Bio 13A Lab #1: Human Anatomy & Physiology in Perspective

Lab #1 Table of Contents:
- Expected Learning Outcomes . . . . . . . . 1
- Introduction . . . . . . . . . . . 2
- Activity 1: Building Chimpanzees & Humans . . 3
- Activity 2: Comparison of Cat, Monkey, & Human. 4
- Activity 3: Comparison of Fossil Skulls . . . . 9
- Homework Assignment . . . . . . . . 11

Expected Learning Outcomes
At the end of this lab, you will be able to
- develop a timeline of the major events since life evolved on earth including the appearance of humans;
- explain the similarities and differences between humans, other mammals, and other primates;
- describe major trends in human evolution over the past 5 million years;
- demonstrate unique features of our own species, Homo sapiens.

Fig. 1.1 Human Skeleton
Introduction
Human anatomy and physiology is shaped by our evolutionary past and can best be understood within a comparative, evolutionary framework.

Charles Darwin laid the foundation for the study of human evolution in his landmark book *The Origin of Species*, written in 1859. He outlined the concept of natural selection which proposes that organisms adapt and change through long periods of time in response to environmental conditions. Tantalizingly, there was only one sentence in the book that related to humans: in the conclusion Darwin merely stated, “Light will be thrown on the origin of man and his history.” Thus began nearly 150 years of investigation that has yielded breathtaking discoveries about human evolution.

In recent decades, several lines of evidence have converged that provide information about the human lineage. First, numerous fossils from several sites indicate that the first humans emerged in Africa. Fossils consist mainly of bones and teeth and give us information about what humans looked like, what they ate, how they moved, and the environment in which they lived.

Fossils are interpreted in the context of comparative anatomy. Molecular data indicate that humans are most closely related to chimpanzees (we share nearly 99% of our DNA). Comparisons between humans and living apes such as chimpanzees and gorillas provide insight into early human way of life. The first humans looked similar to chimpanzees but were unique in their locomotion. All hominins (modern humans and our upright ancestors and cousins) walk on two legs, a form of locomotion called bipedality. Bipedality profoundly shaped human anatomy and behavior; for example, it freed the hands for uses other than supporting body weight.

In addition to many new fossil finds, current techniques have yielded precise dates for fossils and provide a firm chronology for events in human evolution. Together, the evidence indicates that humans shared a common ancestor with chimpanzees some 5 million years ago. Then we set out on our own unique human journey.
Check Your Understanding: Answer the following questions based on your reading of the introduction.

1. Evidence from fossils and comparative anatomy shows that the first innovation in hominin evolution was
   a. increased brain size.  b. tool making.  c. the use of fire.  d. bipedal locomotion.

2. Fossil, molecular, and comparative studies of apes indicate that hominins first emerged in

Activity 1: Building Chimpanzees and Humans

Locomotion provides the framework for much of any animal's anatomy. We will compare human and chimpanzee anatomy in this exercise. When chimpanzees move through the forests of Africa, they walk on all fours on the ground. They have a wide repertoire of locomotor behavior, and are able to briefly stand and walk upright, and hang and climb in trees. How does this compare to human locomotion?

Procedure:
1. Work in groups of three to four people.

2. Obtain an envelope that is labeled Chimpanzee & Human Anatomy Pieces.
   In the envelope, you will find 1) a page with a list of clues for assembling the chimpanzee and human anatomy pieces, 2) 12 plastic squares with isolated chimpanzee and human anatomical regions, and 3) a primate reconstruction page.

3. Use the clues to place the plastic squares in their appropriate position on the primate reconstruction page. (We won’t use the middle image of the Australopithecine.) Six plastic squares are human and six are chimpanzee. The clues give an indication of whether a particular region is chimp or human. The squares will overlap when you are finished. Hold them in place with a large paperclip.
Check Your Understanding:
What do the letters spell from top to bottom for the chimp?

________________________

What do the letters spell for the human?

________________________

Compare the features of the chimpanzee and human and select any items below that are not correct:

a. Chimpanzees are knock-kneed but this allows them to better balance the body over their legs while walking upright.
b. Compared to chimpanzees, humans show relative shortening of the arms and lengthening of the legs.
c. Despite having a torso of about the same size as a human, a chimpanzee cranium is much smaller than a human cranium.
d. The human pelvis is long and narrow providing little surface area for attachment of large buttock (gluteal) muscles useful in standing and walking upright.
e. The human foot has a divergent big toe, giving the foot a strong grip.

Activity 2: Comparison of Cat, Monkey, and Human

Humans are classified as **primates**, one of the orders of mammals that diversified after the extinction of the Dinosaurs 65 million years ago. Early primates resembled rodents; they were small, had a diverse diet, and lived in trees. Living primates include prosimians (which resemble some of the earlier primates from around 50 million years ago), monkeys, apes, and humans. Primates are characterized by grasping hands and feet (except humans no longer have grasping toes!) with **opposable thumbs**, a reliance on vision with forward facing eyes and ability to see color, and large brains compared to mammals of similar size. The large brains provide the opportunity for learning, behavioral flexibility, and complex social interactions. Primates live in social groups and offspring take a long time to grow up.

Comparison of a mammal (cat), a monkey and a human highlights features shared by all mammals, features shared by primates, and features that are unique to humans.
In assigned groups, examine the cat, monkey, and human skeletons and answer the following questions. Be prepared to explain your answers to the rest of the class.

1. Identify the following regions on each of the skeletons. Notice the general shapes of each of the different areas.

- **Skull**

- **Vertebral Column**

- **Pelvis**

- **Forelimb**

- **Hindlimb**

<table>
<thead>
<tr>
<th>Structural Similarities</th>
</tr>
</thead>
</table>

List three similarities between the skulls.

1. ____________________________

2. ____________________________

3. ____________________________
Find two features of the vertebral columns that are alike.

1. ____________________________
2. ____________________________
3. ____________________________

List three similarities between the limbs.

1. ____________________________
2. ____________________________
3. ____________________________

Explain why the animals have many similarities in their skeletons.

**Structural Differences**

Cats, monkeys, and humans share many features because they are mammals. However, they have different evolutionary histories and different ways of life and therefore have different anatomical features.

**Hands and Feet**
Examine the hands and feet. What are differences?

a.

b.

How do the differences relate to the animal’s way of life?

**Vertebral Column**
Examine the vertebral column. What are differences in the cervical region?

Can you explain the differences? Hint: Think about the way a cat uses its head and neck to eat, grasp prey, etc., versus how a monkey might use its head. How does a monkey or human eat compared to a cat and how might that behavior translate into structural differences?
How does the human vertebral column differ from the cat and monkey?

a.

b.

Explain the differences.

Pelvis
Examine the pelves. The cat pelvis is similar to that of many quadrupedal animals. It is long and narrow from side to side. How does the cat pelvis differ from the chimpanzee pelvis?

a.

b.

What are differences between the monkey and human pelvis?

a.

b.

Explain the unique structure of the human pelvis.

Limb proportions
Compare the lengths of the forelimbs and hindlimbs. Which two skeletons are most similar?

________________________________________________________________________

Explain the human limb proportions from a functional perspective.

Summary and Review
Which two of the three skeletons are more similar?

________________________________________________________________________

What anatomical features led you to the conclusion that these two were more similar?

Why would the pair have more similarities?

What features of the human skeleton are unique?

How do unique features of the human skeleton relate to human locomotion?
Fig. 1.2 Cat Skeleton

Fig. 1.3 Monkey Skeleton
Activity 3: Comparison of Fossil Skulls

The defining characteristic of early hominins (also called hominids) is that they were bipedal, as is indicated by features of the pelvis and lower limb. In other aspects of anatomy such as cranial capacity and dentition they were similar to apes.

A variety of hominids have been found that span the time period between 5 million years ago up to our own species, Homo sapiens, which appeared approximately 200 thousand years ago. One of the most challenging tasks is to assign the fossils (which are usually fragmentary) to an appropriate taxonomic category (e.g. genus and species). Variation in anatomical features such as tooth shape or facial configuration is usually due to species differences; variation in size may be due to differences between males and females or species differences. Scientists use information from comparative anatomy to try to group the fossils in genera and species.

Early fossils are usually assigned to the genus Australopithecus (“Southern Ape”). Within the genus there are several species. In general, these early hominids had a brain size comparable to apes, their dentition suggests that they ate mostly plant foods, and they had adaptations in the pelvis and lower limb for bipedality.

Genus Australopithecus
Examine the Australopithecus fossil cast.

Australopithecines are extremely varied and comprise several species from East and Southern Africa. The earliest examples date from more than 4 million years ago and the youngest are about a million years old. One of the most complete hominid skeletons ever found is the famous “Lucy”, discovered in the early 1970’s. This skeleton (officially “AL-288) from Hadar in Ethiopia has features of the pelvis and lower limb that indicate it was fully bipedal, although its pelvis and limb proportions are different than modern humans. “Lucy” and other Australopithecine fossils had small cranial capacities (400-500 cubic centimeters compared to 350-400ccs for chimpanzees). They had large back teeth compared to later humans, suggesting they were adapted for grinding plant food. Fossils from East Africa and Southern Africa show two distinct forms of Australopithecines, the Gracile and Robust. Gracile Australopithecines had more delicate faces and smaller molars. Robust forms had flaring cheek bones and enormous molars, bigger than your thumbnail! The australopithecines persisted in Africa until about 1 million years ago. Populations of Australopithecines gave rise to later species of hominids.
Genus Homo
Examine the *Homo ergaster* skull.

This cast represents part of a nearly complete 1.6 million year old skeleton found near Lake Turkana in Kenya. It is sometimes called the “Turkana Boy” because it is an adolescent. It is a member of the species *Homo ergaster* (but is sometimes assigned to *Homo erectus*). Despite its antiquity, it exhibits modern proportions with long legs, short arms, and tall stature. The presence of immature teeth and unfused ends of bones indicate that the individual had not yet achieved adult size.

Examine the Neandertal skull.

Neandertals lived in Europe and probably appeared about 500,000 years ago. Their scientific name is *Homo neandertalensis*. They migrated south to the Middle East by about 60,000 years ago and coexisted for several thousand years in the same areas as modern humans, *Homo sapiens*. Neandertals had a different skull shape than our own species, and, on average, had even larger brain size. They were robust and well-muscled, used sophisticated stone tools, and there is evidence that they cared for elderly members of their groups. The last Neandertal disappeared about 35,000 years ago. The reason for their extinction remains a mystery.

Check Your Understanding
Answer the following questions based on your observations of the skulls and information in the preceding paragraphs.

Determine which of the following statements is/are false, and explain why.
1. Neandertals have smaller brain size than humans, but have a similar shape to their skulls.
2. Australopithecines had a brain size similar to chimpanzees.
3. Australopithecine skulls show that they were adapted to eat meat.
5. Neandertals interbred with modern humans, so essentially still live among us.
7. Modern humans (*Homo sapiens*) originated in Asia 500,000 years ago.
Homework Assignment: Human Evolution in Context

Humans have been on earth a short time compared to the history of life on earth. Life originated by 3.8 billion years ago, as fossils of one-celled organisms from South Africa and Australia show. Hominids have existed for a mere 5 million years! Use the information below to construct a timeline of major evolutionary events. Take a blank piece of paper and draw a horizontal line. Use colors and small illustrations for a more effective and fun presentation. **This is homework and will be due next week.**

1. Life began at least **3.8 billion years** ago. This is off our chart.

2. **Eukaryotic Cells** appeared by **1.8 billion years** ago. Eukaryotic cells differ from earlier Prokaryotic cells by having a true nucleus that contains the genetic material, DNA.

3. By **1 billion years** ago, Eukaryotic organisms diversified because by this time there was **Sexual Reproduction** which paved the way for new combinations of genetic material.

4. **Multicellular Organisms** appeared by approximately **700 million years** ago. These had specialized cells and tissues and complex body forms.

5. The first **Vertebrates** appeared at about **500 million years** ago. These were ancient fish that had an internal skeleton with a backbone. Vertebrates continued to diversify over the next several hundred million years.

6. **Mammals** appeared approximately **200 million years** ago. The first mammals were small. The mammals revolutionized reproduction. Mammalian mothers carry the developing fetus inside their bodies and mobilize their own internal resources to produce milk for the infant once it is born.

7. The end of the Cretaceous period at **65 million years** was marked by a widespread extinction that wiped out the dinosaurs, among other organisms. This paved the way for mammals to diversify and all of the modern orders of mammals have their roots in this time, among them the Primates, the order that includes chimpanzees, apes, and humans.

8. Primates continued to diversify. By **35 million** years ago, monkey-like fossils had appeared in Africa. These **anthropoids** (higher primates) share features with modern-day monkeys.
Apes appeared in the Miocene period, at about 20 million years ago. They are distinguished from monkeys primarily because of features of the dentition and they probably had a different locomotor pattern.

The earliest humans appeared 5-6 million years ago. They belong to a group called Australopithecines (“Southern Ape”). They are distinguished from apes because of their bipedal (upright) locomotion.