

Human Evolution

Task

Introduction of the Problem/Context: In this activity, high school biology students will investigate the evolutionary changes in primates by simulating fossil investigations performed by scientists.

Selected GPS:

Co-Requisite: Characteristics of Science

Habits of Mind

- **SCSh1:** Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.
 - a. Exhibit the above traits in their own activities.
- **SCSh3:** Students will identify and investigate problems scientifically.
 - c. Collect, organize, and record appropriate data.
 - e. Develop reasonable conclusions based on data collected.
- **SCSh4:** Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.
 - a. Develop and use systematic procedures for recording and organizing information.

Nature of Science

- **SCSh7:** Students will analyze how scientific knowledge is developed.
 - c. From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Major shifts in scientific views typically occur after the observation of a new phenomenon or an insightful interpretation of existing data by an individual or research group.
 - d. Hypotheses often cause scientists to develop new experiments that produce additional data.
 - e. Testing, revising, and occasionally rejecting new and old theories never ends.

Co-Requisite: Characteristics of Science

Content

- **SB5.** Students will evaluate the role of natural selection in the development of the theory of evolution.
 - a. Trace the history of the theory.

- b. Explain the history of life in terms of biodiversity, ancestry, and the rates of evolution.
- c. Explain how fossil and biochemical evidence support the theory.
- d. Relate natural selection to changes in organisms.

Classroom Materials: Lesson Outlines

Human Evolution

Grade Level/Subject: High School Biology

Overview: In this activity, students

Key Objectives:

- To investigate a problem scientifically (GPS: SCSH3 c, e).
- To use tools and instruments for observing and measuring anatomical features (GPS: SCSH4).
- To keep detailed and accurate records of data collected (GPS: SCSH4 a).
- To understand analyze how scientific knowledge is developed and changes over time (GPS: SCSH7 c, d, e).
- To understand human evolution can be supported by fossil evidence (GPS: SB5 c).

Learning Outcomes:

- Students will know:
 - that fossil records of teeth, hips, and craniums support the theory of human evolution.
 - that conclusions can be drawn based on evidence.
- Students will be able to:
 - investigate problems scientifically using the appropriate measurement tools.
 - keep detailed records of observations and data collected.
 - draw conclusions based on data collected.

Possible Materials:

- Rulers
- Protractors
- Masking Tape
- Journals or science notebooks
- The Human Evolution Coloring Book by A. Zihlman (1981) is a good resource for both teachers and students for diagrams.

Task: Students are to observe and measure multiple pieces of fossil evidences in order to better understand the nature of human evolution. Students examine and record data on skulls and pelvic structures of *Homo sapiens*, *Australopithecus*, and gorillas. Specifically students investigate brain areas as compared to face areas, cranial capacities, brow ridges, lower jaw shapes, pelvic shapes, and teeth numbers, sizes, and diastemas.

Sample Data Collection Sheet:

(Note: Students may also develop their own data collection charts)

Comparison Data Table

Characteristic	Gorilla	<u>Australopithecus</u>	Modern Human
Face area			
Brain area			
Is brain area smaller than face area?			
Is brain area larger than face area?			
Is brain area 3x larger than face area?			
Cranial capacity in cm ³			
Jaw angle			
Does lower jaw stick out in front of nose?			
Sagittal crest present?			
Brow ridge present?			
Number of teeth in lower jaw			
Number of molars in lower jaw			
Number of premolars in lower jaw			
Number of canines in lower jaw			
Number of incisors in lower jaw			
Size of lower jaw canines			
Diastema present?			
Distance across back of jaw			
Distance across front of jaw			
Distance across front and back of jaw the same?			
Is lower jaw U-shaped?			
Is lower jaw V-shaped?			
Shape of top half of pelvis			
Shape of bottom half of pelvis			

Sample Questions:

- Using your data, describe the general change in face to brain area seen in the three animals studied.
- Describe the general change in cranial capacity.
- Describe the general change in jaw angle and prognathism (how far the jaw protrudes forward).
- Describe the general change in the brow ridge and sagittal crest.
- Describe the general change in teeth number, size, and diastema.
- Describe the general change in lower jaw shape.
- Using your data, decide if *Australopithecus* was quadrupedal or bipedal. Justify your answer.
- How many traits are similar when comparing (a) gorilla to *Australopithecus*? (b) *Australopithecus* to modern human? (c) gorilla to modern human?
- Based on your answers to the above question, does a modern human seem to be closer in evolutionary development to the gorilla or *Australopithecus*?
- Write a detailed summary that discusses what was done in this activity and the conclusions you can draw from the data.

Assessment Ideas:

- Teacher observation: are the objectives being met?
- Write a detailed summary that discusses what was done in this activity and the conclusions you can draw from the data.
- Student journals or science notebooks: is their evidence of student learning?
- Teacher-constructed test, based on observations made and discussed.

Extension Ideas:

- If available, have students compare their data with actual fossil reproductions. For example, skulls can be purchased at Carolina Biological Supply and Ward's.
- Ask students to research specific species such as chimpanzees, *A. afarensis*, *A. africanus*, *A. boisei*, *Homo habilis*, *Homo erectus*, etc.
- Have students plot a chronology of hominin existence, based on the age-ranges of different hominin species.
- Students may investigate other evolutionary evidences such as chromosomes, DNA, and proteins.

Sample Question Solutions:

- Using your data, describe the general change in face to brain area seen in the three animals studied.
→ The gorilla's face area is greater than the brain area. *Australopithecus*' brain area is slightly larger than its face area and the modern human's brain area three times as large as its face area.
- Describe the general change in cranial capacity.

- The cranial capacity of the gorilla is the smallest. *Australopithecus*' cranial capacity is slightly greater than that of the gorilla. The modern human's cranial capacity is substantially larger than both the gorilla and *Australopithecus*.
- Describe the general change in jaw angle and prognathism (how far the jaw protrudes forward).
 - The jaw angle of the gorilla is around 30° and the lower jaw protrudes out far beyond the nose. The jaw angle of the *Australopithecus* is around 45° and the jaw protrudes only slightly beyond the nose. The modern human's jaw angle is about 90° and the lower jaw does not protrude from the nose.
- Describe the general change in the brow ridge and sagittal crest.
 - Both the gorilla and *Australopithecus* have sagittal crests and brow ridges whereas the modern human does not. The sagittal crest in the gorilla is quite prominent as is the brow ridge. The sagittal crest and brow ridge of the *Australopithecus* is not as pronounced. Neither a brown ridge nor sagittal crest is prominent in the modern human.
- Describe the general change in teeth number, size, and diastema.
 - All three species have the same number and types of teeth as each species has 6 molars, 4 premolars, 2 canines, and 4 incisors totally sixteen teeth in the lower jaw. In the gorilla, the size and shape of the molars and premolars are similar whereas in the *Australopithecus* and modern human, the premolars are slightly smaller than the molars. The canine teeth in the gorilla are large and prominent in the mouth. The canine teeth in the *Australopithecus* and modern human are of a similar size of the rest of the front teeth. They are not especially prominent. The incisors of the gorilla are large when compared to the incisors of both the *Australopithecus* and modern human.
- Describe the general change in lower jaw shape.
 - The lower jaw shape of the gorilla is shapes like a 'U.' The lower jaw shapes of the *Australopithecus* and modern human are more 'V' shaped.
- Using your data, decide if *Australopithecus* was quadrupedal or bipedal. Justify your answer.
 - *Australopithecus* was bipedal. I know this because of the similarity in shape between the *Australopithecus* pelvis and modern human pelvis.
- How many traits are similar when comparing (a) gorilla to *Australopithecus*? (b) *Australopithecus* to modern human? (c) gorilla to modern human?
 - (a) gorilla to *Australopithecus*
 - Their brain areas are similar as are their cranial capacities. Their lower jaws both stick out beyond the nose, they both have sagittal crests present, and they both have prominent brow ridges. The numbers and types of the teeth present are also similar (although the sizes and shape vary).
 - (b) *Australopithecus* to modern human
 - Their brain areas are both larger than their face areas. The numbers and types of the teeth present are also similar, as is the shape of the lower jaw. Neither have spaces between their teeth (diastemas) and the distance across the back and front of the jaws are similar. The pelvis shapes are also similar.
 - (c) gorilla to modern human
 - The numbers and types of the teeth present are similar (although the sizes and shape vary).

- Based on your answers to the above question, does a modern human seem to be closer in evolutionary development to the gorilla or *Australopithecus*?
→ Based on observation data, the modern human appears to be more closely related to *Australopithecus* than to the gorilla as *Australopithecus* and modern humans have a great deal of similar characteristics as compared to the gorilla and modern humans who share few features.

*Sample Data Collection Sheet and sample questions provided by Dr. Kim Nichols at Collins High School, 2006.