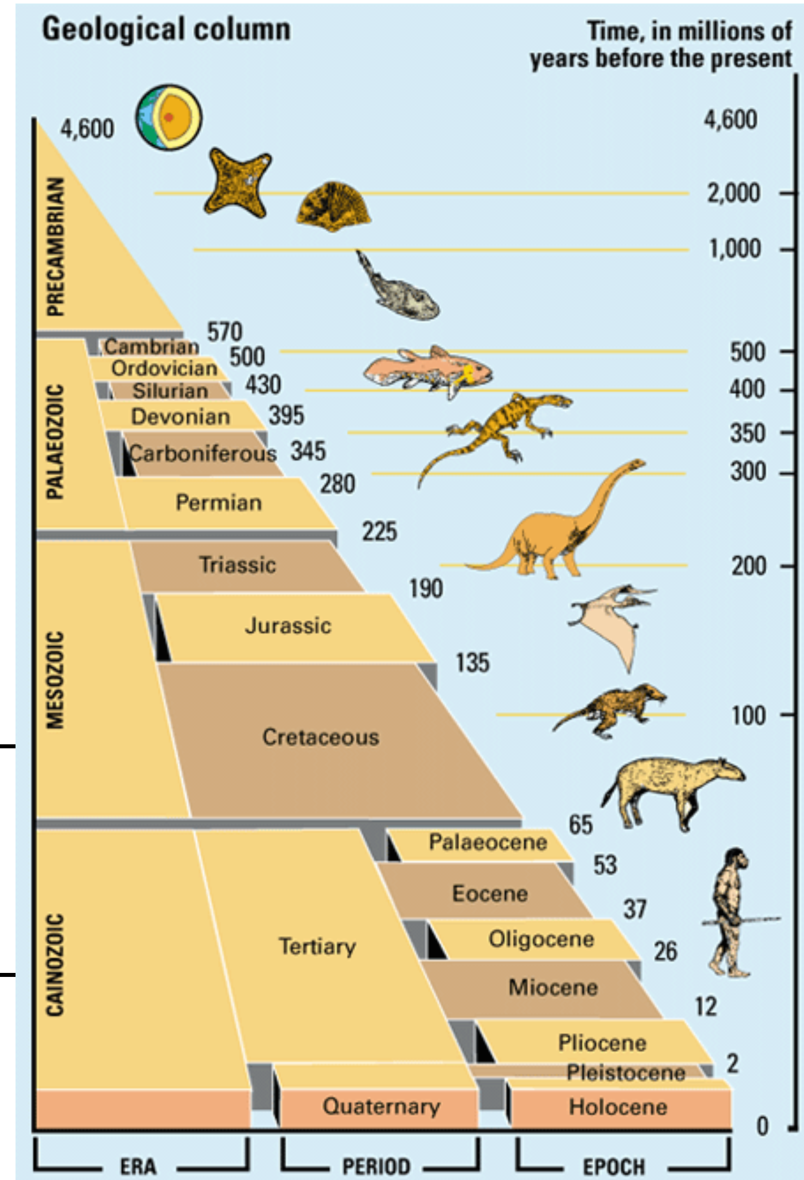
Station 1. Disorders in the Fossil Record

Scientists have been observing and gathering results from their surroundings to develop the evolutionary theory for more than 300 years. Much of the information on extinct organisms and evolutionary relationships has been obtained from paleontology, or the study of fossils. Collections of fossils are found throughout layers of sedimentary rock that have been laid down throughout earth's history. This collection is called the fossil record and it is our foremost evidence of changes that have occurred among the organisms on earth. Evolutionary relationships and age can be inferred depending on where the fossils are located within the fossil layers. It is often assumed that fossils deeper, or lower, in the layers are older than fossils located closer to the top rock layers. Beyond evolutionary relationships, it is also possible in some cases to determine whether the fossilized organism had any disease or disorders. Since fossils primarily consist of harder structures, such as bone, it is usually only the disorders that affect the skeletal system that are observable. At this station, you will have the opportunity to read three articles about disorders that have been found within fossils, and how this information can be used today.



http://www.jeron.je/anglia/learn/sec/science/prehist/01timeline.gif

Materials

"Ancient Tuberculosis Found in 500,000-Year-Old Fossil" article
"Making Sense of Homo floresiensis: Small-Bodied Humans, Dwarfism, or Disease?" article
"Modern Cancer Type Found in Neanderthal Remains" article

Directions

Task	
1	There are three articles about disease or disorders that have been found in the fossil record.
2	Read each article and answer the questions on the lab sheet for each article.

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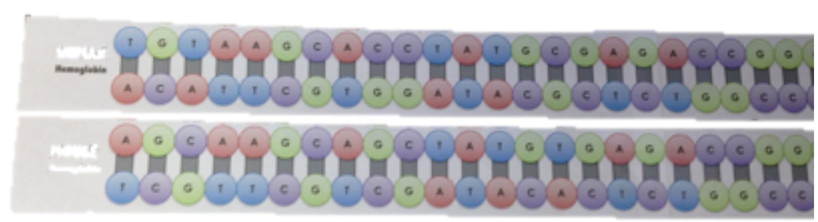
Station 2. Comparing the DNA Sequence of Hemoglobin

The classification of organisms was mainly based on anatomical similarities until the mid-1970s, when researchers began comparing DNA, amino acids, and proteins. If the structure of DNA sequences and proteins is similar between two organisms, it makes sense to infer an evolutionary relationship between those organisms. On the other hand, the less similar an organism's DNA, the farther the two organisms being compared would have evolved from a common ancestor. Why? If the DNA is less similar between organisms, it would be assumed that more mutations have occurred to separate those organisms over time. For example, if a lizard and a rat have DNA that is 35% similar, and a lizard and a chicken have DNA that is 70% similar, we would infer that lizards are more closely related to chickens than they are to rats. In this activity, you will have the opportunity to compare the DNA sequence for a specific protein, hemoglobin, between humans and three other animals, and then infer to which animal we (humans) are most closely related.

Materials

Human DNA Sequence *Fish DNA Sequence* *Mouse DNA Sequence* *Chimpanzee DNA Sequence*

Directions

Task		Image
1	Obtain the human hemoglobin DNA sequence and lay it flat on your table, or the floor if there is not enough room.	
2	Choose one of the 3 animal hemoglobin DNA sequences and lay it parallel to the human sequence.	
3	Starting with the first nucleotide on the left side, compare the nucleotides between the two chains.	
4	Count the number of DNA nucleotides that are different between the two DNA sequences, and record the number in Table 1.	
5	Replace the animal hemoglobin DNA sequence with a different animal, and repeat steps 2 – 4 to compare the other animal sequences to the human sequence.	

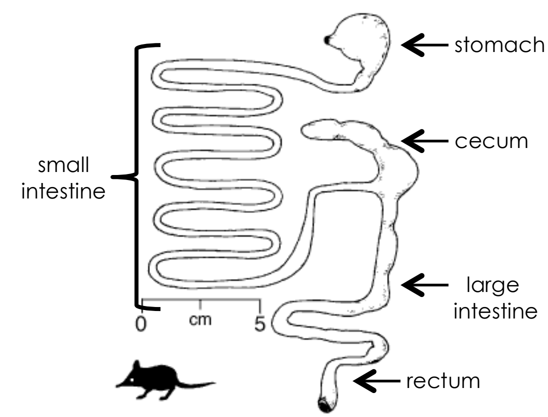
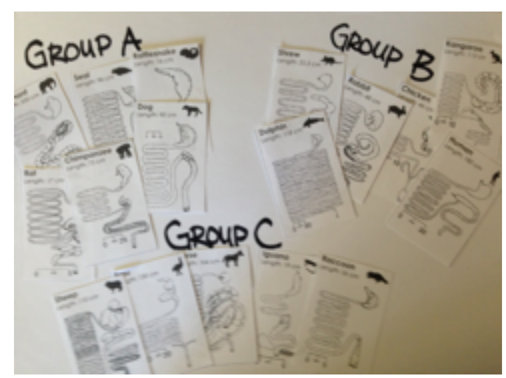
Station 3. Anatomical Similarities in Digestive Tracts

If an organism is related evolutionarily, it would make sense that they have similar anatomical structures. If the structure evolved from a common ancestor, they are considered homologous structures. Most of early evolutionary thinking revolved around observation of anatomical similarities between organisms, since little was known about DNA, genes, and inheritance of traits. The study of **phylogeny**, or the evolutionary history of an organism, focuses on grouping organisms based on similarities and differences. With the ability to look at relationships between anatomy and now DNA and also amino acid sequences' phylogeny, evolutionary scientists can make inferences on the evolution of a species. For this activity, you will get a small glimpse of how scientists can use anatomical homologies to group organisms.

Materials

Digestive Tract sheet | *Scratch paper* | *Scissors* | *Tape/glue*

Directions

	Task	Images
1	Obtain a digestive tract sheet, scratch paper, scissors, and tape or glue.	
2	Cut out each of the digestive tracts from the digestive tract sheet.	
3	Spread the cards out on the table and look at the different digestive tracts.	
4	The digestive tracts of vertebrates have a similar structure. Most vertebrates have a stomach, small intestine, cecum (or appendix), large intestine, and rectum. Not all of them have these organs, and the size, length, and appearance of each structure can vary. See the image to the right for a generalized digestive tract.	
5	Group the animals by anatomical similarities of the digestive tract in 3 - 5 groups. You can choose to group the organisms however you want, as long as it is <u>observable</u> (not assumed) in each organism's anatomy. Suggestions for grouping include the size of stomach, small intestine, cecum, or large intestine, absence or presence of organs, and length of the digestive tract.	
6	Separate each digestive tract into the groups you have created.	
7	Write the group names on the scratch paper and tape or glue the digestive tracts into their corresponding group.	
8	Answer the questions on your lab sheet and staple your groups / digestive tracts to the lab sheet before you turn it in.	

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Station 4. Comparing The Amino Acid Sequence of Insulin

One of the major mechanisms for evolution is mutation. A mutation in an organism's DNA leads to a mutation in the amino acid, and therefore the protein structure. Comparing the similarities and differences of the amino acid sequence of proteins provides evidence for how related organisms are to each other in terms of evolution. We are able to draw an inference based on the number of different amino acids, and therefore mutations, that exist between two organisms. In general, we assume that the less different the amino acid sequences for a protein, the closer the two organisms are related. For example, if canines have 12 differences in their amino acid sequence for the protein keratin as compared with humans, and felines only have 5 differences, we could assume that we are more closely related to felines than canines due to the fact that there are fewer mutations separating us. This process is much more complex, but this is the general concept. In this activity, you will compare the amino acid sequence of the protein insulin between humans and five animals to determine to which we are more closely related.

Materials

Human Insulin Amino Acid Sequence
Dog Insulin Amino Acid Sequence
Sheep Insulin Amino Acid Sequence
Mouse Insulin Amino Acid Sequence
Ape Insulin Amino Acid Sequence
Horse Insulin Amino Acid Sequence

Directions

Task		Image
1	Obtain the human insulin amino acid sequence and lay it flat on your table, or the floor if there is not enough room.	
2	Choose one of the 5 animal insulin amino acid sequences and lay it parallel to the human sequence.	
3	Starting with the first amino acid on the left side, compare the amino acids between the two chains.	
4	Count the number of amino acids that are different between the two amino acid sequences, and record the number in Table 2	
5	Replace the animal insulin amino acid sequence with a different animal, and repeat steps 2 – 4 to compare the other animal sequences to the human sequence.	

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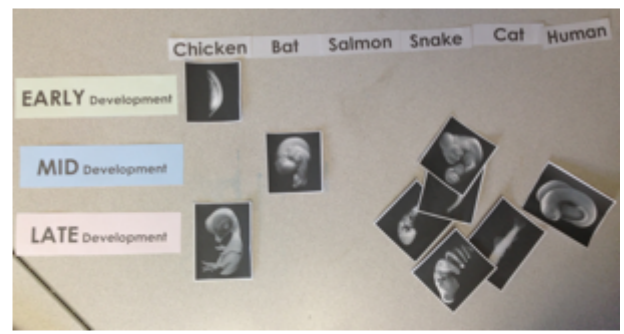
Station 5. Embryo Similarities

An **embryo** is a ball of dividing cells that eventually differentiate to form an organism. **Embryology** is the study of the development of embryos. In terms of evolution, it has been observed that embryos from vastly different species have many similarities. Vertebrate embryos have a common path of development that point to a common ancestry. In more recent research, it has been discovered that common genes, called **homeobox genes**, contribute to the development of a common body plan that differentiates into different organisms as an embryo develops. In this activity, your group will compare the embryos from different species through early, mid, and late development to observe the similarities and differences among them.

Materials

Embryo images and animal/developmental stage labels

Directions

	Task	Image
1	Obtain a plastic bag containing the embryo images. DO NOT LOOK AT THE BACK OF EACH IMAGE!	
2	The embryo images are from the development of 6 animals: salmon, chicken, snake, bat, cat, and human.	
3	There is one image from early development, one from mid-development, and one from late development for each animal.	
4	There are also labels in the bag. Arrange the labels like a table, with the stages down the left side and animal names across the top (see image).	
5	Spread the embryo images out on the table face up.	
6	The goal of this activity will be to arrange the embryo images by their stage and by animal.	
7	Look at each embryo and place it on the table for the developmental stage and animal to which you think it belongs. It is OKAY if they are not correct, just do the best you can!	
8	The answer for each image is on the back of the card. When you have placed all of the images, turn the cards over.	
9	Record your results in Table 3 of your lab sheet by putting an X in the box of each embryo you guessed correctly.	
10	Now, using the answers arrange the cards into their correct spots with the embryo image facing up, and answer the analysis questions for Station 5.	