

Unit 1B

Chapter 20

Classification of the human species

Unit content

Variation and evolution

Biological classification of humans (as vertebrates, mammals, primates and hominins) is based on a variety of features. Classification systems are dynamic.

Classification:

- characteristics of vertebrates, mammals, primates and hominins
- reasons for classification of organisms
- problems with classification
- changes in classification schemes.



Figure 20.1
Chimpanzees share many characteristics with humans

The chimpanzee in Figure 20.1 is your relative! He may not look like your parents, grandparents, and brothers and sisters, but he does have many characteristics in common with you. Look at Figure 20.2. Can you see any features that are shared by all the animals in the photographs?

Humans are primates. So are apes, monkeys and some other related animals. They are called primates because they are all classified together in a group called the order Primates. Classification is a basic part of science, and the classification of the human species is of particular interest to human biologists.

Principles of biological classification

Classification is placing things into groups based on similarities in characteristics. It is a basic part of science. Chemists classify substances, geologists classify rocks, astronomers classify stars and planets and doctors classify diseases. Classification is not limited to science. One of the most basic human urges is to look for patterns, to sort things into categories and to give them labels. Librarians are experts at this. They classify the books in a library so that those on similar topics are grouped together.

Carolus Linnaeus (1707–78) was one of the first to consider that all the known animals and plants could be placed into groups based on similarities in structure. It was Linnaeus who established the basis of our present system of classifying and naming organisms.

Living things are classified into groups that form a hierarchy. A hierarchy is a series of groups that move from broad general categories to narrow specific ones. Living things are grouped first into kingdoms. Two of the kingdoms are the plants and the animals. Each kingdom is then divided into groups known as **phyla** (singular phylum), each phylum is divided into classes, and so on. As we go down the hierarchy the organisms in each group have more and more characteristics in common. The basic groups in the classification of living things are:

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species.

The hierarchy of classification can be seen in Table 20.1. Notice how the animals in each group are more and more alike until, at the species level, all the members of the group, human beings, are very similar indeed. In Table 20.1 all the sub-groups have been included for completeness but you only need to focus on the groups that are highlighted in colour.



Figure 20.2 Primates: lemur, macaque, spider monkey, gibbon, human

Table 20.1 The classification of humans

Kingdom	Animalia	The animals
Phylum	Chordata	Chordates include sea squirts, acorn worms, fish, frogs, lizards, snakes, birds, platypus, kangaroos, bats, rabbits, dogs, elephants, horses, tarsiers, lemurs, monkeys, apes and humans
Subphylum	Vertebrata	Vertebrates include fish, frogs, lizards, snakes, birds, platypus, kangaroos, bats, rabbits, dogs, elephants, horses, tarsiers, lemurs, monkeys, apes and humans
Class	Mammalia	Mammals include platypus, kangaroos, bats, rabbits, dogs, elephants, horses, tarsiers, lemurs, monkeys, apes and humans
Order	Primates	Primates include tarsiers, lemurs, lorises, monkeys, apes and humans
Suborder	Anthropoidea	Anthropoids include monkeys, apes and humans
Superfamily	Hominoidea	Hominoids include apes and humans
Family	Hominidae	Hominids include all modern and extinct orangutans, gorillas, chimpanzees and humans
Subfamily	Homininae	Hominines include all modern and extinct chimpanzees and humans
Tribe*	Hominini	Hominins include extinct ancestors of humans and modern humans
Genus	<i>Homo</i>	Some extinct ancestors of humans and modern humans
Species	<i>sapiens</i>	Modern humans

*Note: Tribe is a classification group within a subfamily. The meaning of tribe here is different from the use of tribe to describe an ethnic group of people.

Classifying organisms in this way helps communication. For example, if a person tells you an animal is a vertebrate, you immediately know that it will have a backbone because that is a characteristic of vertebrates. You will also be able to think of other animals that have a backbone.

Naming living things

The names that we use every day for animals and plants, names like cat, dog and gum tree, are called common names. Common names vary from place to place and are different in different languages. To avoid confusion scientists use scientific names. Scientific names are internationally accepted and are the same in every language.

(a)



Figure 20.3 Two primates with their scientific names: **(a)** Philippine tarsier, *Tarsius syrichta*; **(b)** Golden-headed lion tamarin, *Leontopithecus chrysomelas*

(b)



The **scientific name** of an organism is its genus and species. Humans belong to the genus *Homo* and to the species *sapiens* so the scientific name for humans is *Homo sapiens*. The scientific name for dogs is *Canis familiaris* and for cats *Felis domesticus*. Notice that scientific names are always printed in italics and the genus always starts with a capital letter and the species with a small letter.

Classification of humans

Humans as vertebrates

Humans, along with all the other primates, are classified in the phylum Chordata and subphylum Vertebrata. As vertebrates within the phylum Chordata, humans and the other primates share the following characteristics:

- a **bony spinal column** (backbone or spine): the spinal column develops from a structure in the embryo called a notochord
- a **nerve cord**, one end of which is enlarged to form a brain while the remainder forms the spinal cord: the nerve cord is towards the animal's back and is described as hollow because it has an open tube running through it
- **gill slits** at some stage: gill slits are clefts in the neck region; in the primates, they disappear very early in the development of the embryo
- a **post anal tail**: a tail that extends beyond the anus; in humans and some other primates this is present only during embryonic development.

For more on the classification and naming of living things visit:

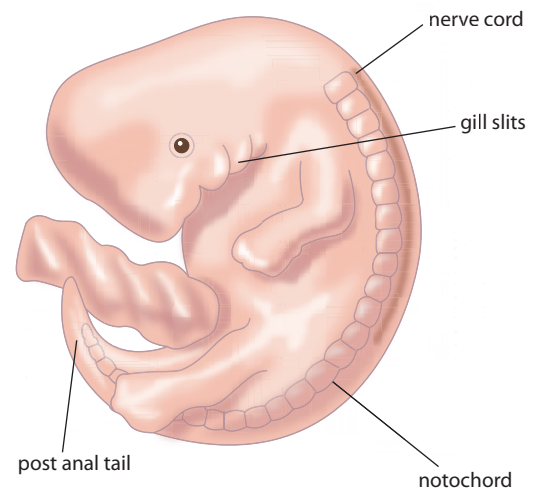
- <https://www.msu.edu/~nixonjos/armadillo/taxonomy.html>
- <http://anthro.palomar.edu/animal>

Humans as mammals

Humans belong to the class Mammalia, which is one of the classes in the subphylum Vertebrata; that is, humans and the other primates are mammals.

All mammals have the following features in common:

- a body covered by **hair**
- a constant body temperature (that is, they are warm blooded or **homoiothermic**)
- a **four-chambered heart**
- the development of young within the **uterus**
- feeding of the young on milk from **mammary glands**.



Humans as primates

There is no one characteristic that can be used to separate the primates from all other mammals. However, there are some features shared by all primates that can be used to identify them as a group. Some other groups of mammals may share one or more of these features, but only the primates have them all.

Characteristics of primates

1. Primates tend to have an **unspecialised body**. This contrasts sharply with most other mammals, which tend to be specialised for the environments in which they live.
2. The **limbs** of primates also tend to be unspecialised in structure, which allows for a great range of uses. Each limb is **pentadactyl** which means it has five digits (fingers or toes). The fingers and toes are very flexible, and the thumb and big toe can be moved in such a way that they can touch each of the other digits (see Figs 20.5 and 20.6). The first digits, thumb and big toe are able to wrap around objects in the opposite direction to the fingers. For this reason the first digit

Figure 20.4 A human embryo thirty-seven days after fertilisation: at this early stage the embryo shows some vertebrate characteristics that cannot be seen later



Figure 20.5 Flexibility of the human hand: the thumb can move across the palm to touch the other digits

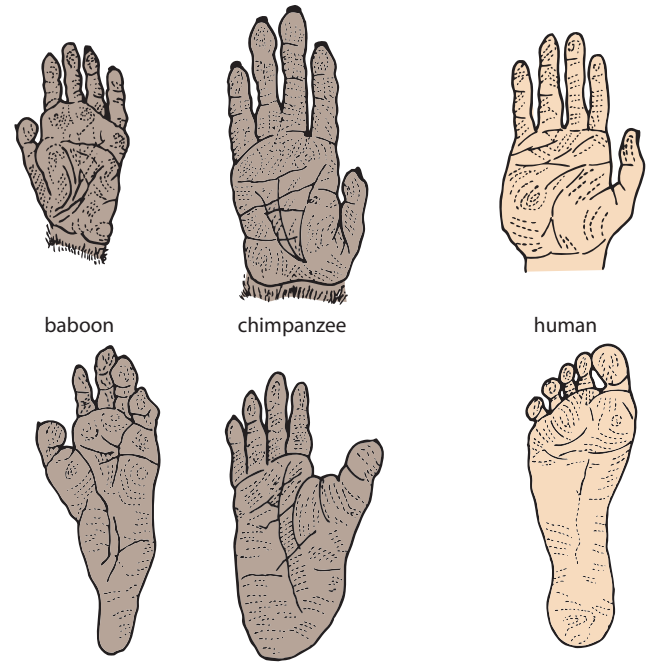


Figure 20.6 Hands (top) and feet (bottom) of three primates: only humans are not able to use the big toe for grasping

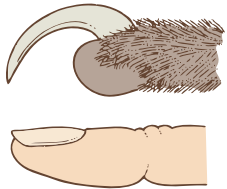
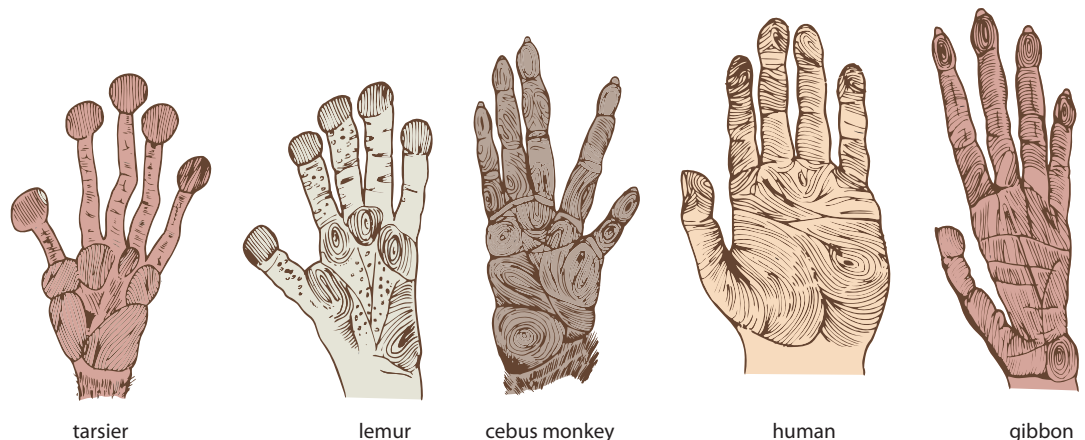


Figure 20.7 Differences between claws and nails

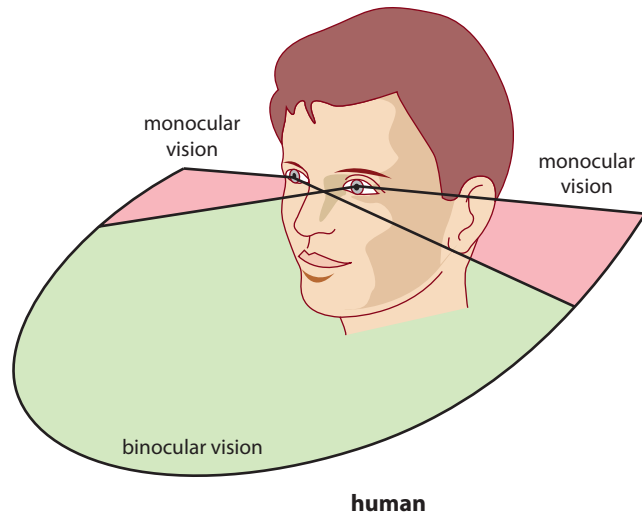
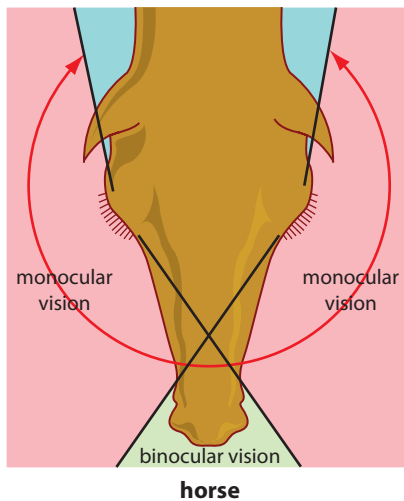
is said to be **opposable**. Almost all species of primates have a big toe that is opposable. Humans are a notable exception.

3. Primates have **nails** instead of claws on their fingers and toes. This was an important development to allow the hands and feet to grasp an object. Claws limit grasping, as they prevent the tips of the fingers coming together with the thumb to hold an object (see Fig. 20.7). To increase the grip between the fingers and toes and an object, small ridges developed. These are called **friction ridges**, or fingerprints, and the pattern varies between individuals and from species to species. (You can observe your own pattern quite simply with the use of a magnifying glass.)

Figure 20.8 The fingerprint patterns of a variety of primates (left hands are shown for all but the cebus monkey)

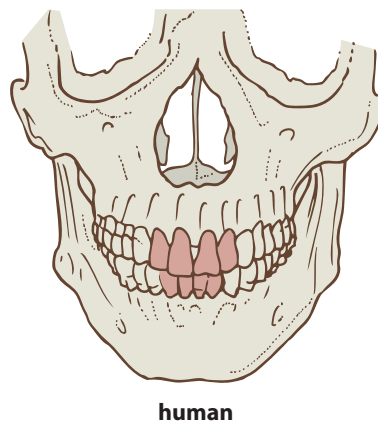
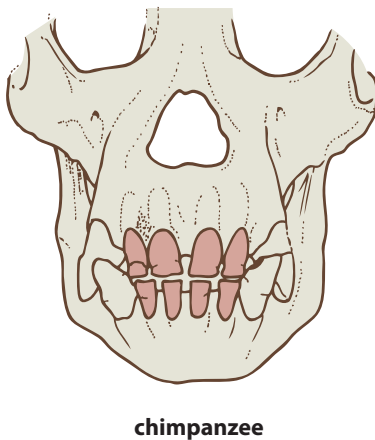


4. Most primates have **forward-facing eyes** that allow them to judge depth and distance. This is called three-dimensional vision. Most of the other mammals have eye sockets that face sideways, but primates have developed eye sockets that face forward (see Fig. 20.9). This means that there is overlap between what is seen with each eye. Because each eye sees a slightly different view of an object, the primates are good judges of depth and distances. Most primates are able to distinguish colours.

**Figure 20.9**

Forward-facing eyes allow three-dimensional vision because there is considerable overlap between what is seen with each eye; compare the overlap of humans with that of a horse

5. With the development of more efficient vision, the need for a keen sense of **smell** became less important. Unlike most mammals, which rely on smell rather than vision, primates have a poorly developed sense of smell.
6. Most primates have four **incisors**, or biting teeth, in both the upper and lower jaw (see Fig. 20.10), as well as canines, premolars and molar teeth.

**Figure 20.10**

The four incisors, or biting teeth, in the upper and lower jaws of a chimpanzee and a human

7. As primates have evolved, the part of the **brain** responsible for complex functions, the **cerebrum**, has progressively increased in size. The outer part of the cerebrum, known as the **cerebral cortex**, is concerned with so-called higher functions: vision, memory, reasoning and the ability to manipulate objects. Figure 20.11 illustrates the increase in size and complexity of the brain from lemurs to humans.
8. Primates show a trend in the development of **reproductive structures** and **reproductive behaviour**. Most primates are not restricted to a limited reproductive season. They have a rhythmical sexual cycle, which is different from most of the other mammals. Also, most primates have only a single offspring at a time. Associated with this is a long period of growth and maturation for the young, during which time there is a lot of parental care.

Table 20.2 summarises the characteristics of primates.

You can see photos of primates at:

- <http://www.primates.com>
- or
- <http://homepage.mac.com/wildlifeweb/primate/new/photos.html>

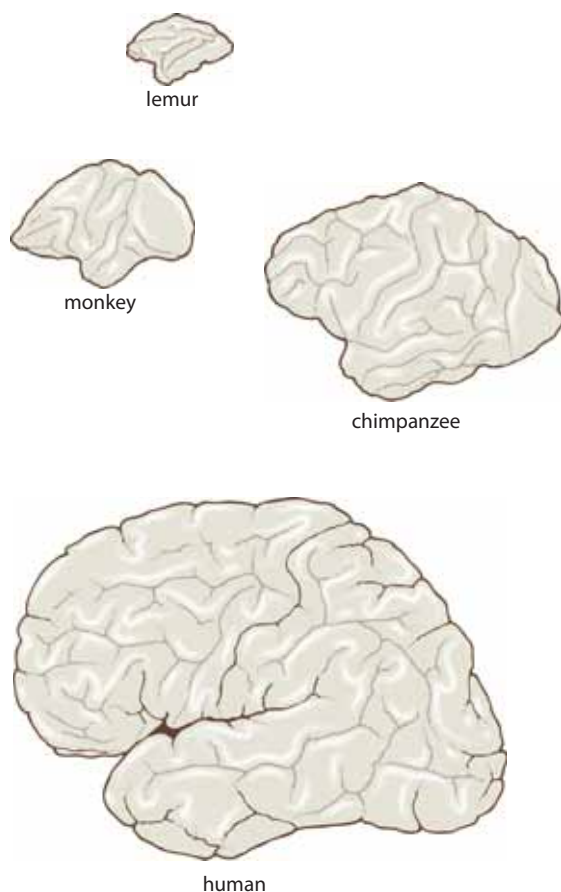


Figure 20.11 The increase in size and complexity of various primate brains (drawn to scale)

Table 20.2 A summary of the characteristics of members of the order Primates

Feature	Primate characteristics
Body	Not specialised for a particular environment
Limbs	Generally unspecialised
Hands/feet	Pentadactyl: five fingers or toes Nails instead of claws Grasping fingers and toes with friction ridges for gripping First digit opposable
Eyes	Forward facing for three-dimensional vision Most are able to distinguish colour
Sense of smell	Very poor
Teeth	Four incisors in both the upper and lower jaw
Brain	Large and complex Cerebrum increases in size as primates become more highly evolved
Reproduction	Not restricted to a breeding season Rhythmical sexual cycle Usually only one offspring at a time Long period of parental care for offspring

Humans as hominins

Humans are hominins; they belong to the tribe Hominini. Tribe is used here to mean one of the levels of classification. In the classification hierarchy it is a group between subfamily and genus. However, in other situations, tribe is used to mean a social group of humans, for example, the various tribes of the native Indians of North America.

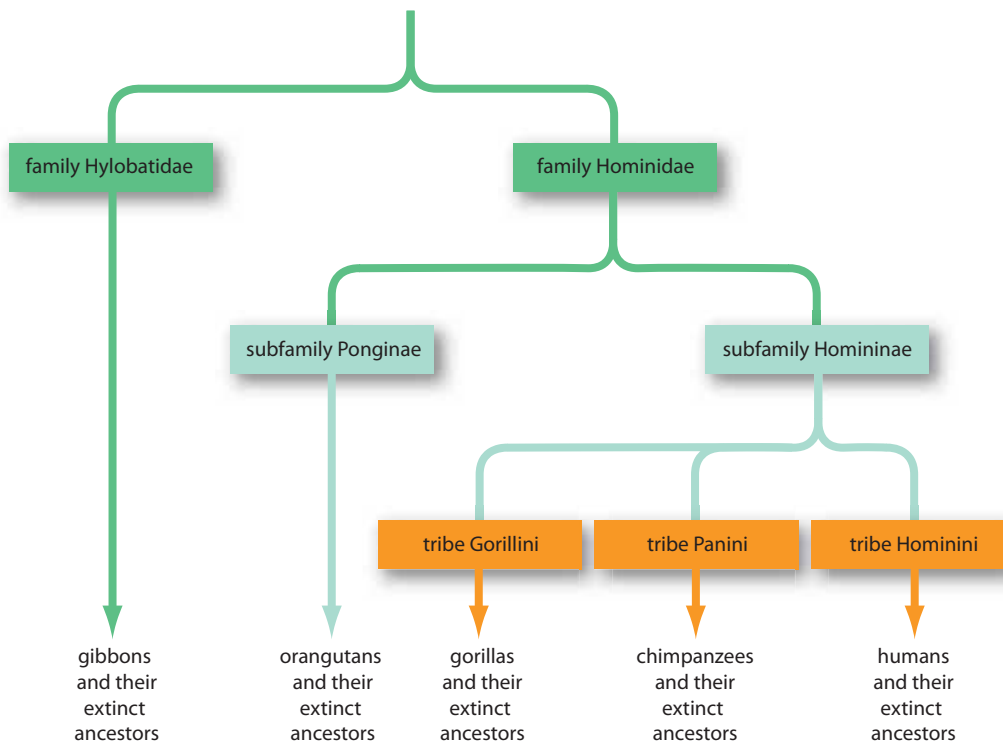
Classifying humans as hominins is relatively new. It takes into account the close relationship between humans and the Great Apes: chimpanzees, orangutans and gorillas. These apes, together with humans, are placed in the family Hominidae (the hominids). Chimps and humans are placed together in the next level of classification, the subfamily Homininae (the hominines), and then humans (along with some of our extinct ancestors) are classified into the tribe Hominini (the hominins). Figure 20.12 shows this diagrammatically.

If you look carefully at Figure 20.12 you will notice that certain word endings are used for specific levels within the classification. For example, 'family' names always end in 'idae' (e.g. Hominidae), 'subfamily' names end in 'inae' (e.g. Homininae) and 'tribe' names end in 'ini' (e.g. Hominini). These formal names are then shortened to give the common names hominid, hominine and hominin respectively.

Hominins differ from the apes in their appearance, structure and behaviour. Most noticeably, hominins are relatively hairless compared with the apes, and the structure of their upper and lower limbs allows for a fully **bipedal** way of walking. Walking bipedally means walking on two legs with the body upright. Humans stand and walk with an erect posture and a striding walk that is unique. It is not found anywhere else in the animal kingdom.

For more on primate classification go to <http://www.zooschool.ecsd.net/primate%20classification.htm>

Figure 20.12
Classification of the apes
and humans



You may have heard of *Homo neanderthalensis* (Neanderthal man), *Homo erectus* and perhaps *Australopithecus*. These are extinct ancestors of humans that we know from fossils. The fossil bones show us that these people could also walk upright on two legs and they are therefore classified as hominins.

Hominins also have greater development of the brain, changes in the size and shape of the teeth, development of speech and sexual characteristics that separate them from the other hominids.

Reasons for classification

In our discussion of classification so far, we have touched on many of the reasons for classifying living things into groups. To summarise, we can list the following reasons for classification:

- *Classification makes it easier to study organisms.* The diversity of living things is so great that it is not possible to study each type individually. Placing organisms into groups based on similarities enables scientists to focus on particular groups for investigation. For example, the special interest of human biologists is the primates.
- *Classification aids communication.* If we know the names of groups and their characteristics it makes it easier to communicate with other people. For example, if we read that a particular animal is a mammal, without being given any other information we will know many of its characteristics. It will have hair or fur, it will be warm blooded, the females will have milk glands for feeding their young and so on. Knowing the group to which an organism belongs gives us a lot of information.
- *Classification shows relationships between groups of living things.* If organisms are grouped together they will be related to each other—they will share

common ancestors. For example, the chimpanzee, gorilla, orangutan and humans are all grouped together in the family *Hominidae*. This means that at some time in the past they all evolved from a common ancestor.

- *Scientific names of living things are directly related to their classification.* An organism's scientific name is recognised and understood by scientists everywhere no matter what country they come from or what language they speak.

The changing nature of classification

The basic system of naming and classifying living things that was devised by Linnaeus in 1758 is still used in a modified form today. Animals and plants are still identified as belonging, in descending order, to a kingdom, phylum, class, order, family, genus and finally a species. This classification system was based largely on the physical characteristics of the organisms. Organisms that looked alike were placed together.

When Linnaeus first devised his system of classification he had only two kingdoms, plants and animals. Then, a hundred or so years later, a third kingdom was added which included the single-celled organisms. Now, with the invention of instruments that can see microscopic organisms in great detail, five kingdoms are used. Some scientists are still not satisfied and would like to see the addition of at least one more kingdom.

Linnaeus' classification was used to identify and name organisms. Classification is still used for this purpose but it is now used to show relationships between organisms as well. Organisms that share a common ancestor are grouped together. Advances in technology, such as DNA profiling and chromosome analysis, have helped scientists to show relationships between organisms in new ways. Discovery of new fossils is also an important source of information. These advances have resulted in constant changes to the classification of organisms as we get more and more detailed knowledge of their structure, the way they function and the relationships between them.

One of the consequences of this detailed knowledge of relationships is an increase in the number of levels of classification. Instead of the basic levels that Linnaeus proposed we now have groups like superfamilies, subfamilies and tribes (see Table 20.1).

Like all aspects of science, classification is dynamic—it is constantly changing as new evidence about organisms is discovered.

Problems with classification

You might think that classifying an organism into a group is easy and clear cut. It is easy to see the difference between a cat and a dog, or a gorilla and a human. However the classification of some organisms causes much disagreement and argument among scientists.

One of the problems is the relative importance of some characteristics. For example, is the ability to walk on two legs of more importance than a large brain? Should a large-brained primate that is able to walk on two legs be put in a group with large-brained primates or should it be grouped with those that walk on two legs? There may be disagreement on which characteristics are the most important.

Another problem, especially in the classification of extinct organisms, is that we only know them from fossils. It is not possible to see how a fossil functioned although it may be possible to make an assumption from comparison with similar living organisms.

In the case of human ancestors, fossils of a whole person are rarely found. More often the fossil is just a part of a skull or perhaps part of a leg or arm bone. From a fragment, experts have to make assumptions about the rest of the skeleton. We cannot be sure that assumptions are correct so the classification of organisms on the basis of fossil evidence is not reliable.

DNA evidence is causing problems in classification. Often the DNA evidence conflicts with the evidence from structure and function. For example DNA evidence showed that the relationship between humans and the African apes was far closer than once believed. In addition, the relationship between the African apes and the Asian orangutan was more distant than was assumed from structural similarities.

Working scientifically



Activity 20.1 Getting to know a primate

In this activity you will study one primate species in detail to gain a greater understanding of primates as a group and to use some of the research and investigation techniques you have learned.

What to do

- Choose a species of primate. You may have a particular favourite such as an ape or a monkey. If you are unsure what species to choose you could go to <http://www.primates.com> which is a picture gallery of primates.
- Decide on four things you would like to know about your chosen primate. Write these down as questions. To give you a start two possible questions are written below. You may wish to use these two questions and two more you complete yourself, or you may wish to make up all four.
 1. What primate characteristics are most obvious and what primate characteristics are poorly developed in this species?
 2. How do the individuals of the species behave towards one another when in a social group?
- Carry out research into your chosen primate to find answers to your four questions. The best way to observe primates is by first hand experience in a zoo. If you are unable to visit a zoo, this activity could be done using reference books on primates or by visiting some of the excellent websites that deal with primates.
- Write a report on your chosen primate. Include in your report the answers to your four questions. Your teacher may ask you to present your report in a particular format.

Activity 20.2 More about classification

Linnaeus compiled a classification of all the living creatures that were known at the time that he lived. He developed a scheme by which organisms were grouped together according to certain shared characteristics. His system relied heavily on similarities in structure. Many of the traditional ways of classifying primates use similarity of structure as their basis. However, with advances in technology, scientists have been able to use molecular studies to more closely examine relationships between species. More recently, DNA and chromosomal studies have further added to our knowledge, especially of the links between humans and other primates.

What to do

- Using books, scientific journals and Internet resources, find out how the classification of apes and humans has changed as new evidence has become available. In particular, examine the way scientists have classified chimpanzees and humans over recent years.
- Once you have gathered your information, write a brief report on how classification changes as new evidence becomes available. Do you think that chimps should be placed in the genus *Homo*? Give a detailed reason for your answer.

Activity 20.3 Are we unique?

Humans like to think of themselves as unique. We consider ourselves to be different from (and perhaps superior to) all other species of animals. But are we unique? What separates us from other animals?

With a partner, try to draw up a list of features that are unique to humans. Consider all aspects of humanity in your discussion—physical characteristics, behaviour, human achievements and others.

Have a class discussion on the lists proposed by the various pairs in the class and try to agree on a class list. Be prepared to criticise others, but do so in a constructive way. It is more important to be involved in actively thinking about the topic than in arriving at a correct answer. In fact there may be very few points on which the whole class will agree.

Activity 20.4 Observing primates

In this activity you will study some of the structural and behavioural characteristics of a variety of primates. Studying the physical characteristics of non-human primates gives some idea of the characteristics of the ancestors from which humans evolved. In the same way the study of primate behaviour can give insights into the origins of human behaviour.

The best way to observe primates is by first hand experience of the animals in a zoo. If you are unable to visit a zoo, this activity could be done using reference books on primates or by visiting some of the excellent websites that deal with primates. For example:

- <http://animaldiversity.ummz.umich.edu/site/accounts/classification/Primates.html#Primates>
- <http://nationalzoo.si.edu/Animals/Primates/MeetPrimates/default.cfm>

What to do

Select a lemur, an African or Asian monkey, a South American monkey and two species of ape. Make the following observations on each of the selected species. Keep written records of your observations.

1. Record the common name and the scientific name of the species.
2. Record the distribution of the species. The names and distribution will be shown on the label attached to the enclosure in which the animals are housed.
3. Observe and describe each of these physical features:
 - overall body size
 - limbs, especially the relative lengths of front and hind limbs

- tail: present, absent; furred, not furred; length compared to body length; able to be used to grip an object or not
 - colour of coat and patterns of colour
 - eyes: directed slightly sideways or fully forward-facing
 - facial appearance
 - hands and feet, with particular reference to the digits and whether the thumb and big toe can be used in gripping an object
 - any differences in characteristics between males and females
 - any other obvious physical characteristics.
4. Observe and describe as many of the following behaviours as possible (you will need to be patient and spend some time watching the animals to observe all the behaviours):
- locomotion: how the animal moves
 - vocalisation: communication using sound
 - non-vocal communication such as facial displays or body movements
 - feeding: how is food consumed?
 - social behaviour: interactions with other individuals
 - behaviour towards young
 - any other behaviours seen.

Studying your observations

1. Write a paragraph summarising the primate characteristics that you were able to observe in the species studied.
2. Describe any trends in physical characteristics that were observed as you progress from lemurs to monkeys and then apes.
3. Describe any behaviours you observed that were similar to human behaviour.

REVIEW QUESTIONS



1. (a) Why do scientists classify organisms?
(b) What characteristics are used to classify organisms?
2. What is meant by the term a 'hierarchy' of classification groups?
3. (a) What are scientific names?
(b) Why are scientific names used instead of common names?
4. List the characteristics that primates possess because they are:
(a) vertebrates
(b) mammals
5. List the characteristics that tend to be shared by all primates.
6. (a) To what family do humans belong? Why are they classified into this family?
(b) Who are humans' closest living relatives?
7. In what ways do the hominins differ from the apes?
8. What causes a classification scheme to change over time? List as many possible reasons as you can.
9. What are some problems that can occur in the classification of organisms?
10. Why do scientists classify organisms?
11. The following terms are used to describe some primate characteristics. Explain the meaning of each term.
(a) homoiothermic
(b) pentadactyl
(c) post anal
(d) opposable.



APPLY YOUR KNOWLEDGE

1. It is thought that primates may have evolved for life in trees. Many primates are still tree dwelling species. Explain how forward-facing eyes and having only one offspring at a time could assist life in trees.
2. (a) Describe why primates would have found claws difficult for life in trees.
(b) How do you think friction ridges may have improved the way primates could use their hands and feet?
3. Refer to Figure 20.12. Is the orangutan more closely related to the gorilla or to the gibbon? Explain how you decided on your answer.
4. 98.8% of the DNA of chimpanzees and gorillas is the same, but the chimpanzee has only 98.2% of its DNA in common with an orangutan. The gorilla has even less at 97.6%. This shows that chimps and gorillas are more closely related to each other than they are to the orangutan. Suggest why there is this difference in relationship. (Hint: think about where the animals live.)
5. Chimpanzees are now classified by many scientists as being more closely related to humans than they are to the gorilla and orangutan. What characteristics do chimps have that make them more closely related to humans than to the other apes? You may like to use reference material to provide a complete answer to this question.
6. Use an Internet search engine to find out what current problems exist in the classification of the primates. Do all experts agree with the classification presented in this chapter?