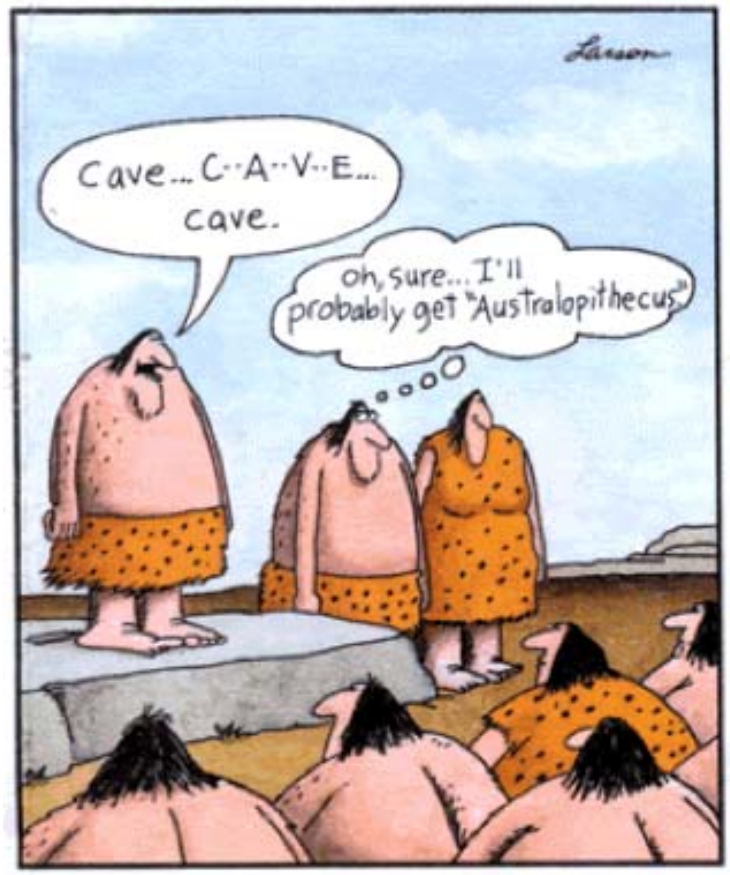
Name: _____

Lab 6
Fossil Record for Human Evolution I:
Australopithecus*, *Paranthropus*, and early *Homo

- Objectives -

- Learn to appreciate the nature of variation among the australopiths.
- To examine the evolution of the genus *Homo* during the late Pliocene and early Pleistocene.
- Introduce you to the various casts of fossil skulls of the genus *Homo* and compare them to *Australopithecus*.



Primitive spelling bees

Introduction

Near the end of the Miocene epoch (between 8 and 5 million years ago), several lineages of African hominids were established: one leading to gorillas, one to chimpanzees, and one to hominins. The word **hominin** refers to the family of primates that includes humans and all of our ancestors since diverging from the last common ancestor with chimpanzees about 6 million years ago.

Living humans differ from other living hominids in many features, including:

- habitual bipedal locomotion (& associated adaptations)
- decreased size of the anterior teeth (incisors and canines)
- parabolic dental arcade
- lack of prognathism
- lack of a CP_3 honing complex (P_3 is bicuspid and humans lack a diastema)
- increased size and complexity of the brain
- a high degree of precision grip ability in the hands
- great reliance on material culture (i.e., tools)

These characteristic features of modern humans that clearly separate us from other great apes did not all evolve together. Some traits appeared early on and others evolved later in a pattern called **mosaic evolution**.

Classification of early hominins

There are six (6) genera and twelve (12) or more species of early hominins currently described: *Orrorin*, *Sahelanthropus, Ardipithecus*, *Australopithecus*, *Paranthropus*, and *Kenyanthropus*. Several of these are poorly known and their designation as separate genera and species is still a contentious issue.

Sahelanthropus tchadensis	7 – 6 Ma	Chad
Orrorin tugenensis	6 Ma	Kenya
Ardipithecus ramidus	4.5 Ma	Ethiopia
Australopithecus anamensis	4.2 – 3.9 Ma	E. Africa
Australopithecus afarensis	3.9 – 3.0 Ma	E. Africa
Australopithecus bahrelghazali	3.5 Ma	Chad
Australopithecus deyiremeda	3.5 – 3.0 Ma	Ethiopia
Australopithecus africanus	3 – 2.4 Ma	S. Africa
Australopithecus garhi	2.5 Ma	Ethiopia
Australopithecus sediba	2.0 Ma	S. Africa
Paranthropus aethiopicus	2.5 Ma	E. Africa
Paranthropus robustus	1.9 – 1.5 Ma	S. Africa
Paranthropus boisei	2.2 – 1.4 Ma	E. Africa
Kenyanthropus platyops	3.5 MA	Kenya

Around 2.5 Ma, the climate in Africa underwent drastic change, becoming drier, cooler, and more seasonal. This shift in climate resulted in a reduction in closed-canopy forests and a concomitant increase in woodland and grassy savannas. These changes in turn caused an increase in the number and diversity of savanna species, especially ungulates, primates, and their predators.

The genus *Homo* first appears (branches off from its australopith ancestors) in the late Pliocene. At this time, we see several interesting things happening in our lineage. The first manufactured stone tools appear, butchered animal bones are found in association with stone tools, and shortly thereafter the first fossils are found that have been allocated to the genus *Homo*. From this time we find several species (an **adaptive radiation**) with a mixture of

primitive and derived features (**mosaic evolution**) and a lack of clarity about how the various species are related to one another.

The earliest specimens seem to be of two types. One, called ***Homo habilis***, has a brain only slightly larger than an australopith's, reduced dentition, and a small, less prognathic face. The other type, now called ***Homo rudolfensis*** by some, has a significantly larger brain combined with very large teeth and a large, flat face. Originally both were put into the same species (***Homo habilis***), but the significant morphological differences between the two types have led many researchers to allocate them to two different species. In this lab you will get the chance to examine an example of both types and decide for yourself whether they are one species or two.

Trends within the genus *Homo*

All living humans are hominins who belong to the species *Homo sapiens*. The present distribution of *H. sapiens* is worldwide and is accompanied by a great amount of morphological and physiological variation, as well as tremendous cultural diversity. Thus in the history of our lineage, there has been a trend toward increasing adaptability to a wider range of environments, facilitated by our cultural and technological advancements.

The more notable trends of the genus *Homo* include:

- increase in brain size and complexity
- increase in amount of learned behavior
- increase in length of pre-adult life history stages (facilitates learning)
- increased behavioral repertoire and flexibility
- decreased tooth size and more parabolic dental arcade
- gracilization of facial and mandibular structure
- decrease in cranial cresting and relative size of cranial musculature (i.e., decreased cranial robusticity)
- increased reliance on manufactured objects (tools) and increased complexity of the tool kit
- increasing ability to manipulate and change the environment

Classification within the genus *Homo*

Multiple species of fossil hominins are known from the genus *Homo*. Paleoanthropologists sometimes differ in their interpretations of fossil remains, which has led to conflicting taxonomic classifications. In other words, classifications are not absolute but are based upon differences in interpretation. The classification presented here represents one consensus point of view, but remains subject to revision.

Note: most of the species of the genus Homo *will be covered in the second half of the semester and not appear on the midterm.*

Family Hominidae

Subfamily Homininae

Tribe Hominini

Species	Time span
Homo habilis	1.9 -1.4 Ma
Homo rudolfensis	2.4 -1.9 Ma
Homo erectus	1.6 – ? Ma
Homo ergaster	1.9 – 0.9 Ma
Homo antecessor	~ 800 Ka
Homo heidelbergensis	600-300 Ka
Homo naledi	335-236 Ka
Homo sapiens neanderthalensis	130-30 Ka
Homo sapiens sapiens	315 Ka - present

Station 1. Compare the Taung specimen with the skulls of a baby chimpanzee and human. Fill in the chart below.

	Chimpanzee	Taung (*Au. africanus*)	Human
Relative brain size			
Position of the foramen magnum (more anterior vs. more posterior)			
Forehead height (receding vs. vertical)			
Relative size of supraorbital tori (browridges)			
Degree of prognathism (very projecting, slightly projecting, little/ none)			
CP_3 honing complex and/or diastema present?			
Relative size of anterior teeth versus posterior teeth?			

Stations 2 & 3: *Australopithecus* and *Paranthropus*

Sagittal crest: A thick ridge of bone that protrudes from the top of the cranium, along the path of the sagittal suture. Presence indicates very strong chewing muscles.

Figure 1

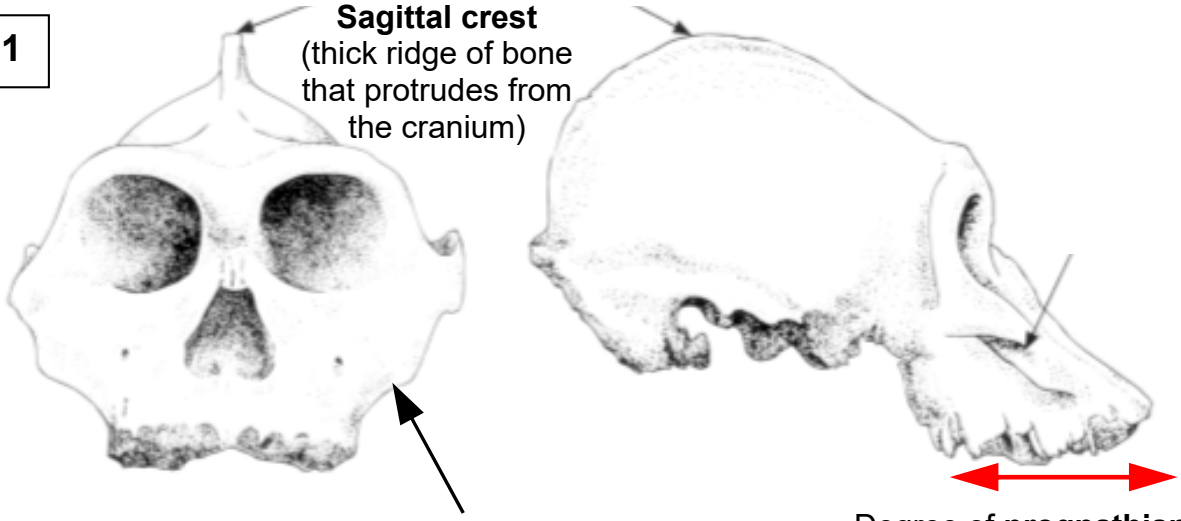
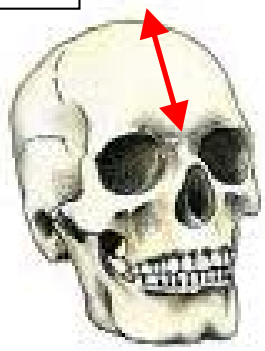


Figure 2



Forehead height: does the area above the eye orbits project up (creating a forehead), or immediately recede or slope back (no forehead)?

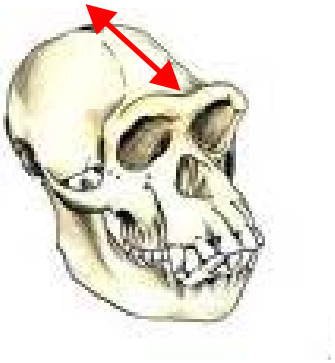
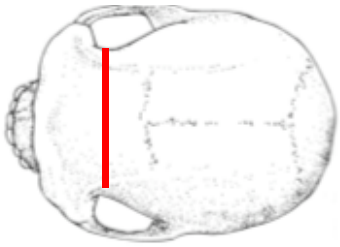


Figure 3

<u>Postorbital constriction</u>: how "pinched in" is the skull behind the browridges when looking from above?



Station 2: *Australopithecus* and *Paranthropus* from East Africa

Compare the two fossil skulls with that of a modern chimpanzee and modern human. Fill in the chart. Refer to the figures for help with some of the features.

	Pan troglodytes	***Au. afarensis***	***Paranthropus aethiopicus***	***Paranthropus boisei***	***Homo sapiens***
Position of the foramen magnum?					
CP_3 honing complex and/or diastema present? Y/N					
Degree of prognathism? (Fig. 1)					
Sagittal crest present? (Fig. 1) Y/N					
Facial dishing? (Fig. 1) Y/N					
Degree of postorbital constriction (Fig. 3)					
Relative size of molars to incisors?					

Station 3: *Australopithecus* and *Paranthropus* from South Africa

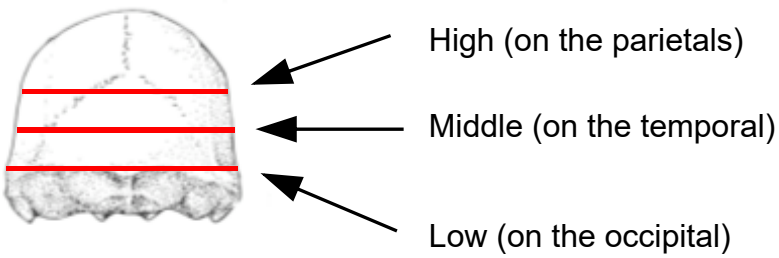
Compare the two fossil skulls with that of a modern chimpanzee and modern human. Fill in the chart. Refer to the figures for help with some of the features.

	Pan troglodytes	***Australopithecus africanus***	***Paranthropus robustus***	***Homo sapiens***
Position of the foramen magnum?				
Facial dishing? (Fig. 1) Y/N				
Degree of prognathism? (Fig. 1)				
Sagittal crest present? (Fig. 1) Y/N				
Forehead height (receding vs. high) (Fig. 2)				
Degree of postorbital constriction (Fig. 3)				
Brain size (average)	400 cc's	All species of *Australopithecus* 350-550 cc's	All species of *Paranthropus* 400-500 cc's	1,350 cc's

Station 4: Australopiths and early *Homo*

Figure 4

<u>Widest point on the cranium</u>: when viewed from behind, is the widest point low, middle, or high on the cranium? Is the widest point on the parietal, temporal or occipital bone? (Measure with spreading calipers)



Station 4 - Early *Homo* and *Australopithecus*

Compare the two fossil *Homo* skulls with that of an australopith. Fill in the chart. Refer to the figures for help with some of the features.

	Au. africanus	***Au. sediba***	***Homo habilis***	***Homo rudolfensis***	***Homo sapiens***
Relative size of anterior to posterior teeth					
Is the lower face prognathic? (Fig. 1)					
Degree of postorbital constriction (Fig. 3)					
Location of the widest point on the skull (Fig. 4)					
Brain size (average)	450 cc's	450 cc's	630 cc's	775 cc's	1350 cc's

Follow-up questions

Once you have completed all four stations, discuss the following questions as a group and record a summary of your responses.

Based on Stations 1-3 (*Australopithecus* and *Paranthropus*)

1. Do you think that Dart had a strong case to argue for the hominin status of the Taung specimen? Based on your answers to the questions for station 3, suggest whether you think there is sufficient morphological evidence to argue that Taung is a hominin, and what specific evidence supports your view.

2. What feature(s) identify *Australopithecus* and *Paranthropus* as hominins?

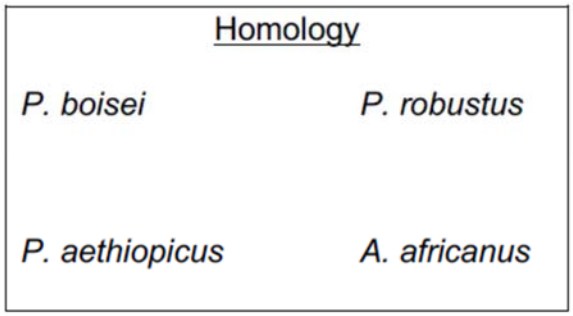
3. Which traits are shared between *Australopithecus* and chimpanzees (i.e., ancestral)? Which are shared between *Australopithecus* and modern humans (i.e., derived)? Which traits in *Australopithecus* appear intermediate between chimpanzees and modern humans?

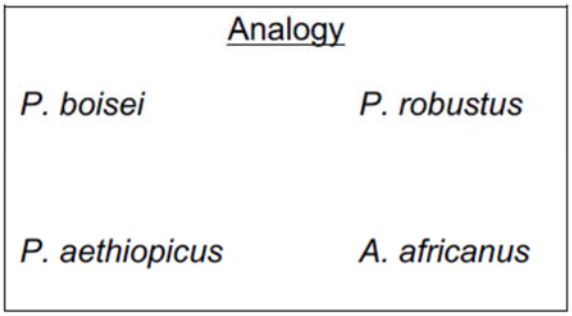
4. In general, how do *Australopithecus* and *Paranthropus* differ in their cranial (not dental) morphology? Name and describe at least three specific features.

5. Is there a correlation between the size of the molars and the robusticity of the mandible? In other words, do specimens with larger molars also have bigger, thicker or deeper mandibles?

6. How do you think the unique cranio-dental features of *Paranthropus* may be related to their diet?

7. In lecture, two hypotheses (evolutionary scenarios) were given for interpreting the phylogeny of *Paranthropus*. Remember that homology means having similar features due to common ancestry, while analogy (homoplasy) means having similar features due to common function. Reproduce those hypothetical relationships by drawing in the arrows indicating evolutionary descent (from the ancestor towards descendants) below:





8. Which phylogenetic hypothesis (from the previous question) best fits the observations you made in lab? What does this mean for why robust features evolved and spread?

Based on Station 4 (*Australopithecus* and early *Homo*)

9. What traits do *Homo habilis* and *Australopithecus* share that *Homo rudolfensis* lacks?

10. What traits do *Homo habilis* and *Homo rudolfensis* share that *Australopithecus* lacks?

11. What features of *Australopithecus sediba* are more similar to *Homo sapiens*? And to *Australopithecus africanus*? Are any intermediate? Based on these comparisons, could one argue that *Australopithecus sediba* should be reclassified on the genus level as *Homo sediba*? Why or why not?