POST-CRANIAL COMPARATIVE ANATOMY: Implications for Bipedalism

INTRODUCTION

As we embark on the journey into our evolutionary past, it is important to know that all of our information about human evolution, that is, the changes and adaptations that occurred in our species over time, is preserved in the form of fossils. It is therefore necessary to be able to identify the bones of the postcranial skeleton in order to understand the basic differences between living quadrupeds and bipeds (humans) so that we may interpret the fossils we find. Examining the differences in skeletal anatomy between quadrupeds and bipeds as well as observing the social behaviors and environment of the living non-human primates, enables us to get an idea of what selective pressures may have been operating in making the transition from a quadrupedal to bipedal mode of locomotion. Chimps, bonobos, orangutans, and even baboons are of particular interest in this respect.

For example, studying baboon troops on the African savanna is important in an evolutionary context because baboons not only have a high degree of complexity in their social organization, the savanna habitat was an important feature in early hominid life. Looking at adaptations to this environment by baboons can shed light on other features that may have been important for the survival of the early hominids. As Park (2001) points out, however,

> Similarities between humans and baboons exist because we have evolved variations of the same basic primate behavioral theme. Our specific expressions of those themes, though, are the results of separate and independent evolutionary histories (2001:172).

Almost all primates are, at least to some degree, *quadrupedal*, meaning they use all four limbs to support the body during locomotion. However, to describe most primate species in terms of only one or even two forms of locomotion would be to overlook the wide variety of methods they may use to move about. Many primates employ more than one form of locomotion, and they owe this important ability to their generalized anatomy. Primatologists have defined seven primary modes of primate locomotion:

(1) Slow quadrupedal climbing (e.g., slow loris, a prosimian)
(2) Vertical clinging and leaping (e.g., Indri, a prosimian)
(3) Quadrupedal walking, running, leaping (e.g., many monkey species)
(4) Brachiation or arm swinging (e.g., gibbons and siamangs)
(5) Knuckle-walking (e.g., gorillas and chimpanzees)
(6) Slow quadrumanous climbing (e.g., the orangutan)
(7) Habitual upright bipedalism (e.g., the hominids)

Although the majority of quadrupedal primates are arboreal, terrestrial quadrupedalism is fairly common and is displayed by many species, including some lemurs, baboons, and macaques. Typically, the limbs of terrestrial quadrupeds are approximately of equal length, with forelimbs being 90% (or more) as long as hind limbs. In arboreal quadrupeds, forelimbs are shorter and may be only 70% to 80% as long as hind limbs.

By now you should have acquired at least a minimal working knowledge of proper anatomical terminology. The purpose of this lab is to give you further practice in applying these terms in identifying skeletal features, and for interpreting the significance of those features in relation to behavior.

INSTRUCTIONS
In the lab folders at the table, review the ***"Atlas of Primate Skeletal Anatomy,"*** and use it to compare the following post-cranial features of the primate skeleton for each of the primate species listed.

OLD WORLD MONKEY Old World Monkey species tend to spend time both in the trees (arboreal) and on the ground (terrestrial). They move about on all fours and are therefore, quadrupedal, distributing their body weight equally through the upper and lower limbs in both arboreal and terrestrial contexts.

1. Describe the length & robusticity of the arm bones in relation to the length of the leg bones.

2. Describe the size and shape of the pelvis.

CHIMPANZEE Chimpanzees are also arboreal and terrestrial quadrupeds, but they have developed a specialized mode of locomotion due to their greater body size. In order to support their upper body weight, chimps must use their knuckles to support them during locomotion, known as knuckle walking.

1. Describe the length of the arm bones in relation to the length of the leg bones.

2. Look carefully at the humerus (upper arm bone). Compare the build of the humerus with that of the femur (upper leg bone – thigh bone) and describe.

HUMAN As bipedal primates, humans have a strikingly different functional anatomy than quadrupedal primates. Major differences occur in the pelvis, the verterbrae, the limb bones, and the bones of the foot.

1. Describe the length of the arm bones in relation in to the length of the leg bones.

2. Look carefully at the humerus and the femur. Compare the build of the humerus with that of the femur and describe.

3. Look carefully at the radius and ulna (lower arm bones) and the tibia (lower leg bone – shin). Compare the build of the lower arm bones with that of the tibia.

4. Look at the spines of the chimpanzee and the human. Describe any differences you observe in the shape of the spine and in the cervical (neck) vertebrae, thoracic (trunk) vertebrae, and lumbar (lower back) verterbrae.

5. Now, compare the pelvic bones of the Human and the Chimpanzee.

Pelvic feature:	Chimpanzee	Human
Length of pelvis		
Robusticity of pelvic bones		
Pelvic opening (wide or narrow?)		
Sacrum (size & robusticity)		

- Now, turn to the page in the *Atlas of Skeletal Anatomy* (last page) which depicts the skeletons of four primates which use different types of locomotive patterns. Answer the following questions based on your observations of the illustrations.

A) What do the long arms and short legs of the gibbon (skeleton d) tell you about this primate's primary locomotive pattern?

B) What do the long and relatively thick & strong leg bones tell you about the movements of the indri (skeleton c)?

C) The limbs of the savanna baboon (Old World Monkey) and the bearded saki (New World Monkey) are relatively similar in proportion. However, the tails of these two types of monkey differ in length. Why would the tail of a terrestrial quadruped be different from that of an arboreal quadruped? Explain.

- Go to the lab table where the human and bonobo hands and feet are placed. Observe each specimen carefully and answer the questions below.

1. Using the labels, identify which hand and foot belong to each primate. Check your answers with instructor.

   Chimp hand _____ Human hand _____

   Chimp foot _____ Human foot _____

2. What explains the curvature to the bones of the bonobo hand and foot?

3. In what features of the foot (use correct anatomical terminology) do you observe the strongest differences?

ANALYSIS: Answer the following questions based on your observations from this lab.

1. Explain why the bones of the human arm are smaller (in both length and size) than the chimpanzee.

2. Explain why the arm bones of the chimpanzee are larger (in both length and size) than their leg bones.

3. Explain why the arm and leg bones of the monkey are of approximately equal length & robusticity.

4. *Explain the differences* in the size and shape of the pelvis of chimps and humans in terms of how each primate carries their body during locomotion.

5. Why would a divergent and opposable big toe be advantageous for chimps & bonobos?

6. Why would a non-divergent and non-opposable big toe be advantageous for a bipedal walker?