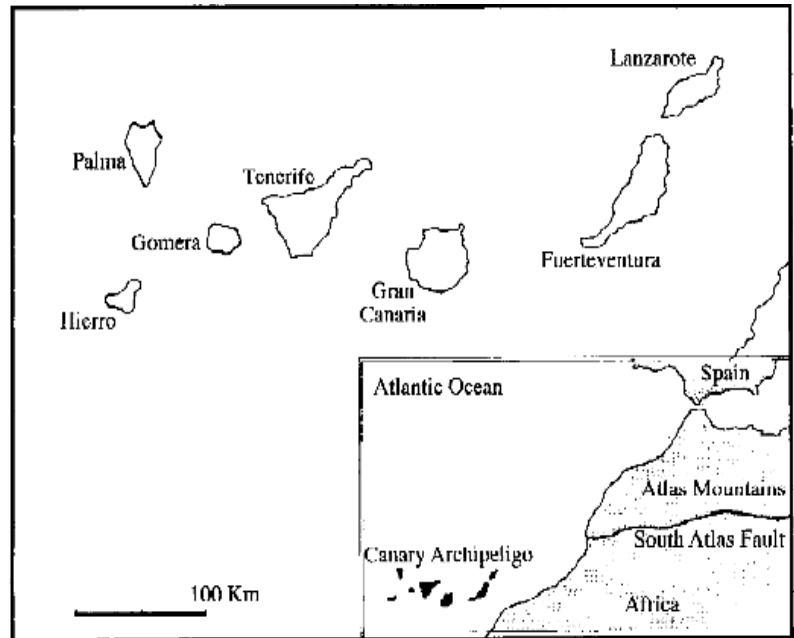
The Canary Islands are an archipelago of seven volcanic islands starting about 50 miles west of the African continent. Geologists theorize that a geologic hot spot of upwelling magma has been drifting westward for the past 20 million years gradually forming the islands as it moves. Thus, the furthest east island, Lanzarote is oldest and Hierro is the youngest, about 0.5 million years old. There are three species of lizards of the genus *Gallotia*, and within one of these species, *Gallotia galloti*, four separate unique island populations. The arrival of the *Gallotia* lizards was probably by rafting, that is, rafts of natural vegetation are often washed out to sea when high river levels cause river banks to collapse, carrying away both plants and clinging animals alike.

9. *G. galloti* has colonized the four western most islands and each population is morphologically (physical appearance) distinct from the other. Does the presence of these four morphologically different populations imply continuing evolution?

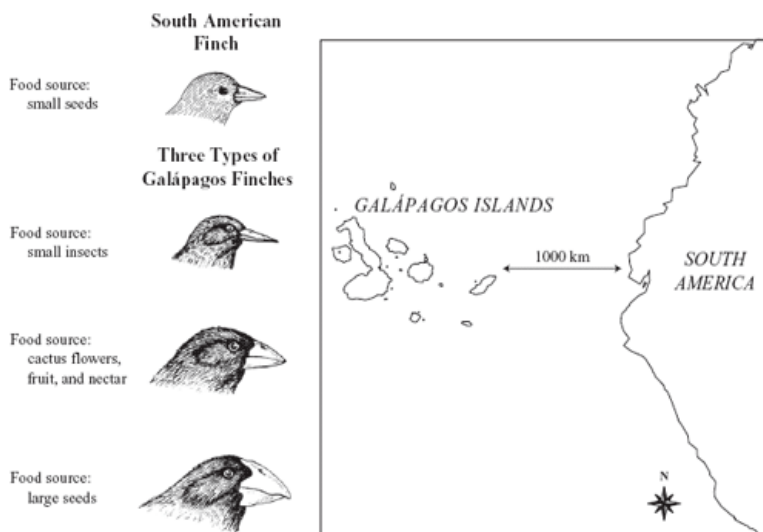
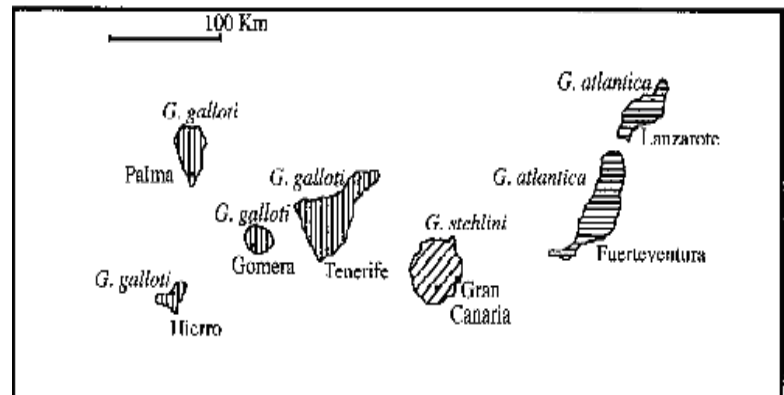
10. What may happen over time to these four populations? Why?

11. The species of lizard on Lanzarote and Fuerteventura are nearly identical to each other, where as the species of lizard on Palma and Hierro are very physically different from each other. What do you think is the reason for this?

Map 1. The Canary Islands Archipelago

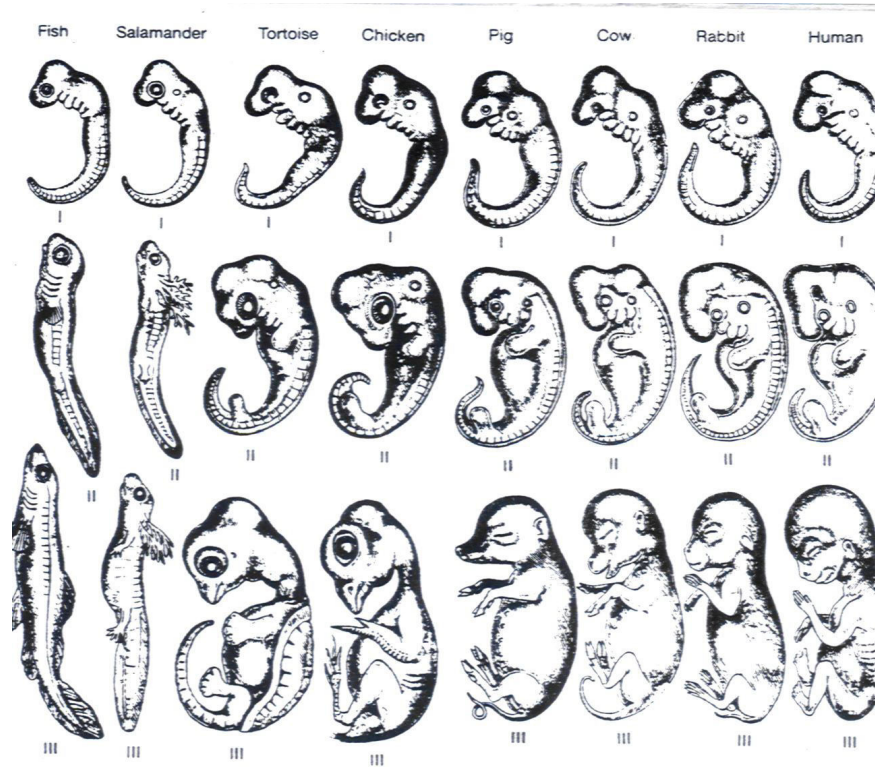


Map 2. Gallotia Lizard Distribution, Canary Islands



12. Describe two ways that the finches to the left show evidence of evolution. Use the terms "adaptation" and "common ancestor" in your response.

Embryology:



The diagram above shows the embryos of various vertebrates. Study the pictures and answer the following questions.

13. List three similarities between the embryos of vertebrates.

1. _____
2. _____
3. _____

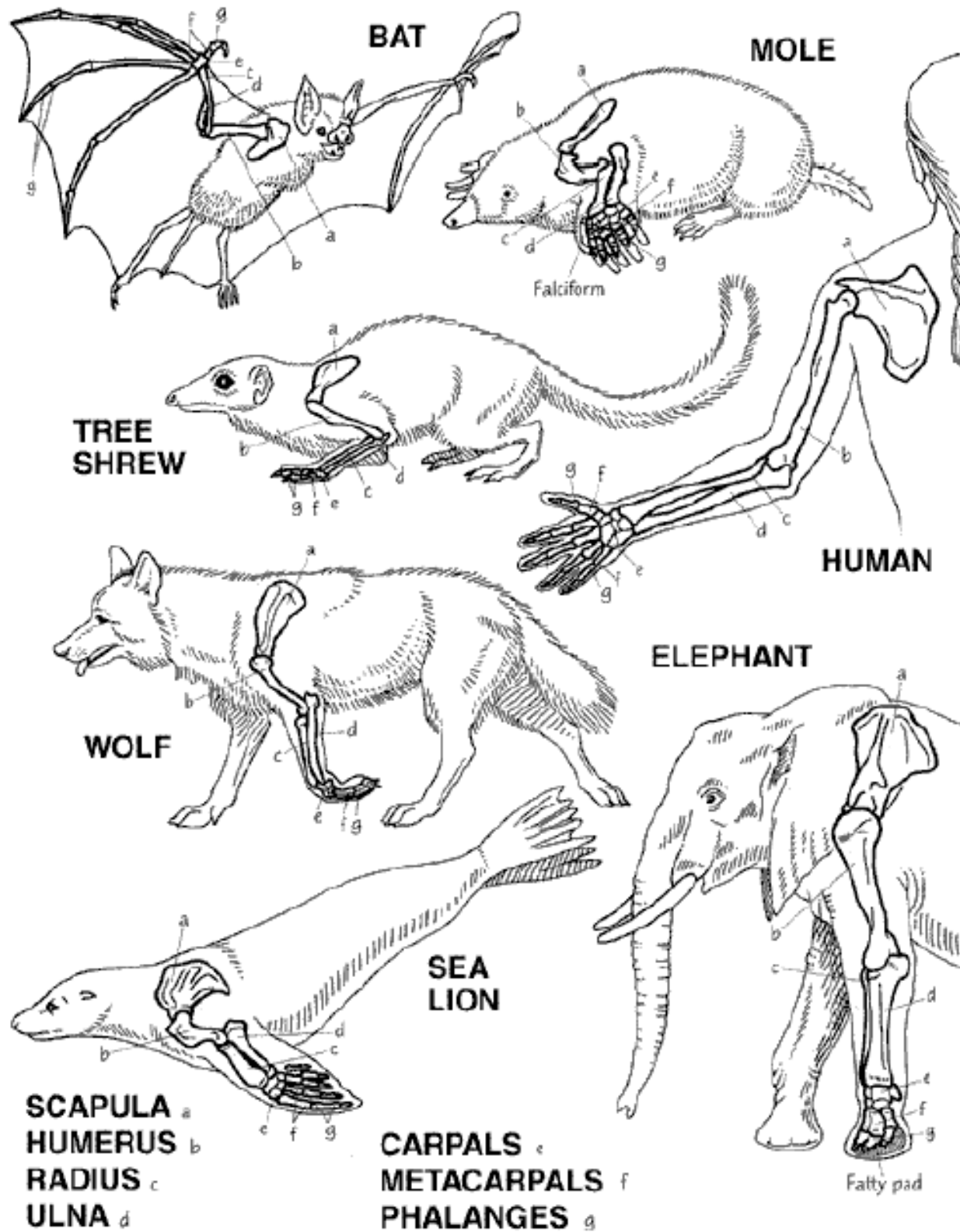
14. In your opinion which two embryos stay the most similar throughout their development? What does this say about their relatedness?

Homologous Structures and Vestigial Organs:

Despite the obvious differences in shape, mammalian forelimbs share a similar arrangement of bones and arise from the same embryonic, homologous structures. Through natural selection, the form of mammalian forelimbs has been modified during the last 65 million years into many shapes to perform a variety of functions.

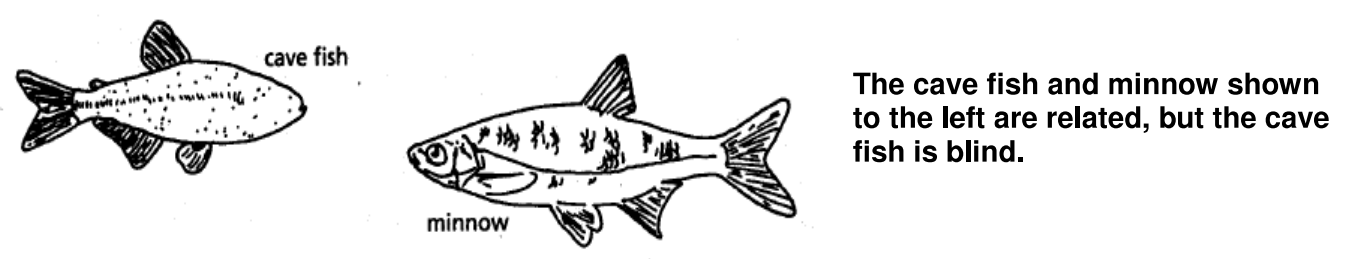
On the diagram on the next page, using light colors, color the bones in the different animals. Use a different color for each bone (ex. Scapula = green, Radius = pink). After you have colored all the structures in each animal, notice the variation in the overall shape of the forelimb. Notice, too, how the form of the bones contributes to the function of the forelimb in each species.

Mammalian Forelimbs



15. Select one of the bones of the forelimb and speculate as to why it evolved (its shape and function) differently as it did in two different organisms.

Gradual changes have occurred through time that have in some cases reduced or removed the function of some body structures and organs The penguins wings and the leg bones of snakes are examples of this phenomenon. Organs or structures that have lost their function in the organism or become reduced in size because of efficiency are called vestigial structures.



16. Explain why eyesight is not an important adaptation to life in an underwater cave.

17. Does the appearance of the cave fish and minnow suggest common ancestry?

18. What do you think it means when it says the organs lose their function “because of efficiency”?

19. Fill in the following table regarding human vestigial structures.

Structure	Probable past function?	Possibly why it became vestigial?
wisdom teeth		
coccyx (tail bone)		
muscles that move the ears		

Biochemical Evidence:

Cytochrome-C is an enzyme found in almost all living things. It is involved in the conversion of food to useable energy, that is, cellular respiration. The protein chain that makes up the enzyme is 60 amino acids long. Even though all organisms have this enzyme, there is a slight variation in the exact amino acid sequence between organisms. The letters stand for one of the 20 amino acids. The actual amino acids are not as important as their sequence for this exercise, so just consider the letters.

First 50 Amino Acids in Cytochrome C

	1	5	10	15	20	25	30	35	40	45	50
Human ...	GDVEKGKKI	FIMKCSQCHT	VEKGGKHKT	GPNLHGLF	GRKTGQAP	GYSYTA					
Turtle	GDVEKGKKI	FVQKCAQCHT	VEKGGKHKT	GPNLNGLI	GRKTGQAE	GFSYTE					
Shark	GDVEKGKKV	FVQKCAQCHT	VENGGKHKT	GPNLS	GLFGRKTG	QAQGFSTP					
Fruit fly ...	GDVEKGKKL	FVQRCAQCHT	VEAGGKHKV	GPNLHGLI	GRKTGQAA	GFAYTN					

20. Fill in the table below comparing the amino acid sequence of human cytochrome to that of other organisms. Record total number of substitutions and calculate the percentage of difference for each cytochrome from human cytochrome. To calculate this percentage, divide the number of substitutions for each organism by the total number of amino acids in the sequence (50) and multiply by 100.

Human vs.	Number of Substitutions	Percentage difference
Turtle		
Shark		
Fly		

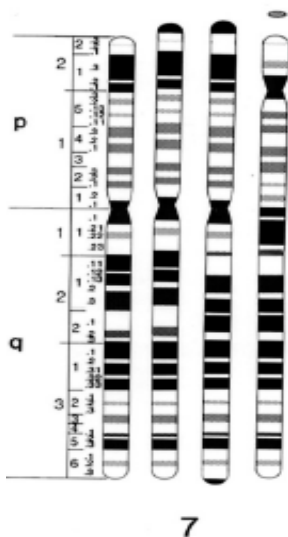
21. Using the percentage difference, with which organism did we share the most recent common ancestor? _____

22. With which organism did we share the most distant common ancestor? _____

23. Based on the amino acid sequences, which two organisms have a most recent common ancestor?

What is percentage difference of their amino acids? _____

24. What is the actual CAUSE of these biochemical differences? _____



Species that are more closely related should have more similar chromosomes. To the left is a section of a karyotype comparing chromosome 7 from left to right – a human, chimpanzee, gorilla, and orangutan.

25. What are three characteristics of these chromosomes that scientists could use to compare organisms? _____

26. According to the diagram, with whom did we share the most recent common ancestor? _____

According to the diagram, with whom did we share the most distant common ancestor? _____