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PRIMATE STUDY

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BLOCK 3 PRIMATE STUDY

Introduction

Man is primate of the primates with a unique place in the animal kingdom due to most distinguishable primate characteristics. He and the non-human primates of apes and monkeys descended from a common ancestor. The non-human primates particularly the apes are our close relatives. Primates as multi-cellular animals are mammals with a rather generalised anatomy. Two categories can be distinguished among the primates: prosimians or lower monkeys (tree-shrews, lemurs, lorises and tarsiers), anthropoids or higher primates (New World or platyrrhine monkeys, Old World or Catarrhine monkeys and man). There are many characteristics which are common to both the groups of primates. Humans are closely related to great apes as shown by anatomical- molecular-behavioural evidences inspite of many typical characteristics in which they differ from each other. The ancestral or basal primate stock separated from the common eutherian stock, emerged as an independent order and evolved as prosimians during Palaeocene of 70-60 myr BP, as cuboids and pongids of Oligocene of 40-20 myr BP, and as protohominids during Pliocene of 12-4 myr BP. Squirrel-like, simple prosimian primates made their first appearance, followed by their adaptive radiation till the Oligocene time when the New World monkey and the anthropoid apes came to the scene. The predominance of the latter continued during the Miocene epoch. During the Miocene and Pliocene epochs the Pliopithecus-Proconsul-Dryopithecus-Ramapithecus groups made remarkable progress in the Old World. Of all the classifications of primates, the one by G G Simpson seems to be most convincing.

The human behaviour including that of the extinct hominids can be best understood and interpreted from the studies of non-human primates in their natural setting. This has to be gauged from the findings of field investigations among the non-human primates on their activity pattern, social organisation, mating patterns, reproduction, parental care, territoriality, communication, life span, dominance and aggression, communication, social behaviour, sexual behaviour, and so on. These behavioural aspects have been examined among such non-human primates as rhesus monkeys, baboons, presbytis, and great apes. The rhesus monkey helped in the discovery of Rh factor, which has been found to be hereditary in Homo sapiens. The great apes have been found to be similar to humans in anatomical, physiological and behavioural traits.

In the construction of primate phylogenies including those of hominids, the biological sciences of palaeontology, comparative anatomy and morphology played a significant role. These methods have been found to be inadequate in the matter of convincing interpretation of the phylogenies. Recent advances in modern genetics revealed the development of important techniques and approaches of signal importance in understanding the relationships between the great apes and man. Among these can be mentioned the immunological technique, molecular approaches, DNA hybridisation, mobile DNA elements approach, and human-chimpanzee-gorilla trichotomy. Morris Goodman's 1960s analysis revealed greater similarity between African apes and man than between Asian apes and humans. Sarich and Wilson through their molecular approach in 1971 found that man; gorilla and chimpanzee shared a common ancestor about five million years

ago. Yunish and Prakash, Mai and kluge all in 1983 and Schwar in 1984 found biomolecular similarities between man and African apes. DNA hybridisation, mobile DNA elements approach and man-gorilla-chimpanzee trichotomy also support the above findings. The process of hominisation is supported by details of comparative anatomy of man and apes in the context of skull, spine, pectoral girdle, pelvic girdle, and lower limbs. The block on Primate Study will facilitate in understanding Man better.



UNIT 1 LIVING PRIMATES

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- 1.1 Introduction
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Learning Objectives



We consider ourselves as the highest among all beings. But we hardly know about ourselves. Once you have studied, this unit you will be able to understand the

- distribution of MAN including non-human primates (our closest relatives);
- characteristics of MAN including non-human primates;
- classification of MAN including non-human primates; and
- evolution of MAN including non-human primates.

1.1 INTRODUCTION

That modern MAN, *Homo sapiens sapiens*, is a primate and a close cousin of monkeys and apes cannot be denied. Yet, few people understand the relationship between them. Neither man nor the non-human primates can be defined on the basis of one or two features. They can be best defined on the basis of the general pattern displayed by them or by the complexes of their characteristics. So, what do we mean by the term primate (as this term also includes human beings)? Unless we know this, it would be difficult for us to proceed with our discussion on *living primates*, “our close relatives”.

Carl von Linnaeus, a Swedish botanist, chose the term ‘primate’ (meaning first or the highest amongst all), for the specific order Primates of Animal *Kingdom*, Class Mammalia, including humans and the nonhuman primates, i.e., lemurs, tree-shrews, lorises, aye-ayes, pottos, bush babies, tarsiers, monkeys and apes. From a little shrew like ancestor, these animals are dominating this kingdom.

The evolutionary story of the primates – beginning from the prosimians at one end of the spectrum to the highly complex man at the other end – is now revealed in an ever new and fascinating manner.

Within the Class Mammalia, there is tremendous diversity — from tiny shrews to gigantic whales, from flying bats to burrowing badgers, from pronghorns to sloths, from opossums to artists and engineers and mammalogists.

1.2 DEFINITION

Primates are multicellular animals (metazoans), possess an internal skeleton (chordata), segmented vertebral column (vertebrates), maintain constant body temperatures within a few degrees like other mammals and birds (homeotherms), are mammals for they possess a complex of traits such as mammary glands, suckling of young ones, hairy body, give birth to young ones, warm blooded, heterodontism, have a single dental arch which articulates with the squamosal bone of the skull, have the thorax separated from the abdomen by a muscular diaphragm and are diphyodont. The primates have retained rather a primitive and generalised anatomy, which lacks many specialisations; they are not radically changed from earliest mammals, especially those ancestral to primates.

Primates represent the 7th largest order (including both living and extinct) with 51 genera and 168 species. Of these, 16 genera and 50 species are in the New World. This order is often considered to be the most important of the mammals. No one denies that modern man is a primate yet few people understand why man is classified with animals such as the tree shrew, loris and aye-aye. Most nonhuman primates occur in tropical areas. Because of his (Man's) cultural and biological plasticity, man adapts to most biomes.

None of these traits characterise all members of the order *Primate*. There are always exceptions to singular traits. Even today the classic definition of the order *Primate* propounded by Mivart in 1873 holds good. Primates cannot be easily defined as they are characterised by a combination of primitive features and progressive trends; for instance, primates can be defined as under:

“Unguiculate, clavicate, placental mammals; with orbits encircled by bony rim; three kinds of teeth; at least at one time of life; brain always with a posterior lobe and a calcarine fissure; the innermost digits of at least one pair of extremities opposable; hallux with a flat nail or none; a well-developed caecum; penis pendulous; testes scrotal; always two pectoral mammae (Mivart, 1873)”.

1.3 CHARACTERISTICS

There are no distinguishing features which characterise them all – except a negative one, i.e. their lack of specialisation. Primates are distinguished from other mammals by one or more of the following traits: unspecialised structure, specialised behaviour, a short muzzle, comparatively poor sense of smell, prehensile five-digit hands and feet possessing flat nails instead of claws, acute vision with depth perception due to forward-facing eyes, a large brain, and prolonged pre- and post-natal development. Most species bear a single young and live in troops headed by a male. They include the prosimians or lower monkeys lemurs, lorises and tarsiers and the anthropoids or higher primates (New World monkeys, Old World monkeys, and apes and man). Primates range in size from the Mouse Lemur, which weighs only 30 grams (1.1 oz) to the Mountain Gorilla weighing 200 kilograms (440 lb). Monkeys range in size from the Pygmy Marmoset measuring 140 to 160 millimeters (5½–6½) long (including tail) and

weighing 120 to 140 grams (4–5 oz), to the male Mandrill of about one metre (3.3 ft) length and having a weight of 35 kilograms (77 lb). Some are arboreal (living on trees) while others live in the savanna. Their diet differs amongst various species. It may contain any of the following: fruits, leaves, seeds, nuts, flowers, eggs and small animals (including insects and spiders).

In the past, tarsiers (commonly called as owl monkey) have been grouped together with the strepsirhines as prosimians, because they retain many primitive features which are absent in higher primates. Tarsiers are crepuscular and have very large eyes unlike in any other primate. They have adapted to a specialised lifestyle as vertical clingers and leapers. However, tarsiers share a number of distinctive specialisations with anthropoids that suggest that they are more closely related to each other than to the strepsirhines. Hence, tarsiers and anthropoids (higher primates) are classified together as haplorhines.

The following are the main characteristics of the primates:

- ❖ The anatomy of Primates enables them to maintain semi-erect and erect postures and locomotor patterns.
- ❖ They have pentadactyl hands and feet (a very primitive trait).
- ❖ They have flattened nails on each of their digits excepting tree shrews.
- ❖ They possess a relatively low density of body hairs (hair instead of fur).
- ❖ They have fewer tactile hairs.
- ❖ The olfactory area of their brain is reduced. They thus have an increased dominance of vision over smell, and reduction in the length of the (nose) snout
- ❖ The visual area of their brain is expanded.
- ❖ Their eye sockets are completely encircled by a bony ridge. Their eyes are more forwardly directed on the skull (for binocular vision) suggesting development of a stereoscopic vision.
- ❖ They show an increased reliance on stereoscopic vision at the expense of smell (the dominant sensory system in majority of the mammals).
- ❖ Some primates have developed a three color vision.
- ❖ They have pseudo-and true-opposability of the thumb and the great toe (i.e., the two function, to a varying degree, independently of the other digits. They are widely separated from them); usually they have both these digits, on hands and feet, opposable for grasping purposes.
- ❖ Some have prehensile tails.
- ❖ They possess relatively larger and complex brains.
- ❖ Most female primates have a simple unicornuate uterus.
- ❖ They are placental mammals with longer gestation period and generally give birth to only one or two infants at a time.
- ❖ They have year round fertility.
- ❖ Their infants have prolonged physical and emotional dependence upon their mothers, i.e. they have a longer period of infant dependency and parenting.
- ❖ They have prolonged growth and maturation periods and long life spans.

- ❖ They display a reduction in the number of teeth, i.e. they have an incisor and premolar less in each half of the upper and lower jaws unlike those in the primitive placental mammals.
- ❖ They have retained a primitive clavicle.
- ❖ They possess a separate radius and an ulna in the forearm and a separate tibia and a fibula in the lower leg (excepting tarsier).
- ❖ They show reduction in the length of their external tail.
- ❖ They possess a shortened vertebral column.

Prosimians, the simplest and the lowliest of the primates, have comb-like incisors and canines (lower front teeth forming a toothcomb; also known as procumbent lower incisors and canines); and a specialised claw on their back feet for grooming whereas monkeys use their hands.

Platyrrhines display a variety of quadrupedal locomotor types ranging from squirrel like scrambling to leaping and forelimb suspension. Atelines and capuchin monkeys are distinctive among primates in having a specialised prehensile tail that can grasp around branches for extra support. Their dental formula (DF) is 2.1.3.3. Though this DF is similar to that of prosimians yet the typical prosimian tooth comb is absent in them.

Strepsirhines have elongated and forwardly projecting lower front teeth that form a toothcomb. These teeth are used for grooming the fur and for obtaining resins and gums from trees as source of food. The digits of the hands and feet bear flattened nails, rather than claws, excepting the second toe, which has a sharp toilet claw for grooming. They also have a moist, naked rhinarium and cleft upper lip (similar to the wet noses of dogs). Most strepsirhines are nocturnal and have large eyes. Their brain size is relatively small and the snout tends to be longer than the haplorhines.

The Old World monkeys include some terrestrial species such as the baboons and man, whereas the New World monkeys are exclusively arboreal. Some New World monkeys have a prehensile tail for grasping. Cercopithecids or the Old World monkeys, and the hominoids or apes and humans are distinguished from Ceboidea in the development of a tube like (rather than ring like) tympanic bone to support the eardrum (refer table below):

Ceboidea	Cercopithecoidea	Hominoidea
Platyrrhines	Catarrhines	Apes (Pongidae)
New World Monkeys (NWM)	Old World Monkeys (OWM)	Man (Hominidae)
Flat nosed	Sharp nosed	Sharp nosed
Broad nasal septum	Narrow nasal septum	Narrow nasal septum
D.F. 2.1.3.3; an extra premolar	D.F. 2.1.2.3	D.F. 2.1.2.3
	Bilophodont	Dryopithecus pattern of lower molar
	Incisors broad and spatulate	Incisors broad and spatulate
Prehensile tail	Tail never prehensile	Tail altogether absent



(Broad nasal septum)



(Narrow nasal septum)

Platyrrhines (Ceboidea or NWM) Catarrhines (Cercopithecoidea or Hominoidea; OWM)

Source: Seth, P.K and Seth, S. 1986. The Primates, New Delhi, Northern Book Centre

Diagrammatic representation of the nasal septum in the NWM and OWM

Catarrhines (OWM; DF 2.1.2.3) are a highly successful group comprising more than 80 species. They are distinguished from other anthropoids in having bilophodont molar teeth which bear a pair of transverse crests. They also have naked, roughened sitting pads on their rumps called ischial callosities - a feature they share with hylobatids.

Hominoidea is the superfamily to which both apes and humans belong. MAN shares numerous structural similarities with the apes but the most significant feature is the absence of tail, large body size and shortened trunk. Hominoids are distinguished from cercopithecoids by the occurrence of primitive nonbilophodont molars, larger brains, longer arms than legs (except in humans), a broader chest, a shorter and less flexible lower back, and absence of tail. Many of these specialisations are related to a more upright posture in apes associated with a greater emphasis on vertical climbing and forelimb suspension.

Hominoids contain two families: pongidae and hominidae. Pongidae includes the hylobates (gibbons and siamangs), and the great apes (orangutan, chimpanzee and gorilla). The Hominidae includes the humans (*Homo sapiens*) only. The gibbons and siamang (*Hylobates*) are the smallest of the hominoids (4–11 kg or 9–24 lb), and due to which they are sometimes referred to as the lesser apes. The nine or so species are common throughout the tropical forests of Asia.

The great apes are remarkable in having the longest arms in any primates, which are 30–50% longer than their legs. The gibbon and the closely related siamang of the superfamily Hylobatinae are characterised by their highly specialised mode of locomotion, called brachiation, by which they swing below the tree branches using only their forelimbs. They are small tailless, arboreal apes having ischial callosities and exceptionally long arms including prehensile hands.

The Gibbons are fruit eaters, whereas the larger siamang consumes a higher proportion of leaves in its diet. Hylobatids live in monogamous family groups in which males and females are similar in size.

The Great apes are included together in their own subfamily of Ponginae to distinguish them from humans, who are placed in the family Hominidae. However, recent anatomical, molecular, and behavioural evidence has confirmed that humans are closely related to the great apes, especially the African apes. For this reason, most scientists now classify them together in a single family, the Hominidae.

MAN	APES
Orthograde locomotion	Pronograde locomotion
Great toe largest	Great toe not the largest
Forward positioning of foramen magnum	Foramen magnum backwardly directed
Strong development of mastoid processes	Mastoid processes not well developed
Vertebral column has moved anteriorly into thorax	Vertebral column dorsally placed
Dorsal shift of shoulder joints and scapula	Shoulder joints and scapula laterally placed
Largest brain	Small brain
Marked reduction in the size of face and lower jaw	Large face and lower jaw
Everted chin	Receding chin
Forward positioning of eyes	Obliquely laterally directed eyes
Post-canine length less	More post canine length
Canine size same as other teeth	Canine protrudes out of the tooth rows

1.4 EVOLUTIONARY TRENDS

The oldest known fossil remains of primates appeared about 60 mya. Man, even today, is regarded as the most evolved among the primates. These earliest primates were small, forest dwelling, and insectivorous mammals not larger than a rat. The Primate adaptive radiation began sixty-five to seventy million years ago in the Palaeocene epoch. Though the living primates could be arranged in order of increasing their anatomical and behavioural complexity, they are the end products of their own evolutionary lines.

Early Tertiary Period

The climate of the early Tertiary period — about 66.4 million years ago - was warm with wide tropical and subtropical zones extending from the equator up to the higher latitudes in both the Old and the New World. During this period, the most primitive of the primates were in existence. During the Palaeocene epoch, which lasted for about 8.6 million years (c.66.4 million-c.57.8 million years ago), there were many primates in existence. Three of these families had long chisel-shaped teeth that resembled those of the rodents with which they competed for a similar ecological niche, or habitat.

During the Palaeocene and Eocene epochs (from about 66.4 million to about 36.6 million years ago) early in the Tertiary period, more advanced primates appeared. During these epochs, an explosive primate radiation took place which dwindled in the Oligocene (Oligo = small). Lemuroids, Tarsioids and Platyrrhines have been recognised in the Palaeocene and Eocene epochs of America, Europe, Egypt and Burma. The Adapidae family represented by the Lemuriformes, was

the most widespread one as per the fossil record. The Tarsiiformes are known from one family, the Omomyidae. The characteristic tarsiod (tarsier-like) specialisation of the skull and hind limbs were already well advanced in the known fossil forms, but some of the European genera have some structures indicating relationships with the early monkeys.

The New World witnessed the appearance of three-fourth of the primates. Their development and human origins probably took place in the Old World. *Amphipithecus*, implying both ways an ape, a platyrrhini, found in the Eocene of Burma is considered to be ancestral to the *Parapithecus* (Para = near) of Egypt. Generally speaking, there is hardly any fossil evidence of the Eocene ancestors of the Old World monkeys and apes. Thus, the Eocene epoch terminated after about 30 million years of primate evolution with lemur-like and tarsier-like forms.

Later, during the Oligocene epoch (36.6 to 23.7 million years ago) which followed, there came into existence primitive monkeys and exceedingly primitive anthropoid apes. The Fayum deposits of the Oligocene epoch in Egypt yielded fossil remains of *Propliopithecus* (Pro = before, Plio = more), the earliest anthropoid ape on record (they had small brains, long snouts, skulls resembling those of monkeys or lemurs and their teeth like those of modern apes; they lived in trees and had tails) and *Parapithecus* (known from some lower jaws 30 mya), a very small sized (squirrel-like) and earliest Old World Monkey on record having a generalised Tarsiod appearance. Gregory regarded *Propliopithecus* as a primitive gibbon and *Parapithecus* as a primitive monkey. These fossils are distinguished by traits normally necessary for adaptation to arboreal life: grasping extremities, nails instead of claws, pentadactyly, an opposable thumb and a big toe, forearm consisting of ulna and radius, reduced snout, forwardly directed eyes and orbits closed from behind, and enlarged visual centers.

Apidium, which is also included in the family of Parapithecidae, could be the forerunner of African monkeys. The Egyptian Oligocene epoch also contributed to several primitive fossil apes including *Aeolopithecus*, which may be an ancestral gibbon, and *Aegyptopithecus*, which may be ancestral to the modern great apes. One other fossil ape from the Fayum that deserves special mention is *Propliopithecus*, formerly believed to be an ancestral gibbon. It has been suggested, primarily on the basis of its generalised dentition, that *Propliopithecus* is possibly ancestral to the hominids.

The Miocene Epoch

About 23.7 million years ago the Miocene epoch began and lasted about 18.4 million years. It was a incredible phase in primate evolution which witnessed an increase in the number of larger primates that were widely spread throughout the Old World, including Europe, Asia, and Africa. The large Miocene hominoids appear to belong to three groups, the *Sivapithecus*, the *Dryopithecus*, and the *Proconsul* groups.

The Miocene fossil forms of Asian and African apes suggest that the Asian apes formed a distinct category which diversified in Asia and Southeast Europe by fourteen million years ago (e.g., *Sivapithecus*, *Ramapithecus*, etc). There were other significant fossils reported from the Miocene of Europe, Egypt and Africa. The lower Miocene epoch is often referred to as the 'Age of Apes'. Skeletal

remains from Africa were classified into three major groups: *Proconsul* (a non-specialised ape), *Sivapithecus* (a transitional form between the anthropoids and man), and *Limnopithecus* (an early type of gibbon).

From Europe, the fossil material of *Pliopithecus* was recovered. The name means that the individual is thought out as ancestral to the modern gibbons. A small-sized primitive gibbon (*Prohylobate*) frequented Egypt during the Miocene. This ape was slightly bigger in size than the *Propliopithecus*. This epoch, thus, saw the rise of the generalised apes of large size which are regarded as the offshoots of *Propliopithecus* of Oligocene.

Dryopithecids (a very heterogeneous group) and *Oreopithecus* were inhabiting in India and Europe during the Pliocene. Pliocene signals the decline, both in numbers and diversification, of these closely related Miocene forms and the commencement of the primitive hominids. The *Dryopithecus* group comprises the first specimen of the *Dryopithecus fontani* found in 1856 in Saint-Gaudens in France. Its molars possess five cusps and the Y-5 pattern -its fissure pattern is typical of dryopithecines.

The *Proconsul* groups are known from the early Miocene period of Africa. It includes three species—*Proconsul africanus*, *Proconsul nyanzae*, and *Proconsul major*—as well as *Rangwapithecus gordonii* and several other smaller-bodied apes. The second group of Middle Miocene apes (all from East Africa) is represented by the Oreopithecidae, which includes *Nyanzapithecus*, the large *Afropithecus*, and two species of *Kenyapithecus*.

Dryopithecinae

These fossil remains represent the most interesting and the controversial part of the primate evolution. The entire subfamily Dryopithecinae has been named after a mandible (*Dryopithecus fontani*) by Lartet. Similar finds have been reported from China, northern India, Africa and parts of Europe, viz., France, Germany, and Spain. The dryopithecines are a very heterogeneous group representing a stage of primate evolution rather than a single phylum and its branches. Numerous species of *Dryopithecus* have been described. They show considerable variation in their dental anatomy, some suggesting closeness to the chimpanzee, some to the orangutans and yet others to the gorilla.

This ape complex is represented by teeth, jaw fragments, cranial and long bones (humerus shaft, ulna and a femur). The humerus bone, with its both ends missing, was reported from France and uncertainly labeled as that belonging to *Dryopithecus fontani*. A complete femur found in Germany has been assigned to *Paidopithecus* (Boule and Vallois, 1957). These long bones are gibbon-sized. Dryopithecinae fossils range in size from animals as big as gibbons to as large or larger than the modern gorillas. They are distinguished from the Hominidae on the basis of their dentition alone.

The incisors are small and more vertical compared to those of the Ponginae. Canines are larger than those in the Hominidae. The lower premolar is sectorial in shape. The molars usually increase in size within the series $M1 < M2 < M3$. Their characteristic 'Y-5' cusp pattern is not commonly found in modern man. This suggests that the pattern is of fossil origin. The primordial crown pattern of human lower molars is comprised of set of three grooves in the form of 'Y' lying

on its side with its tail pointing forwards and its two arms pointing to the rear. In each obtuse angle are stationed two cusps, and in the acute angle, a fifth cusp is located forming the Y-5 pattern (Coon, 1963). In the teeth of modern human beings, the molar crown patterns have been simplified in two ways: the groove pattern has changed from 'Y' to a simple '+' and the number of cusps has reduced from five to four or even less (three or two).

Pliocene of Siwalik Hills in North India is a highly productive radiation center of fossil pongids during the second half or late Miocene and lower Pliocene.

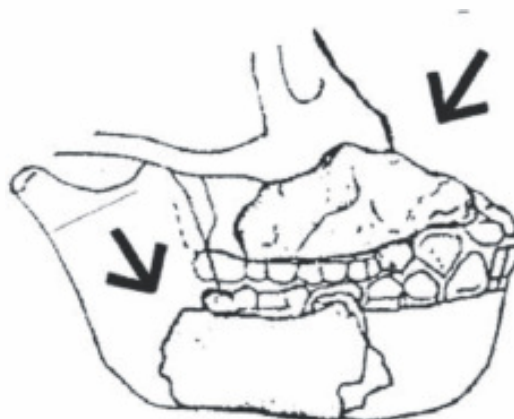
Dryopithecus

Dryopithecus, a genus of extinct apelike animals, is representative of a group of small, generalised apes that contains the ancestors of both the modern apes and humans. Although *Dryopithecus* has been known by a variety of names based upon fragmentary material found over a widespread area including Europe, Africa, and Asia, it appears that only a single genus is represented. *Dryopithecus* is found as fossils in Miocene and Pliocene deposits (23.7 to 1.6 million years old) and apparently originated in Africa.

Ramapithecus

The first *Ramapithecus* fossils (fragments of an upper jaw and some teeth) were discovered in 1932 in fossil deposits of the Siwalik Hills of Northwestern India. No significance was attached to these fossils until 1960, when Elwyn Simons of Yale University began to study them and 'fit' the jaw fragments together (refer Figure below). Based on his observations of the shape of the jaw and dentition - which were transitional between those of apes and humans, Simons advanced the theory that *Ramapithecus* represented the first step in the evolutionary divergence of humans from the common hominoid stock that produced modern apes and humans.

Ramapithecus (from the Middle and Late Miocene epochs) represents the earliest known hominid and its existence establishes from that of the African apes fifteen million years ago. This basic tenet is now regarded as questionable, even if an alternative 'correct' answer cannot be provided. Lewis (1933) first described the fossil remains of a fragment of an upper jaw from Haritalyangar in the Siwalik Hills (India) and christened it *Ramapithecus brevirostris*. This fragment has a wide curving jaw with an arched palate (man-like feature) and was so named as it resembled the Indian God 'Lord Rama'. It has a short snout, a feature characteristic of the apes.



Ramapithecus punjabicus (upper and lower jaws fit very well)

According to Simons, the two jaws fit i.e., this lower jaw fits with the widely curving upper jaw fragment denoting that the two might have belonged to same/similar individuals. The facial features (sloped and slightly concave facial profile) and the anterior dentition (forward jutting of canines) suggest similarities with orangutans.

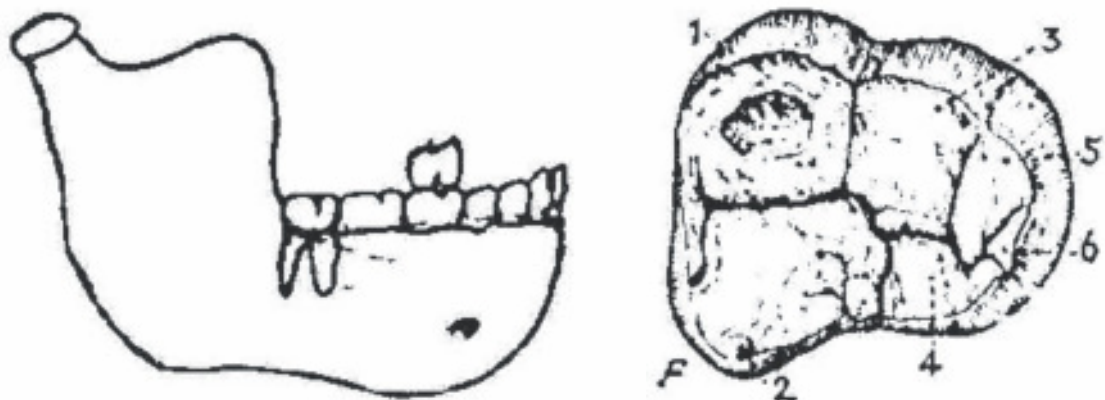
From amongst the various ramapithecinae finds, the '*Brahmapithecus*' lower wide jaw fits well with the upper jaw fragment of *Ramapithecus brevirostris* (Simon, 1961). This clearly shows that the two are the same.

Gigantopithecus



Gigantopithecus mandible

Gigantopithecus remains from the Siwaliks of India have been dated as ca. 6.3 mya. Hominid features of *Gigantopithecus bilaspurensis* from the Indian Siwaliks (for instance, marked reduction of the front teeth, relatively small canine and tooth wear) suggest that hominid-like tendencies were already underway some 5 to 10 mya in the Pliocene period. Being considerably older than the Chinese *Gigantopithecus*, these remains provide newer insights into the initial stages of differentiation of hominoids and man-like primates. These Siwalik finds were found associated with antelopes and primitive elephants further indicating that they inhabited open woodland areas. It can also be argued that the hominoids were displaced from India and after the emergence of MAN, they made a re-entry? The Siwalik hominoids probably used ad-hoc tools to compensate for the reduction of the anterior dentition, exposure to forest ecology accompanied by dietary change and emergence of incipient bipedality (Simons and Pilbeam, 1965).



Lower jaw of *Gigantopithecus blacki* and right lower molar of *Gigantopithecus*

1.5 CLASSIFICATION

There are numerous classifications of primates suggested by various scientists. However, the classification of Simpson (1945), based on their morphology, is widely accepted, and is given below:

Taxonomic category	Groups including primates	Members
Kingdom	<i>Animalia</i>	Multicellular (have sexual reproduction, nervous system, differentiated tissues)*
Phylum	<i>Chordata</i> <i>Nonchordata</i>	Animals with vertebral column Animals without vertebral column
Class	<i>Aves</i> <i>Pisces</i> <i>Amphibia</i> <i>Reptilia</i> <i>Mammalia</i>	Animals with feathers, wings formed by forelimbs Animals having gills throughout life, usually have fins Animals with 4 pentadactyl limbs; pelvic girdle unlike fish, have eggs without protective shell, fertilised without coition Animals having no direct articulation of dentary bone with the skull, homodont, polyphyodont Warm blooded furry animals, heterodont animals, diphyodont, single dentary arch which articulates with squamosal bone of skull, thorax separated by a diaphragm from abdomen, and all other animals that suckle their young
Subclass	<i>Prototheria</i> <i>Metatheria</i> <i>Eutheria</i>	Egg laying mammals Pouched mammals Placental mammals
Order	<i>Insectivora</i> <i>Chiroptera</i> <i>Dermoptera</i> <i>Edentata</i> <i>Pholidota</i> <i>Primates</i>	Ordinarily insect eaters, small and nocturnal, simple brain Ulna reduced to a vestige, have wings to fly Larger than chiroptera Usually without teeth, slow in locomotion Really toothless, scales on their body <i>Prosimii</i> (the lower primates: tarsiers, lorises, lemurs, etc.)* and <i>Anthropoidea</i> (monkeys, baboons, apes and man)*
Suborder	<i>Prosimii</i>	Lemuriformes, Lorisiformes, Tarsiiformes (the most primitive of the primates)*

	<i>Anthropoidea</i>	<i>Ceboidea</i> (Platyrrhines/New World Monkeys)*, <i>Cercopithecoidea</i> (Catarrhines/Old World Monkeys)* and <i>Hominoidea</i>
Superfamily	<i>Ceboidea</i>	Cebidae and Callitrichidae (monkeys: owl, saki, howler, capuchin, spider and goeldi's, marmosets)*
	<i>Cercopithecoidea</i>	Cercopithecidae (monkeys: rhesus, drill, baboon, colobus, nasalis, langur etc)*
	<i>Hominoidea</i>	<i>Pongidae</i> and <i>Hominidae</i>
Family	<i>Pongidae</i>	Hylobatinae (gibbon, siamang)* and Ponginae (orangutan, chimpanzee, gorilla)*
	<i>Hominidae</i>	Man (<i>Homo</i>)*, ape-man (<i>Australopithecus</i>)*, and early ape-man (<i>Ramapithecus</i>)*
Genus	<i>Homo</i>	Early man (<i>Homo erectus</i>)* and modern man (<i>Homo sapiens sapiens</i>)*
Species	<i>sapiens</i>	Modern humans including early subspecies and all living races

*Text within brackets as suggested by other taxonomists

Yet another classification of the primates has been proposed by (Hill, 1957-63):

Order Primates

Suborder Strepsirhini (Prosimians) (or curly-nosed primates, to include non-tarsier prosimians)

 Infraorder Lorisiformes

 Superfamily Lorioidea

 Family: Lorisidae (lorises)

 Galagidae (bush babies)

 Infraorder Lemniformes

 Superfamily Lemuroidea

 Family: Cheirogaleidae (dwarf lemurs)

 Lepilemuridae (sportive lemur)

 Lemuridae (true lemurs)

 Indriidae (sifakas, indri, woolly lemur)

 Daubentoniidae (aye-aye)

Suborder Haplorhini (or dry-nosed primates)

 Hyporder Tarsiiformes

 Superfamily Tarsiioidea

 Family Tarsiidae (tarsiers)

 Hyporder Anthroidea

Infraorder Platyrrhini ("flat nosed") or New World monkeys of South and Central America

Superfamily Ceboidea (New World Monkeys)

Family: Callitrichidae (marmosets, tamarins)

Cebidae (capuchins, squirrel monkeys, douroucoulis, titis)

Atelidae (sakis, uakaris, howler monkeys, spider monkeys, woolly monkeys)

Infraorder Catarrhini (narrow nosed)(of Africa and south eastern Asia)

Superfamily Cercopithecoidea

Family Cercopithecidae (Old World monkeys)

Superfamily Hominoidea

Family: Hylobatidae (gibbons, siamang)

Hominidae (orangutans , gorillas, chimpanzees, humans)

1.6 DISTRIBUTION

The prosimians are subdivided into three major groups: the lemuroids, which are restricted to Madagascar (more than 30 species are represented, belonging to five different families); the lorisooids, which are found throughout tropical Africa and Asia; and the tarsiooids (tiny primates) (weighing only about 120 g), which inhabit the islands of Southeast Asia (all belong to a single genus, *Tarsius*).

The platyrrhines from South and Central America are a diverse group of primates comprising more than 50 species and 16 genera. All members of the suborder Ceboidea (NWM/platyrrhines) are arboreal. They are widely distributed throughout tropical forests extending from Mexico to northern Argentina. The catarrhines include all anthropoid primates from Africa, Asia, and Europe. The Old World monkeys are widely distributed throughout sub-Saharan Africa and tropical Asia. They also occur in the extreme southwestern tip of the Arabian Peninsula, northwest Africa, Gibraltar (their only European record), and East Asia.

Apes

The gibbons and siamang (*Hylobates*) are the smallest of the pongids (4–11 kg or 9–24 lb), and for this reason they are sometimes referred to as the lesser apes. The nine or so species are common throughout the tropical rain forests, and the semi deciduous mountain forests of Southeast Asia. They are known for their remarkably longer arms than in any other primates, which are 30–50% longer than their legs. This is related to their highly specialised mode of locomotion called brachiation by which they swing below the tree branches using only their forelimbs. Gibbons are fruit eaters, while the diet of larger siamangs incorporates a higher proportion of leaves.

The great apes include the orangutans (*Pongo*) from Asia and Gorillas (*Gorilla*) and chimpanzees (*Pan*) from Africa. The orangutan is restricted to the tropical rainforests of Borneo and northern Sumatra. They are large, arboreal primates and climb cautiously through the trees using all four limbs for support. Orangutans subsist mainly on fruits (www.accessscience.com).

The Gorillas are the largest of the hominoids found in tropical Africa. Because of their huge size, gorillas are almost completely terrestrial, although females and young individuals frequently climb trees. They often build nests on the ground. Gorillas move quadrupedally. Like the chimpanzees, their hands are specialised for knuckle-walking when the weight of the animal is borne on the upper surface

of the middle joints of the fingers. They are of two types: mountain Gorillas and lowland Gorillas. Mountain Gorillas eat a variety of leaves, stems, and roots, while the lowland gorillas eat a larger proportion of fruits. They live in groups which consists of a dominant male, several adult females, sub adults, and infants.

There are two species of Chimpanzees, the common Chimpanzee (*Pan troglodytes*) and the bonobo or pygmy chimpanzee (*Pan paniscus*). The common chimpanzee is far and wide distributed in the forests and woodlands stretching across equatorial Africa. The pygmy chimpanzee is limited to the tropical rainforests of the Congo. Both species make nests and feed in trees, but they by and large travel on the ground. Common chimpanzees have eclectic diets, including meat, which they get hold of by hunting small to medium-sized mammals. Tool-using behaviours are common among them and more than a dozen simple tool types have been recognised. Chimpanzees are gregarious and sociable animals. They live in communities where there are many males that divide into smaller subgroups for foraging.

1.7 ADAPTATIONS

Primates have diversified in arboreal and terrestrial habitats (trees, bushes and land) and retain many characteristics facilitating adaptations to these environments:

- ❖ Retention of the collar bone in the pectoral girdle.
- ❖ Shoulder joints with a high degree of movement in all directions.
- ❖ Possession of five digits on the fore and hind limbs with opposable thumbs and big toes facilitating them in grasping objects and climbing trees.
- ❖ Presence of nails on the fingers and toes in most species.
- ❖ Presence of sensitive tactile pads on the ends of the digits.
- ❖ Orbits encircled in a bony rim facilitating rotation of eyeballs in the socket.
- ❖ Trend towards a reduced snout and flattened face supposedly leading to the development of vision at the expense of olfaction.
- ❖ Complex visual system with stereoscopic vision, high visual acuity and color vision – all contributing to quicker movements on the trees.
- ❖ Large brain in comparison to body size especially in simians.
- ❖ Differentiation of the enlarged cerebral cortex.
- ❖ Reduction in the number of teeth compared to primitive mammals.
- ❖ Three kinds of teeth.
- ❖ Longer gestation and developmental period; and
- ❖ Trend towards holding the torso upright leading to bipedalism.

Primates exhibit a wide range of characteristics. Some primates, inclusive of some great apes and baboons, do not live primarily in trees. But all species possess adaptations for climbing trees. Their locomotion techniques include leaping from tree to tree, walking on two or four limbs, knuckle-walking, and swinging between branches of trees (known as brachiation). The three-color vision has developed in some primates.

1.8 SUMMARY

We consider ourselves as the highest among all beings. But we hardly know about ourselves. Modern MAN, *Homo sapiens sapiens*, belongs to the group of mammals known as Primates and is a close cousin of monkeys and apes. Yet, few people understand the relationship between them.

Here in this unit, we find that neither man nor the non-human primates can be defined on the basis of one or two features. They can be best defined on the basis of the general pattern displayed by them or by the complexes of their characteristics. So, what do we mean by the term primate (as this term also includes human beings)? The term 'primate' means first or the highest amongst all. Primates belong to the Animal *Kingdom*, Class *Mammalia* and include humans and the nonhuman primates, i.e., lemurs, tree-shrews, lorises, aye-ayes, pottos, bush babies, tarsiers, the monkeys of the New World and Old World, and also the apes.

As primates, we all share many characteristics; for instance,

- ❖ overlapping fields of vision due to the forwardly directed eyes (this allows for greater 3D vision),
- ❖ fine ability to grasp and handle objects in our hands and
- ❖ enlarged brain relative to body size.

In this Unit, we also discuss the distribution, classification, evolutionary trends, typical physical characteristics, and similarities and dissimilarities within primates including man.

The distinctive features of all the primates (include prosimians, monkeys, apes, and humans) are that they have:

- ❖ hair instead of fur;
- ❖ nails instead of claws;
- ❖ opposable thumb and big toe (thumb/big toe can touch all other digits) – The exception is humans in which the big toe is modified for bipedal walking;
- ❖ prehensility – ability to grasp with fingers and/or toes;
- ❖ pentadactyly – five digits on each hand;
- ❖ padded digits with fingerprints;
- ❖ reduced olfactory sense and dependent on vision more than smell;
- ❖ stereoscopic vision – forward rotation of eye with protective bony structure;
- ❖ binocular vision– both eyes focus on one object (depth perception); and
- ❖ large brain compared to the body size – high level of intelligence.

We find that primates have a two-fold division: prosimians (lowliest of primates) and Anthropoidea. The Anthropoidea further includes new world monkeys (platyrrhines – flat nosed) and the old world monkeys (catarrhines - sharp nosed).

We find that chimpanzee is closest to MAN genetically. Humans and chimpanzees have very similar DNA (about 98% of human and chimpanzee DNA is identical). Genetic studies show that chimpanzees and humans share a common ancestor.

Gorilla is the largest primate on earth and the most powerful of all the primates, a group which includes everything from small arboreal creatures such as the tree shrew, bush babies, several types of monkeys to humans.

1.9 GLOSSARY

Apes	: Gibbons, Siamangs, Chimpanzees, Gorillas and Orangutans.
Arboreal	: tree dwelling.
Bipedalism	: walking on two limbs.
Brachiation	: swinging from branch to branch using forearms.
Caecum	: end part of intestines.
Clavicate	: have a clavicle (collar bone).
Dental formula (D.F.)	: number/type of teeth in each half of the lower and upper jaws; for instance, human D.F. is 2.1.2.3; each half of jaw has 2 incisors, 1 canine, 2 premolars, 3 molars; total number of teeth = 32.
Extremities	: limbs, i.e. arms and or legs.
Great apes	: Orangutans, Chimpanzees and Gorillas.
Hallux	: great toe.
Ischial callosities	: hardening of skin in the region of buttocks which comes in contact with the surface while sitting.
Knuckle walking	: walking using bent fingers.
Lesser apes	: Gibbons and Siamangs.
Opposable	: oppositely directed.
Orbits	: eye sockets.
Pectoral mammae	: mammary glands on chest region.
Penis pendulous	: male genital organ hanging outside body.
Pentadactyl	: having five digits (fingers or toes).
Placental mammals	: mammals with umbilical cord.
Pollex	: thumb.
Quadrupedalism	: walking on all four limbs.
Terrestrial	: ground dwelling.
Testes scrotal	: testes in the scrotum.
Three types of colour vision	: (trichromacy or trichromaticism) is the condition of possessing three independent channels for conveying colour information; derived from three different cone types. Organisms with trichromacy are called trichromats. Their retina contains three types of colour receptors (called cone cells) with different absorption spectra. Trichromatic colour vision is the ability of humans and some other animals to see

different colour, mediated by interactions among three types of colour -sensing cone cells.

Unguiculate : have nails on fingers and toes.

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- 1) Who is Man?
- 2) Who are his immediate relations and why?
- 3) What are Man's distinguishing physical characteristics?
- 4) How does MAN differ from his nearest relatives?
- 5) What do you know about the evolution of MAN?



UNIT 2 PRIMATE BEHAVIOUR

Contents

- 2.1 Introduction
- 2.2 Activity Pattern
- 2.3 Social Organisation
- 2.4 So What Sort of Behaviours do We See in Primates?
- 2.5 Rhesus Monkey (Common Monkey)
- 2.6 Papio (Commonly Known as Baboons)
- 2.7 Presbytis (Hanuman Langur)
- 2.8 Lesser Apes (Siamangs and Gibbons)
- 2.9 Great Apes: Orangutan
- 2.10 Chimpanzee
- 2.11 Gorilla
- 2.12 MAN and Other Primates
- 2.13 Summary
- 2.14 Glossary
- References
- Suggested Reading
- Sample Questions

Learning Objectives



MAN is a primate. However, it is difficult to understand why he behaves differently under different situations. At the same time, it is not possible to study man in the laboratory. In order to understand his changing behaviour, emotions, etc., under different conditions, it is important to study the behaviour and social structure/organisation of non-human primates and then extrapolate that to MAN. Once you have studied this unit you will be able to understand

- primate behaviour under different ecological conditions; and
- insight into the behavioural variables as seen in MAN.

2.1 INTRODUCTION

The very fact that non human primates have been so frequently used in biomedical researches shows that structurally, physiologically and behaviourally, they display greater similarities to the Homo sapiens.

It is only on man's closest relatives, the non-human primates, that behavioural studies can be conducted and extrapolated to MAN. The social behaviour of the non-human primates may be viewed as a simplified model of human behaviour.

So the question arises as to how we can study primate behaviour? Study of their behaviour in captivity is not their natural behaviour but conditioned behaviour.

Thus, we need to understand how they adjust into their environment, i.e., to understand the life style/behaviour of our non-human primate relatives in their natural habitats. This depends on a number of variables, including different types of trees on which they move, sleep and collect food (amount and types of food needed as also food distribution across the habitat occupied) during different seasons. As such, non human primates occupying different environments must meet different demands. Many of the behavioural differences prevalent among them reflect adaptations to this diversity. For instance, different primate groups live within a single forest but move and feed on different levels and or on different types of trees (e.g. bamboos, palms, vines, etc.). Most primates eat a variety of foods resulting in differential development of teeth. For example, insectivores have pointed cusps on their teeth, plant gum eaters have typically sturdy incisors and sometimes canines that protrude forward for scraping off gum, frugivores have wide incisors and low rounded molar cusps for scraping out the fruit from the rinds, and folivores have sharp ridged molars for shearing leaves into tiny bits.

The ultimate needs of human and non-human primates are not as divergent as they appear since the survival of both depends upon the conservation of the natural habitats. Rapid urbanisation and industrialisation is not only forcing the non-human primates to move into smaller home ranges but it is also disturbing their ranging patterns (due to destruction of trees, undergrowth and arboreal pathways), group structure, dominance, etc. Such demographic changes and ecological disturbances transform their behaviour as well as movement patterns, temporarily if not permanently.

Researchers on the above lines reveal that urban primates depict higher competition and aggressive instinct than their forest counterparts. On the contrary, the role of leadership and dominance is much more defined amongst the forest primates in tune with the exigencies of the environment. Aggression is quite common among the urban primates whereas communication is well developed amongst the forest monkeys. Seasonal changes in the ecosystems and the annual variations in the weather year after year influence their daily activity pattern.

2.2 ACTIVITY PATTERN

Primates normally begin their day early in the morning and retire to their sleeping areas (usually trees, abandoned buildings, etc.) in the evening. Their major activities that occupy them most of the day are eating, travelling and resting; they have well defined areas through which they move in groups in search of food and places to rest or sleep. Grooming, playing, fighting and mating activities occupy a small fraction of their time budget. Of course, the amount of time they spend in each of these activities varies according to the season, availability of food, and the habitat occupied by them.

All primates have a home range or territoriality which they defend from other groups. The neighboring groups actively defend the boundaries of their home ranges. Ranges of non-territorial primates may overlap. At times, when different groups occupying the same territory come face to face, an encounter occurs leading to fight with the lesser dominant group yielding to the higher-ranking group.

2.3 SOCIAL ORGANISATION

Living in social groups is one of the significant characteristics of primates. They solve their major adaptive problems within this social context. Social groups among non-human primates probably formed due to two main selection pressures: predation (gaining protection by living in groups) and group life (increasing the efficiency in acquiring food sources in the forest). The richness of the environment determines the composition of the population, a poor habitat supporting fewer non-human primates than the richer one.

Many different patterns of social organisations exist among the primates. Usually, the primate social group includes members of all ages and both sexes. This composition does not vary significantly during the annual cycle.

The following are the main social groups that can be encountered among the living primates:

- ❖ Solitary individuals, e.g. a mother and her dependent offspring, adult males and adult females.
- ❖ Family, or monogamous pairs (a mated pair and their young ones).
- ❖ Multi-male groups (several adult males, several adult females, and their young ones).
- ❖ Offspring and (perhaps) several non-sexually active females.
- ❖ Uni-male groups.
- ❖ Single male (or harem) groups (a single adult male, several adult females, and their offspring).
- ❖ All female groups (several adult females and their offspring).
- ❖ All adult male groups.

These categories reflect the sizes of the social groups. But medium sized groups of about a dozen individuals can have either one or several males. In any case, groups of a given size need not have the same internal structure. This applies to dominance hierarchies. For instance, in multimale groups of macaques and baboons, there is a clear rank order among the adult males, whereas it is absent in the multimale groups of spider monkeys and chimpanzees. Besides these, there are other social groups such as foraging and hunting groups.

Group life is likely to increase competition for resources and any benefits of groups must outweigh the costs of such competition. The nocturnal primates live in monogamous family groups. They are not gregarious animals. The diurnal species usually live in relatively large and stable groups. Most of the diurnal species form sizeable groups.

For all primate species, the primary social link is the mother-infant bond. In group living primates, relationships between females and successive generations of their female off springs usually form the core of the group. Primate social groups are stable only in a relative sense, as individuals migrate between them when they become sexually mature. In most of the groups, males leave the group whereas females remain behind.

Mating and paternal care are the keys to successful reproduction. From amongst the primates, females must make a substantial commitment of time and energy to pregnancy and lactation once they have conceived. This naturally leads females to emphasise parental care.

Females in Groups

The females generally protect themselves by living in groups. As a consequence, the males usually compete for control over such groups of females. A single dominant male might be able to keep other competitors away when groups are small (e.g. less than 10 females) and thereby monopolise matings with the females within the group. Primates living in more open country like the baboons and macaques are exposed to much greater risks of predation and thus tend to live in larger groups. As groups become large, a male cannot prevent other males from joining his group. This also leads to competition for access to females for mating.

In large multimale groups like baboons and macaques, males are usually organised in a dominance hierarchy. Most of the matings are generally performed by one or two 'top' ranking males.

Home Range/Territory

This is an area in which the non-human primates normally confine themselves for their day-to-day activity. This may or may not change during the individual's lifetime. The changes vary according to both the species and their sex. Home range is often described as an area, which provides the animal or group of animals with food.

Individuals or groups of most of the non-human primates actively defend part or all of their home range against other members of their own species with displays, vocalisations and interactions. On the other extreme, baboons have an extensive overlapping area between their home ranges, within which groups usually avoid each other. The degree of territoriality depends on the costs and benefits of defending resources as in the case of scarce water resources, food resources, and so on.

2.4 SO WHAT SORT OF BEHAVIOURS DO WE SEE IN PRIMATES?

Social Grooming

Social grooming is a regular primate activity. Allogrooming (others) is an important affiliative mechanism. It can be used to fortify links: subordinate animals tend to groom more dominant ones; males groom females for sexual access.

Social grooming is an important and a unique primate entity since it facilitates social cementing of the organisation of the group. This activity eases the interaction between the individuals where there is a possibility of friction and/or aggression thus resulting in the establishment and/or strengthening of friendly social relations among the animals within the group. It plays an important role in the life of most of the non-human primate. It also helps in keeping the body clean since it removes parasites and debris from the fur and the skin.

Parental Care

An infant usually depends upon its mother for 2-6 months after birth for food, etc., depending upon one's size, etc. Most infants are usually carried by their mothers for a further period of 6 to 12 months. The infants also depend upon their mothers for support during fight or for protection against danger for another 3 to 4 years. Some females as among baboons and rhesus monkeys have longer inter-birth intervals enabling the mothers to invest more time and energy in the care of each infant.

Reproduction

In all primates, except for humans (and perhaps Chimpanzees), the females are seasonally or cyclically receptive. This is usually associated with visual changes such as genital swelling clearly indicating that the females are experiencing heat. Pair bonding of any sort is rare among primates though Gibbons seem to be life-long monogamists. Also some New World monkey groups such as marmosets have only one reproductively active pair in any group. Chimpanzees have been seen to have consortships of several weeks where copulation is frequent.

Mother-Infant Relationship

It has been observed that this mother infant bonding is required to allow the infant to be able to interact properly as an adult. This attachment between the mother and her infant which begins at birth itself is the most fundamental social unit within the primate social relations and begins at birth itself. Infants are mostly cared for by their mother. Primates learn what to eat, where to find food, how to eat different foods, mating rituals, social structure, and females learn maternal behaviour.

Dominance

Primates are mostly group-living animals and tend to form "dominance hierarchies". These hierarchies are also referred to as status rank. A dominant individual always gets priority and even in a confrontation this is usually the last word.

Animals higher in the hierarchy tend to displace lower ranked individuals from resources like mates, space and food. The hierarchy is not a fixed one and depends on a number of changing factors such as age, sex, body physique, aggression and even intelligence perhaps.

Dominance serves to organise social interactions. Since the primates are born within the group and grown therein, they learn the processes and norms of behaviour by sheer observation. This helps in avoiding chaotic and unpleasant situations within the group.

Males are generally dominant over females in most of the non-human primate societies. Higher ranking males are also responsible for protecting the group, particularly the females in estrus or with off springs, from predators or from attack by other groups.

Aggression

Aggression is either intra- or inter-specific and is generally associated with one or more of the following: competition for food, defense of an infant by its parents, struggle for dominance or change in social status, failure to comply with signals,

the consort formation at oestrus, and changes in the internal biological state of the animal. Aggression builds up spontaneously and must be released. It has been shown that hierarchies are considered to reduce the amount of aggression but when hierarchies are most rigid, aggression is most common.

Communication

The communication system of the non-human primates which includes scents, body postures, gestures, and vocalisations as monkeys and apes is rather an expanding field. From the human perspective, we often find it easier to associate sounds with specific meaning, whereas among the non-human primates, gestures and actions are often used. Presentation and mounting behaviour is often used to diffuse potentially aggressive situations. Yawns exposing teeth are often threats, like direct eye contact. Facial expression is important too. It's very obvious in chimpanzees: their expression often appears all too human-like, but other primates also use stereotyped eyelid flashes or lip slaps.

'Display' communicates to other members one's emotion such as greeting, fear, threat, happiness, danger, pain, hunger, courtship etc., through a wide variety of body movements, facial expressions, vocalisations and olfactory signals. A display primarily communicates information that is useful to an individual of the group, to the social group to which he belongs and to other species.

We have now familiarised ourselves with basic behavioural characteristics of non human primates. Let us now examine the behavioural aspects of some common non human primates such as Rhesus monkeys, baboons, presbytis and great apes (Orangutan, Chimpanzee and Gorillas).

2.5 RHESUS MONKEY (COMMON MONKEY)

Hindus regard the rhesus monkey as God Hanuman and as such it is considered as sacred in India. These monkeys are omnivorous feeders and often raid cultivated fields and gardens.

Social Behaviour

They live in large multimale-multifemale groups. Macaques (rhesus monkey) live in troops of varying sizes in which both males and females have well-defined rank. Ranking females benefit from easier access to food and water, space, and grooming partners. Their group sizes range from 5 to 80; at times groups as large as 125 individuals are also encountered. Macaques have a variable social structure.

Matrilineal hierarchies are very strong. As in many Old World monkeys, females get genital swellings when they are in oestrus (sexually receptive). This occurs often in multimale groups. In this way, all the males become aware that the female is for copulation. For this purpose, they compete with one another and ultimately the stronger male will copulate with her.

After a conflict, they have a ritual reconciliation behaviour in which the subordinate presents its hindquarters to the dominant, which clasps the presenter by the rump. The dominant animal may present to a low-ranking individual to reassure or pacify it. This eases the tension between individuals. Grin, teeth chattering, and lip-smacking are other signs of submission. Grooming is a form of social interaction that promotes appeasement and group cohesion. The teeth-

chattering face is a greeting or appeasement signal. When attacked by a high-ranking animal, a stump tail macaque may redirect its aggression by attacking a nearby subordinate.

Sexual Behaviour

Male rhesus monkeys make intense sexual friends. Males, especially younger ones, use a number of ritualised erotic “greeting” gestures with one another, including embracing, face-licking or kissing, fondling or grabbing of the erect penis, mounting and rump fingering.

Reproduction

Dominant males copulate with high-ranking females throughout their oestrus cycles. When low-ranking males mate, they are often interrupted by the dominant male; to avoid interruption, they mate while he is mating with another female (www.cellar.org).

Vocalisations

The most common vocalisation of rhesus monkeys is a ‘coo’ used when approaching other group members to avoid aggression and initiate grooming or other friendly interactions.

2.6 PAPIO (COMMONLY KNOWN AS BABOONS)

Baboons have complex social systems. The average size for a baboon troop is closer to 40-80 individuals (at times as large as 200 individuals). All live in a multimale - multi-female social group. Males fiercely defend the group. Baboons normally sleep in large troops, no matter what their foraging patterns are, in some high place where they are protected from predators. Mutual grooming functions as a strong social bond.

Dominance

All baboons have strong dominance hierarchies where ranks are inherited from the females. Females outnumber male group members, though males tend to be dominant, herding females around and determining their foraging direction. The highest ranking male of the group is dominant over all other males and females. There is a ranking system between the females that is established at birth. A daughter assumes the rank just below her mother. The ranking of the females is stable, where as that of the males frequently changes. The dominant male is challenged by other males who want to be in the highest ranking position.

Males will often, though not always, live elsewhere. Male olive baboons use infants as “social buffers” in dominance struggles. Males may change troops more than once in the course of their lives.

Reproduction and Lifespan

Baboons attain sexual maturity from 3.5 to 6 years (approx) whereas the males become mature when they are of 60 months. Oestrus cycles run roughly for 30-35 days. Gestation time varies from 170-190 days with most falling around 180 days. Infants are born throughout the year. Baboons live around 35-45 years.

Baboons communicate through a variety of facial, gestural, postural, olfactory and vocal means. Lip smacking is associated with affiliative behaviour.

2.7 PRESBYTIS (HANUMAN LANGUR)

Activity Pattern

The word “langur” means “long tail” in Hindi language. They are generally shy creatures, spending most of their time in the trees, although some langurs spend a major part of their time on the ground. Langurs are most active in the early morning and late afternoon. They sleep in a shady grove during the hot midday hours. Feeding occurs at dawn and again during the evening. The Hanuman langur often feeds in troops, which contain males and/or females of various ages. A troop of langurs returns to the same resting place every night. They sleep on the extremities of branches, a precaution against large beasts of prey. Groups may forage over several kilometers in the course of a day.

Their home range varies between .05-13 km for groups containing both males and females, and 7-22 km for all-male groups. A portion of the home range is a core area in which most of the time is spent.

Social Behaviour

Langur groups range between 13-37 individuals. But this can swell up to 125 when several groups gather at rich food areas. Groups usually consist of 8 - 125 individuals. Males without females form bachelor groups of 2-32. Langurs have variable social structure: one male-multifemale, multimale-multifemale, all females with infants and adolescent males and females and all male groups. Bisexual groups usually contain between 10 and 30 members – one adult male besides adult females, young individuals of both sexes and infants. All male troops are more variable in number, and comprise solely of adult and subadult males. Larger groups may break into subgroups in some seasons. In the groups with several males, the high-ranking males can mate with any female, while the other males can only mate when they can sneak by the high-ranking males.

Females stay in the same home-range for their whole lives in association with their mothers, grand-mothers, sisters, daughters and aunts. These home ranges slightly overlap.

Reproduction

The young ones are weaned in 10-12 months. Female langurs become sexually mature at 3-4 years, and the males at 4-5 years. They however do not mate until they attain 6-7 years of age. Gestation lasts for about 190-210 days. Mothers usually bear one infant at a time. The oestrus cycle is about 24 days long. But if the infant is lost, cycles can resume within 8 days. The normal interval between births is 15-24 months.

Infanticide

When a male takes over a troop, he will kill the infants to gain a reproductive advantage. Normally, a female takes around nine months to wean her young one and another year or so to be sexually receptive again. Infanticide serves to shorten

this waiting period as females whose infants have been killed will be in oestrus shortly. As such the new male will establish himself as the leader.

Locomotion

They move through the forest and on the ground quadrupedally. Langurs also use a leaping gait on trees through the forest. Their tails can be up to three feet long and are used as balancing rods (like a bamboo pole) for swinging in the trees. Langurs can be entirely terrestrial or entirely arboreal depending on the ecological situation. In areas where trees are scarce, the langurs adapt well to life on the ground. When on the ground, langurs walk or run on all four feet. In the trees, they are remarkably agile. Langurs can jump horizontally from 3-5 m. The grasping capacity of their hands and feet allows them to move on the trees at great speeds.

Communication

Presenting behaviour is performed by the female to elicit copulation from the male. From this condition the male understands that the female is ready for copulation. Head-shaking precedes the display of the female presenting behaviour.

In the morning, the resident male in a group of females gives long-distance shouts, viz., whoop, whoop! They produce a variety of sounds, e.g., a joyous “whoop”, a guttural alarm, and a booming whoop.

Lifespan

Langurs can live up to 20 years in the wild and about 25 years in captivity.

2.8 LESSER APES (SIAMANGS AND GIBBONS)

The lesser apes are monogamous and live in small stable family groups consisting of an adult male and an adult female (for life) and their immature off springs. Unlike great apes, these lesser apes do not make sleeping nests. They simply sleep (in sitting posture) between the forking branches of the trees.

They have a throat pouch (also known as gular sac) which enables them to make louder calls. This hooting can be heard up to longer distances (approx 2-3 kms) through the dense rain forests. These apes in the morning make loud territorial hooting calls and menacing gestures signaling their presence in the area. Such calls warn others to stay away from their territory particularly from the local fruit trees. These diurnal apes are otherwise quite social animals. They are territorial and emigrate from their natal groups around adolescence.

2.9 GREAT APES: ORANGUTANS

Orangutans are the largest and rarest of the great apes. They are found in the tropical rain forests of Borneo and Sumatra in the southeastern islands of Asia. Males often grow to over 150 pounds with a high degree of sexual dimorphism.

They are arboreal and good climbers having much longer arms than legs. But on the ground, they have an obliquely quadrupedal mode of locomotion, generally knuckle walking.

Orangutans are intelligent, peaceful and predominantly frugivores. Adult males and females forage independently in their habitat.

Social Behaviour

Orangutans have little social organisation, their maximum group size being the mother with her infant. A couple may have brief associations when the female is in oestrus. A few orangutans may congregate at a good fruit tree. Orangutan adult males mostly lead a solitary life, except when they copulate with females. This is probably because their food is scattered thinly throughout the rain forest. Further they need lots of food owing to their being large creatures.

Their population densities range from 0.2 to 5.0 individuals per sq km. Local variation has been reported in the social structure of the orangutans. Adult males occupy larger home ranges than adult females and are hostile to one another. Males' home ranges are often 2 - 6 sq. km. in size, and overlap the ranges of several females.

To avoid violent disputes, males make distinctive 'long call' unique to orangutans which produces a booming sound that can be heard up to 1km away. In this way, males avoid each other.

Orangutans are active during the day and are almost exclusively arboreal. They forage in the early morning, resting during the midday heat and resume their activity in the afternoon. They live alone in large territories probably due to their eating habits.

Orangutans also construct a sleeping nest high up in the trees to rest at night. But only the lighter female and juveniles do this. The heavier males usually sleep on the ground. Each night, they construct nests out of leaves and branches. The nests are of a platform style ranging from 40 to 60 feet high in a tree.

Reproduction

Orangutans have a very low reproductive rate. They mature and become capable of reproducing when they are 7 to 10 years old by which time they attain their adult size. The males however continue to grow until they are 10 years old and do not have successful mating until they are about 14 years of age.

A female usually has her first infant at the age of 12-15 years. It gives birth to one offspring at a time. They give birth once in every 3-8 years. Their gestation period is 227 to 275 days (8 to 9 months). The young ones are not weaned from their mothers until they are 3 ½ years old. The female orangutans have an estrous cycle of about 30 days in length.

The male and female adults come together only for a brief period of courtship. For purposes of mating, males prefer fully adult females. The choice of sexual partners is very much a prerogative of females. When she is ready to mate, the female listens to the loud calls of males following which she reaches out to one of them for mating.

Mother - infant

Like human children, orangutan babies have to be taught everything that they need to know to survive. Since males have nothing to do with the female after mating, the mother takes the responsibility of teaching the infant. The mother even feeds her baby pre-chewed food until it can eat on its own.

A newborn orangutan weighs 2 kg and remains totally dependent on the mother for the first 18 months. A female adult usually establishes a territory near her mother often overlapping with hers. A male travels far away to establish a separate territory.

Life Span

Orangutans live about 50 to 60 years in captivity while their life span in the wild is only 40 to 50 years.

Locomotion

Orangutans have longer and more powerful arms than other great apes. Their arms measure 2.2 m across in their outspread position. They are longer than their height. In contrast, their legs are short and weak. Too heavy to brachiate, the adult orangutans swing slowly, not letting go of a branch until they reach the next branch. They usually move slowly and deliberately using all the four limbs. Orangutans usually move in the forests by swinging from one branch to another called brachiating. On the ground, they usually walk on all fours. Though they have really mobile joints, they do not really swing like the gibbons. It is more like climbing with four hands. Adult males get so big that they sometimes have to get down and walk from one tree to the next!

As one of man's closest relatives, the orangutan (Asiatic great ape) or commonly referred to as 'man of the forest', is a severely endangered species.

Communication and Vocalisation

Orangutans are quieter but make very long, loud calls that can be heard through forests for up to 1 km for territorial and courting purposes. Males have a large throat sac that lets them make these loud calls. They scream when scared, and males sometimes roar.

Tool Use

Orangutans show a remarkable ability to arrive at certain trees just when their fruit is ripening. Like other great apes, they have been observed to use tools but less extensively than has been observed in chimpanzees.

They use sticks for digging and winking out edible seeds from a spiny fruit case, or use a stick even to hit a snake. They may also use sticks to fight each other or scratch themselves.

2.10 CHIMPANZEE

Chimpanzees are diurnal, semi terrestrial and generally frugivorous. During the dry season seeds, nuts, flowers, leaves, resin, eggs, etc., form the important food resources.

Social Behaviour

Chimpanzees are social animals and are active during the day (diurnal). Their social structure can be categorised as fusion-fission. They live in small, stable groups (called communities or unit groups) of about 40-60 individuals who would defend a common territory. Smaller subgroups of 6-7 chimpanzees stay together for a while, with the membership changing over time. A 38 year long study in the

Gombe Stream Reserve revealed that the number of individuals in the main study community ranged between 40 and 60.

Chimpanzees live in relatively large and complex social groups based on permanent relationships among males. All chimpanzees are highly sociable. Common chimpanzees live in loose, extended groups that may include more than 100 animals. Social-bonding among them is not as strict or structured as in gorillas and relations within a group are complex. It is hard to identify groups because their members travel around individually, in pairs and other combinations. But they usually forage alone.

Grooming one another (cleaning the hair of another chimpanzee) is an important activity by which they maintain positive relationships. This kind of behaviour is a major occupation among chimpanzees. Males do social grooming with a wider range of individuals than females do. Grooming plays a vital role in establishing and reinforcing bonds. Chimpanzees are particular about their territoriality.

Like other apes, they build bowl shaped sleeping nest in trees with leaves and other plant material usually at a height of 6-25 m from the ground for safety from predators. Every evening, chimpanzees construct a new “sleeping nest” in the trees where they curl up and sleep. They use the same nest for several nights if the troop is not on the move. They keep their nests clean. Each adult makes its own nest, only young chimpanzees share their mother’s nest, until the next baby is born.

Dominance

Within the community, there is a linear hierarchy with one of the males emerging as number one (or alpha). All adult males dominate all females. The males of a community regularly patrol their boundaries. Adolescent females may migrate into a new community permanently. When they become pregnant, they move back to their own natal group.

Hierarchy is based on age and size as well as on alliances and friendships. A male chimpanzee gains rank or dominance on the basis of his mother’s higher rank. In such fluid communities, aggressive behaviour is common which seldom results in outright violence.

Male chimpanzees proclaim their dominance with spectacular charging displays during which they may hurl themselves along the ground, or stand upright, slap their hands, stamp their feet, drag branches, or even hurl rocks (www.janegoodallug.org).

Sexual Behaviour

Mothers engage in sexual activity fairly often with their infants. Young females typically experience a one-to-three year period of long adolescent sterility following their first menstruation. During this period, they mate heterosexually without conceiving. Incestuous matings between adults are not common (www.forum.philosophynow.org).

Reproduction

There is no distinct breeding season among chimpanzees. They mate whenever a female ‘comes in season’ whereupon she develops massive pink swellings on

her hind region lasting two to three weeks or more and occurring every four to six weeks. This condition is an invitation for males for copulation. Chimpanzees attain full growth and are able to reproduce by the age of 12-13 years. Female chimpanzee's pregnancy period lasts 8.5-9 months. They usually have a single baby at a time; twins are rare. The female gives birth once every 4 to 5 years. The gestation period ranges from 230 to 250 days (8 to 9 months). The females are good mothers and raise their young ones alone.

Infanticide

Infanticide is common among them. This generally happens when there is a change in the leadership as it immediately leads to the weaning females coming in estrus; thereby the new leader can have sexual relationship with the adult females to raise his own offspring.

Tool Use

Chimpanzees have opposable thumbs (although much shorter than the human thumb) and opposable big toes capable of a precision grip, which enables them to use tools especially in extracting ant and termites out of a mound and or a ground as also to crack open nuts with a stone using a hard platform. Chimpanzees have been observed to use sticks to obtain ants and termites to eat and to scare away intruders. They also use chewed up leaves as a sponge to sop-up water to drink.

Life Span

Chimpanzees live about 50 to 60 years in captivity while their life span in the wild ranges from 35-40 years. Like most animals, they survive for longer period in captivity.

Locomotion

Chimpanzees' arms are longer than their legs which enable them to reach out to fruits growing on thin branches that would not support their weight. This also helps them climb trees and brachiate (swing from branch to branch by their arms). Chimpanzees can also walk upright (on the two legs in the bipedal position), when carrying something in their hands or when looking over tall grass.

Chimpanzees are known as "knuckle walkers" because they place their soles and the back of the finger joints on the ground. They are terrestrial creatures. While most primates walk on the flats of their hands, chimpanzees walk on their knuckles with their hands turned over. This type of walking is typical of not only chimpanzees but also of gorillas. Chimpanzees usually walk using all fours (on the soles of feet and the knuckles of their hands).

Communication and Vocalisation

Chimpanzees have complex communication methods involving facial expressions, gestures and calls. Their crying calls warn other chimpanzees of the likely danger in the area. Such danger calls can be heard through the forest for about 2 miles (3 km). When they spot food in abundance, chimpanzees bark loudly to call others in their group to a feast.

The intra-group communication is mostly achieved through posture, gesture or facial expression, and submissive signals of crouching, presenting the rump and holding the hand out accompanied by pant-grunts or squeaks.

2.11 GORILLA

These are the largest of the primates in the world weighing up to 400 pounds. Their build is much heavier than that of chimpanzees. Further, they have big canine teeth and much larger stature. They are diurnal, terrestrial apes. Some of them prefer arboreal climbing. Gorillas possess widely set and deeply sunken eyes and flaring nostrils. They inhabit lowland and montane forests with a discontinuous distribution in equatorial Africa.

Ecology

Gorillas are mostly folivorous. They eat fruit, leaves, bark, ants, and bamboo shoots. They never eat all the leaves from a single plant. Instead, they leave plenty of leaves so that the plant can replace the leaves quickly.

Activity Pattern

The activity pattern of the gorillas depends upon the food availability, social conditions and their reproductive status. Gorillas are shy, social animals and are most active in the morning.

Gorillas are active during the daytime. They wake up just after sunrise (troop rises between 6 A.M. and 8 A.M.) and search for food such as leaves, buds, stalks, berries, bark and ferns, which they consume and rest and relax. During midday, adults usually nap while the young play games. Gorillas do not appear to drink water but derive the same from their juicy diet. They feed again in the afternoon, finally retiring for the night in nests made of twigs and leaves. Unlike the chimpanzees, they construct nests of leaves on the ground for sleeping at night.

Home Range

Gorilla groups wander about within a home range of 10 to 40 sq km (4 to 15 1/2 sq mile), which is not defended or marked at the boundaries. Some conflicts may arise with neighboring groups, but encounters are generally avoided by communications such as drumming on the ground from a distance.

Social Behaviour

Gorillas live in structured family groups with a polygynous mating pattern. The gorilla's social system is usually composed of a single adult male with multiple females. They live in small groups (bands or harems) consisting of close family members and other relatives (6–7 individuals) that may number up to 30 individuals. The adult females maintain hierarchy within the group which they pass on to their offspring.

A typical harem is a closely-knit group including a dominant male, one or two subdominant males, and several mature and young females. Some groups may contain only the dominant male, two or three females and the young. Males are normally driven out of a harem once they reach an age of 11-13 years. Males may form all male groups or travel lonely until the opportunity to start their own harem arises.

Dominance

The gorilla is essentially a peace-loving creature that would rather retreat than fight except in circumstances when its life is threatened and retreat is impossible. However, once provoked, an adult male will attempt to intimidate his aggressor by standing on his legs and slapping its chest with cupped hands, simultaneously roaring and screaming. Adult males perform elaborate displays, including chest beating, running sideways and tearing up vegetation to frighten an intruding male or similar other threat. Males also use these displays as a show of dominance within the group. Adult females can become aggressive while defending their infants, or while helping each other to drive out rowdy, young adult males. The dominant male leads the family group and decides where the members should feed and sleep. Females are strongly bonded to the male.

Grooming

Grooming one another (cleaning the hair of another gorilla) is a major occupation among gorillas in a band. Female gorillas not only groom their offspring but also one another and the dominant male. Unlike most other primates, each gorilla takes care of its own toilet routine. Mutual grooming is quite rare among the gorillas.

Reproduction

Females reach sexual maturity during 6-9 years of age. Males become sexually mature in the wild between 8 and 9 ½ years of their age and in captivity as early as 6 ½ years. Males are not considered fully mature until they become about 15 years old. The oestrus cycle lasts 26-30 days. Gorillas do not have a distinct breeding season. Gestation lasts from 250 to 285 days. In the wild, female gorillas usually deliver their first offspring at their age of 10½ years old and subsequently at four-year intervals.

Locomotion

Gorillas walk in an obliquely quadrupedal mode of locomotion by actually using their knuckles to support part of their weight. However, they do stand erect on occasions. Gorillas perform knuckle-walking by using both their legs and long arms. They can climb trees but do not do so very often because of their heavy weight.

Communication and Vocalisation

Gorillas generally communicate with each other using many complicated sounds and gestures. Some of their gestures range from chest-beating, high-pitched barks, lunging, throwing objects to staring, lip-tucking, sticking out the tongue, sideways running, slapping, rising to a two-legged stance, etc.(www.animalcorner.co.uk).

2.12 MAN AND OTHER PRIMATES

Macaques are the favorite animals for laboratory tests. Tests on the rhesus macaque resulted in the discovery of the Rh (rhesus) factor in 1940. This is a hereditary blood antigen. When Rh and non-Rh blood samples are mixed during blood transfusions, fatal reactions can occur. The crab-eating macaque was the clinical test animal for the development of the polio vaccine.

Orangutans have senses very similar to ours, including hearing, sight, smell, taste and touch.

Chimpanzees on occasions exhibit such behaviours as group hunting, food sharing and tool making which were once considered as the exclusive trait of humans. These behavioural traits suggest close anatomical and behavioural kinship between *Homo sapiens* and chimpanzees. They have senses very similar to ours, including hearing, sight, smell, taste and touch. Chimpanzees are very intelligent and can learn even extremely complex tasks. Chimpanzees are the most violent primates besides humans!

It is hardly impossible to emphasise the importance of friendly physical contact in maintaining good relationships among chimpanzees. Social grooming is one remarkable trait which is probably the most important social behaviour (in humans as well), serving to maintain or to improve friendships within the community as also to calm nervous or tense individuals.

2.13 SUMMARY

Non human primates are referred to as Man's closest relatives. Therefore, in order to understand Man's changing behaviour and emotions, etc., under different conditions, it is important to study the behaviour and social structure/organisation of non-human primates, man's closest relatives, and then extrapolate that to MAN. In this Unit, we briefly discuss the behaviour of our closest relatives, i.e. the non-human primates.

Major activities that occupy these primates most of the day are eating, traveling and resting, grooming, playing, fighting and mating activities.

For all primate species, the primary social link is the mother-infant bond. In group living primates, relationships between females and successive generations of their female off springs usually form the core of the group.

We find in this unit that the frequently observed primate activity is social grooming. It helps to strengthen links. The mother-infant relationship is the most fundamental social unit within the primate social relations and begins at birth itself.

Primates are mostly group-living animals and tend to form "dominance hierarchies". These hierarchies are also referred to as status rank. Dominance serves to organise social interactions. Since the primates are born within the group and grown therein, they learn the processes and norms of behaviour by sheer observation. Aggression is either intra- or inter-specific.

In this Unit, it is observed that the primates have a very interesting system of communication amongst themselves. For example, 'display' primarily communicates information that is useful to an individual of the group, to the social group to which he belongs and to other species. This mode of communication conveys to other members of the group, one's emotion such as greeting, fear, threat, happiness, danger, pain, hunger, courtship, , etc., through a wide variety of body movements, facial expressions, vocalisations, and olfactory signals.

Macaques are the favorite animals for laboratory tests. Tests on the rhesus macaque resulted in the discovery of the Rh (rhesus) factor in 1940.

Baboons have complex social systems. They live in a multimale - multi-female social group. Baboons normally sleep in large troops, no matter what their foraging patterns are, in some high place where they are protected from predators. Mutual grooming functions as a strong social bond.

The word “langur” means “long tail” in Hindi language. They are most active in the early morning and late afternoon. Feeding occurs at dawn and again during the evening. Langur groups may forage over several kilometers in the course of a day. A troop of langurs returns to the same resting place every night.

The lesser apes (siamang and gibbon) are monogamous and live in small stable family groups consisting of an adult male and an adult female (for life) and their immature offsprings. Unlike great apes, these lesser apes do not make sleeping nests. They simply sleep (in sitting posture) between the forking branches of the trees (www.miamimetrozoo.com).

Orangutans, the largest and rarest of the great apes, have senses very similar to humans, including hearing, sight, smell, taste and touch; are usually frugivores. Chimpanzees are diurnal, semi terrestrial and generally frugivorous. During the dry season seeds, nuts, flowers, leaves, resin, eggs etc. form the important food resources. Chimpanzees on occasions exhibit such behaviours as group hunting, food sharing and tool making which were once considered as the exclusive trait of humans. Gorillas are the largest of the primates in the world weighing up to 400 pounds. They are diurnal, terrestrial apes. Some of them prefer arboreal climbing. Gorillas possess widely set and deeply sunken eyes and flaring nostrils.

These behavioural traits speak of the close anatomical and behavioural kinship between man and chimpanzees. These non-human primates have senses very similar to ours, including hearing, sight, smell, taste and touch. Chimpanzees are very intelligent and can learn even extremely complex tasks but are the most violent primates besides humans!

2.14 GLOSSARY

Alpha male/female	: highest ranking individual within a dominance hierarchy.
Arboreal	: tree dwelling.
Affiliative behaviour	: behaviours which promote group cohesion (friendly/ positive gestures), e.g. grooming, touching, and hugging
Brachiation	: locomotion by arm swinging.
Crepuscular	: active during twilight hours.
Diurnal	: active during day time.
Dominance	: ability to intimidate others.
Estrus	: period in which an adult female is sexually receptive.
Frugivorous	: fruit eating.
Gestation	: conception and development of young one in uterus.
Grooming	: cleaning of body surface by licking, nibbling, picking with fingers or kind of manipulation.
Home range	: area of land used.
Infanticide	: killing of infants.
Mating	: having sex.
Matrilocal	: residence with mating female.

New World	: American mainland.
Nocturnal	: active during night.
Old World	: Europe, Africa and Asia.
Patrilocal	: living with male.
Perineal	: area in between anus and the pubic arch.
Quadrupedal	: walking on four limbs.
Rank	: position or status in hierarchy.
Reproductive success	: number of surviving offspring of an individual.
Sexual dimorphism	: difference in the body size and form of the males and females.
Terrestrial	: living on ground.
Territory	: area which is exclusive and defended.
Weaning	: gradually stop breast feeding.

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Sample Questions

- 1) How does home range influence behaviour of primates?
- 2) What is the role of a female in estrus within the social structure of the group?
- 3) How do sleeping sites, food, and water resources affect the social structure of primates?
- 4) Compare and contrast the social behaviour of rhesus monkey and apes.
- 5) Write short notes on
 - a) Territoriality
 - b) Dominance and aggression
 - c) Prosimians and insectivores.

UNIT 3 PHYLOGENY OF LIVING PRIMATES AND PRIMATE ANATOMY

Contents

- 3.1 Introduction
- 3.2 Biogenetic Basis of Phylogeny of Living Primates
 - 3.2.1 Immunological Techniques
 - 3.2.2 Molecular Approach
 - 3.2.3 DNA Hybridisation
 - 3.2.4 Mobile DNA Elements Approach
- 3.3 Comparative Anatomy of Man and Apes
 - 3.3.1 Skull
 - 3.3.2 Spine
 - 3.3.3 Pectoral Girdle
 - 3.3.4 Pelvic Girdle
 - 3.3.5 Lower Limbs
- 3.4 Hominization
 - 3.4.1 Skeletal Changes Due to Erect Posture and its Implications
- 3.5 Summary
- 3.6 Glossary
- References
- Suggested Reading
- Sample Questions

Learning Objectives



Comparative anatomy and fossil records for constructing phylogenies are very important for paleontologists. The development of sophisticated techniques in the field of modern genetics has facilitated in the endeavor. After you have read this unit you will follow the

- biogenetic basis of phylogeny of living primates; and
- comparative anatomy of Man and Apes.

3.1 INTRODUCTION

Before the development of sophisticated techniques in the field of modern genetics, paleontologists had to depend on comparative anatomy and fossil records for constructing phylogenies. Sometimes the interpretation of the fossils varied so much that instead of one phylogeny there could be two or more.

But now majority of the paleontologists and biological anthropologists agree that genetic data of the living primates offer useful information for constructing their phylogeny.

Anatomy refers to observation and description of the structures of animals. Hence, the comparison between man and apes will be based on all the structures of their body.

3.2 BIOGENETIC BASIS OF PHYLOGENY OF LIVING PRIMATES

New researches in molecular genetics have influenced many disciplines. Its application in Physical Anthropology has led to a better understanding of human evolution. And as such the pre-molecular evidence (based on physical characteristics) has been replaced by post-molecular evidence. The following discussion is related to the latter.

3.2.1 Immunological Techniques

During the early 1960s it was Morris Goodman who developed immunological tests to establish the close genetic relationships among humans, chimpanzees, and gorillas. The technique involved production of antisera by injecting an animal with protein (albumin) from another species. The antisera produced in this way contained antibodies of the foreign protein which was injected. The cross reaction is done between the antiserum and the immunological protein, i.e., homologous antigen. Similarly cross reaction is also done between the antiserum and the protein of other species, i.e., heterologous antigens. It was observed that greater the similarities in the immunological properties of the two species, the greater the reactions are. That is how Goodman showed that immunologically there is greater similarity between African apes and man than between Asian apes and humans.

3.2.2 Molecular Approach

During 1966 and 1967 Sarich and Wilson carried out more elaborate immunological experiments. The results they got supported Goodman's findings and also enabled them to construct a molecular clock. They injected human albumin into rabbits which produced antihuman albumin. When this antihuman albumin was brought in contact with human albumin the reaction was very strong and same was the case with chimpanzee albumin, while with monkey albumin the reaction was weaker. This shows that the degree of cross reaction depends upon the number of amino acid differences between the homologous albumin (the albumin injected) and the heterologous test albumin. Sarich and Wilson thus established that closer the genetic relatedness of two species, the antigens of one will cross react with the antibody of the other antiserum.

Sarich and Wilson (1971) concluded that man, gorilla and chimpanzee last shared a common ancestor five million years ago. In their further research of 1995, they suggested that chimpanzee and man might have shared a period of common ancestry after the split of gorilla line.

Yunish and Prakash (1983) in their comparative analysis of high- resolution chromosome suggested that the taxonomic scheme of man and apes should be revised. The taxonomists' classification of two families-*Hominidae* for man and *Pongidae* for apes be changed to two subfamilies-*Hominae* for man and large apes and *Ponginae* for Orangutan. This kind of classification instead of solving the problem generated controversy. The protein-enzyme nucleic acid analysis based biomolecular evidence, showing similarities between man and African apes of Chimpanzee and Gorilla, has been found to be of primitive retentions of earlier inheritance from the common hominid stock as shown by works of Mai (1983), Kluge (1983), Schwartz (1984) and a host of others on the chromosome number and karyotyping variability.

But to suggest the revision of the taxonomic scheme of man and apes on the basis of comparative analysis of chromosome alone is a far fetched idea. It is well established fact that the family Hominidae contains single genus Homo and single species Homo sapiens. There are many characters supporting the influences of the family in the Primate order. Needless to say that “Man the tool maker” is the only culture-creating, culture-retaining, culture-transmitting creature with a complex brain and articulate speech in the animal kingdom.

3.2.3 DNA Hybridisation

Besides the above approaches there is DNA comparison based on hybridization technique. In this technique single stranded DNA of one species is allowed to seek out its complement in the single stranded DNA of another species. DNA strands can be separated and combined in the laboratory. When the DNA sequences of two species are similar, the bonds that develop will be stronger but when the sequences are different the bands will be weak. If the bonded pair is strong the temperature is also high. Examination of the hybrid strand shows that a double strand composed of one human and the chimpanzee strand is 97.5% fit and 2.5% amino acid sequences are different. It indicates that they have descended from a common ancestor and the minor difference in their DNA might have been due to changes since the time of their separation.

3.2.4 Mobile DNA Elements Approach

Mobile DNA elements are distinct DNA sequences that have remarkable ability to transport or duplicate the other regions of the genome.

It has been observed that nearly 50% of the primates genome is made up of mobile repetitive DNA sequences such as Alu and LINE elements. The causes and evolutionary consequences of these mobile elements have been studied during the last decade.

Due to their distinctive mutational mechanism, these elements are exceedingly useful in constructing phylogeny particularly human-chimpanzee-gorilla trichotomy as well as that of New World Primates.

Without going into the details of the two different types of mobile DNA elements (**DNA Transposons and DNA Retrotransposons**), let us examine the role of Alu elements which are primate specific. Alu elements have been extensively used in primate phylogenetic studies.

Human-Chimpanzee-Gorilla Trichotomy

According to Paterson et al. (2006), the relationship among humans, chimpanzees, and gorillas have been a difficult and long standing problem. Several studies have tried to resolve this problem. Though the mtDNA studies by Horai et al. (1965) support chimpanzee as nearest living relative of humans, Satta et al. (2000) who analysed the sequences from 45 nuclear loci found that 60% of the loci support human-chimpanzee relationship. Salem et al. (2000) analysed 117 Alu Ye subfamily and 16 loci from Alu Y sub- family. They found a single most parsimonious tree with high levels of support. The resulting tree clearly clusters human and chimpanzee as a sister clad with gorilla as outgroups.

3.3 COMPARATIVE ANATOMY OF MAN AND APES

Comparative anatomy is one among many branches of Comparative Biological Sciences such as comparative physiology, comparative embryology, comparative biochemistry, and so forth. Comparative method is widely used by scientists in their fields of specialization.

3.3.1 Skull

It consists of two parts – Cranium and Face.

Cranium is a more or less dome shaped case which contains the brain.

Face consists of the upper and lower jaws, the cheek and the nasal bones. Between the face and cranium are the orbits.

The great size of the cranium and reduction of the face are the characteristics of man. In apes the face is very large and heavy whereas cranium is proportionately very small. In man the face is not only small but it does not project beyond the cranium. Hence the skull is **orthognathous** (orthos- straight, gnathous – jaw). On the other hand, the large face and jaws project in front of the cranium and form a snout. It means that cranium is placed behind the face instead of over it and as such the skull becomes **prognathous**.

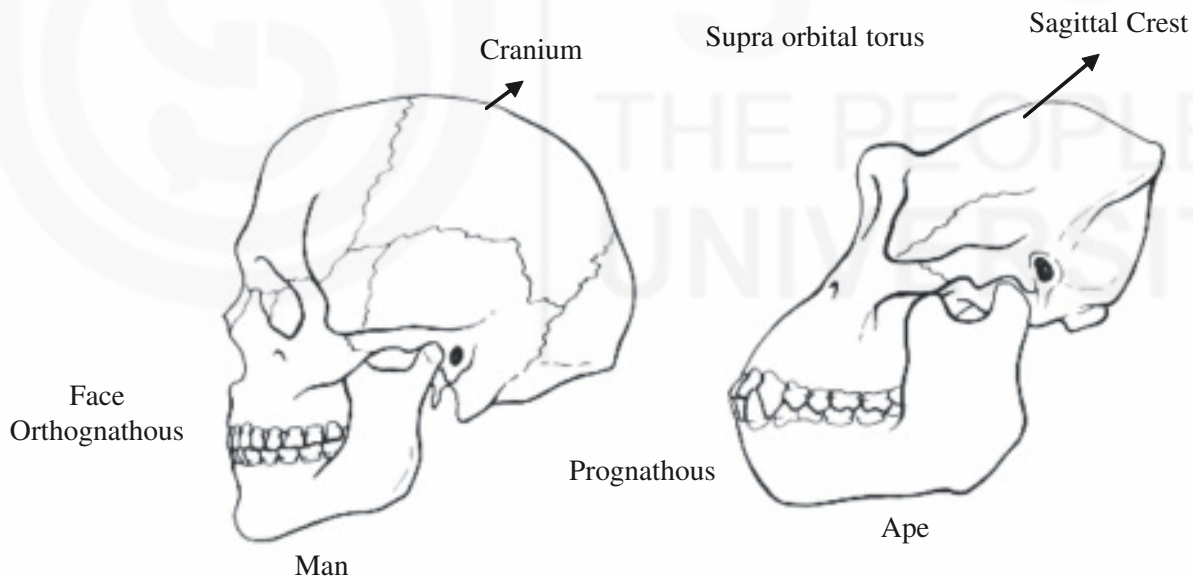


Fig.3.1: Lateral view of human and ape skulls

In man, the cranial capacity is larger because of the larger dimensions in length, breadth and height than that of the apes. The average cranial capacity in man varies from 1000 cc to 1400 cc. The average cranial capacity of adult gorilla varies from 540 cc to 600 cc; in chimpanzee it is between 420 cc to 500 cc and in orangutan it ranges from 450 cc to 550 cc. The smallest cranial capacity of 100 cc is found in the gibbon.

The roof and the sides of cranium constitute the vault. The vault of the human skull is smooth and convex in the frontal, occipital and parietal regions which overlie the corresponding regions of the brain associated with intelligence, vision and sense of touch and control of muscles. The vault of the ape skull lacks these convexities also known as eminences or bumps.

The bones in the vault of human and ape skulls are firmly joined together. The frontal bone of the forehead makes contact with the occipital bone of the back. There are two parietals between these two, one on each side of the midline on the top of the skull. There are two more bones namely the temporal and the sphenoid which complete the side of the vault. The junction along the edges of these bones is marked by line known as sutures. There are many sutures such as coronal suture between frontal and parietals, lambdoid between occipital and parietals, squamous between temporal and parietal where the former overlaps the latter, sagittal between the two parietals in the midline at the top of the skull, and speno-temporal between temporal and sphenoid. These sutures are clearly seen in man but tend to cynostose (fuse) in old age and become completely obliterated. In apes the sutures are not easy to see.

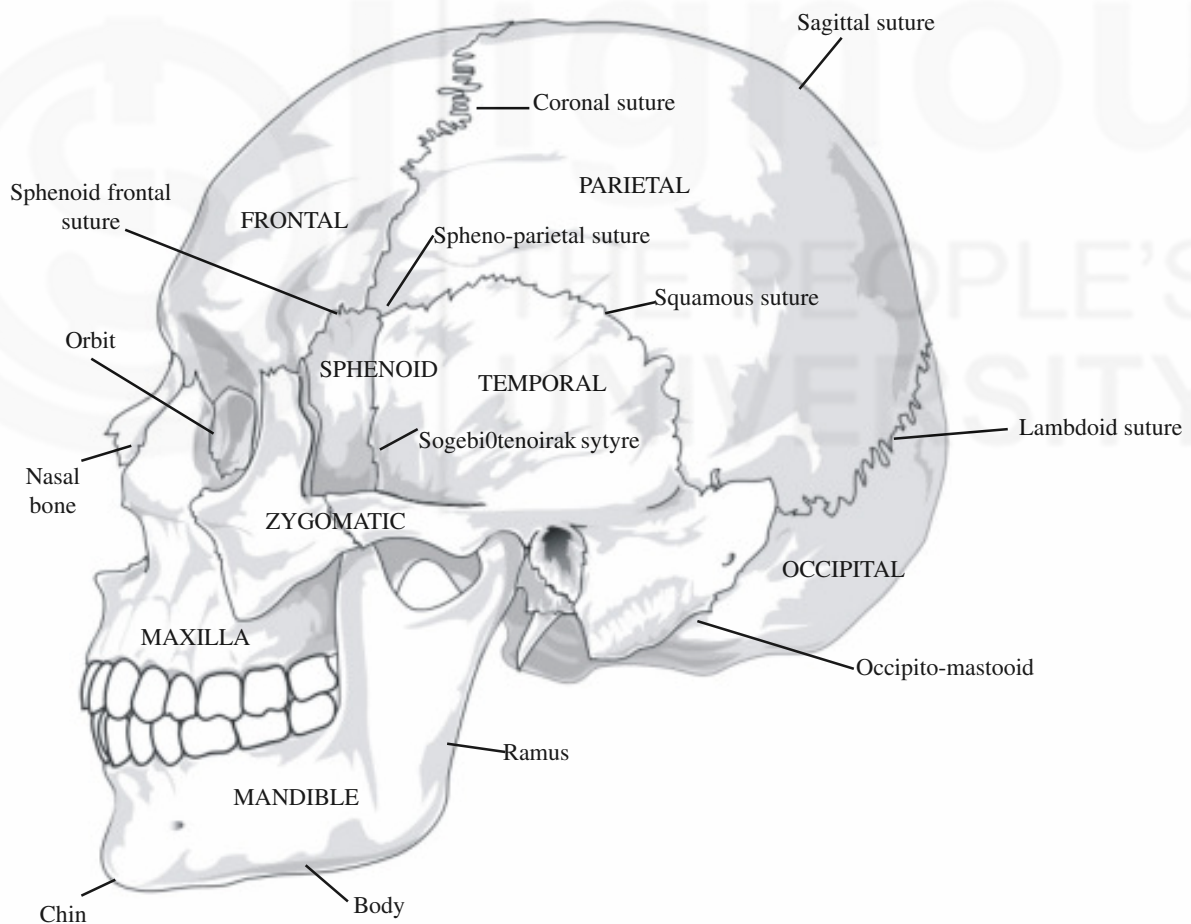


Fig. 3.2 : Lateral view of human Skull

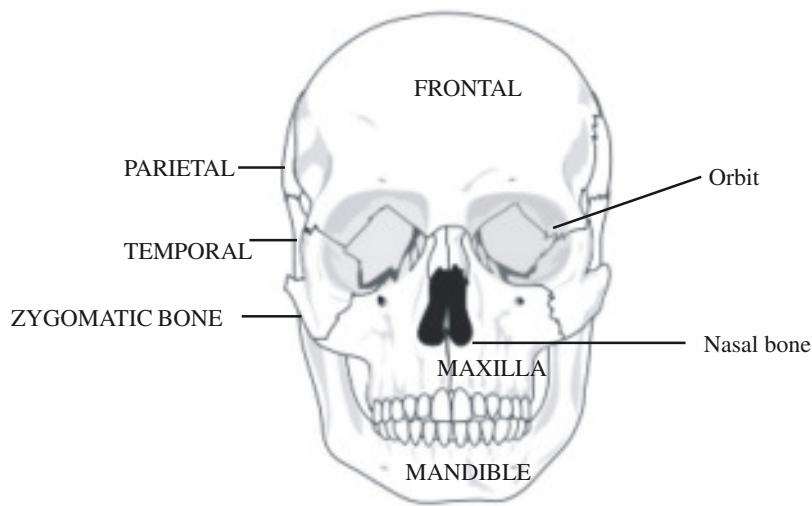


Fig. 3.3: Frontal view of human skull

The differences between man and ape skulls are prominently marked in the development of ridges and the areas for the attachment of neck and masticatory muscles. In man the side of the vault has extensive flattened area known as temporal fossa for the attachment of temporal masticatory muscles. These muscles extend from the side of the cranium to the lower jaw. They help the jaw in moving up and down and sideways during mastication. The temporal fossa in apes is much larger than in man. Because of the large size of jaw and teeth, the temporal fossa in apes has to provide greater surface for the attachment of the masticatory muscle. The line of its attachment known as temporal line rises right up to the top of the skull where it meets the midline and forms a vertical crest called the **sagittal crest**. This crest joins a transverse crest called **occipital crest** in the posterior region of the skull.

The frontal bone in man has two eminences, one on each side and the forehead is vertical, whereas in apes there are no eminences and the forehead is flat and retreating. There are two conical cavities which accommodate the eyeballs. These orbital cavities are connected with the temporal region in man by two narrow spaces, one between the zygomatic (malar) and sphenoid bones and the other between the zygomatic and maxillary. The orbital cavities are large and almost completely shut off from the temporal fossa by the extension inwards of the zygomatic bone.

The frontal bone forms the upper border of the orbits and in between them it makes sutural contact with the nasal bones. The upper border is curved and thickened known as supraorbital ridge. In man, the two supraorbital ridges may not be prominent. They are separated from the midline by a depressed area. The supraorbital margins are very strongly developed in apes but in gorilla they are massive and form a continuous **supraorbital torus**. In orangutan this torus is conspicuous but not massive.

The occipital region in the back of the skull forms the vault and also enters into the part formation of the base. The vault portion in man is smooth and bulging and the basal portion is less bulging. The occipital bone in the apes is less convex and less uniform in outline and the rough muscular portion is flattened and looks backwards and downwards. The external occipital curve line is raised into a prominent occipital crest which is joined by the sagittal crest. As compared to

man, the ape's skull is large and projecting and is ill balanced on the vertebral column. The muscular area has to be extensive in the occipital bone. At the base of the skull, there is a large opening through which the spinal cord passes into the vertebral column. Because of the bulge of occipital bone, there is a considerable extension of the base of the skull behind the foramen magnum in man and as such its position is relatively forward. Since there is reduction in the occipital bulge in apes, the base becomes small and so the foramen is placed far back and faces downwards.

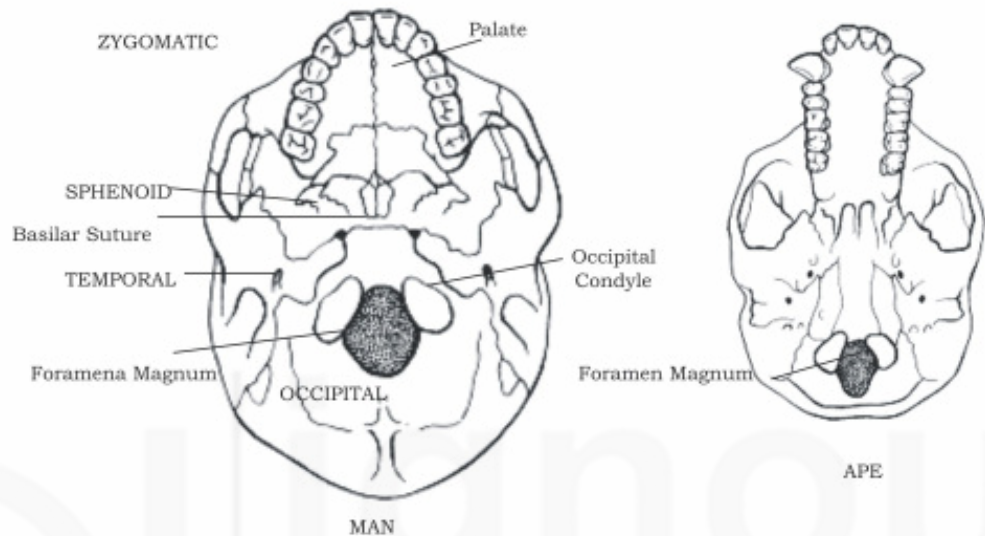


Fig. 3.4: Basal view of Human and ape skulls

The face consists of upper jaw formed by two symmetrical bones joined together in the lower part to form the palate. It has several processes. Its frontonasal process connects the maxilla to the frontal bone and also supports the nasal bones. In apes, it is stronger and shorter than in man and acts as a buttress. The lower curved margin of the maxilla is the alveolar process which bears the teeth. It is stronger and larger in apes than in man because of the larger teeth.

The zygomatic or the malar bone supports upper and outer part of the cheek on each side and joins (connects) the maxilla to the cranium on the outer side of the orbit. It acts as a buttress or support and conveys pressure forces up to the base of the skull. It is very stout in apes as it has to support the strains (pressure) produced during mastication by the heavy jaws. The palatal processes of the maxillae form the hard palate which separates the mouth from the nose and forms the roof of the mouth and the floor of the nasal cavity. The only difference between man and apes is that the premaxillary part of the palate is fused with maxilla in the former whereas it is separate in the latter. The upper surface of the maxilla extends as the orbital process under the eye. The alveolar process shows a number of vertical ridges raised by the roots of the teeth and one of these near the margin of the nasal aperture is prominent. This is the canine ridge. The ridges are more prominent in apes than in man because of the larger roots of the teeth.

The zygomatic bone connects the upper jaw to the base, and medially and below it is continuous with zygomatic process of the maxilla. The inner process of the zygomatic bone meets the angular projection of the frontal bone while the outer process extends to meet a similar process of the temporal bone across the temporal

fossa. This is how the zygomatic arch is formed. In apes we find the same processes as in man but they are shorter and stronger. The zygomatic arch is also shorter.

The paired nasal bones are raised above the level of the face and meet in the midline. They are in contact with the maxilla on each side and meet the frontal in the upper end. The lower ends widen out to form the nasal aperture. In apes the nasal bones are not raised above the level of the face as they are flat and thus there is no nasal bridge, a prominent feature of nasal bones in man.

The lower jaw or the mandible has two symmetrical halves which become fused early in infancy. The junction of the two halves in the midline is known as symphysis menti or mental symphysis (joint of the chin). The bodies of the mandible (i.e., the two halves) diverge backwards from the symphysis. The mandibular body accommodates the teeth of the lower jaw. The ramus of the mandible is a broad flat plate of bone which turns up from the posterior of the body. The upper part of the ramus is separated into two processes by a depression known as sigmoid notch. The anterior coronoid process gives attachment to the temporal muscles whereas the posterior process or condyle fits into a fossa on the undersurface of the squamous portion of the temporal bone to form the temporo-mandibular joint. The backward divergence of the bodies of the mandible and the chin are characteristic features of man. The general description of the mandible of apes is same as that of man but there are differences between them. In apes, the body of the mandible is heavier and the two halves are parallel. There is no mental eminence. The two halves of the body at the symphysis are buttressed behind by a bony bar called **simian shelf**. The ramus is also wider than in man and the sigmoid notch is shallower.



Fig.3.5: Dental Arch in Man and Apes

There are three parts of a tooth. The crown is above the gum, the root fits into the socket of the alveolar hard enamel material. The neck is the slightly constricted region between the crown and the root.

According to the shape, special functions (cutting, grinding) and location in the jaws, the teeth are classified as incisors, canines, premolars, and molars. The total number of teeth both in man and apes is 32 represented by the dental formula of 2123/2123. There are two incisors, one canine, two premolars and three molars found in each half of the upper and lower jaws ($8 \times 4 = 32$). The teeth in apes are much larger than in man.

Incisors are sharp cutting or nibbling teeth in front. They are larger and clumsier than in man. Canines are the tearing teeth. They are large and long with blunted crown in man. In apes they are large and out of proportion of the adjacent teeth. On account of great length, they are accommodated into the spaces of the upper and lower jaws at the time of oscillation or closure of the jaws. The space is known as **diastema** characteristic of simian dentition. Diastema between the upper canines and the lateral incisors is present. The canines project forward and are interlocked.

Premolars are also known as **bicuspsids** because they have two conical crowns. They are also grinding teeth. In man, the upper premolars have two roots and the lower ones possess only one root, whereas in apes the upper ones have three roots and the lower ones have two roots. Molars are grinding teeth. In man they have four dome shaped cusps on the upper and five on the lower molars. The last molar is the smallest in the series. The molars of the apes have large well developed cusps. The third molar is the largest in the series.

3.3.2 Spine

The spine is made up by a number of superimposed blocks of bone called vertebrae. They form a vertical column supporting the head and the ribs. That is why it has been named as vertebral column. The vertebral column protects the spinal cord which is a downward prolongation of the central nervous system. It represents a series of curvatures. These are cervical, thoracic, lumbar, sacral and caudal or coccygeal. In man, the thoracic and lumbar curves are called primary curves because they are the parts of the embryo. The cervical curve develops only after birth when the head is lifted and the lumbar curve appears when the trunk is raised as the child begins to walk. The curvatures in the cervical and lumbar region are convex forwards, whereas in the thoracic and pelvic region they are concave forwards. The cervical vertebrae are seven in number. They are small and their spines are short and bifid. The first vertebra called atlas supports the head and is modified to twist horizontally around the second or axis. The rotation of the head takes place on the atlas and axis. The apes also have seven cervical vertebrae which are proportionately larger than those of man. Their spines are long and stout. The graceful hollow of the neck in man is filled up in the apes.

The thoracic vertebrae are normally twelve but may be thirteen in number. The thoracic vertebrae resemble those of man. The lumbar vertebrae also known as lion vertebrae and are five in number in man but may be reduced to four or increased to six. They are broad from side to side and rough. The lumbar vertebrae in apes are very flat and broad.

The sacral vertebrae in the pelvic region are fused together to form a wedge shaped bone. It lies in the posterior part of the pelvis where it is firmly attached. The curvature or concavity of the sacrum is well developed. In apes this curvature is less marked and the sacrum is narrower as compared to that of man.

The coccygeal vertebrae of the tail region are reduced to small plates of bone hardly recognizable as vertebrae both in man and apes.

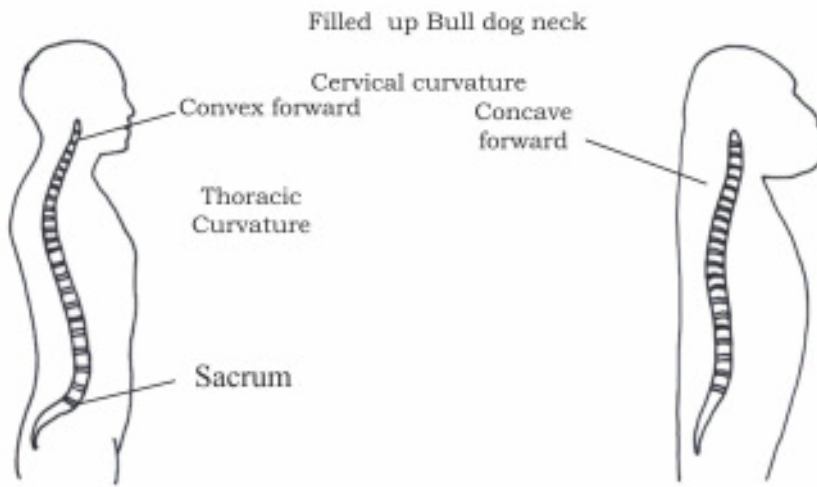


Fig. 3.6: Vertebral Column Curvatures

3.3.3 Pectoral Girdle

The bones of the pectoral girdle are the clavicle (collar-bone) and the scapula (shoulder-blade). The clavicle is a long sigma-shaped bone. It is joined to the top of the sternum by a movable joint and its other end meets the scapula. One can feel it with the hand. In apes, the clavicle occupies the same position and connections as in man. In gibbons, the clavicle is long and slender due to their arm swinging mode of locomotion.

The scapula is flat and triangular in shape. It lies on the back of the shoulder region. It is attached to the outer end of the clavicle and accommodates the head of humerus in its glenoid cavity. The ape scapula has the same attachments and shape as in man. It is narrower than in man.

3.3.4 Pelvic Girdle

The pelvic girdle is formed by two ossainnominata (hip bones). They have five bones which are fused. The outer side of each hip bone has a cup-shaped cavity called acetabulum which receives the head of the femur (thigh bone). The two hip bones form a basin-shaped cavity closed by sacrum in the posterior region. In man, this basin is wider specially in females as compared to males. The iliac element of the hip bone is expanded. In apes, the pelvis as a whole is longer because of the elongation of the ilium. The basin is also narrower than in man.

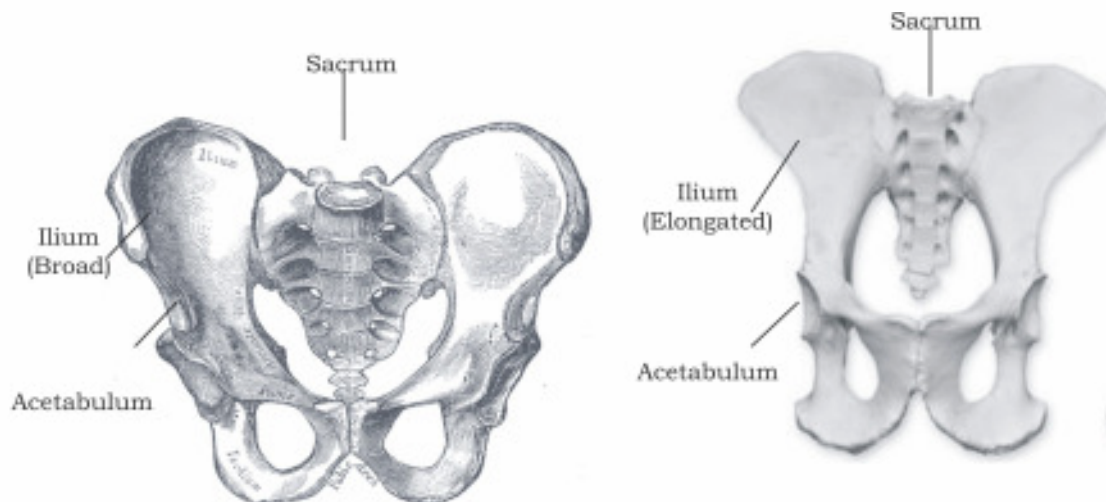


Fig.3.7: Pelvic Girdle of Man and Ape

Source: WKO-187-PF:Female Chimpanzee Pelvis and Femur (Museum Quality bone clones™ Replica)

3.3.5 Lower Limbs

The lower limb of the body has the longest bone called femur (thigh bone). It has a spherical head connected to the shaft through the neck. The femoral head fits into the acetabulum of the os innominatum and the lower end with its two condyles (knuckles) which are expanded into a broad base and enter into the knee joint. This arrangement forms an efficient support for the body. In apes, the head of the femur is not so extensive. The neck is shorter and at a less obtuse angle with the shaft. The shaft is short and stout, and its lower end is less expanded.

In man, the tibia transmits the weight from the femur to the foot. The upper end of the tibia is horizontally expanded to support the triangular shaft, whereas the lower end is slightly expanded which rests on the talus, one of the tarsal bones of the foot. The tibia does not enter into the knee-joint but articulates with outer surface of talus. It acts like a spring-bone as it takes up the strain of the outward bends of the foot at the ankle-joint.

The bones of the tarsus have adapted for bearing weight of the body. The metatarsals form a somewhat conical arch. Thus the long heel bone, calcaneus, slopes backward from below to reach the ground at the posterior end. In apes, the plane of the tibio-talus joint is oblique in such a way as to twist the foot a little inwards. The arching of the inner side of the sole is not so marked.

In man, the metatarsal of the big toe is firmly bound together with the other four in marked contrast with that of the thumb. In apes, the metatarsal is relatively and separately movable. Thus the big toe can be opposed to the other toes and functions as a grasping organ like the human hand.



Fig. 3.8: Foot of Man and Ape

We have considered the comparative anatomy of man and apes and have seen the differences between them. However it must be noted that there are many shared features which are ancestral traits, that is, traits inherited from the shared common ancestor. These are human trunk similar to that of an ape, length of arm, breadth of trunk, and shortness of the lumbar region (back bone), length of clavicle, and many details of bone joints and muscles.

3.4 HOMINIZATION

The earliest evidence of hominids that was found, included teeth and cranial pieces which were not enough to distinguish modern man from our closest relatives the apes. Then, how can we identify hominids from other types of animals, especially when these occur only as fragments of fossil remains?

The Olduvai Gorge in Tanzania is the most important site that yielded the fossil evidence in abundance about the skeleton and behaviour of hominids. The layers

through which the Gorge cuts are divided into four numbered from the bottom as Bed I, Bed II, Bed III and Bed IV, the uppermost.

In 1960 Leaky's son found pieces of jaws, partial cranial vault and hand bones from Bed 1 dated to 1.8 million years ago. The bony remains were encircled by loosely piled stones. Leaky thought that it was a dwelling of a hominid which belonged to genus *Homo*. He named it *Homo habilis* (handy man) believing it to be a tool maker. The piled stones, according to Leakey were windbreak constructed by *Homo habilis*. The cranial capacity after reconstruction was found to be 680 cc which to Leakey was further proof for separating *Homo habilis* from the *Australopithecus africanus*.

The debate among the palaeanthropologists over which of the traits-tool making, large brain, and bipedalism-was critical in defining mankind. Yattersall has very rightly pointed out that the spin off of this mindset was the idea of hominization, that is, becoming human in some way was definable and separate process which could be studied. It must be noted that all these traits did not develop simultaneously as can be seen in hominid evolution over the last seven million years. The process of hominization may be examined in the biocultural nature of hominid evolution.

3.4.1 Skeletal Changes Due to the Erect Posture and its Implications

The Miocene and Pliocene apes were arboreal but they could also move on the ground. Our ancestors came down from the trees probably more than 4 million years ago. Due to paucity of fossil record, we do not know the successive stages through which hominids passed before they walked upright. The anatomical changes associated with erect posture and bipedal gait are found throughout the body- toes, legs, vertebral column, pelvis, skull, and various muscles. The changes are seen in the shape, position and function.



Fig 3.9: Bipedal Locomotion in Man

Foot

The big toe or hallux is enlarged and projects beyond the other toes, but it is in line with other toes. The bones of the foot are arranged in such a way that a marked longitudinal arch is formed along the inner side of the foot. There is a less marked longitudinal arch along the outer side, and a third arch, the transverse arch across the heads of five metatarsals. The arches perform several functions in standing and walking. They ensure that the weight of the body is evenly distributed over the sole. They absorb shock and work as spring in the stride. The usefulness of these arches in bipedalism is also associated with certain disadvantages. The arches may become flattened due to several reasons. The flat feet not only reduce functional efficiency but also affect the skeleton adversely. The strains felt in maintaining the arch under the increasing weight may stretch tendons and ligaments until the arches collapse. The flat footed hominids cannot stand for longer period and cannot also run fast.

Knee Joint

The large human knee joint is particularly well adapted for weight bearing and locomotion. The lower limbs are elongated. The femur is angled inward so that the legs are directly under the body.

Pelvis

Adaptation of upright posture led to many alterations in the pelvis. The ilium bones become shorter and broader for balancing the weight of the body and for transmitting it from the vertebral column to the limbs. The pelvis is shaped like a basin to accommodate the internal organs.

Vertebral Column

The Vertebral column of man is adapted to his upright posture. It has two distinct curves, a backward thoracic one (convex) and a forward lumbar one. These two curvatures keep the trunk and weight centered above the pelvis.

Upper Limb

Man's upper limb shows some anatomical specializations including the freedom and mobility of the shoulder joint. Also the human hand can be brought into almost any position.

Skull

The cranium becomes globular and voluminous. The foramen magnum at the base of the skull is placed further forward and as such the head is balanced on the vertebral column.

Implications

There are numerous models that suggest the evolution of upright posture. According to one view the evolution of erect posture may be associated with the disappearance of thick forests and their replacement with small woods separated by tracts of open tall grasses which indicate that such countryside might have existed in Kenya during the Miocene epoch, once the upright posture was attained by the hominids, bipedalism became the mode of locomotion as an adaptive response to life in the tall grasses of savanna. They could thus spot ground predators and potential prey.

Another model accounts for better dispersion of body when the head is raised and less surface is exposed to the sun during the hottest time of the day. This might have played an important role in the thermoregulation of the brain in early hominids for the development of brain.

The importance of allowing the hands to be free while the legs are moving has been stressed by paleoanthropologists. Selection may have favoured critical activity if it were necessary to carry food from one location to other. Hence, bipedal locomotion offered an adaptive advantage.

Tool use and tool making favoured bipedalism. It was an appropriate adaptation for hominids to scavenge food. There is however no direct evidence in support of any of these models on hominization.

3.5 SUMMARY

We read in biogenetic basis of phylogeny of living primates that various sophisticated techniques have been developed by scientists for establishing the phylogenetic relationship between humans and apes. The results of immunological tests and the molecular clock constructed by Sarich and Wilson suggest the divergence of man and apes from a common ancestor around 5 million years ago (mya). The chimpanzees are closer to man than the gorilla. The human-chimpanzees-gorillas trichotomy is accepted by the majority of the scientists.

The unit also provides a comprehensive background on comparative anatomy of man and large apes, supported by suitable diagrams, followed by the process of hominization. The changes that took place due to erect posture and their implications are discussed. Models have been advanced to explain the development of erect posture and bipedalism, but none of them is fool-proof in the matter.

3.6 GLOSSARY

Adaptation	: successful interaction between populations and environment.
Antibody	: a protein produced in response to foreign antigen.
Antigen	: a substance (also a protein) that causes the production of antibody.
Brachiation	: a mode of movement through the trees by swinging alternate arms to reach from branch to branch. Among the apes Gibbon is the extreme brachiater.
Cranial capacity	: the measurement of interior volume of the brain case expressed in cubic centimeter (c.c.)
Dental Formula	: shorthand notation for the number of teeth on each side of the upper and lower jaws.
DNA (Deoxyribonucleic acid)	: a long stranded molecule in the gene. It directs the making of an organism according to the <i>instructions</i> in its genetic code.

Gait	: manner of walking, such as bipedal or quadrupedal gait.
Genome	: the total DNA sequences of an organism.
Foramen Magnum	: the large opening on the base of the skull where the spinal cord enters.
Pelvic outlet or basin	: the brim of the pelvic cavity. It is wider in human female.
Posture	: the disposition or arrangement of the body parts.
Phylogeny	: the evolutionary history or genealogy of the species or groups of species
Savanna or Savannah	: open grasslands in which the food resources are spread.
Zygomatic arch	: the cheek bone formed by the zygomatic and temporal bone on the side of the skull.

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Sample Questions

- 1) How has genetic research clarified biological relationship between humans and large apes?
- 2) Write notes on:
 - a) Man-chimpanzees -gorilla trichotomy
 - b) Comment on the existing taxonomic status of man and apes.
- 3) Compare the morphological features of human skull with those of large apes.
- 4) Describe the changes associated with evolution of erect posture in human body.
- 5) Discuss the models that have been proposed by different authors to explain the emergence of erect posture and bipedalism.