Name: _____ Date: _____

Student Exploration: Human Evolution - Skull Analysis

Prior Knowledge Questions

1. Label one of the **skulls** below as human and the other as a chimpanzee skull.

 _____  _____

2. What features did you use to identify which skull was human and which was chimpanzee?

_____

_____

Warm-up

In 1924, a fossilized skull that looked very similar to a chimp skull was discovered. But the skull most definitely did not belong to a chimp. The location of the **foramen magnum**—a hole in the skull where the spinal cord exits—indicated that the individual was **bipedal**, or walked on two legs. This fossil was some of the earliest evidence of human evolution.

In this lab you will discover some of the ways that skulls can be used to learn about human evolution. Start by comparing two modern **hominids**: a human and a chimpanzee.

1. Examine the front of the **Homo sapiens (modern human)** skull. Then examine the same view of the **Pan troglodytes (chimp)** skull.

   How do the skulls compare? _____

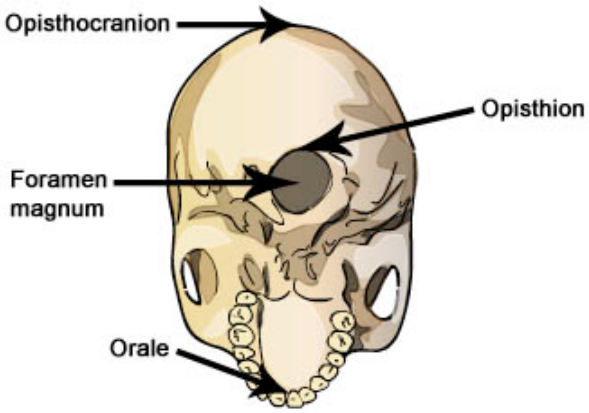
   _____

2. Now, examine the bottoms of the two skulls. How do they compare? _____

   _____

   _____

Activity A: Activity A	Get the Gizmo ready: **_Foramen Magnum_**	



Introduction: Skulls, even from the same species, can have a wide variety of shapes and sizes. To compare skulls, scientists use measurements of certain features to calculate indexes. An **index** is a ratio of one measurement to another.

An important index for measuring hominid skulls is the ***opisthion index***. This index indicates the position of the foramen magnum in the base of the **cranium**. The opisthion index can indicate whether a hominid species was bipedal or not.

Question: How does the location of the foramen magnum indicate if a species was bipedal?

1. To determine the opisthion index of each skull, follow the steps below and complete the table.
    - Measure the distance from the opisthocranion to the opisthion, as shown at top right. Record the opisthocranion-opisthion distance in the table below.
    - Measure from the opisthocranion to the orale, as shown at bottom right. Record the opisthocranion-orale distance in the table.
    - To calculate the opisthion index, divide your first measurement by your second measurement. Multiply this number by 100.

Species	Opisthocranion-opisthion distance (cm)	Opisthocranion-orale distance (cm)	Opisthion index
A. afarensis			
A. africanus			
A. bosei			
H. habilis			
H. erectus			
H. ergaster			
H. sapiens neanderthalensis			
Kenyanthropus			

Humans, chimpanzees, and the other great apes are hominids. Hominids **evolved** from a common ancestor that lived about 13 million years ago. **Hominins** are hominids that belong to the lineage that led to humans.

2. Analyze: An opisthion index greater than 15 means that the foramen magnum is situated close to the center of the cranium. This position is usually found in species that stand upright. An opisthion index less than 15 means the foramen magnum is situated in the rear of the cranium. This position is found in species that walk on their knuckles or on four legs.

   Using the index values you calculated, what can you conclude about which skulls belonged to a species that was bipedal?

   _____

   _____

3. Analyze: Hominins are characterized by bipedalism.

   A. Based on their opisthion indexes, which of the hominids are hominins?

      _____

      _____

   B. Based on opisthion indexes, which hominin skulls are most similar to human skulls?

      _____

      _____

4. Explain: Why do you think the foramen magnum is positioned near the rear of the cranium for knuckle-walking species and near the center of the cranium for bipedal species?

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   _____

   _____

   _____

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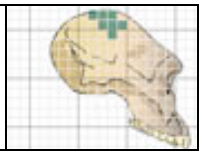
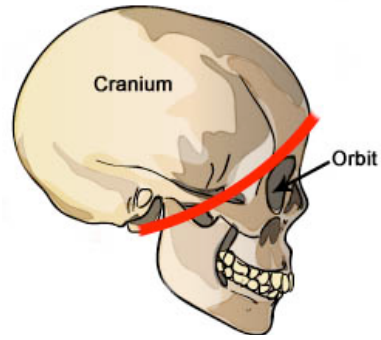
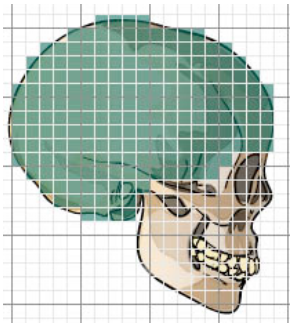
Activity B	***Cranial Capacity***	

Introduction: The brain is housed inside the cranium. The internal volume of the cranium is called the **cranial capacity**. The larger an organism's cranial capacity is, the larger its brain tends to be.

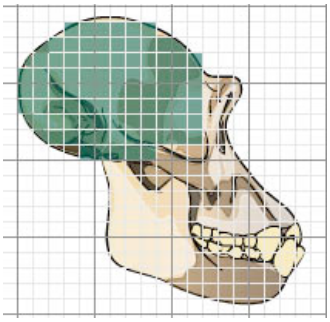
Question: How does the cranial capacity compare amongst hominids?

1. Measure: **To estimate the cranial capacity of each skull, use the photographed image**.
    - Measure the diameter of the circle in cm. This represents the part of the cranium that houses the brain. The diameter is the distance across the exact center of each circle.
    - Multiply the cranial diameter by 200cm^2. This gives the cranial capacity (brain volume) in cubic centimeters.
    - Record your data in the table below.

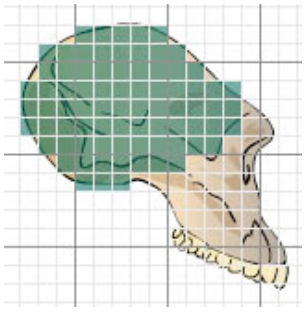




Homo sapiens



Pan troglodytes



Australopithecus

Species	Cranial diameter (cm)	Estimated cranial capacity (cm^3)
A. afarensis		
A. africanus		
A. bosei		
H. habilis		
H. erectus		
H. ergaster		
H. sapiens neanderthalensis		
Kenyanthropus		
H. sapiens		**1350-1450 cc**

2. Analyze: Examine the estimated cranial capacities you calculated.

   A. Which species probably had the largest cranial capacities?

   _____

   _____

   B. What do you think cranial capacity is a good indicator of? _____

   _____

   _____

   C. Did any hominids have a larger cranial capacity than humans? If so, which species?

   _____

3. Compare: Compare the size and shape of the foreheads, brow ridges, and sagittal crests (the bony ridge running across the top of the skull; may be absent) of the skulls to each other and the skull of a modern human.

   A. Which skull shares the most similar features? Which one is the most dissimilar?

   _____

   _____

   B. Why do you think humans have such large foreheads and lack both the prominent brow ridge and sagittal crest?

   _____

   _____

5. Draw conclusions: Compare the data you collected in activity A with the data you collected in this activity. Which evolved first in hominins: bipedalism or large brains? Explain.

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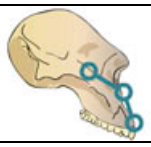
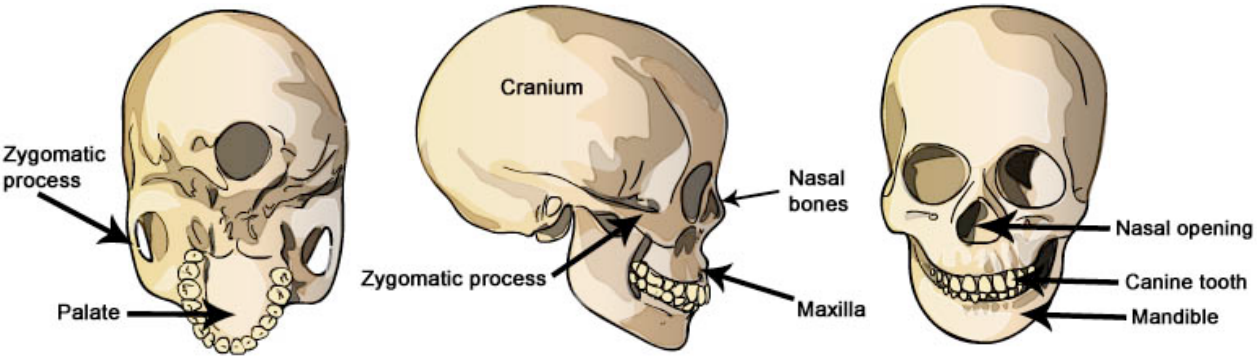
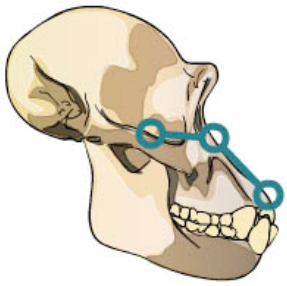
Activity C	***Maxilla and Mandible***	

Introduction: Teeth and the bones around the mouth give a great deal of information about both a species' diet and how it eats. Take a look at the skull features below.



Question: How do the mouths of hominids compare?



1. Measure: Position the protractor as shown at right. The protractor's vertex/center at the top of the nasal opening (Hint: You may have to look at the **Front view** in order to see where the top of the nasal opening is in relation to the **orbit**). On the top of the zygomatic process (cheek bone), level the bottom of the protractor. Now measure the *maxillary angle* using the protractor. Measure from the zygomatic process to the teeth. Complete the table. (Note: You will not be able to do this measurement on incomplete skulls.)

2. Describe: Next examine the size and shape of each species palate shape. Record your observations in the table below.

Species	Maxillary angle	Palate Shape
Homo sapiens	**90**	
Australopithecus afarensis		
Australopithecus africanus		
Australopithecus bosei		
Homo habilis		
Homo erectus		
Homo ergaster		

Homo sapien neangerthalensis		
Kenyanthropus platyops		

An angle of more than 90 degrees means the lower jaw sticks out in front of the nose. An angle of 90 degrees means the lower jaw does not stick out in front of the nose.

2. Observe: How does the maxillary angle and palate shape relate to the size of each species' mouth?

_____

_____

3. Compare: Compare the number, size and shape of the teeth for each species. What can the teeth tell you about that species diet? How does comparing the teeth and jaw bones of each species allow you to determine relatedness to each other?

_____

_____

4. Infer: What is the relationship between the evolution of bipedalism, the increase in cranial capacity, and the decrease in tooth and mouth size of hominins? (Hint: As cranial capacity increased, the use of sophisticated stone tools became more common.)

_____

_____

6. Summarize: On a separate sheet of paper, record the age of each fossil. Then, look over all the data you collected. Summarize how hominins changed as they evolved. _____

_____

_____

_____

_____

7. Evaluate: Of the fossils presented, *Homo floresiensis* is the youngest. In what ways does this species NOT follow the pattern of human evolution you described above?

_____

_____

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