

**Subject: Anthropology**

Production of Courseware

 **-Content for Post Graduate Courses****Paper No. : 01 Physical/Biological Anthropology****Module : 04 Comparative Anatomy Between Man and Apes**

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Description Of Module	
<b>Subject Name</b>	Anthropology
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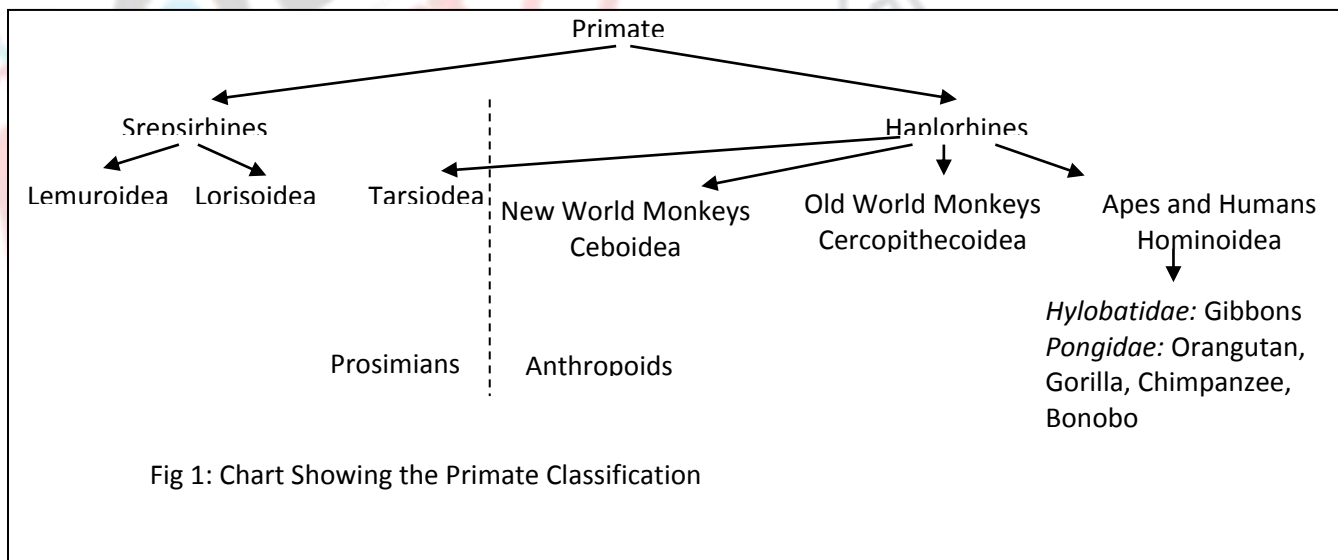
### Learning Objectives

- Relation of Human And Apes
- Overview of Living Apes
- Anatomical Difference Between Human And Apes

## Introduction

Human and apes belong to the same order – primate along with monkeys and small prosimians. Primates are mammals which have grasping hands, large brains and high degree of learned rather than innate behavior. But primates are diverse group and not all species share the same traits. There are about 300 species of non human primate currently recognized, but including all the minor taxonomic variations of these species, there are more than 400 varieties (groves, 2001). Carl Linnaeus divided the primates into two suborder base or anatomy – prosimian (lemurs, lorise and tarsiers) and anthropoid (monkeys, apes and human). However, later on, saint hillarie has developed a modified classification system base on genetic relationships – strepsirhine or strepsirhine (lemurs and lorises) and haplorhini or haplorhine (tarsiers, monkeys, apes and human). The different in these two classification system is the position of tarsiers. Later scholar considered tarsiers as haplorrhine primate and though to occupy an evolutionary position between prosimian and anthropoid primate. They possess a mixture of traits of anthropoid and prosimian primates but they are generally considered to be closer to anthropoids.

Human and apes are classified in the super-family hominoidea under haplorrhines suborder which also included monkeys and tarsiers. Hominoidea have three families – hylobatidae (the gibbons); pongidae (the chimpanzee, bonobos, gorilla and orangutan) and homininae (the humans) (see chart on primate classification).



## Overview of living apes

Apes can be divided into two – lesser and greater apes. Gibbons are considered as lesser apes while members of pongidae family are considered as greater apes.

**Gibbons:** gibbons are the smallest apes of all. They are found in Asian tropical and subtropical forest from easternmost India and Bangladesh through mainland Southeast Asia and Indonesian archipelago. Their body size ranges from 4kg to 12 kg. They are highly arboreal and adopted brachiation mode of locomotion. Their arms are long and have extremely elongated fingers with shortened thumbs and suspensory shoulder especially designed for treetop life. They are frugivorous and eat varieties of fruits. They are among the most vocal of all non-human primates.

**Orangutans:** orangutans are the most enigmatic hominoid primates. They are found only in the rain forests of Indonesian islands of Sumatra and Borneo. They have large body size and exhibit extremely sexually dimorphic. Male may weigh about 78kg while female may weigh only half of male's weight. They are highly arboreal and travelled slowly and cautiously on the canopy of the forest. But sometime they travel quadrupedally on ground. Sometime, they are referred to as four handed for their tendency to use all four limbs for grasping and support. They are frugivorous but also eat bark, leaves, insects and rarely meat.

**Gorillas:** gorillas are the largest primate weighing more than 200kg. They are restricted to the forest areas of western and eastern equatorial Africa. They are primarily terrestrial and practice knuckle walking on ground. They are extremely sexually dimorphic with male weight more than 50% of female weight. They have tall head due to the presence of vault crest. They are exclusively vegetarian and eat leaves, pith, stalk and fruits. They are gentle and move slowly. They live in group which include both male and female adult with their sub adult offspring.

**Chimpanzees:** chimpanzees along with bonobos are our closest living relatives. Men share a great similarity genetically with chimpanzee. They are extraordinarily adaptive animals found across equatorial Africa from lowland rain forest to nearly open grasslands. Male weight up to 68kg and female are about 10-15% lesser. Chimpanzee spent more time on tree. They are frequently excited, active and noisy. In addition to quadrupedal, knuckle walking they may brachiate. On ground they frequently walk bipedally for short distance when carrying food or other objects. They eat a highly diverse diet including fruits, insects, nuts, bird's eggs, berries, caterpillar and smaller mammals. They sometime kill monkeys, wild pig, young antelope and other small animals for food. Occasionally male and female take part in group hunting.

**Bonobos:** bonobos are also called as pygmy chimpanzees because of their slightly more slender build. They exhibit more modest sexual dimorphism than the other great apes. Male and female have similar

body sizes but male have larger skull and canine teeth. They are found only in an area south of the Zaire river in democratic republic of the Congo. They have longer legs relative to arms, relatively smaller head, and dark face from birth and tufts of hair at the sides of the face. They are more arboreal than chimpanzees. They eat largely fruit diet but rely more on leafy plant material from the forest floor than chimpanzee do. They occasionally eat meat derived from small mammals.

### **Comparative anatomy of human and apes**

Since human and apes belongs to same super family, they share many similar traits like increased brain volume and intelligence, extended ontogeny, increases complexity of social interaction and large body size. They also share some key postcranial anatomical traits. Most importance one is suspensory, rotating shoulder apparatus that allows for arm hanging and arm swinging or brachiation. The four great apes have developed form of quadrupedalism called knuckle walking or in case of orangutan fist walking.

Amidst these similarity human and apes also have lots of anatomical difference. Most of these differences are raised because of bipedalism and adoption of erect posture in human. Changes in dietary habit like rely on cock and more tender food in human also brings many changes in dentition. Some of this difference will be discussion in the following headings.

#### **A. skull**

The size of the human brain increased during the cause of evolution and become much larger than any of the living apes. It ranges from 1300 cubic centimeter (cc) to 1450 cc. The size of orangutan brain ranges between 365 cc to 425cc; that of chimpanzee between 400 cc to 500cc and that of gorilla between 400 cc to 550 cc. Thus, in human the brain size is almost three fold larger than the average apes' brain size. To accommodate this large brain size, human cranium becomes larger and more protruding. Consequently, the facial portion is reduced and become smaller than the cranium portion in human. However, apes have larger facial portion then the cranium portion. In human face is also becomes more vertical than that of apes'.

As a result of larger brain size, human have more prominent and arched forehead. Apes lack forehead. The frontal and parietal tuberosities become well marked in human cranium compared to that of apes. Occipital bone is well arched and is more protruding in human compare to apes. The vault of human cranium is smooth and rounded and more or so in chimpanzee but gorilla have sharp crests with rough surface while orangutan has less marked ridges. The foramen magnum, the hole where spinal cord joined with the brain, is anteriorly placed on the base of the occipital bone in human. The position of foramen magnum is important because it is the attachment point of vertebrate column with skull. By placing the foramen magnum anteriorly, the skull is well mounted on the top of the vertebral column in



a proper balance. But in case of apes the foramen magnum is placed toward posterior making the skull to hang on vertebral column. To balance the head a strong muscle need to be attached to the posterior side of the skull in apes. So, the nuchal region is rugged in apes while it is comparatively smooth in human. Moreover, the nuchal plane is also horizontally flat on the base of the skull facing directly downward in human. But in apes it faced backward forming an angle with the base of the skull. The sutures in human cranium are highly serrated and fused at very late age or exist throughout one's life. While the sutures of apes are less serrated and starts to fuse at the early age.

The shape of orbit in human is rectangular with rounded angles. But the chimpanzee have more or less elliptical orbit while orangutan and gorilla have oval or rounded orbits. The supra-orbital ridges in human are varies in size and separated. But gorilla has massive and fused supra-orbital ridges. Chimpanzee have prominent but separated supra-orbital ridge while orangutan have prominent but continuous.

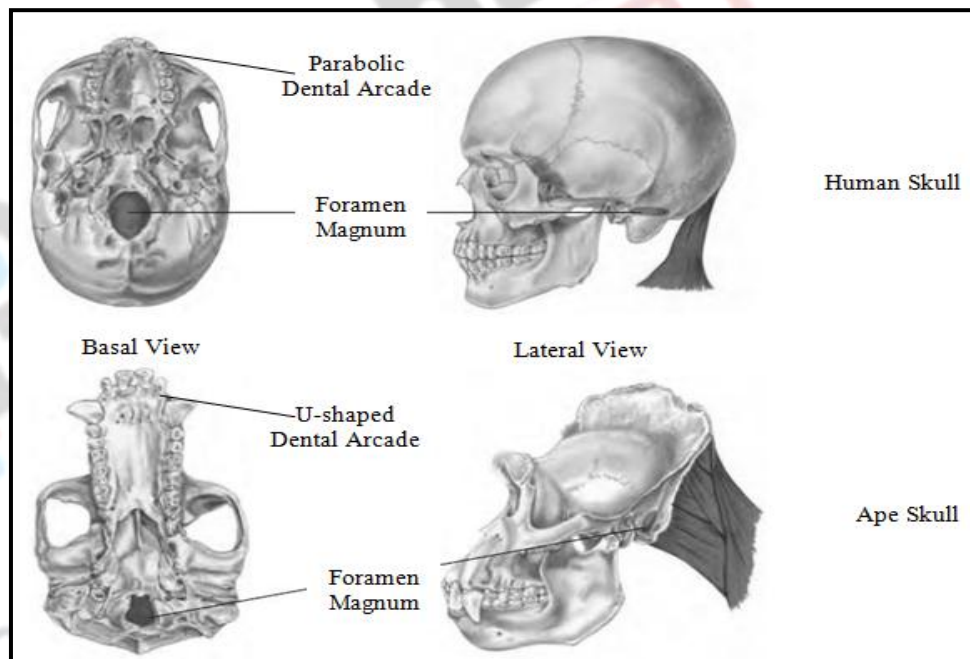


Fig 2: skull of human and ape (source: biological anthropology by stanford c, allen js and anton sc. Pearson prentice hall, 2012)

The nasal bones in human are short and broad with raised nasal bridge. But apes lack nasal bridge completely. The nasal bones in chimpanzee are short and flat; long in orangutan and long and wide at base in gorilla. Nasal sutures are present in human and chimpanzee but tend to absent in gorilla and often absent in orangutan. The nasal apparatus in human are pear shape. It is so in chimpanzee and orangutan but gorillas have oval shaped nasal apparatus. Infranasal spines are sharp in human but absent in apes. Premaxilla is fused to maxilla in human but it is well marked in apes. Alveolar

prognathism is well marked in apes but it is variable in human makes the face more vertical compared to apes.

## **B. teeth and lower jaw**

The morphology of teeth is associated with the dietary habit of the animal. Since human have adapted to cooked tender food the size of the teeth is also reduced. Human have comparatively smaller teeth than the apes. The canine in human is no more use for tearing of flashes. So, it is much reduced in size that it becomes more or less in same height with other teeth. The canines in ape are larger, pointed sharp and projecting. **Diastema** are variably present in apes while it is absent in human. The posterior teeth in apes are larger than the human and are arranged in parallel. This give the *dental arcade* of apes a u shaped. In human it is parabolic. The roots of the molars are convergent in human but divergent in apes.

Human have slender and light mandible or lower jaw with distinct chin. Apes have large and massive mandible without chin. The sigmoid notch is deep and narrow with ascending narrow and high ramus. Ape have shallow and broad sigmoid notch with broad, short and large ascending ramus. In human genial tubercle is present and simian shelf is absent while it is opposite in apes.

## **C. vertebral column and thorax**

The vertebral column is made up of series of bones called vertebrae joint together. It can be divided into four region or segments – cervical vertebrae (neck), thoracic vertebrae (thorax), lumber vertebrae (lower back) and sacrum-coccyx (pelvic). In apes vertebral column has a single curve forming c-shaped making thoracic region slightly convex. But in human it is s-shaped by adding two secondary and opposing curves in cervical and lumber region to the c shaped curve of apes. The s-shaped vertebral column brings the center of gravity just below the body between the two feet. The s-shaped vertebral column also made it able to carry the weight of the body and transmitted over the hips and then ultimately over the two feet. However, in apes the center of gravity falls in front of their feet causing them to fall forward when stand or else dance to avoid falling.

In human, the amount of weight bore increase as we go down the vertebral column. This is reflected by the gradual increase in size of these vertebrae toward the lower region. Vertebrae are largest in lumber region. The increased size of the lower vertebrae poses a side effect in human. Lower back pain is a common medical problem especially among the pregnant women when the weight bore by the vertebral column increased. However, in apes the weight bore by the vertebral column remain more or less same along the vertebral column and hence the size of the vertebrae body is almost equal throughout.



The spinous process of the vertebrae is projected downward specially in cervical region in human. But in apes these process are vertical to the axis of the vertebral column. The orientation of vertebral column in human is also different from apes. In human, as the position of the foramen magnum is changed, the column comes out from the base of the skull rather than from the back of the skull in apes.

Shifting the center of gravity also brings changes in the shape of the thorax. The human thorax is barrel shaped with the content of thoracic pulling downwards by gravity. The transverse diameter is greater than the dorso-ventral diameter. The shoulder girdle is broader and clavicles become longer than the apes. However, in apes the shaped of the thorax is like an inverted cone with the point at the top.

#### **D. Pelvis and birth canal**

Adaptation to bipedalism brings lot of changes in the pelvis anatomy. When walking, the weight of the body has to balance over a single leg alternatively. Human pelvis has evolved changes that automatically facilitate this balancing. In apes, this balancing is done by throwing their weight over the supporting leg making then rock from side to side when walking on biped. This causes them more energy than human.



Fig 3: pelvis of human and ape (*source: biological anthropology by stanford c, allen js and anton sc. Pearson prentice hall, 2012*)

Anatomically, pelvis is made up of two innominate (os coxae) bones. Each innominate bone is again composed of three bones – ischium, ilium and pubis – fused together during adolescence and the sacrum part of the vertebral column. The ischium is the bone that we sit, ilium is the bone that we feel on our hip and pubis is the anterior bony portion of the pelvis in the pubic region. These bones are arranged in such a way that it gives a basin shaped in human with a short, broad ilium that runs from posterior to the anterior of the person. But in apes, ilium is long and flat and placed on the back of the animal. This basin shaped pelvis support the abdominal organs that are in a constant tendency to be pulled down by gravity and hence help in locomotion. The shortening and broadening of ilium in

human makes the *acetabulum* to placed closer to the joint between sacrum and ilium. This is good modification for balancing but it makes the birth canal. A. Human narrow. These, along with enlarges cranium make child birth a more difficult task for human compared to apes.

### E. Leg

Bipedalism brings changes in the anatomy of legs also. The weight of the body through the pelvis is passed on to femur in human. The femurs are adapted to facilitate bipedalism. Though the femur of both man and apes are same in appearance lots of variation does exist. The head of the femur articulate with acetabulum at pelvis which faces downward and outward. The human pelvis becomes broader than the apes. This made the head of the femur to place far apart to the side of the person. But the center of the gravity should be brought between the feet for better balancing. In order to facilitate this femur is placed in an angle from the hip into the knee making the lower end of the femur become closer at knee. In apes, the femurs are placed almost parallel to one another. This make the angle form by the head of the femur and the axis of the femur is larger in human compared to that of apes. This change gives an efficient striding and less energy loss during walking in human compared to apes.

Moreover, to borne the weight of the body the shaft of the femur in human is slightly curved. *Linea aspera* is well marked in human but diminish in apes. Further, the distal or lower end of the femur (femoral condyles) is enlarged in human. Correspondingly, the top of the tibia or shin bone, where lower end of the femur articulate is also enlarged. However, in apes the lower end of femur and top end of the tibia is comparatively smaller. In overall the leg is lengthened relatively to the trunk length than that of apes during the cause of evolution. Longer legs are always in favor because of increase stride length and efficiency in walking.

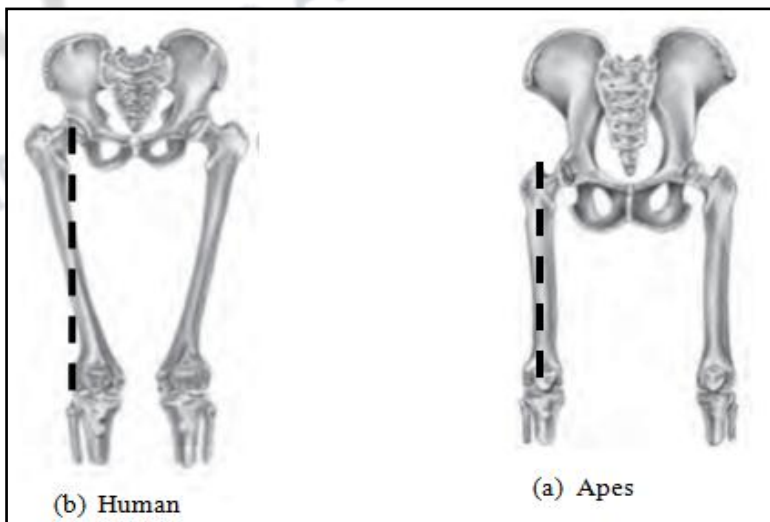


Fig 4: position of femur (source: biological anthropology by stanford c, allen js and anton sc. Pearson prentice hall, 2012)

## F. Foot

Most different in the anatomy of human and apes foot is the outcome of the bipedalism and adoption of erect posture in human. The foot skeleton is composed of three types of bones: tarsal's which form the heel and ankle region; metatarsals and phalanges which form the toes. To facilitate efficient striding and carry body weight, the human feet got adaptation. When one walks the heel strikes first on ground and follows by rest of the foot. When leaving the ground, heel raised first and the main propulsive force comes from the toes off. To get this force big toes pushed off the ground by bending strongly backward (dorsiflex). To make this possible the big toe in human become larger and aligned together in same line with other toes. But quadruped apes' big toes are not in same line and place far apart from the other toes. The phalanges in human are shorten than that of apes'. In human the tarsal portion is longer than the phalanges portion whereas it is vice versa in case of apes. Moreover, human foot is stouter with robust tarsal and big toes which are tightly bind together by ligaments making it more stable but less flexible. But in apes big toe is place apart from the other toes and is opposable. This make the foot of apes prehensile. All the toes in apes are equally developed and hence are more or less same in size but in human big toes is the biggest and lateral digits gradually reduced in size making the last digit the smallest.

Human foot is also complement with two arches to accommodate the body weight. First, the transverse arch running from the medial to lateral side formed by wedge shaped tarsal's. Second, the longitudinal arch running along the length of the foot formed by metatarsals and tarsal's. This structure help in reducing the chance of fatigue fracture of lower legs. Apes lacks transverse arch.

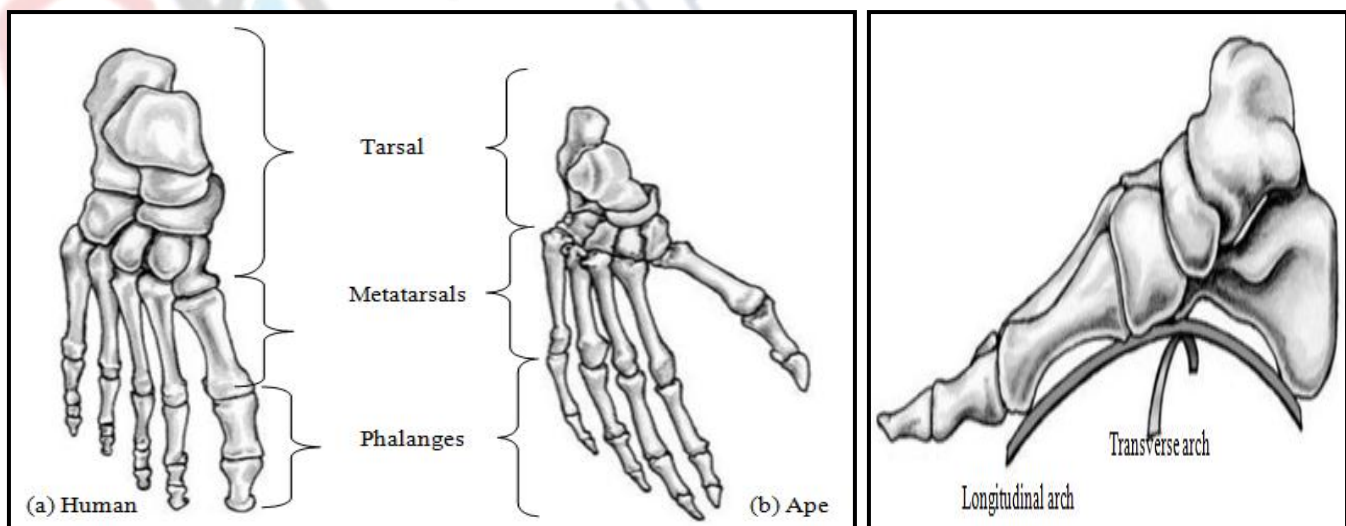


Fig 5: anatomy of foot (source: introduction to physical anthropology by jurmain r, kilgore l, trevathan w and ciochon rl. Wadsworth, cengage learning, 2010)

## G. Arm

Unlike in apes human arm is no longer used for walking. It become free and extensively use for carrying objects, hold things and making tools. In apes hands are still using for walking. This makes the hand bones of apes robust to carry the body weight when walking. Human hand becomes less robust. Apes arm are also longer than the lower limbs but in human lower limbs are longer than the arms. Thumbs is opposable and do not orient downward in human but in apes thumb is shorter than human and face downward. Phalanges are comparatively shorter than that of apes. The fingers are straight in human but curved in apes to help them hanging on branches of tree. Human have stronger power and precession grips compared to apes.