FOSSILS AND EVOLUTION

Intermediate and Senior Phases

NATURAL SCIENCES AND SOCIAL SCIENCES

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Full colour sheet of fossil pictures inside

Contents

Introduction

Fossils in South Africa

A very large number of fossils have been found in South Africa. These fossils range from some of the very first organisms that appeared on Earth right up to evidence of early humans.

This book covers the following Natural Sciences content:

- Fossils are the remains of life forms that have been preserved in stone. Fossils are evidence that life, climates and environments in the past were very different from those of today.
- South Africa has a rich fossil record of animals and plants which lived many millions of years ago. Many of those animals and plants were different from the ones we see nowadays.

Human evolution

Humans may have their origins right here in southern Africa! Fossil remains from 'The Cradle of Humankind' provide much of the best evidence in the world of our history as early humans. This World Heritage Site is centred at the Sterkfontein Caves 40 km outside Johannesburg.

The fossils show that humans today belong to one species, *Homo sapiens*. Variations like skin colour, eye shape and hair texture are only very tiny differences. An understanding that we are all human together can go a long way in helping us to overcome prejudice, racism and xenophobia.

This book covers the following Social Sciences content and skills:

- early hominid discoveries in South Africa and East Africa
- becoming human in southern Africa.

This book shows how to:

- Compile and organise information from a number of sources.
- Use information from sources to answer questions.
- Develop timelines and create diagrams.
- Make links to show cause and effect.
- Describe how archaeologists work with material remains of the past.

> ***Note to Social Sciences teachers:*** Activities 11, 12, 13 and 14 focus on Human evolution. Make sure that you introduce the general concept of evolution to your classes before looking at human evolution. (In other words, complete Activities 1 and 2 as well as Activities 6, 7 and 8 before completing Activities 11,12,13 and 14.)

1 The History of the Horse

Social Sciences and Natural Sciences

By the end of this activity, learners will be able to:

- show how the horse has changed physically over the past 50 million years (*change over time/similarities and differences*)
- explain the links between changes in the horse skeleton and changes in the environment (*cause and effect/adaptation*).

A study of the evolution of the horse helps to explain the concept of adaptation to changing environments. Fossils show that early ancestors of the horse were quite small animals that lived in forests. As the climate became drier, the forests turned into grassland and the horses were forced to adapt to their new environment. Those with longer legs could run faster than their predators and they survived. They gradually lost all their toes except the middle one. The nail of this toe developed into a hoof. Hooves are better than softer toes for galloping over hard ground.

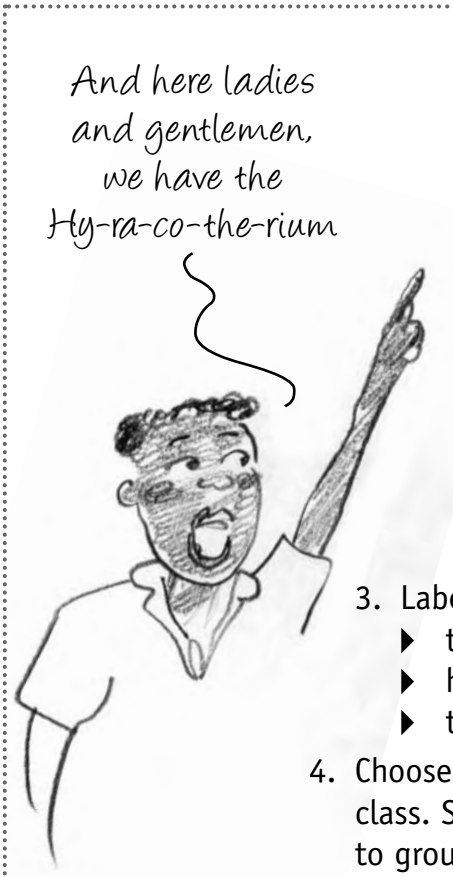
Teacher preparation

1. Make a copy of the Activity Sheet on page 7 for each group of three or four learners. (Groups should be no bigger than four.)
2. Have a large sheet of paper (A3 or bigger) for each group to do a group drawing together. Make sure that you have pencils and crayons for all learners to draw with.
3. Give each group one of the following letters: A, B, C or D.

What learners do

In groups of three or four:

1. a) Read your part of the horse story (A, B, C or D) on the Activity Sheet on page 7.
   b) Practise saying your horse's name.
   c) Look at the pictures and talk about what you have read. How are you going to show all these ideas in a drawing?
2. Do your drawing together. Your drawing should include:
   - the horse
   - a detail of the foot (drawn big, so that it can be seen when displayed to the class)
   - the environment around the horse.



3. Label your drawings. Labels should include:
   - the name of your horse
   - how many million years ago this horse lived
   - the height of your horse.
4. Choose someone in your group to present your horse to the rest of the class. Start with the earliest groups – A. Hyracotherium. Then move on to groups B, C and D – in that order. Make your presentation lively and interesting. You could pretend you are in a circus or at a horse show. Start with the words:

   "And here ladies and gentlemen, we have the Hy-ra-co-the-rium."

   The class then responds by asking: "The Hy-ra-co-the-rium?"

   Presenter: "Yes, ladies and gentlemen, the Hy-ra-co-the-rium…" then go on to tell your audience:
   - Why this is such a special horse. Remember to talk about its feet.
   - How your horse is adapted to live in its environment.
5. Make sure that all your drawings are displayed in the correct time sequence.

Consolidation

Look at all the pictures together.

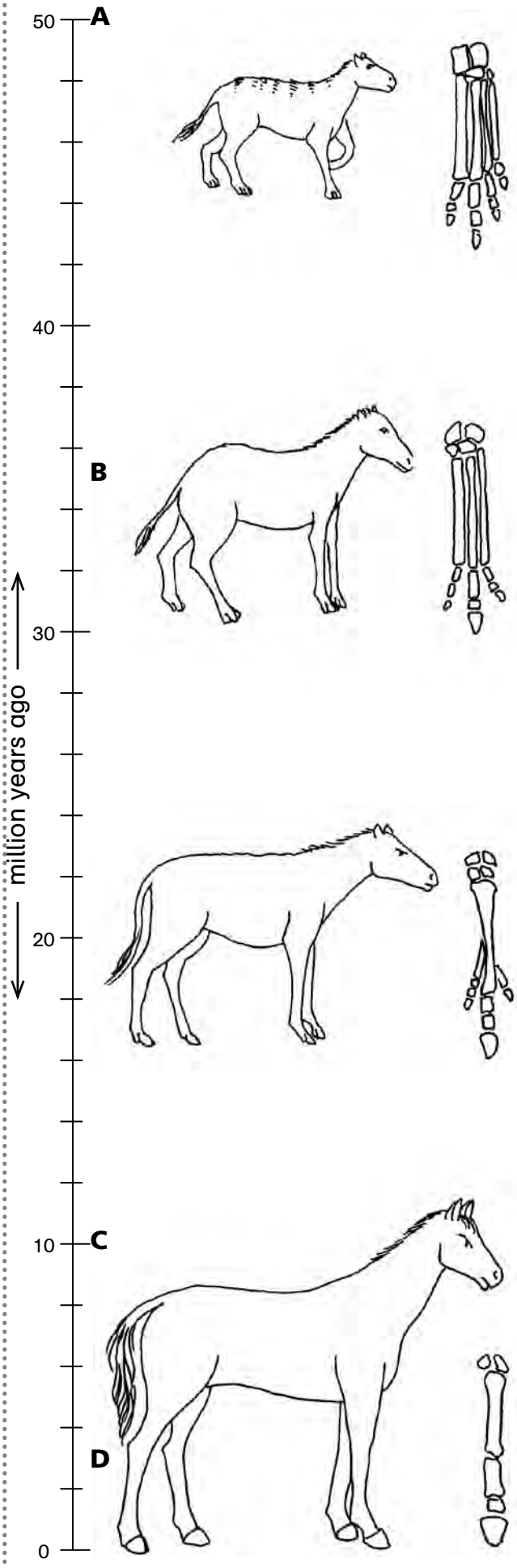
Discuss these questions:

- What has changed and what has stayed the same for the horse over the past 50 million years? (*change and continuity*)
- Which drawings best show the environment?
- What is the connection between the way the environment changes and the way the horse adapts? (*cause and effect / adaptation*)

Talk about

- The concept of millions of years ago.
- The timeline down the side of the Activity Sheet.

Activity Sheet The history of the horse



A Hyracotherium *(Hy-ra-co-the-rium)*

About 50 million years ago there were little 'horses' that were the size of a small dog (about 40 cm high). These creatures lived in forests. They had three toes on their front feet and four toes on their back feet. These toes could spread out and help them to walk on soft leaves and muddy ground.

B Mesohippus *(Me-so-hip-pus)*

From about 50 million years ago until about 35 million years ago the small dog-sized horse became larger. Over a time period of about 15 million years it nearly doubled its size to that of a medium-sized dog (about 75 cm high). By this time the forests were disappearing and there was more grassland. The feet of these larger horses were also different from those of their earlier ancestors. They had just three toes on each foot and their middle toes were larger and stronger. This helped them run faster.

C Merychippus *(Me-ry-chip-pus)*

About 10 million years ago, horses were nearly 1 metre (100 cm) tall. They no longer lived in forests where they could hide from danger. The forests had gone and there was grass and bush covering the land. Now they needed to be able to run fast over drier and harder grasslands to outrun their predators. The middle toe on each foot became stronger, like a hoof. The other toes on each foot became much smaller.

D Equus *(E-quus)*

Horses similar to those of today first lived about 3 million years ago. They have grown in size and now their average height is nearly 2 metres (about 175 cm.). They survive well on grasslands and even in dry, stony areas. Their side toes are just tiny bones near the top of their feet. The nail of the middle toe has developed into a hoof, so that they can run very fast over hard and stony ground.

2 What do we mean by evolution?

Social Sciences and Natural Sciences

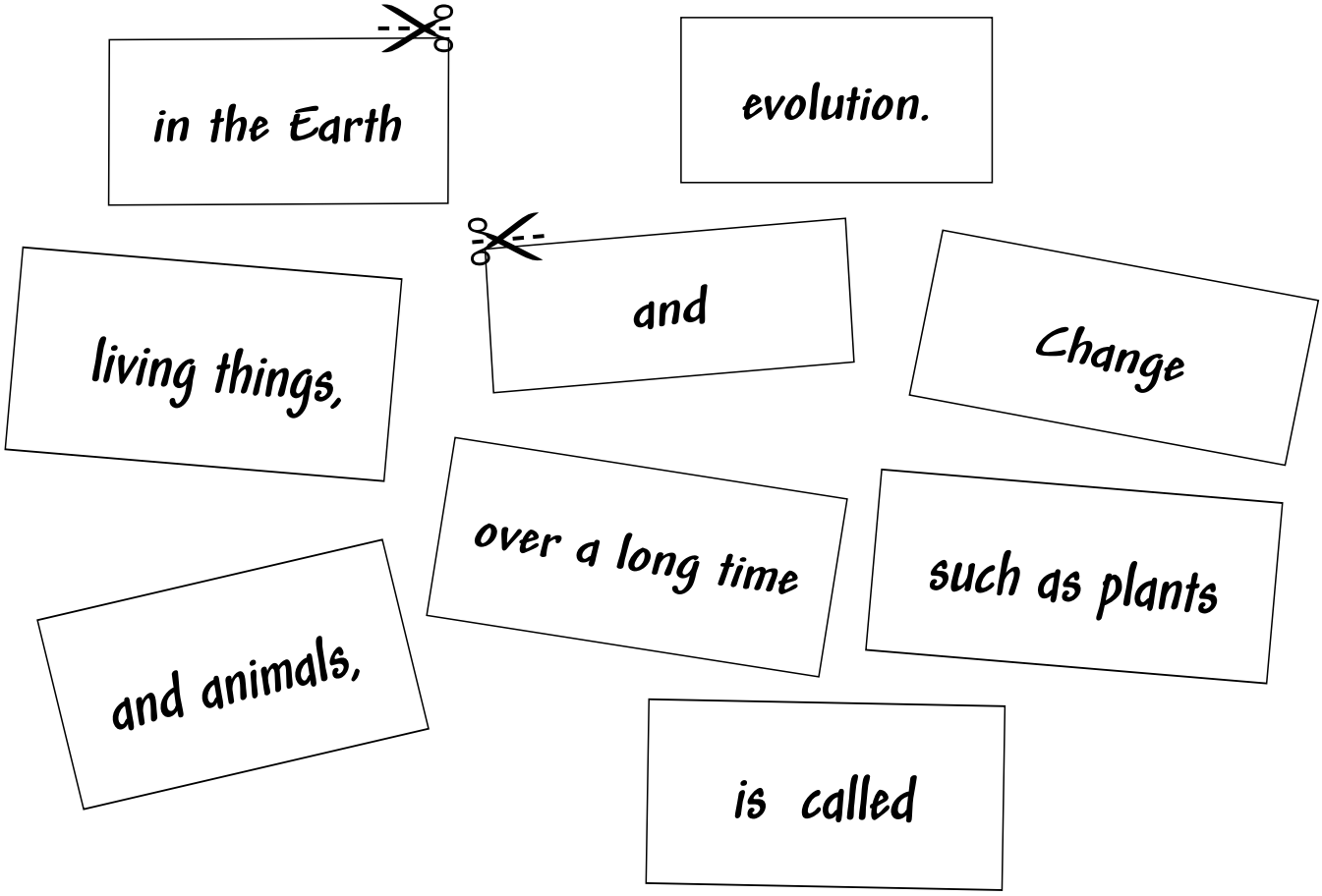
By the end of this activity learners will be able to:

- build a sentence that explains 'evolution'
- identify key words in the definition.

Teacher preparation

For each group of three or four learners:

- Prepare a set of 'words' in the sentence for each group – cut into pieces as shown below.
- Mix up the words so that the order is jumbled.
- Paper-clip each set together to give to each group.



Answer: Change over a long time in the Earth and living things, such as plants and animals, is called evolution.

Or: Change in the Earth and living things, such as plants and animals over a long time is called evolution.

What learners do

In groups of three or four:

1. Look at your set of words and arrange them into a sentence which describes the meaning of 'evolution'.

   Tip: For the first and last words, look for the capital letter and full stop. Also notice the commas.
2. Read out your sentence or definition to the class.
3. Choose two pieces of paper with words from your sentence that you think best help to explain 'evolution'. {These may differ slightly but could include: Change / over a long time/ living things.}
4. Read out your selected words to the class.
   - Explain why you have chosen these words.
   - Try to translate these words or concepts into other languages (especially your mother tongue). Write these down as you go.
5. Now, in your group, select just one word from your sentence that you think best helps to explain 'evolution'.
6. Share and discuss your chosen word with your class.

Consolidation

Learners copy their sentences or definitions of evolution into their books. They underline the key words and make two lines under their final choice of the most important word or concept.

Ask each learner to write an explanation of her or his most important word.

I chose ..... as my most important word because

.....

.....

3 Darwin's Theory of Natural Selection

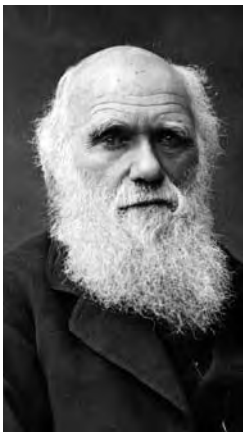
Natural Sciences

By the end of this activity learners will be able to:

- understand the concepts of a **species** and a **population**
- understand that a theory is a set of ideas backed up by evidence from scientific observations
- understand the process of **natural selection**.

Teacher preparation

Read about Darwin and Natural Selection below. Help learners to understand the Reading Activity sheet on pages 11 and 12.



Charles Darwin

Alfred Russel Wallace

How is a scientific theory different from an everyday idea?
An idea cannot become a theory unless it has two parts. One part is the idea; the second part is a collection of evidence or observations, made in the real world to support the idea. Since the theory of natural selection was first formulated, countless scientists have collected a huge amount of evidence and have made many detailed observations that support this theory. They have also added more ideas to the theory as new evidence is found. Our present-day scientific understanding of biology is based on the 'Theory of Natural Selection'.

Who formulated the 'Theory of Natural Selection'?
Charles Robert Darwin was born 200 years ago, in 1809. He died in 1882. Darwin was an English scientist who studied the natural world. In 1844 he put forward the idea that all species of life have evolved over time from a common ancestor. They have evolved through the process he called natural selection. He also provided scientific evidence, which he gathered from his travels around the world to make observations of different species and their environments.

Alfred Russel Wallace (1823–1913) also studied the natural world during his travels in Asia. He developed the same idea as Darwin independently, and wrote to Darwin about it. Wallace and Darwin published their ideas together. Darwin later explained his ideas in the book called *On the Origin of Species by Means of Natural Selection* in 1859.

Since that time other scientists all over the world have found further evidence to support this theory. They continue to collect new evidence. It is the best scientific explanation so far, for how life has changed and developed during the history of the Earth.

Reading Activity Sheet

Darwin's theory of natural selection

What learners do

Read the following information with the help of your teacher.

Living things change and develop

Evidence in the ancient rocks of the Earth tells us that the Earth has changed since it first formed. It continues to change today. Fossil evidence tells us that living things have also changed as the Earth has changed. Living things also continue to change. This change in the Earth and living things over time is called **evolution**. Evolution takes place over very long periods of time.

Scientists observe different species of living things and how they live. They try to explain how evolutionary changes have taken place in these populations of living organisms, and why some organisms survive and some die out (become extinct).

What is a species?

- Living things only breed with other living things that are similar to themselves. The living things that can breed together all belong to the same **species**.
- Each species remains separate from another species because one species cannot breed with a different species. For example, dogs cannot breed with cats because they are from different species. But all kinds of dogs belong to the same species and can breed with each other.
- Within a species each member of the species is slightly different to other members of the same species. These differences within a species are called **variations**. For example, we find many variations within a species of cats: black cats and white cats and ginger (red) cats and stripey cats etc.
- Species survive because they are well adapted to their environment.
- There are many different species of plants and animals.

This picture shows variation within a single species of goat.

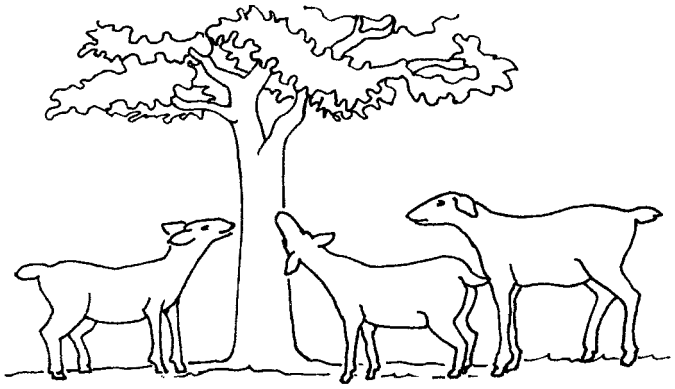
What is a population?

- A **population** is a group of organisms (living things) of the same species that live together in a certain area at a certain time.

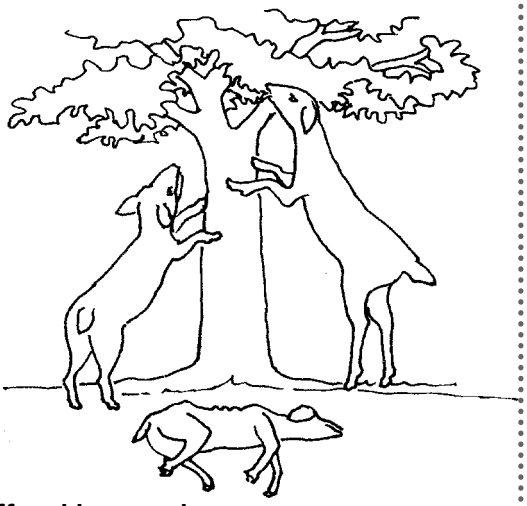
How do species adapt to their environments?

- One of the great ideas in science is the 'Theory of Natural Selection'. This theory helps us to explain how different species become adapted to the environment in which they live. It also explains how certain features allow the species to survive as the environment changes.
- The theory of natural selection was first developed about 150 years ago by two Englishmen, Charles Darwin and Alfred Russel Wallace. The theory of natural selection is a framework of ideas that helps us to explain what we find and observe in nature.

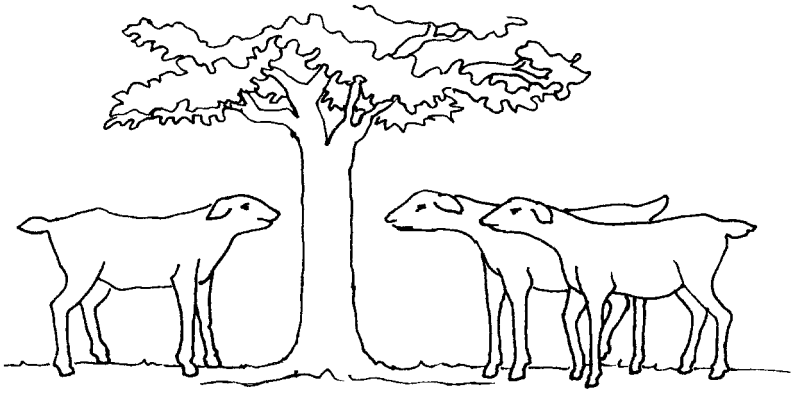
The process of natural selection



Some of these adult animals have long legs and some have short legs. This shows variation within the species.



As the bushes die off and leave only trees, only some of the animals can feed. Those that can't reach the food will die.



Those animals that can feed, can reproduce (have offspring). The population has adapted and a new species has evolved – 'descent with modification'.

Adapted from: 'Hands-on Science Learners' Book Grade 9. Ron Jones, Rose Thomas, Peter Johnston. Juta 2006

What the scientists were not able to explain in the past

Before the theory of natural selection was developed by Darwin and Wallace, scientists wondered:

- Why are there so many different species of plants and animals and where do they come from?
- Why did certain species die out, while others have survived? The scientists could see from fossils that some species had become extinct (they had died out completely).
- Is it possible for one species to change into another species? How could this happen?

KNOWLEDGE BOX

Theory of Natural Selection

The theory of natural selection explains that all living things are related to one another. It helps to explain how species change to become new species. It also explains how species change when the environment changes.

This is how natural selection works

- All living things come from other living things (parents).
- All living things have babies (offspring).
- In every species the babies are slightly different from their parents and slightly different from each other. (This is because they have their own unique DNA in each cell of their body.)
- Sometimes it is hard for all the babies to survive when the environment changes.
- Some babies will die before they are able to grow up and reproduce.
- Some babies, by chance, will have features that help them to survive if the environment changes.
- Those babies that are better suited to the environment will tend to survive, grow up and reproduce.
- After a long, long time, part of a breeding population can change so much that it can no longer breed with the original population. Then a new species has originated (evolved).

  All species have descended (come from) ancestors which lived before them. But they now have changes in their bodies and their behaviour that make them different from their ancestors. Darwin called this 'descent with modification' ('modification' means 'change'). It is one of the important ideas in his theory.

4 How natural selection takes place

Natural Sciences

By the end of this activity learners will be able to:

- explain the meaning of the following terms: adaptation, natural selection, survival and extinction
- understand that 'survival of the fittest' means that living things that are well adapted to their environment will survive and reproduce.

Introduction

Introduce and discuss the following terms with learners:

- **Environment**

  The environment provides the conditions suitable for some plants and animals to live in that environment.

- **Adapted to survive**

  We say a plant or animal species is adapted to its environment when it can survive there and breed successfully.

- **Theory**

  A theory is a way to explain how something works after careful observation of that thing. A theory is a way to explain the workings of nature.

- **Natural selection**

  This is the way that the environment naturally 'selects' the plants or animals that are best suited to survive. Those that are not suited will die out.

- **Extinct**

  An animal or plant species that is not suited to its environment will die out, and become extinct.

- **Camouflage**

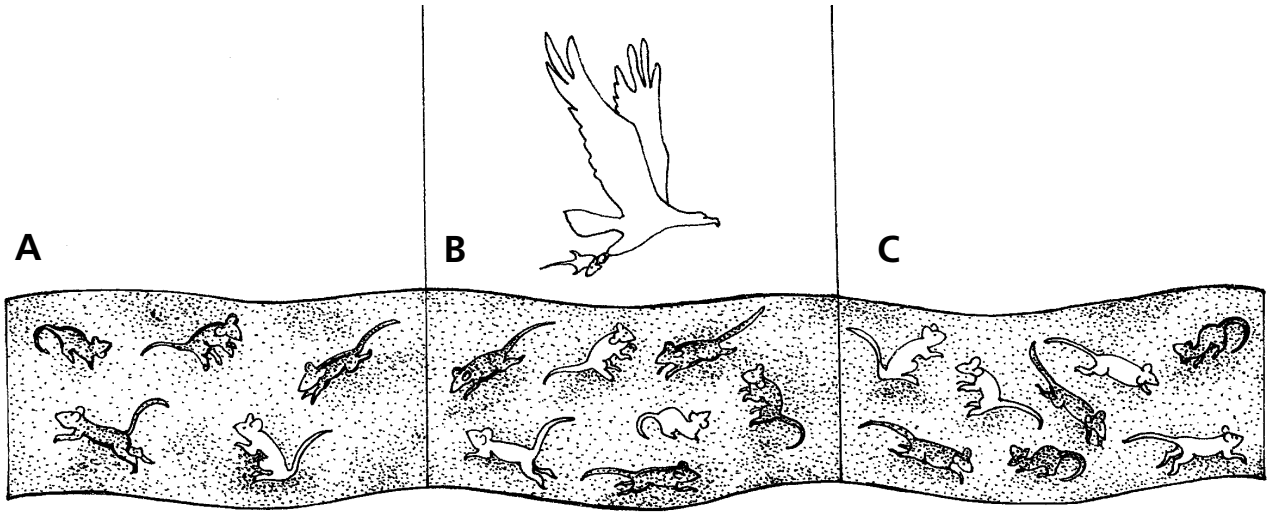
  An animal has good camouflage when its colouring is similar to its environment, which allows it to hide from its predators.

What learners do

A. Adaptations

1. Look at the picture below. It shows three different populations of mice. It also shows the bird of prey that eats the mice. The bird is flying from left to right feeding on mice.

How populations change



A. one white mouse and four grey mice

B. three white mice and four grey mice.

C. equal numbers of grey and white mice

2. Under each diagram, A B and C, describe the population of mice. (Write down the number of mice and their colour.)
3. Why is the population of mice in A different to the population in B? What is the difference?

Living things that are well adapted to their environment survive and reproduce. Those that are not well adapted don't survive and cannot reproduce. An **adaptation** is any characteristic or feature that increases the ability of the plant or animal to survive and reproduce.

4. a) What colour mouse did the bird choose most often? Why?
   b) What colour mouse did the bird find most difficult to capture? Why?
5. What feature of these mice is an adaptation that helps them to survive in that environment?

B. Which is the fittest? (able to survive, and to reproduce best)?

1. Look at the table on the next page. It describes a population of mice. They live in a desert environment where the sand is brown and there are a few dry scattered plants. Birds of prey eat the mice. There are four colours of mice living in this population (black, brown, black-and-brown, white). Only those best adapted to their environment will escape from the birds and survive to reproduce.

Information about variations in the mouse population

Colour of female mice	Black 	Brown 	White 	Black and brown 
Age at death	2 months	8 months	4 months	2 months
Number of babies produced	0	11	3	0
Running speed	8 metres per minute	6 metres per minute	7 metres per minute	5 metres per minute

Adapted from the University of California, Los Angeles Life Sciences 1 Demonstration Manual. Copyright 2007 by Jennifer Doherty and Dr Ingrid Waldron, Department of Biology, University of Pennsylvania

2. Questions about the information in the table:
   a) A baby mouse's fur colour is similar to its mother's fur colour. What colour fur do most of the babies have in this population? (*Brown*)
   b) What variety of mouse survived the best in the brown, sandy environment? Why? (*Brown mice, because the birds can't see them.*)
   c) Did the speed at which a mouse can run help it to survive? How can you tell? (*No, because the black mice can run faster but they still get eaten.*)
   d) If the bird of prey continues to feed on this particular population of mice, what will be the colour of the surviving mice? Why? (*Brown, because they have the best camouflage and all the other coloured mice will get eaten first.*)
   e) Did any variety of mice become extinct, or nearly extinct, in this activity? Which one and why? *(Black mice and Black-and-brown mice became extinct. White mice were nearly extinct. They can be seen easily against the brown sand so the birds can catch them.)*

Knowledge explanation

Over many generations the mouse population in this desert will eventually consist of mostly brown mice. This is because the brown colour is a better adaptation in that environment than black, or black-and-brown, or white. The brown mice cannot be seen against the brown sand. This is called camouflage.

This process is called evolution by natural selection. Evolution by natural selection takes place over many, many generations. Evolution by natural selection leads to adaptation (changes) within a population.

- If the environment becomes wetter with dark green plants, which type of mouse would survive better? Why? (*Probably the black ones; they could hide under the plants and not be seen in the dark shadows.*)

5 Modelling how fossils form

See the sequence of pictures called 'The process of becoming a fossil' starting on page 61.

Natural Sciences

By the end of this activity learners will know that:

- fossils are found only in sedimentary rocks
- fossils were formed in or between the layers of sediments
- sediments are laid down layer by layer over millions of years; the layers are called strata
- the oldest sediments and fossils are found in the lowest strata and the most recent sediments and fossils are found in the top-most strata.

Read the following information.

Sediments and sedimentary rock

Sediments are fine particles of sand or mud that get washed or blown (transported) into an area. Sediments are deposited layer by layer, to form strata (many layers on top of each other). Over time the particles of sediment get squeezed together and eventually become sedimentary rock.

Fossils

A fossil is the remains of a dead plant or animal that is preserved in rock. It usually takes up to a million years for plant or animal remains to become completely fossilized. Fossils are always found in sedimentary rock. Fossils are formed in two different ways. They can form as body fossils and as trace fossils.

Sedimentary rock showing layers or strata

Body fossils

A body fossil forms when the hard parts of a dead plant or animal are buried by sediment (usually mud or sand). The bones and teeth of the animal and the tough parts of the plant slowly get replaced, molecule for molecule, by rock minerals (silica). This is called mineralisation. Body fossils tell us about the structure of the plant or animal body.

Ammonite shells. These ancient sea animals used their shells to float. They all went extinct about 65 million years ago. This is a body fossil.

Trace fossils

A trace fossil is the fossilized remains of anything left behind by an animal: for example a fossilized nest or egg, animal droppings, footprints, marks made by a tail dragging on the ground etc. These fossils tell us more about the behaviour of the animals and how they lived.

Above: Gemsbok footprints in the sands of the Namib Desert.

Right: Fossil footprint made by a dinosaur 200 million years ago in desert sands in Namibia. This is a trace fossil.

Formation of fossils

Teacher preparation

1. Supply four flat pancakes of damp clay (from a pottery supply shop) or plasticine (from a toy shop) for each group of learners.
2. Also collect some bones (chicken bones), shells or snail shells and hard seeds, twigs and leaves.
3. Read the piece called 'Palaeontology' on page 23 for yourself and supply a copy to the learners.

Activity Sheet Modelling how fossils form

What learners do

1. Each group starts with one clay pancake.

Read

- This is a layer of mud deposited here by heavy rains, or it can be a layer of mud on the bottom of a sea or lake.

Do

- Place some shells (not plant material at this stage) on the layer of mud. These are animals that have died and their shells have been left behind in the mud. They slowly sink into the mud. Ask the learners to gently press the shells into the mud.
- Next, place another pancake of clay on top of the shells.

Read

- This is another layer of sediment that has washed on top. It has happened over a long period of time.
- The environment has changed and plants begin to grow here. They drop their seeds and leaves and twigs, which fall onto the ground and die. These seeds, leaves and twigs slowly sink into the layer of mud.

Do

- Scatter some seeds, leaves and twigs onto the top layer of clay.
- Gently press these into the clay.
- Next, place the third clay pancake on top.

Read

- This is another layer of sediment that has washed on top – again, after a long period of time.
- On this layer new plants begin to grow and animals also live there. When they die, some of the animal bones are left behind and also some of the plant leaves, seeds and twigs. These bones, seeds etc. slowly sink into the layer of mud.

Do

- Scatter some seeds, leaves and twigs onto the top layer, and some animal bones. Gently press these into the clay.

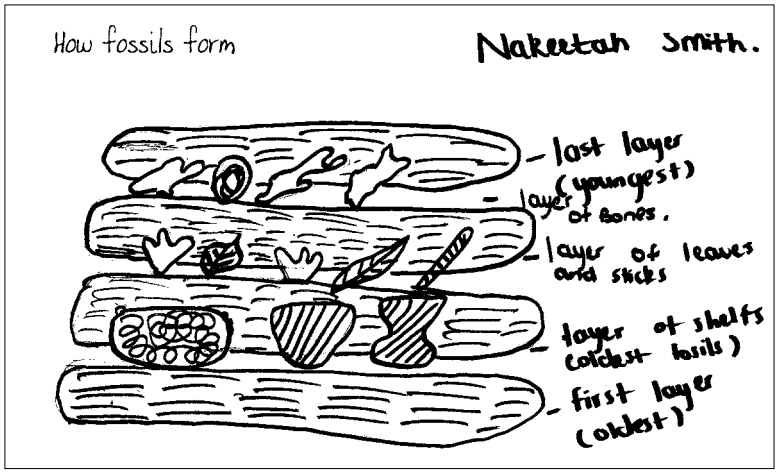
  Finally place the last layer of clay on top of the other layers.

Read

- This is another layer of sediment that has washed on top. Over millions of years these layers and the remains of the animals and plants slowly turn into rock.

2. Draw your pancake layers (strata) to show where the different 'fossils' are found.
3. Label the following on your drawing:

   clay strata
   sea shells
   plant material (leaves, twigs and seeds)
   bones
   oldest layer
   youngest layer



4. Answer these questions:
   - Which layer is the oldest? Why?
     (*The one at the bottom. It was formed first and is therefore the oldest.*)
   - Which layer is the youngest? Why?
     (*The one at the top. It was formed most recently and is therefore the youngest.*)
   - In which layer will you find the oldest fossils which formed very long ago?
     (*In the bottom layer.*)
   - In which layer will you find the youngest, most recently formed fossils?
     (*In the top layer.*)
   - Are fossils made by people or are they made by nature?
     (*They are made by natural processes over millions of years.*)

5. Read about 'Palaeontology' on page 23.

- ***See the sequence of pictures starting on page 61 called:***
  The process of becoming a fossil

Uncovering the fossils

What learners do

1. Think of yourself as a palaeontologist.
2. Pretend that the rain and wind have eroded away the top layer of sediment and you, the palaeontologist, are about to find the fossils.
3. Remove the top layer of clay.
4. Look to see if there are any impressions left in the clay.
5. Try to identify the plant or animal from its impression.
6. Then place the layer in the sun to dry.
7. Answer these questions:
   a) What do you see when you carefully remove the top layer of clay? (*Bones and seeds and leaves and twig fossils. Impressions of body fossils in the clay.*)
   b) How can the palaeontologists tell what plants and animals they were by looking at the impressions in the clay? (*By their shape and size and if they look similar to things that are alive today.*)
8. Remove the next layer and check to see what impressions have been made. Dry the layer in the sun.
9. Remove the last layer. Check the impressions and put the layer in the sun to dry.
10. Answer these questions:
    a) When the palaeontologists uncover the layers, will they come to the oldest fossils first or the youngest/most recently formed fossils? (*The youngest, most recently formed fossils will be uncovered first.*)
    b) Which fossils will they come to last? (*The oldest fossils.*)
    c) Why is it important for the palaeontologists to know exactly where the fossils were found? (*So that they can tell which are the oldest and which are the most recently formed fossils.*)
    d) What must the palaeontologists do to keep a record of exactly where the fossils were found? (*They must know which layer of rock the fossils come from. They must know which fossils are the body fossils and which fossils are the trace fossils. They must know which is the upper side (top) of the fossil and which is the underside of the fossil. They must know how the fossil was lying (its position). To keep a careful record, palaeontologists will have to measure, take photos, and make maps to show where everything was found.*)

A palaeontologist at work

Assessment

Learners must be able to:

- answer the questions showing the correct understanding of fossils and how they are formed.
- correctly draw and label a diagram showing strata, and the remains of plants and animals embedded in them. The drawings must be clear.
- correctly identify the oldest stratum (layer) and fossils, and the youngest stratum and fossils.
- answer the questions showing the correct understanding of how a palaeontologist works.

Note to the teacher

How old is that rock?

Learners might ask how we know the age of the Earth and its rocks. Geologists have found ways to measure the slow changes that have taken place in rocks over millions of years.

1. The position of a layer of rock
One way to measure these changes is to use the 'What's on top?' rule. When you find layers of rock in a cliff or hillside, the younger rocks are on top and the older rocks lie at the bottom.

2. Fossils in the rock
Another way to tell the age of the rock is to look at any fossils that the rock may contain. If any of the fossils are unique to one of the geological time periods, then we can say the rock was formed during that particular time period.

These two methods only give the relative age of rocks compared to each other – which are younger and which are older.

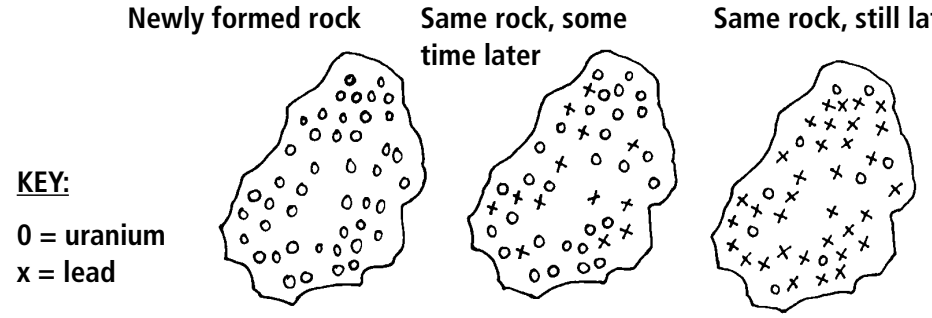
How do we find out how old a rock is in years?

3. Absolute age of rocks

The age of a rock in years is called its 'absolute age'. Geologists find absolute ages by measuring the amount of certain radioactive elements in the rock.

When rocks are formed, small amounts of radioactive elements form part of the rock. The newly formed rock in its original state contains the radioactive metal called uranium. As time passes and the rock ages, the uranium loses its radioactivity and changes into a metal called lead. Uranium changes into lead at a constant rate, like a ticking clock. This change can be measured accurately.

This is just one of the ways to tell the age of rock. There are other, more complicated methods. New methods to measure the ages of rocks are being developed all the time. Geologists will use two or more methods before they decide on the age of the rock they are studying.



Uranium metal changes to the metal called lead over time

KNOWLEDGE BOX

Palaeontology

Palaeontology is the study of fossils. Fossils are the remains of organisms that lived a long time ago, such as short-necked giraffes, African bears, dinosaurs, and are preserved in sedimentary rocks.

What does the word palaeontology mean?
Palaeontology is the study of fossils of organisms that lived long ago.

Palae means 'really old' and *ontology* means 'the study of existence'. A fossil can be any trace of a past life form, including wood, bones and shells. Most of the fossils that palaeontologists study are several million years old.

How is a palaeontologist different from an anthropologist and an archaeologist?
All three of these kinds of scientists may work together at times, but their jobs are very different.

- Anthropologists work mostly with varieties of modern humans and their cultures.
- Archaeologists work with ancient remains, artefacts (tools, beads, pottery etc.), and buildings left behind by people in the past.
- Palaeontologists study the history of all other living things (usually as fossils) from the smallest bacteria to larger animals such as whales, and back in time to the origin of life around 3.5 billion years ago.

How do palaeontologists help us?
Palaeontologists have an important job for several reasons. They explore areas that contain fossils hidden in sedimentary rocks, so we can find fossil fuels such as coal, oil and peat. Palaeontologists also study fossilized plants and animals to help us understand what Earth's climate and environment were like long ago. They also work to understand how plants and animals lived in the past, so that we can understand how our world might change in the future.

A palaeontologist removes a fossil in order to study it.

6 Fossils of South Africa

Natural Sciences

By the end of this activity learners will be able to:

- recognise some South African fossils
- compare the fossils to living organisms
- describe the body features of some fossils
- infer in which kind of habitat the fossils lived
- infer how the fossil animals lived.

South African fossils

South Africa has one of the richest fossil records in the world. Many fossils can be found today in the sedimentary rocks of the Karoo region of South Africa. Those sediments and fossils formed between 300-200 million years ago. At that time the Karoo was a large, shallow inland sea, which slowly dried up and eventually became a desert.

A huge variety of animals and plants lived in the Karoo for over 100 million years. During this time many different kinds of plants and animals evolved and survived and then became extinct. They became extinct mainly because the climate became much drier.

Many of the animals and plants that lived then are the ancient ancestors of the plants and animals living in South Africa today. Most of the ancient reptiles living in the Karoo became extinct, but some survived and evolved further. Some reptiles evolved to become more like mammals. They are the very ancient ancestors of the mammal species we find today.

People who study fossils are called palaeontologists. They find, excavate, uncover and describe these fossils.

Studying fossils

Teacher preparation

- Show learners the colour pictures of fossils from the middle of the book or from the CD that comes with this book.
- Hand out the Activity sheet ***Fossils of South Africa*** (page 28-29) and the pictures of ***Fossils of Africa*** (page 27) and the pictures of ***Plants and animals living today*** (page 26).

What learners do

1. Look at the pictures of the fossils.
2. Can you name any animals and plants living now that look similar to these fossils?
3. What kind of habitat do you think these fossil animals and plants lived in?
4. Discuss the following.

   How do you think each of the fossil animals was able to:

   - breathe?
   - reproduce?
   - move?
   - feed?
   - excrete?
   - sense other animals, and sense their food or danger?
   - grow bigger?
5. Now look at the pictures of the animals and plants living today on page 26.
6. Match up each fossil with its living animal or plant relative.
7. Write down the name of the fossil and the name of its living relative in the table of the Activity Sheet on pages 28 and 29. Then write a sentence to describe what features they have in common.
8. Choose one fossil and write a paragraph to describe it.

Note to the teacher

There are many places in South Africa where you can see fossils. Most museums have collections of fossils on display.

The West Coast Fossil Park, where you can see how they find, excavate and prepare fossils, is a wonderful site to visit.

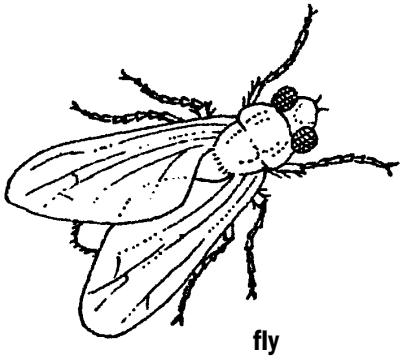
Contact details: Tel. 0227 661606

e-mail: info@fossilpark.org.za

website: www.fossilpark.org.za

Plants and animals living today

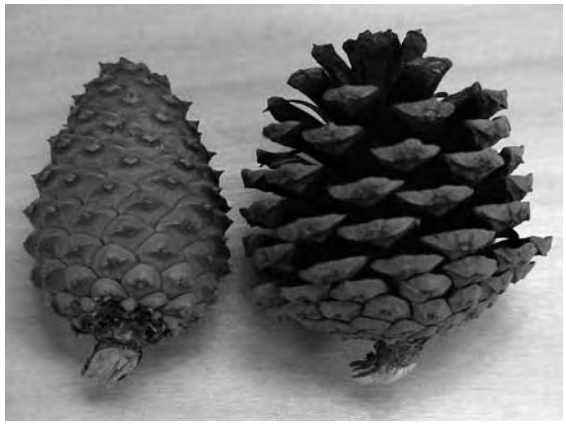
frog



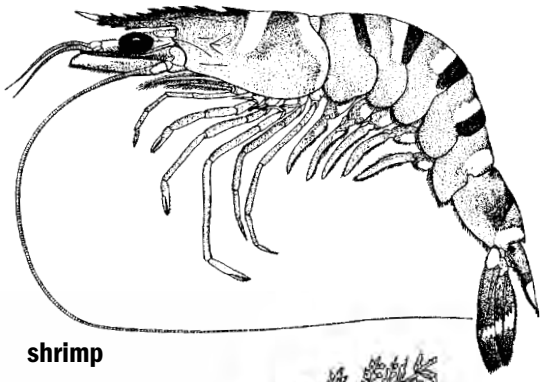
fly

Nautilus (squid family)

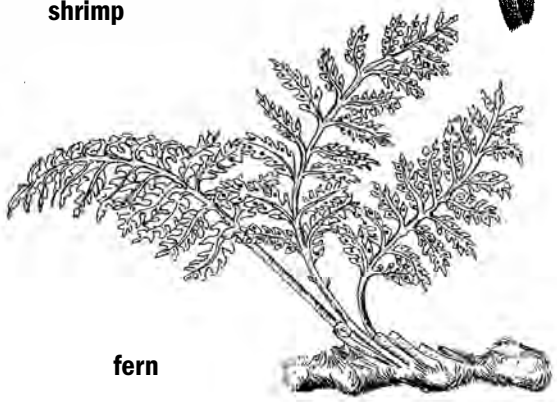
fish



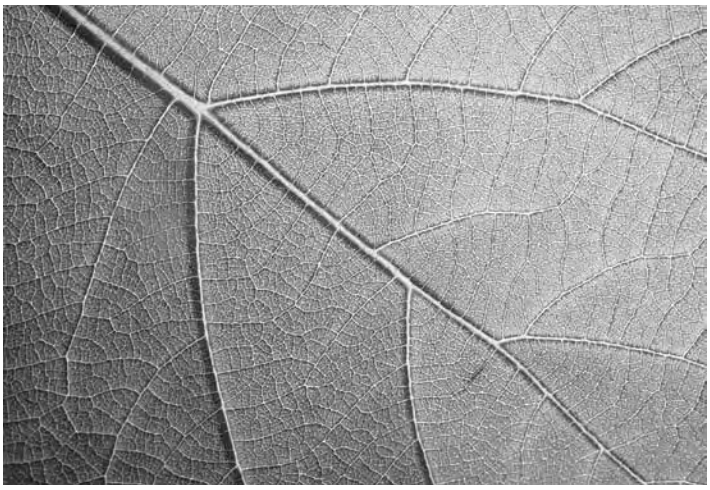
pine cone



shrimp

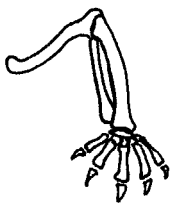


fern

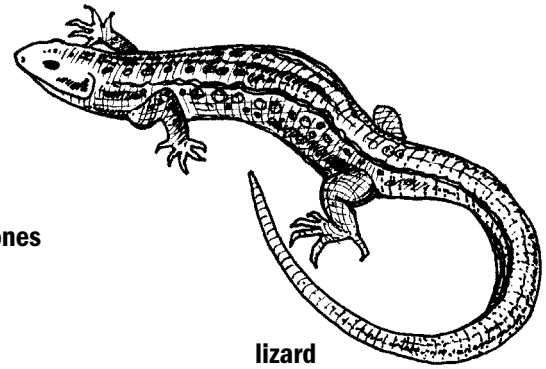


leaf

starfish



reptile hand bones

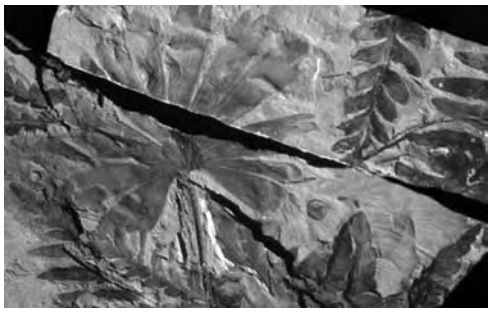


lizard

Fossils of Africa

Right hand of an extinct swimming reptile called *Claudiasaurus* (250 million years old).

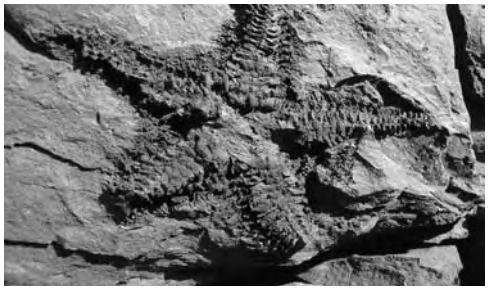
An animal called *Galesaurus* – an ancestor of all mammals. It shows two types of ribs that may show the presence of a diaphragm to help the animal breathe underground (250 million years old).



Fossilized leaves of a ginkgo tree and a fern (235 million years old).

Fossil trilobite – an extinct marine invertebrate. It had a hard exoskeleton and compound eyes and is distantly related to today's shrimps and crayfish (350 million years old).

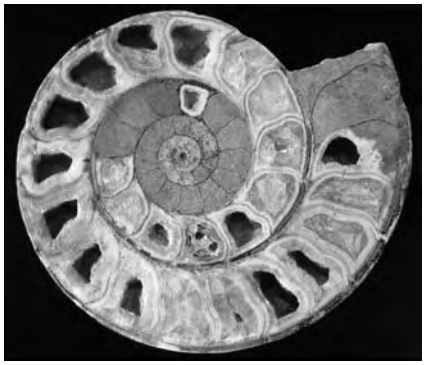
Fossilized frog from a pond which was formed in an ancient volcanic crater near Kenhardt in the Northern Cape (70 million years old).



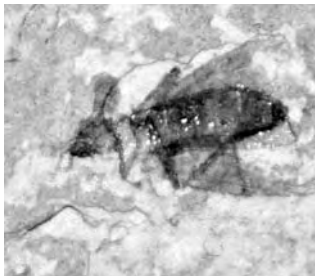
Fossilized starfish, like those living today, but these are 350 million years old from Prince Albert district in the southern Karoo.

Fossilized pine cone from Tanzania (255 million years old).

Fossilized *Glossopteris* leaves from the ancient Karoo.



The inside of an ammonite shell. These animals pumped fluid in and out of the chambers to allow them to float or sink.

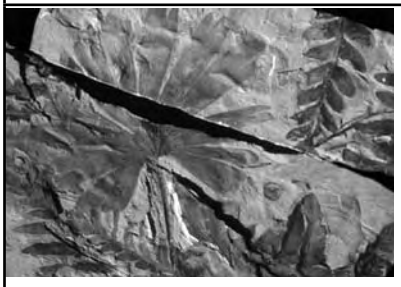
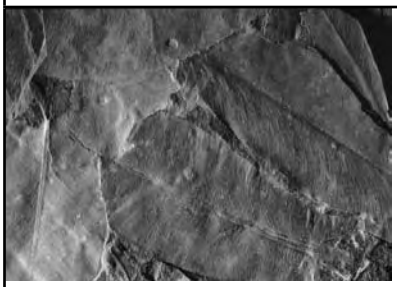


Fossilized insect

Fossilized fish that died in a lake near Kenhardt some 70 million years ago. It is named *Stompooria mandelai* in honour of Nelson Mandela.

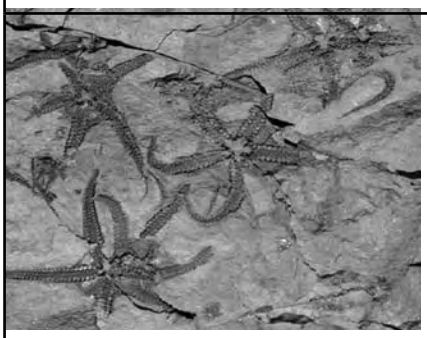
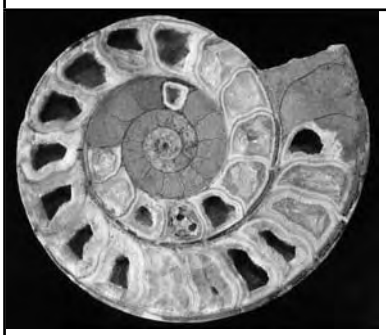
All photographs: IZIKO MUSEUMS OF CAPE TOWN

Activity Sheet Fossils of South Africa

Fossils	Name of relative	Common feature
 Pine cone fossil from Tanzania	Pine cone	It has the shape of a pine cone today. It has a central core with leaf-shaped scales.
		
		
		
		
		

All photographs: IZIKO MUSEUMS OF CAPE TOWN

Activity Sheet Fossils of South Africa

Fossils	Name of relative	Common feature
		
		
		
		
		

All photographs: IZIKO MUSEUMS OF CAPE TOWN

Knowledge explanation

When palaeontologists study a fossil, they have only the hard parts to look at. All the soft tissue has gone. Some of the things they look for are:

- teeth which look like those of living animals. These tell us what kinds of food that animal could have eaten.
- body features (shape e.g. wings; bones e.g. skull; body parts e.g. teeth etc) similar to those of living animals. These tell us how the animal might have carried out its seven life processes.
- shapes of bones such as the limbs and feet, the neck and the hips, which tell us how the animal may have moved about.
- shape and size of the skull that tells us a lot about an animal's sense of smell, hearing and eyesight.
- fossils that look totally different from any living plants or animals. These tell us that these organisms once lived but they are now extinct.

Questions

What do you think the palaeontologists can infer (tell or guess) about the fossil animal if they compare it to a similar living animal?

1. Can they infer or tell:
   - something about what the body parts were used for?
   - something about how the fossil animal lived?
   - something about the environment in which it once lived?
2. Sometimes a fossil is very different from anything that is living today. What does that tell us? (It is an extinct species.)

Enrichment

- Visit a museum to see specimens of fossils and how they are uncovered and prepared.
- Use books or the internet to research fossils from other places on Earth.

Check that learners can:

- recognise some South African fossils
- compare the fossils to living organisms
- describe a fossil
- infer in which kind of habitat the fossils lived
- infer how the fossil animals lived
- find out about fossils from other places on Earth.

7 Understanding time

Social Sciences and Natural Sciences

By the end of this activity learners will be able to:

- write out large numbers in words and numerals
- explain concepts such as 'century' and 'billion'
- begin to understand the huge timescale of Earth's history.

This activity and 'An Evolution Timeline' (Activity 8) are central to developing an understanding of change and development over a VERY long period of time.

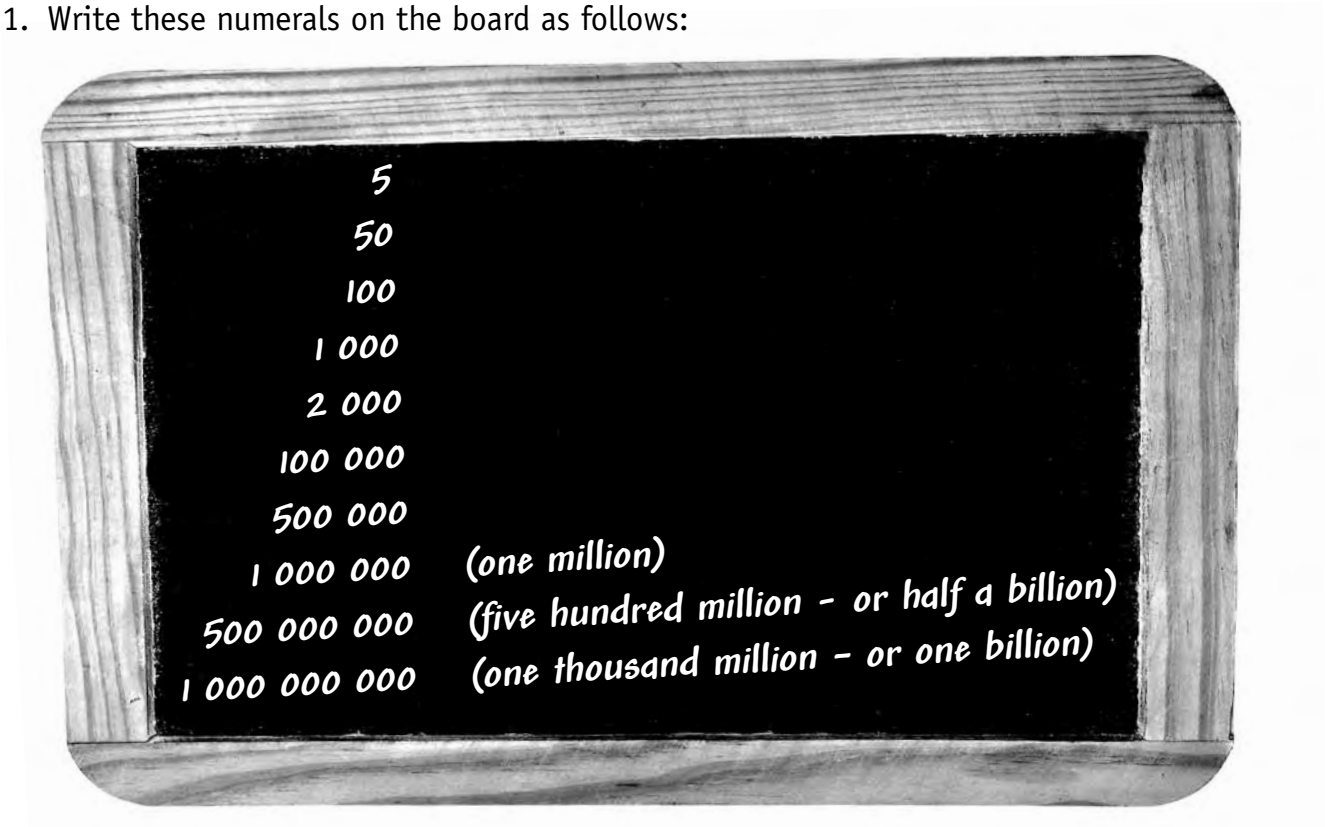
Teacher preparation

What you need:

- Nine rolls of toilet paper. (You will only unroll one of them!)

You will use these to help learners understand some of the large numbers they will encounter as they learn about evolution.

1. Write these numerals on the board as follows:



2. Ask learners the questions below. Add your own questions and refer to the numbers on the board as you go.
   a) Can you remember something that happened five years ago?
   b) Who is the oldest person you know? How old is she/he?
   c) How old is your school building? Was it all built at the same time?
   d) How long is a century? (*100 years*)
   e) How long is ten centuries? (*1 000 years*)
   f) How long ago did Jesus Christ live? (*about 2 000 years ago*)
   g) How long ago did Prophet Mohammed live? (*about 1 400 years ago*)
   h) Who was alive more recently – Christ or Mohammed? (*Mohammed*)
   i) How do you write one hundred thousand in numerals? (numbers) (*100 000*)
   j) How do you write half a million in numerals? (*500 000*)
   k) How many thousands are there in a million? (*one thousand thousands*)
   l) How do you write a million years in numerals? (*1 000 000*)
   m) How many millions make a billion? (*one thousand millions: 1 000 000 000*)
3. Explain these points to your class:
   - The oldest rocks in the world are about 4.5 billion years old.
   - This is all much, much longer ago (*further back in history*) than anyone can imagine. We are going to try to imagine how long ago this is with the help of nine rolls of toilet paper.

4. Unravel one roll around the classroom – learners can pass it from one person to the next as they unroll it. Do this gently so as not to break it.
5. How many squares or sheets of paper do you get on a roll of toilet paper? (*500*)
6. Imagine that each sheet of toilet paper shows 1 000 000 (*one million*) years. How many years will one full roll of toilet paper give us?
   (*half a billion or 500 million – 500 000 000 years*)
7. Now for the BIG question:
   How many rolls of toilet paper do you need to show how long ago our planet began? (*4.5 billion years = 9 rolls!*)
8. Roll up the unrolled toilet roll again and place all 9 toilet rolls in a row for all to see.

Consolidation

1. Ask learners to write a rap song in their groups, about time and how old the Earth is.
2. Read the rap songs and decide which group should perform their rap.

8 An evolution timeline

Social Sciences and Natural Sciences

By the end of this activity learners will be able to:

- demonstrate how change has taken place over millions of years by making a range of clay creatures
- follow a timeline which outlines the process of evolution.

This activity builds on Activity 7, where learners explore the concept of millions and even billions of years.

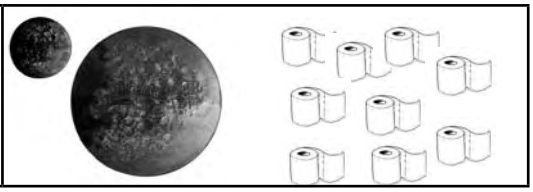
Teacher preparation

This activity needs careful preparation.

What you need:

1. One photocopy of the timeline on pages 36–38. Make the pages even bigger if you can. Cut this timeline into long strips across the pages. Each strip should have a date with its event and picture.

   First strip from the Evolution Timeline

4 500 million (4,5 billion) years ago	Formation of planet Earth and Moon – balls of hot rock (oldest rocks)	

   Note: You will be sticking these strips up around the room as learners make their creatures in sequence.

2. Enough Prestik to stick up each date strip.
3. The 9 rolls of toilet paper from Activity 7. (Display them on a table and keep them rolled up.)
4. A small ball of clay, plasticine or play-dough for each learner. (It should fit comfortably into the palm of a hand).

▸ *See page 35 for a play-dough recipe.*

Note: Each learner works individually so that they have a chance to use the clay themselves and develop their own ideas. If it is impossible to use clay, plasticine or play-dough, you can ask learners to draw the different creatures as you move along the timeline.

Guide learners through the activity

Take the class slowly through the process described in steps 1–10 below.

Each learner should use his/her ball of clay to show how things have changed over time.

As learners make their models, let them show one another and explain the models in some detail. Take your time.

1. Take your class back in time to the first strip of the timeline 4,5 billion years ago and the formation of our planet Earth.
   - Stick up the first strip.
   - Learners all roll their balls of clay between the palms of their hands, and feel its round, earthy shape.

   Refer to the 9 rolls of toilet paper displayed on a table. (*Remember that each sheet shows 1 million years. 1 roll of 500 squares represents 500 million, or half a billion years. 9 rolls represent 4,5 billion years.)*

2. Now take learners forward in time to 4,3 billion (4 300 million) years ago, the time of the first rains on Earth. (*This is nearly half of the first roll of toilet paper.*)

   - Display this timeline strip.

4 300 million (4,3 billion) years ago	Hot Earth cools down, the crust cracks, steam escapes, volcanoes, thunderstorms and the first rains fall on Earth.	

   - Ask learners to use their fingers to make rain on their little 'Earths'.

From this point on learners use their clay to make creatures and plants as the teacher reads out and displays each timeline strip in sequence. Learners break up and re-use the clay as they go. This helps to show change and development through time.

3. We are now at 3,5 billion years ago. (*You now have 7 rolls of toilet paper on display – remove the first 2.*)
   - Display the timeline strip and tell learners about the tiny, single-celled bacteria as they squash the clay between their fingers.
4. Now go forward another billion years, explaining that these single-celled organisms changed very, very slowly into creatures with many cells.
   - Display the next timeline strip and remove 2 more toilet rolls (*5 left*).
   - Give learners time to make their worms and jellyfish (no eyes!)
5. Another 2 billion years go by …
   - Remove 4 more toilet rolls. (*There is 1 toilet roll left. We have 500 million years to get to life today.*)

6. Continue displaying the strips of the timeline in sequence as learners change the shapes of their models to show the developments.
7. **Important:** When you get to 10 million years ago, let learners make their 'Proconsul'. Then ask them to break their clay into 2 unequal pieces. With the smaller piece they make an ape and leave it on one side. They then use the bigger piece to complete the 'hominid to human' timeline.

   (*Breaking the clay helps learners to understand that, although we are related to apes, we are not direct descendants from apes.*)
8. When you get to the first 'hominid' or upright walking primate (4,17 million years ago), break off four pieces of toilet paper from the last roll. These represent the time of the earliest human-like mammals we know of.
9. Let the learners conclude this activity by making a model of themselves.
10. Learners then make a model of themselves in 4 million years' time. (How do they think we will change over time?)

Consolidation

Hand out a strip of the timeline (without its pictures) to each pair of learners. They must make a drawing in each block using the information on the strip. Display these with the timeline in the correct sequence.

PS Keep the clay or play-dough in an airtight container

Recipe for play-dough

INGREDIENTS

1 cup flour
1 cup water
1 tablespoon oil
1 teaspoon cream of tartar
$\frac{1}{2}$ cup salt
A few drops of food colouring (optional extra)

METHOD

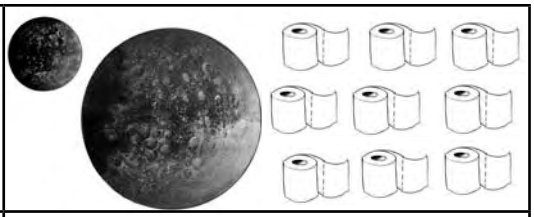
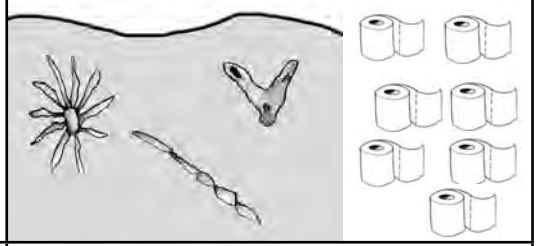
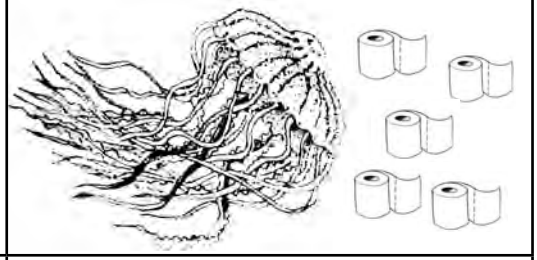
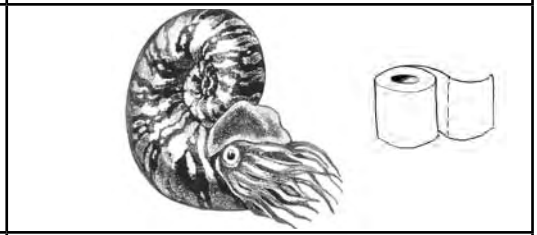
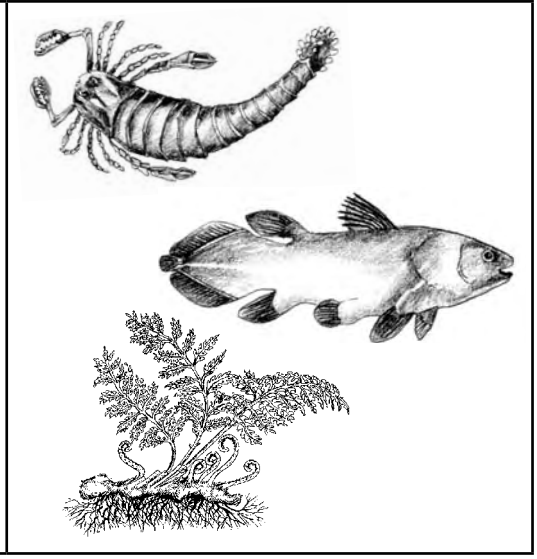
1. Put all the ingredients together in a pot.
2. Cook the mixture on moderate heat until it goes thick like porridge (about 3 minutes).
3. Wait for the mixture to cool off and roll it into a ball. (Put some flour on your hands first.)
4. Store your dough in a plastic bag in the fridge.

Make up the amount of play-dough you need in small batches rather than in one big batch – use the 1-cup recipe and make 6 batches for 40 learners.

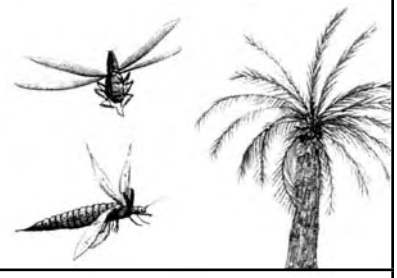
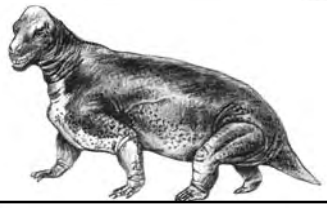
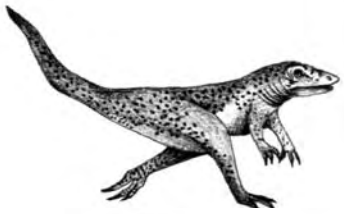
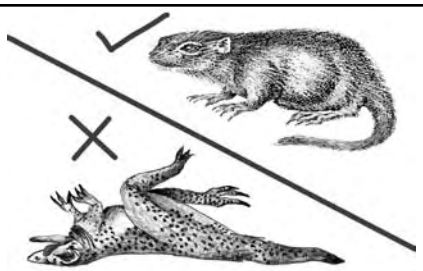
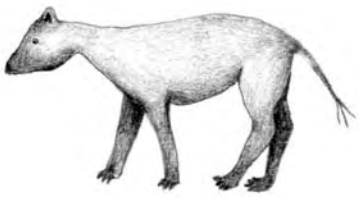
Learners will make all sorts of strange things! This is fine. The important thing is for them to make the whole series and grasp the idea of change over time. When we did it, we re-made and labelled examples of each stage for a display at the end. It was like a still life of each stage in Earth's history.

Teacher from Parkfields Primary, Hanover Park

Evolution timeline

4 500 million (4,5 billion) years ago	Formation of planet Earth and Moon – balls of hot rock (oldest rocks)	
4 300 million (4,3 billion) years ago	Hot Earth cools down, the crust cracks, steam escapes. There are volcanoes, thunderstorms and the first rains fall. The first oceans form.	
3 500 million (3,5 billion) years ago	The first living things appear – single-celled bacteria from chemicals in the sea, like tiny grains of dust.	
2 500 million (2,5 billion) years ago	The first creatures with soft bodies and many cells, such as worms and jellyfish appear. No eyes!	
2 000 million (2 billion) years ago	Evolution continues to continue …	
500 million ($\frac{1}{2}$ billion) years ago	The first organisms with 'eyes' – many 'new' sea and freshwater squid-like creatures with shells – long, thin fish with soft backbones.	
450 million years ago	Large sea-swimming animals like sea scorpions and ancient sharks. Fishes with cartilage spines and fleshy fins with bones inside, e.g. coelacanth. Bony fish with scales and hard backbones. First plants grow on land (mosses and ferns).	

Evolution timeline

350 million years ago	First land animals. Creatures come out of the water and onto the land – centipedes, air-breathing fish, 4-legged amphibians.	
300 million years ago	Mostly hot, wet climate. Forests of ferns and huge conifer trees (with seeds protected in cones). Many insects (6 legs), amphibians – fish-like frogs (that can live on land but have to breed in water).	
280 million years ago	First reptiles – lizard-like. They had scaly skin, ate plants and meat and laid hard-shelled eggs on land.	
200 million years ago	Dinosaurs – huge, cold-blooded reptiles. As dinosaurs grew in number, they destroyed other animal groups which became extinct. ALSO: First mammals (warm-blooded, furry, gave birth to live young and suckled them).	 
150 million years ago	First birds – the scales of the dinosaur evolved into feathers. This made it possible for them to fly away from hungry dinosaurs and catch flying insects.	
80 million years ago	First plants that had flowers, seeds and fruits for reproduction. Pollinating insects.	
65 million years ago	Extinction of the dinosaurs. Mammals could now survive more easily. Start of the 'Age of the Mammal'.	
50 million years ago	The first small 'horse' – a dog-like animal that lived in the forests.	

Finding, excavating and preparing a fossil

Dr Roger Smith is excavating a large fossilized reptile in the Karoo. This specimen of *Bradysaurus* (which means robust reptile) is now on display in the Karoo National Park near Beaufort West.

Layers of cloth soaked in Plaster of Paris hold the fossil together so that it can be lifted and transported to the museum.

Hauling the excavated fossil off the mountain and into the vehicle takes the efforts of 20 men.

The long and slow process of chipping away all the rock from the fossil bones is done by preparators in a special laboratory in the museum.

After two years of painstaking preparation the fossil reptile once again sees the light of day after 255 million years. It is ready to be studied by palaeontologists.

ALL PHOTOGRAPHS ON THIS PAGE: Iziko Museums of Cape Town

Fossils of plants and animals

Fossil trilobite – an extinct marine invertebrate with a hard exoskeleton and compound eyes distantly related to today's shrimps and crayfish (350 million years old).

Cross-section of an ammonite shell showing the spiral arrangement of hollow chambers. These squid-like animals were common in the seas. They pumped fluid in and out of the chambers to allow them to float or sink (120 million years ago).

Fossilized starfish from Prince Albert district in the southern Karoo. Similar to the starfish living today (350 million years old).

Fossilized insect

Section through a fossilized pine cone from Tanzania (255 million years old).

Fossil fern in rocks of the Molteno Formation from the Eastern Cape (235 million years old).

ALL PHOTOGRAPHS ON THIS PAGE: Iziko Museums of Cape Town

Fossils of plants and animals

Fossilized fish that died in a lake near Kenhardt 70 million years ago. It is named *Stompooria mandelai* in honour of Nelson Mandela.

Fossilized frog from a pond deposit formed in an ancient volcanic crater near Kenhardt in the Northern Cape (70 million years ago).

This cynodont called *Galesaurus* is an ancestor of all mammals. It shows two distinctive rib shapes that may indicate the presence of a diaphragm to help the animal breath underground (250 million years old).

Two juvenile *Thrinaxodon* that died together in an underground burrow, possibly while they were hibernating.

A footprint of a three-toed theropod dinosaur preserved in desert sandstone of Namibia (200 million years old).

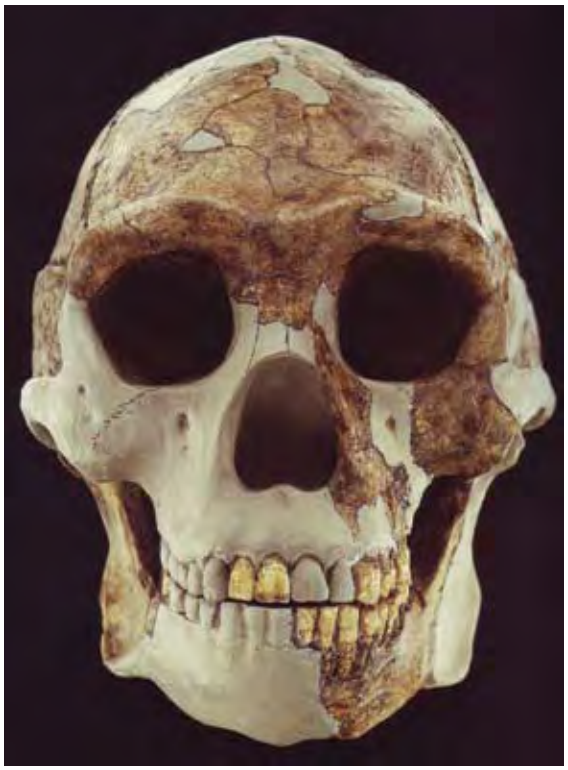
Fossilized droppings (coprolites) of animals that lived in the Karoo. Most contained bone fragments and were probably made by carnivorous therapsid reptiles (*Gorgonopsians*) 253 million years ago.

ALL PHOTOGRAPHS ON THIS PAGE: Iziko Museums of Cape Town

Hominids from Africa

'Work Man' (*Homo erectus*)

Brain the size of the brains of modern humans; similar to skulls found near Sterkfontein in Gauteng (1,5-1 million years old).

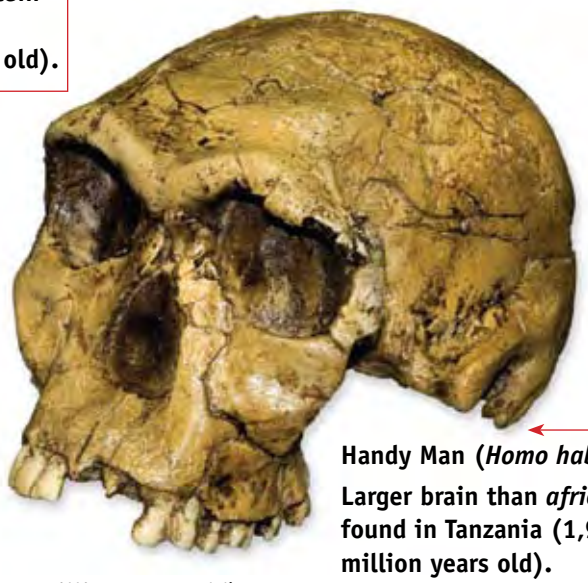


Taung Child (*Australopithecus africanus*)

Small-brained hominid. Found in North West Province (2 million years old).

'Mrs Ples' (*Australopithecus africanus*)

Found at Sterkfontein Caves in Gauteng (2,5 million years old).



Handy Man (*Homo habilis*)

Larger brain than *africanus*; found in Tanzania (1,9–1,6 million years old).

www.skullsunlimited.com

Little Foot (*Australopithecus* ... species not yet decided)

Still being excavated. Found at Sterkfontein Caves, Gauteng (4,17 million years old).

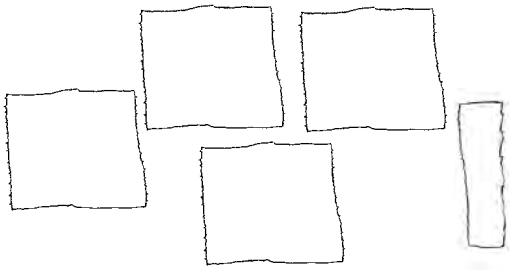
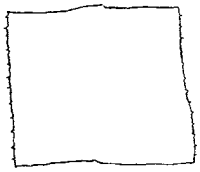
PHOTO: Dr Ron Clarke, Wits University

'Wise Man' (*Homo sapiens*)

Similar to the discovery at Klasies River Mouth in the Western Cape. Modern human (120 000 years old).

Photo: David Brill, UCT

Evolution timeline

25 million years ago	'Proconsul' – a common ancestor of people and apes: ~ hairy, no tail and small brain ~ walked on four legs ~ climbed trees.	
10 million years ago	'Proconsul' split into two groups: a) forest apes with larger brains such as chimpanzees and gorillas b) 'pre-humans' who lived in caves and hunted on the open veld.	
4,17 million years ago	'Little Foot' (Sterkfontein caves) – the earliest hominid in southern Africa and our earliest direct ancestor. (A hominid can walk on its back legs – the hands are free.)	
1,9 to 1,6 million years ago	'Handy Man' – the first user of stone tools, with a large brain. ALSO 'Work Man' who, a few thousand years later, was the first hominid to use fire for cooking. (Both from southern Africa.)	
1 million years ago	Global cooling – the most recent Ice Age. Forests shrink. Two-thirds of apes become extinct.	1 sheet of toilet paper left! 
160 000 (0,16 million) years ago	'Homo sapiens' – 'Wise man', the first modern humans. This is us! (Remains found in the Western Cape and Mpumalanga.)	
19 000 (0.019 million) years ago	Homo sapiens continues. The earliest rock art in southern Africa (San.)	
Today	Homo sapiens continues. We are taller than the early modern humans but still the same species.	

9 Invent an animal

Social Sciences and Natural Sciences

By the end of this activity, learners will be able to:

- create an imaginary animal, modelled to survive in a particular environment (*cause and effect*)
- identify changes to both the environment and the animal over time (*change and continuity/ adaptation*).

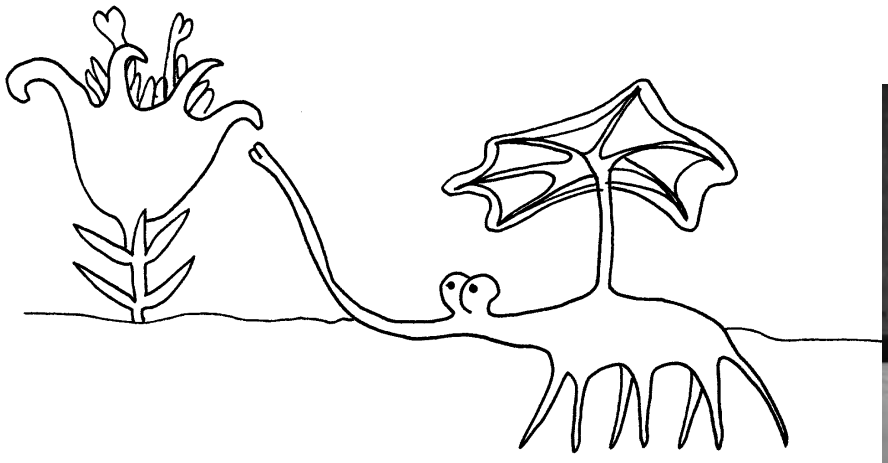
This is a consolidation activity. It gives learners a creative opportunity to demonstrate their understanding of concepts learnt in both Activity 1, 'History of the Horse' and in Activity 8, the 'Evolution Timeline'.

Teacher preparation

Each learner needs:

- two sheets of A4 paper
- drawing equipment – soft pencils and/or crayons
- two pieces of clay or play-dough to make animals (use the clay from Activity 8).

  Note: If you have no clay or play-dough, give each learner a third sheet of paper. Cut the paper in half, so they can draw their two invented animals on each half.

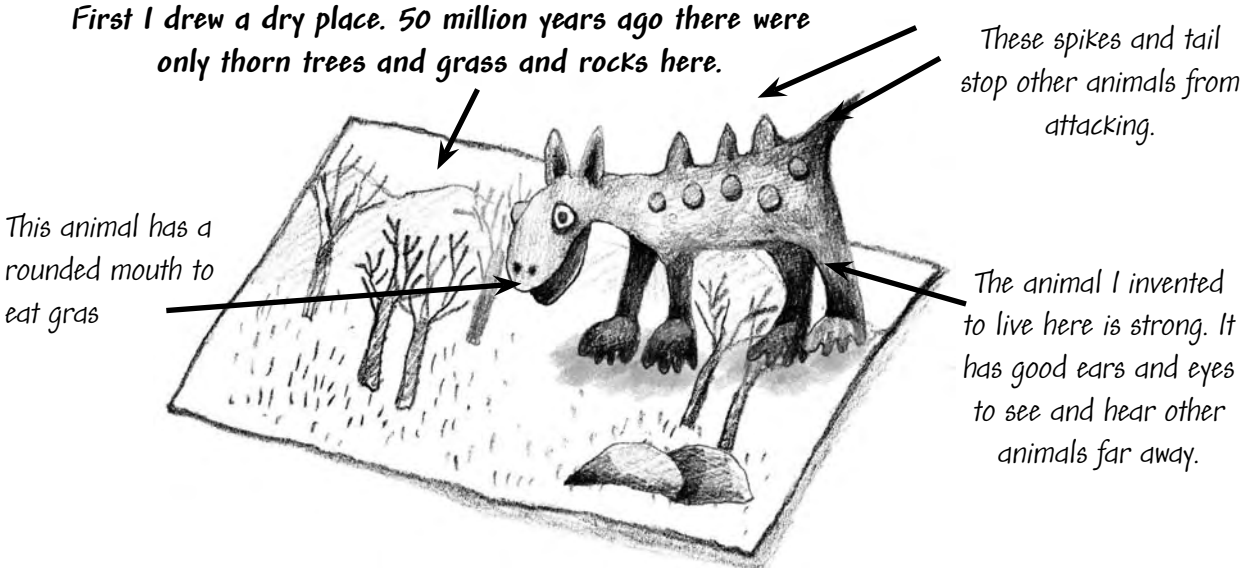


Guide learners through the activity

- Take learners through the instructions on pages 40 and 41, step by step.
- You may need to divide the steps across two lessons. Steps 1–6 can be done in the first lesson and 7–13 in the second lesson.

What learners do

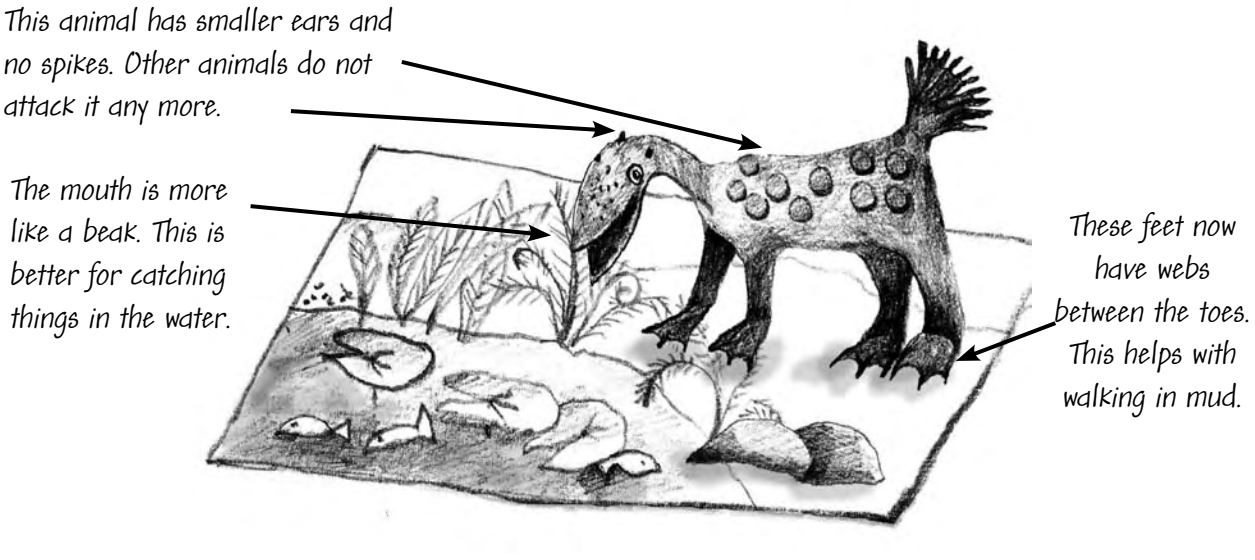
1. Imagine a place in the world about 50 million years ago. It could be in the sea, in fresh water and muddy areas or in forests. You decide on an environment.
2. Draw your environment on a loose sheet of paper. (Give learners plenty of time to do this. Insist on detailed drawings.)
3. Now invent an animal that could have lived in this environment. Think about how it will move, what it will eat, how it will protect itself or survive. Your animal can be as big or small and as strange as you want it to be!
4. EITHER make your animal out of clay or play-dough OR draw your animal and cut out its shape.
5. Place your animal in the environment you drew and display it on your desk or table.
6. Walk around and look at what everyone has created.



7. Now think about the same place today, 50 million years later. Will it be hotter or colder? Will it be developed or built on? How will it have changed?
8. Draw your changed environment on a new sheet of paper. (Give learners plenty of time to do this. Insist on detailed drawings.)
9. Think about how your animal's descendants could be living today, 50 million years later. Think about its changed environment and things that could be different in its life, such as:
   - Will it be eating different foods? (Will it eat plants, insects or other meats?)
   - Will there be new dangers? (How has the climate changed? What other animals are around?)
   - Will it be bigger or smaller, have more hair or be smoother-skinned, be faster or slower in its movements?

10. Use some more clay or paper to make or draw your second animal that has evolved. Remember that it has developed out of your first animal.
11. Place your evolved animal in the environment you drew and display these on your desk or table. Put them next to your display of '50 million years ago'.
12. Walk around and see how other learners have changed their environments and animals.

This is the same place as 50 million years ago. Now it is wet and muddy.



13. Together talk about the different changes you notice and the possible reasons for these.

Consolidation

Use the display time and the discussion at the end as an opportunity to assess your learners' understanding informally.

Check that your learners can:

- talk about how environments and creatures may change over time
- show that they understand the concept of adaptation
- make links between the environment and the creature's means of survival (cause and effect).

10 Understanding bones and skeletons

Natural Sciences and Social Sciences

By the end of this activity learners will be able to:

- name, describe and recognise the main parts of a skeleton – skull, lower jaw, backbone (made up of many vertebrae), ribs, pelvic girdle (hip bone) and pectoral girdles (shoulder bones), limbs, hands and feet
- describe some of the differences between the skeletons of fish, frogs, reptiles, birds and mammals (four-footed mammals and upright humans)
- describe how the different types of skeleton help the different animals to survive
- understand that the bones are hard and are often the only part of an animal that may fossilize over time
- compare the limbs of different vertebrates.

Teacher preparation

Prepare pictures of skeletons and questions for each group.

Similarities between different skeletons

Explain to learners that fossils are formed from the remains of plants and animals. Most fossils that are discovered are formed from shells, teeth, bones and wood. Those are the parts that fossilize the best. This is because they are the hardest parts of the animals' bodies. In invertebrate animals (snails and shellfish) the hard shells can become fossilized. In plants the hard seeds and woody parts can become fossilized.

The fossil bones and teeth of vertebrates can tell us about how the animals lived. We can tell how each animal walked and what kinds of food it fed on.

Activity Sheet 1 Similarities between different skeletons

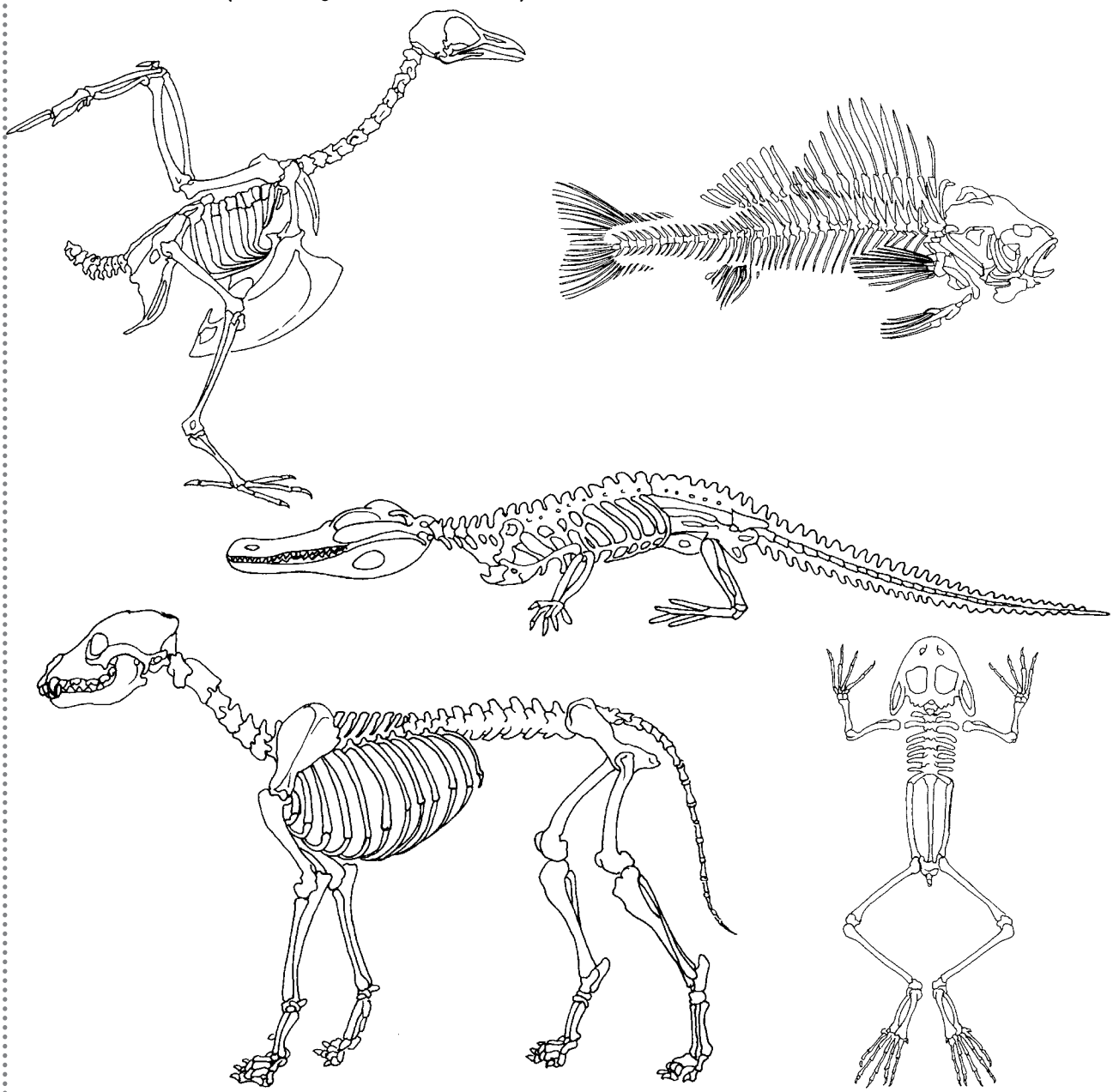
What learners do

1. Look at the pictures of the different skeletons of vertebrates.
2. Place a label on the following parts of each skeleton:

   skull, lower jaw, backbone (made up of many vertebrae), ribs, pelvic girdle (hip bone) and pectoral girdles (shoulder bones), limbs, hands and feet.
3. Answer the following questions about the skeletons:
   a) When you look at their skeletons, do you think that all these kinds of animals are related? Give reasons for your answer.

      (*Yes, because they all have similar parts to their skeletons.*)
   b) Do you think all the animals above belong to the same species?

      (*No, because they cannot breed with each other.*)
   c) Do you think the following statement might be true? 'Living things are related to each other because they have similar body parts.' Give reasons for your answer. (*Yes, they are all related.*)

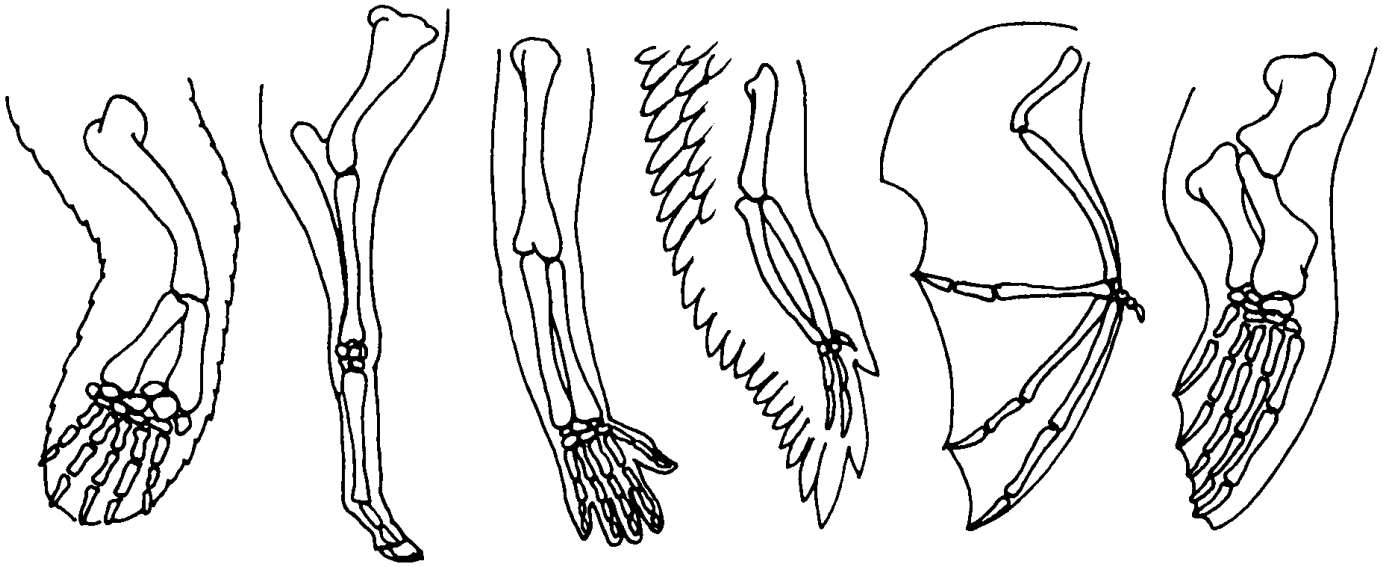


Consolidation

Learners should understand that the same bones are found in the front legs and wings of different vertebrates.

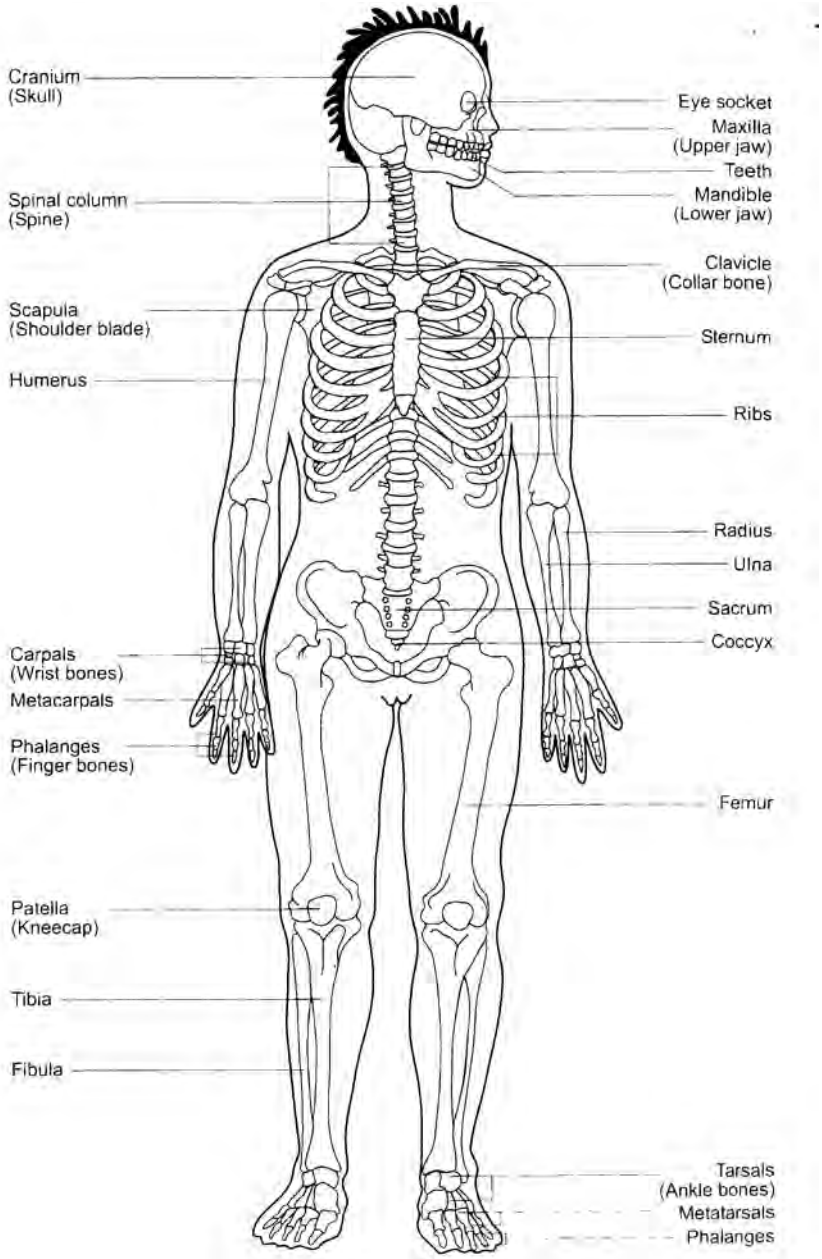
Show learners the different bones in the picture of the human forearm below, or from the CD. See if they can find the same bones in the other animal limbs (arms and legs).

Front limb bones of different animals

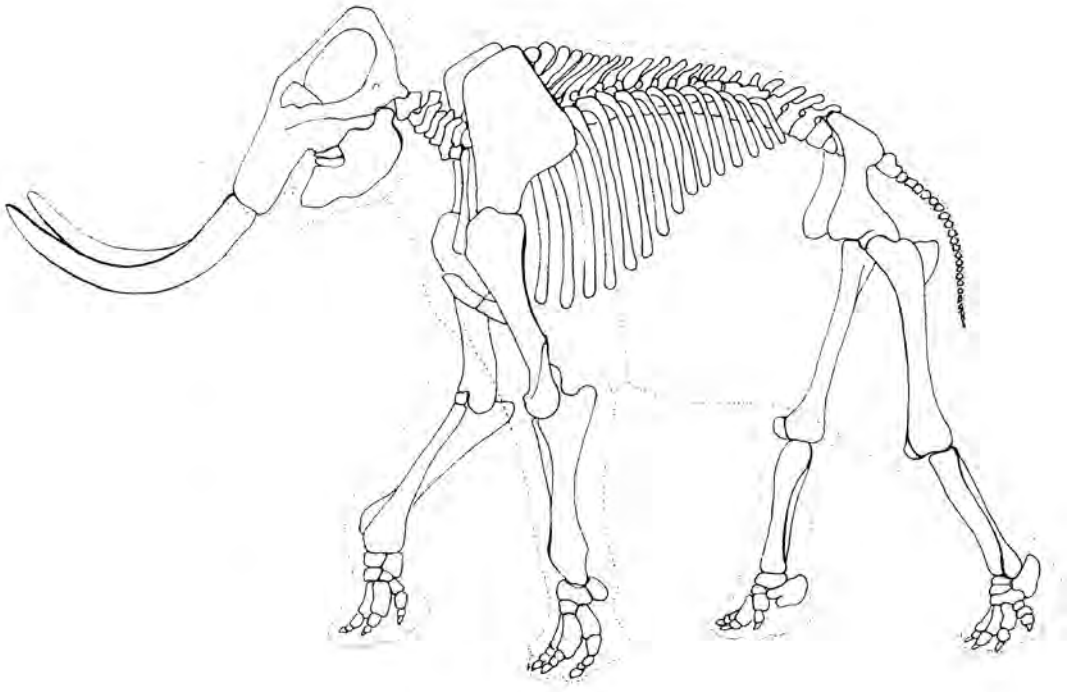


turtle horse human bird bat seal

Activity Sheet 2 Comparing skeletons



We can compare the skeletons of two different mammals (a human and an elephant).



Comparing skeletons (cont.)

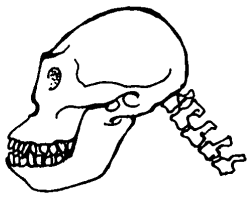
We can compare the skeletons of two different mammals (a human and an elephant). The different ways in which the animals walk mean there are some differences in the ways their skeletons fit together.

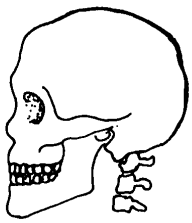
1. Use the pictures of the human skeleton and the elephant skeleton to complete the table below.

	Mammals	
Different parts	**Human**	**Elephant**
Does it walk upright or does it walk on four legs?		
Is the backbone in a vertical or horizontal position?		
Is the skull attached to the backbone underneath the skull or at the back of the skull?		
Are the foot bones horizontal or vertical?		
Do the ribs hang down from the backbone or do they stick out from the front of the animal?		

2. Look at the pictures of these two skulls:

   Which skull came from a four-footed animal and which skull came from a human? Why?





Consolidation

Learners should write a few sentences to explain how a palaeontologist would be able to tell the difference between a human skull and any other mammal skull. (*Look for the opening in the skull, where it attaches to the backbone. In a human it is always under the skull. This is because the human walks upright and the skull sits on top of the backbone. Other mammals walk on four feet and their skull has a hole at the back where the backbone attaches to it.*)

Check that learners are able to:

- identify and name the parts of a vertebrate skeleton
- identify similarities in the different skeletons
- correctly compare a human and an elephant skeleton
- identify the difference between the skull of a human and that of a four-footed animal.

11 What makes humans unique?

Social Sciences

By the end of this activity learners will be able to:

- compare humans to other mammals
- complete a drawing to show some of the things that make humans unique.

Teacher preparation

Make copies of the activity sheet on pages 48 and 49 for each learner to complete.

Activity Sheet What makes humans unique?

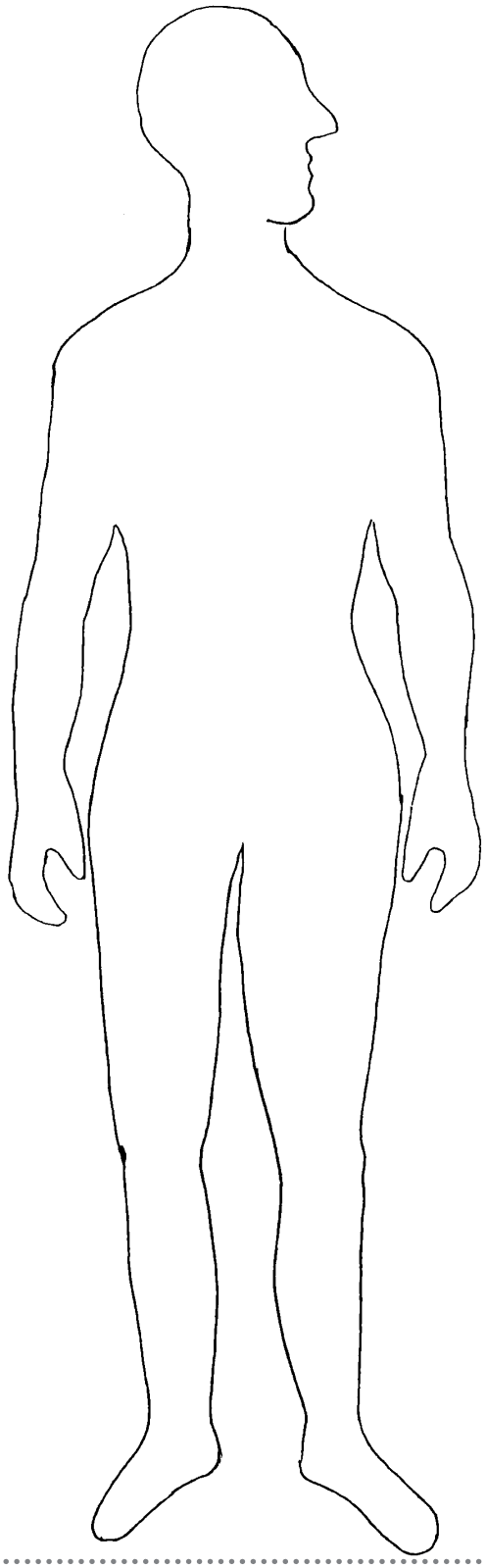
1. Every mammal is unique in some ways and similar to other mammals in other ways. Humans are mammals. What makes human mammals similar to other mammals and what makes them different from other mammals? Complete the table below. Here are some ideas to get you started.

have warm blood
eat
have a backbone
bury the dead
have religious beliefs
have skills
can move
have babies
use money
feel hot and cold
breathe
write
wear clothes
use hands to make things grow
can cook food
make music
excrete
use advanced language
walk on two legs
store food

Similarities (how humans are like other mammals)	**Differences** (things that **only humans** have or do)

2. Add two or more ideas to your lists of similarities and differences.
3. Are any of the things in the lists true for humans and only some other mammals? Talk about your ideas with other learners.
4. What animal is most like humans?

5. Decorate this human body with clothes, tools, ornaments and whatever else you want to show the person's culture, religion, occupation and interests.
   Note: You can also draw other things around the person.



Consolidation

Write a few sentences to explain what you think are the main things that make us human and unique.

12 Hands and feet

Social Sciences

By the end of this activity, learners will be able to:

- observe their own hands and feet carefully (*work with sources*)
- compare the hands and feet of humans with those of other primates (*similarities and differences*).

Teacher preparation

Read through the instructions and the explanation below, so that you are ready to present them to your class.

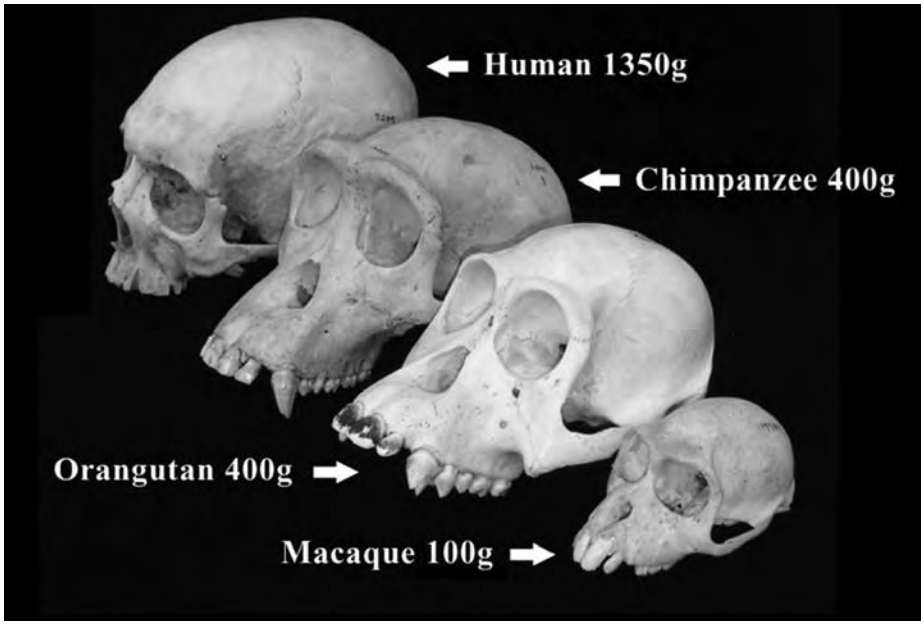
Explain to learners

Humans, monkeys and apes all belong to the group of mammals called primates.

KNOWLEDGE BOX

Primates are a group of mammal species that have highly developed brains, eyes facing forward and opposable thumbs. (Thumbs that can spread out sideways from the rest of the hand which allow them to grip and pick up things very delicately.) They usually live in complex social groups and can adapt their behaviour to live successfully in different environments. Lemurs, monkeys, apes and humans are all primates.

Humans did not develop from apes or monkeys. Humans and apes had a common ancestor called Proconsul. Proconsul lived in Africa until about 10 million years ago. From about this time apes developed separately from humans.



This picture of primate skulls shows the larger brain size and shape of the human skull.

What learners do

1. Look carefully at your hands and feet. Notice especially the different ways you can move your fingers and toes. How are your thumbs and big toes different from your other fingers and toes?

   Did you know that:

   - only humans can easily touch the tip of each finger with the thumb of the same hand? (A chimpanzee can do this, but not very well!)

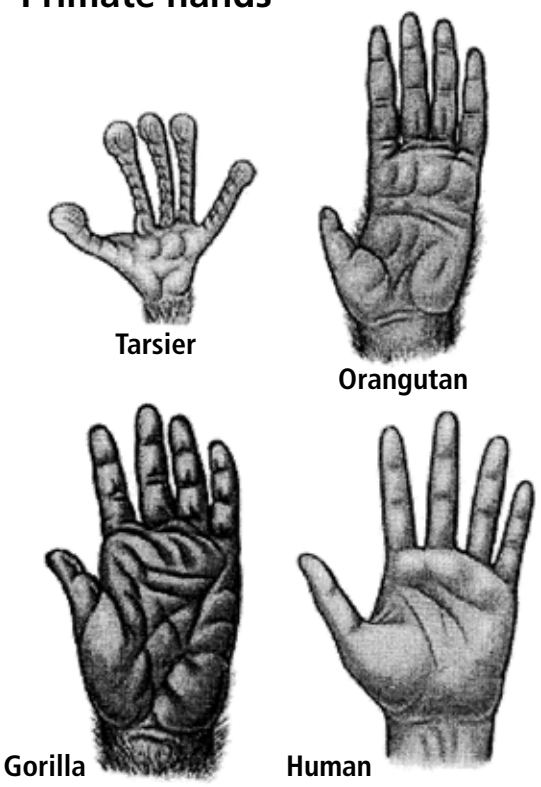
2. Now walk a few steps. As you take each step think about:
   - which part of your foot you put down first
   - how your foot moves as you go forward to take your next step
   - how your toes help you to walk.

3. If possible, go outside and walk barefoot on some sand or soil. Look at your footprints. See how the weight of your body has been pushed down from the heel, along the outside of your foot and across the 'ball' of your foot.

   Did you know that:

   - apes push off from their middle toes?
   - an ape's big toe can spread out sideways from the rest of the foot? This is useful for holding branches and climbing trees.
   - archaeologists have studied fossilized footprints that they found in ancient volcanic lava, in order to work out when primates first walked upright on two legs?
   - humans are the only primates that walk on two legs all the time, leaving their hands free to do different tasks and to make things?
   - modern humans and their ancestors that walked on two legs are called hominids?

Primate hands



Primate feet

13 Discovering 'Little Foot'

Social Sciences

By the end of this activity, learners will be able to:

- read about and appreciate the discovery of 'Little Foot' (*work with sources*)
- explain the significance of the 'Cradle of Humankind' (*answer the question*)
- conduct and write up an interview (*communicate the answer*).

Teacher preparation

- Make one copy of pages 54, 55 and 56 for each pair of learners.
- Read this page and practise reading the text aloud before presenting it to the class.

1. Explain what a hominid is:

Hominid is a name given to humans and their upright walking ancestors. The first hominids show a mix of features that are both ape and human. (*Also see the explanation of Hominid in the glossary on page 69.*)

2. Read the text to the class.

Here is a way to help your learners read, understand and enjoy a fairly difficult text. Make sure they can all see a copy of the three pages.

a) Give learners a few minutes to look at the pictures and headings. Ask them to say what they think they will be reading about (*overview and prediction*).

b) Read the text aloud, with learners following the text as you read.

The discovery of 'Little Foot' is a kind of adventure story. Bring all the interest and wonder of this fantastic new discovery to your reading, as learners listen and follow the printed text on the copies you have made for them.

c) Re-tell the story together with the learners in your own words.

How much of the story can learners tell each other before they read the text again? Keep asking them questions so that they recall the detail. Do this together as a class.

d) Let learners read the story again with their partners.

Learners take it in turns to read to their partners. As they read, they find details they left out when they re-told the story earlier.

2. Complete an interview.

Arrange learners in groups of four. Give the groups the following instructions:

- Imagine that you meet Nkwane Molefe, Stephen Motsumi and Ron Clarke.
  a) Write down all the questions you could ask them.
  b) Decide who in your group will be A. B. C. and D.
  c) Take on the roles of A: Molefe, B: Motsumi, C: Clarke and D: an interviewer.
  d) Use your questions and the information in the report to do a radio or television interview.
  e) Write up your interview, showing the questions the interviewer asked and the answers that Molefe, Motsumi and Clarke gave.
  f) Hand in your written interview for assessment.

Dr Ron Clarke with Little Foot's skull

The Cradle of Humankind

Just 40 km outside Johannesburg are the Sterkfontein Caves. This photo shows a part of the excavation site. Notice how rope has been tied across the site to make a grid. This helps archaeologists to record exactly where they find different fossils. Fossils found here and in the caves below the open area provide much of the best evidence in the world about our history as early humans. This site is so important that it has become known as 'The Cradle of Humankind'. It gives us a window into the past, to a time when our earliest ancestors were developing.

Archaeological dig at Sterkfontein

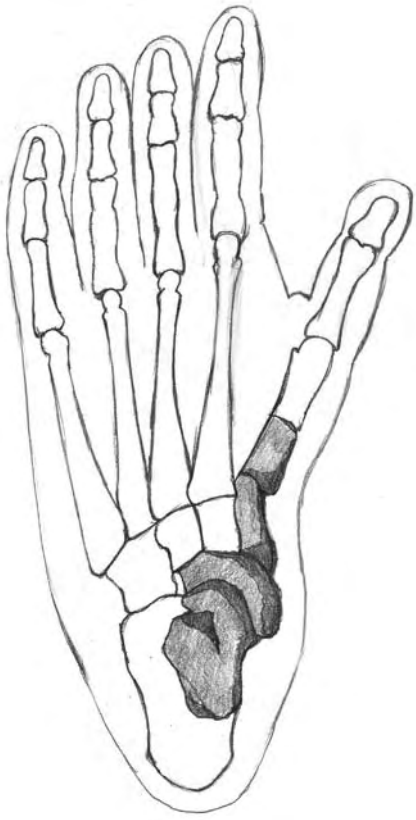
Interesting feet

Some foot bones were found in one of the caves at Sterkfontein in the late 1970s. They were kept in boxes along with bones from other animals. When these bones were found no one knew how important they were. Then, in 1994, Ronald Clarke, an archaeologist, took a close look at them. He recognised them as the foot bones of a primate that could walk on two feet. He also identified some leg bones from the same individual. They were from an early hominid.

Archaeologists later calculated that they were the bones of something that lived over 4 million years ago. They called this creature 'Little Foot'. Little Foot's big toe could spread out sideways like that of an ape. This mammal had been a tree climber. But, unlike an ape, the heel and the arch of the foot seemed to be developed for upright walking, like humans.

The question was: Where is the rest of Little Foot's body? Finding the body and the skull of this strange creature could help to tell the story of the evolution of modern humans. A huge search was about to begin.

The report that follows describes what happened.



Drawing of the footbones of Little Foot

December 1998

Exciting discovery at Sterkfontein of pre-human fossil with its skull and skeleton

THE world's first-ever example of an entire hominid skull – and its skeleton – has been discovered at Sterkfontein by Dr Ron Clarke of Wits University. It is dated at about 4,17 million years old.

The skeleton is of one of our early ancestors and will answer many questions about human evolution.

Dr Clarke had been working at Sterkfontein for a number of years. He made the discovery by following his 'palaeo-detective' instincts after his first finding in 1994 of some fossil foot bones ('Little Foot').

'I was convinced then that the skeleton had to be there in the ancient cave, far below the layers of rock. The whole skeleton was probably fossilized after the hominid fell down a crack in the rock. The rest of the skeleton may well be hidden in the ancient limestone at Sterkfontein.' How right he was!

The team that discovered Little Foot, from left: Dr Ron Clarke, Nkwane Molefe and Stephen Motsumi.

The hunt

Dr Clarke gave his two sharp-eyed assistants, Nkwane Molefe and Stephen Motsumi, a copy of the piece of the leg bone and asked them to search for a matching piece in the deep, dark cave.

It was like looking for a needle in a haystack – searching in the dark cave with hand-held lamps. By some miracle, within two days they found the piece, at the opposite end to where they had looked before. The fit was perfect. More slow and careful picking away of the cement-like rock exposed the lower leg bones and a complete forearm bone.

Again, months went by as the three men chiselled away inside the damp cave. Clarke remembers thinking, 'There must be more – why can't we find the rest of the skeleton?'

Then they noticed a change in the thick lime layers of rock and came to the conclusion that the skeleton could have fallen down a crack or hole. They started to look in the area below.

The find

Dr Clarke felt certain that a great discovery was about to be made. He left Stephen Motsumi with instructions to telephone him if he uncovered the slightest sign of hope. Stephen rang. Clarke quickly drove the 40 km back to Sterkfontein.

He was right again. The signs of another bone had begun to appear.

The careful uncovering of the bone went on. All of a sudden Clarke realised it was the back of a lower jaw.

'Then I saw the shine of enamel. Stephen and I held our breath … "This can't be true," I called out. "This is an upper tooth! We've got the upper jaw – and the lower. I don't believe it – Stephen, Stephen, we've got the whole skull!" '

This was a world 'first' and a dream come true.

The discovery is full of world 'firsts': the skull is complete with both its lower and upper jaws. Even its teeth are there … and the skull is with its skeleton.

Little Foot had fallen face down, his tired head resting on his left arm, and died. Today, 4,17 million years later, he is the most famous South African caveman.

Little Foot had fallen face down, his head resting on his left arm … Today, 4.17 million years later, he is the most famous South African caveman.

14 Hominid discoveries in southern Africa

Social Sciences

By the end of this activity, learners will be able to:

- organise evidence about aspects of the past (*work with sources*)
- sequence events (*chronology and time*)
- identify key points and label a map (*communicate the answer*).

KNOWLEDGE BOX

What does 'hominid' mean?

'Hominid' is a name given to any upright-walking primate. The first hominids show a mix of features that are both ape and human.

Why do we call people today *Homo sapiens*?

'Homo' is the word used to describe all hominids that could make tools from stone. 'Sapiens' is the species that all humans belong to today. They date back to at least 120 000 years ago.

Why is the idea of a 'species' so important?

You can only breed or reproduce with a species that is the same as yours. It takes many generations over thousands of years for all the tiny changes in the offspring (babies) to be passed on and a new species to develop. As a new species evolves the original species may become extinct.

Who or what was *Australopithecus*?

Australopithecus was the earliest known hominid that lived in southern Africa 4 million years ago.

In the 1800s Charles Darwin suggested that the African continent was probably the place that the first humans came from. Scientists have since found fossil evidence to support this idea and have agreed that he was correct.

Many of the earliest hominid remains are in southern Africa. Most of these remains have been found in the Sterkfontein Caves, or the 'Cradle of Humankind', which is near Johannesburg. These caves are now a World Heritage Site.

Teacher preparation

For each small group of two or three learners, photocopy the activity sheet on pages 58–59.

What learners do

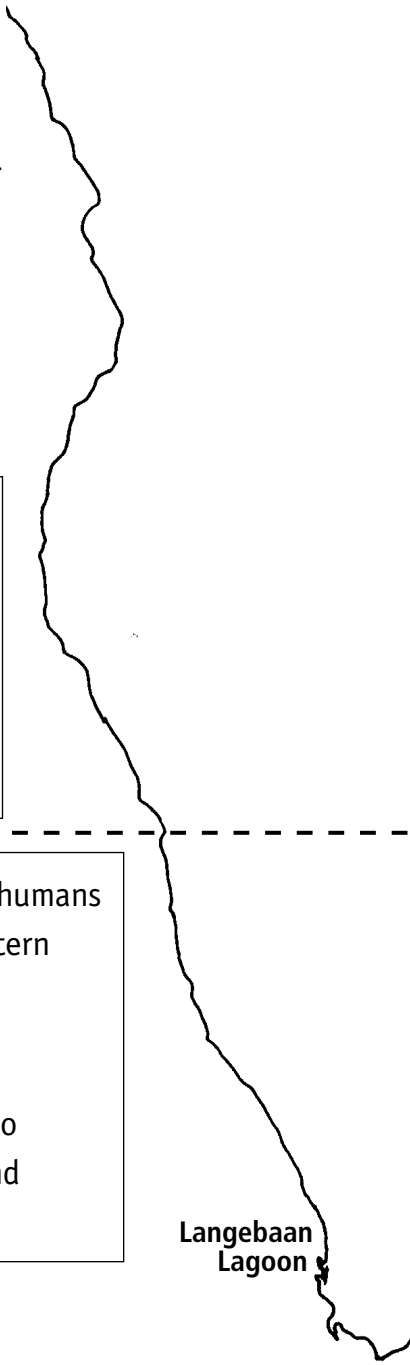
With the class:

1. Look at the map on pages 58–59. Point to different places such as the Equator, the Tropic of Capricorn, the lakes and unmarked places such as Cape Town.
2. Read the note about the 'Cradle of Humankind' in the middle of the map.
3. Check the terms in the **Knowledge Box.** (Note: Make sure learners understand these terms – but they need not recite them off by heart.)

Learners now work in their groups of two or three to complete the activity sheet **Hominid discoveries in southern Africa** on pages 58–59.

Activity Sheet Hominid discoveries in southern Africa

1. Read the information about all the early hominids carefully.
2. Write letters, from A to F, into the squares in the information boxes. Start with the oldest hominid (A) and finish with the most recent hominid (F).
3. Underline the following information in each box around your map:
   - the age of the fossil – how long ago it lived
   - the two facts that you think are most important about the fossil.
4. Draw lines from each box to the place on the map where this fossil was found. Be careful: *Homo sapiens* has lines to three different places!
5. Choose one of the facts you underlined and use the space under the map to:
   - explain why you chose it
   - say what further information you would like to find out about it.



'Taung Child' *(Australopithecus africanus)*
- Skull found at Taung in North West Province
- Lived about 2 million years ago
- Found in 1925 – before any of the others
- A small-brained hominid about 3–4 years old
- The puncture marks in the eye sockets show that it was killed and eaten by an eagle.

Why is the size of the skull so important?

'Wise human' *(Homo sapiens)* – the first modern humans
- Bones found at Klasies River Mouth in the Western Cape
- Also at Langebaan lagoon where footprints are preserved in the rock
- These hominids lived at least 120 000 years ago
- Fossils also found at Border Cave near Swaziland
- This is our modern human species!

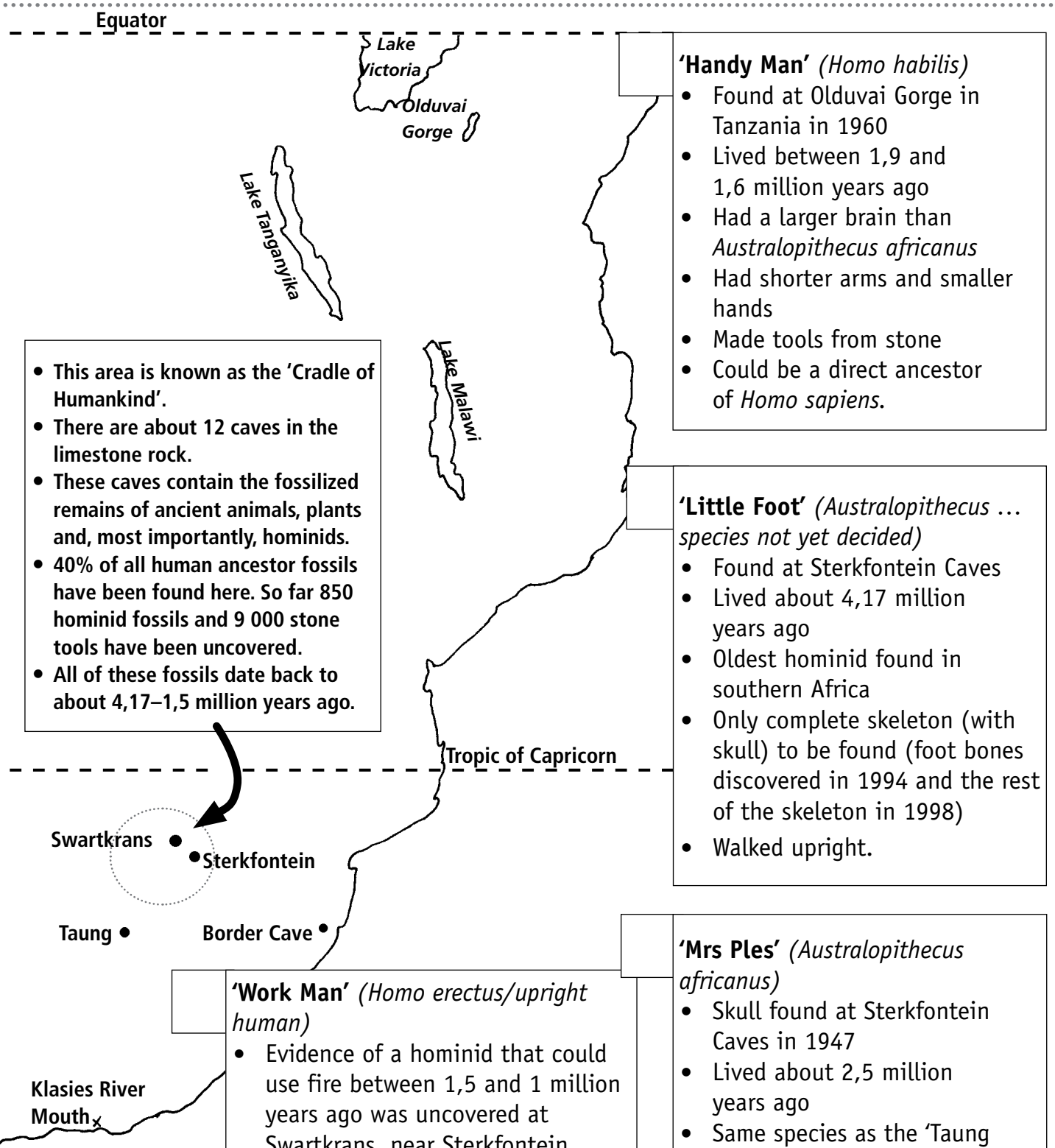
Hominids learned to walk upright before their brains grew in size. Their brains developed as they used their 'hands' more to make and use different tools. It is said that our heads are still getting bigger. With each generation there may be a tiny change in brain size!

An interesting fact is that .....

We would like to find out more about .....

.....

.....



'Handy Man' *(Homo habilis)*

- Found at Olduvai Gorge in Tanzania in 1960
- Lived between 1,9 and 1,6 million years ago
- Had a larger brain than *Australopithecus africanus*
- Had shorter arms and smaller hands
- Made tools from stone
- Could be a direct ancestor of *Homo sapiens*.

'Little Foot' *(Australopithecus … species not yet decided)*

- Found at Sterkfontein Caves
- Lived about 4,17 million years ago
- Oldest hominid found in southern Africa
- Only complete skeleton (with skull) to be found (foot bones discovered in 1994 and the rest of the skeleton in 1998)
- Walked upright.

'Mrs Ples' *(Australopithecus africanus)*

- Skull found at Sterkfontein Caves in 1947
- Lived about 2,5 million years ago
- Same species as the 'Taung Child'
- Called 'Ples' after *Plesianthropis* which means 'near-man'
- Now thought to have been a teenage male – 'Master Ples'
- Possibly about the same number of them as of baboons today
- Probably ate meat.

'Work Man' *(Homo erectus/upright human)*

- Evidence of a hominid that could use fire between 1,5 and 1 million years ago was uncovered at Swartkrans, near Sterkfontein.
- Fire was used for warmth, protection from dangerous animals and, as a burnt bone suggests, for cooking food.
- First hominids that could spread out of Africa to the colder climates of Europe and China.
- Brain size was about $\frac{3}{4}$ the size of modern human brains.

• This area is known as the 'Cradle of Humankind'.
• There are about 12 caves in the limestone rock.
• These caves contain the fossilized remains of ancient animals, plants and, most importantly, hominids.
• 40% of all human ancestor fossils have been found here. So far 850 hominid fossils and 9 000 stone tools have been uncovered.
• All of these fossils date back to about 4,17–1,5 million years ago.

Extend the activity with research

The 'facts' learners chose to highlight and write about in the space below the map will help to define some topics, or key questions, for further research.

The curriculum requires learners to identify and select sources relevant to an enquiry.

- Libraries have many source books on evolution and early hominid discoveries.
- By typing their questions into Google on the internet learners will discover many possible answers.

Ask learners to:

- find sources of information that will help them to pursue their research questions.
- use these sources to write up their research findings more fully.

Consolidation activity

Refer back to Activity 7 (Understanding Time) and the squares of toilet paper.

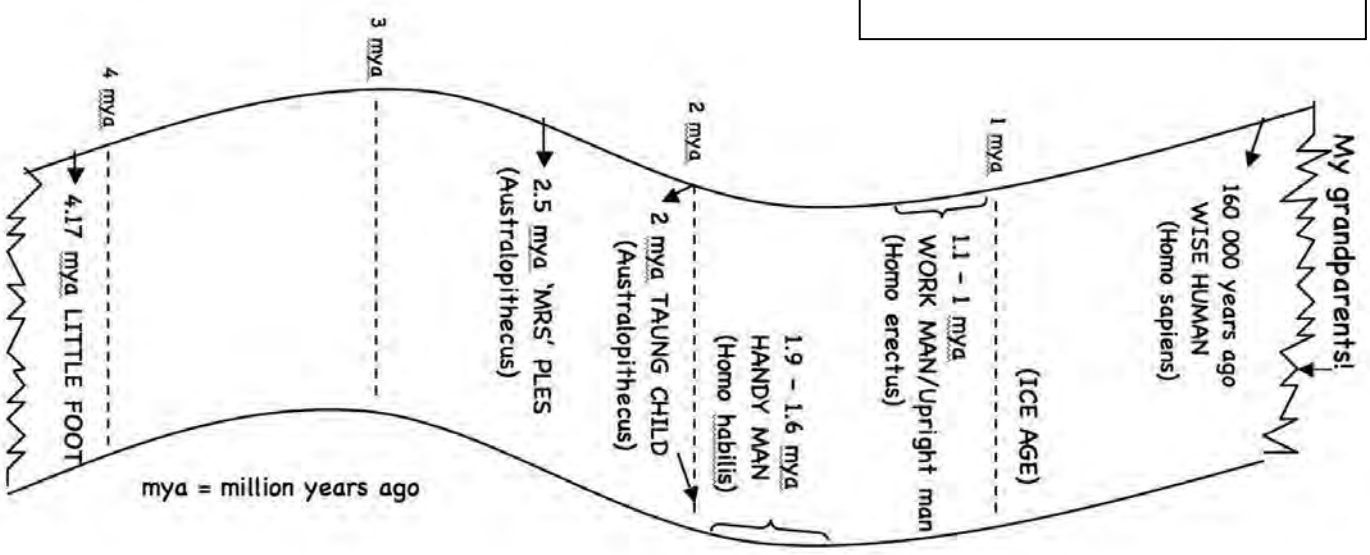
- Give each pair of learners five squares of toilet paper to write on.
- Remind them that one square represents one million (1 000 000) years.
- Ask them to draw lines on their toilet paper to show the hominids on their maps in the last activity.
- Where do they think the birth of their great-grandparents would lie on the line? (*on the tiniest pin-prick at the very end!*)

Scientists continue to make discoveries. This timeline is not complete!

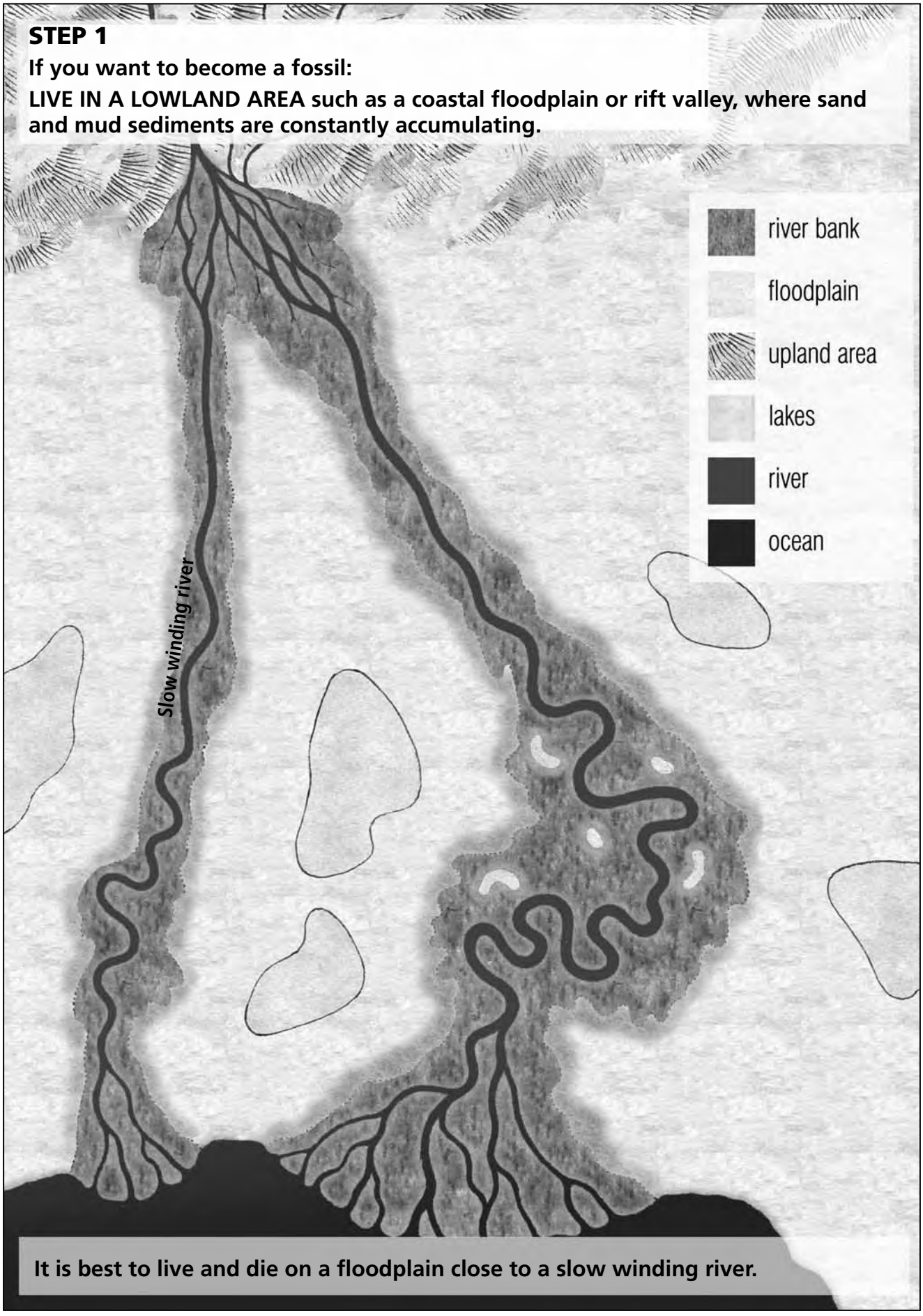
We are still finding out more and more about evolution.

Maybe in the next few years there will be more fossils and more information to help fill out the story.

New studies in genetics are also helping to fill in the picture.



The process of becoming a fossil

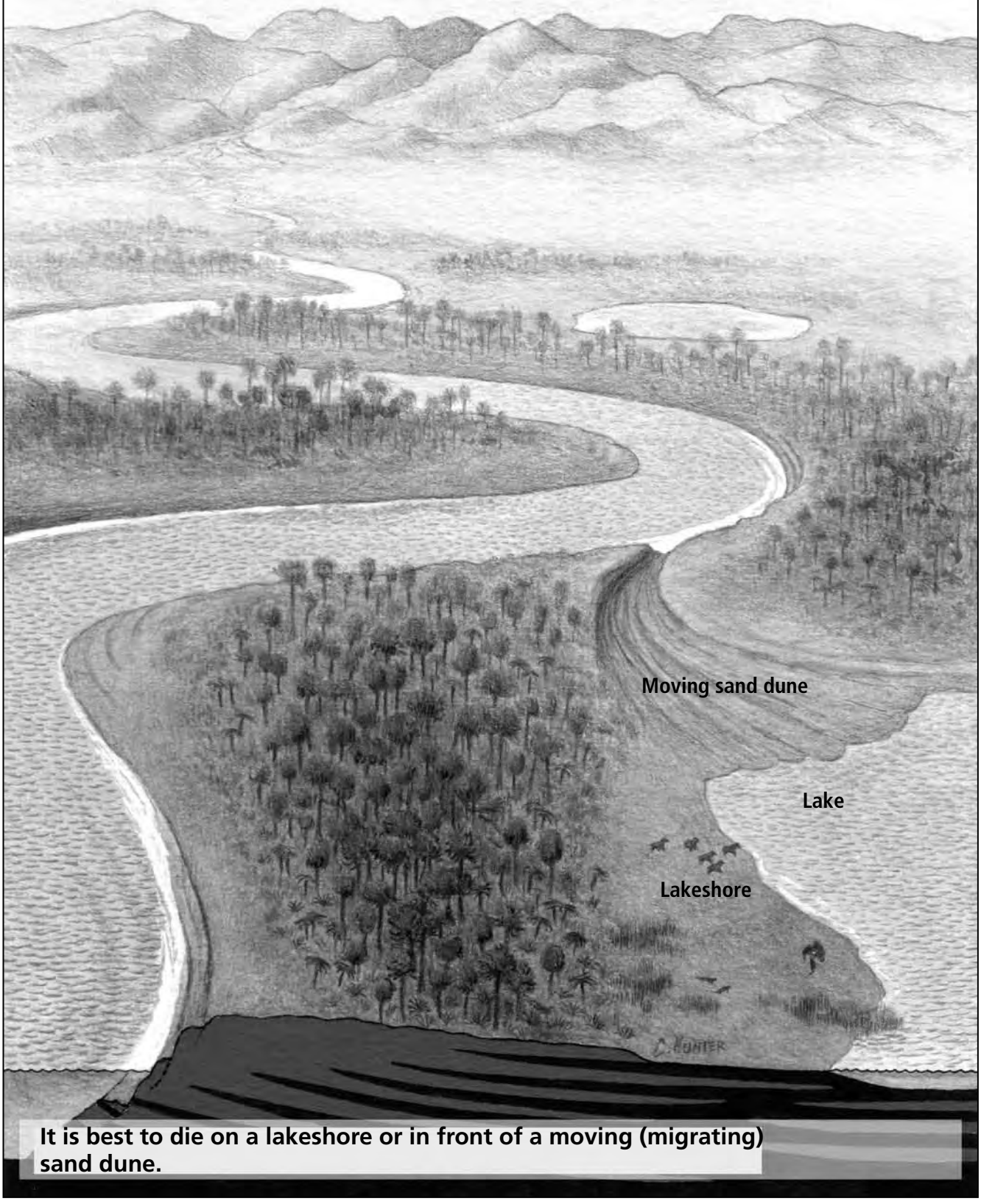


The process of becoming a fossil

STEP 2

If you want to become a fossil:

DIE IN A PLACE WHERE YOU GET BURIED by sand or mud without being swept away by strong currents.



It is best to die on a lakeshore or in front of a moving (migrating) sand dune.

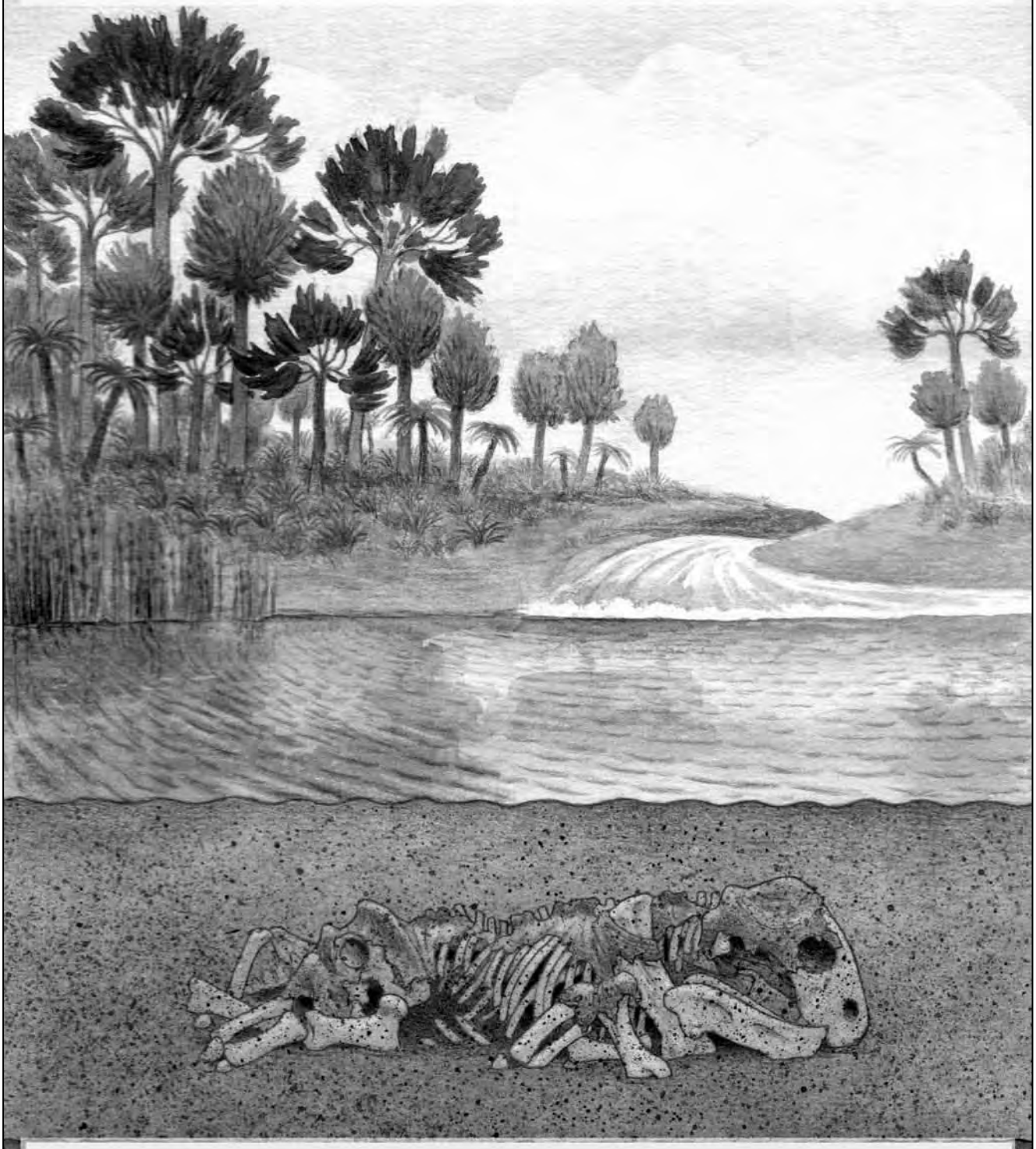

STEP 3
If you want to become a fossil:
AVOID BEING EATEN especially by a big scavenging bone-cruncher.
C. Hunter
It is best to die in an underground burrow that big scavengers can't get to.

The process of becoming a fossil

STEP 4

If you want to become a fossil:

GET BURIED QUICKLY. Silt from a flooding river, or windblown sand will cover your bones in time. Otherwise your bones will disintegrate (break up) in the sun within 5 years.



It is best to die and get buried immediately in a collapsed burrow, or by sinking into quicksand.

The process of becoming a fossil

STEP 5

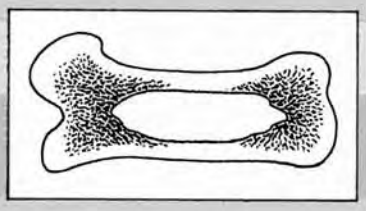
If you want to become a fossil:

YOUR BONES MUST BECOME MINERALIZED as soon as possible, preferably within 50 000 years after being buried.

Mineralization (fossilization of bones) is a very slow process that happens as the skeletons get buried deeper and deeper. Sometimes this takes as long as a million years. Most fossils go through these stages:

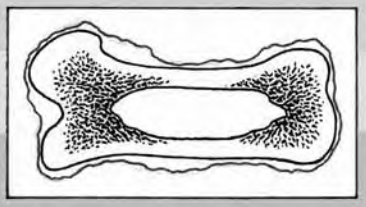
DECOMPOSITION

About 2 metres underground bacteria have rotted away all the organic matter surrounding the bone including the collagen from within the bony material itself. This leaves the bone weak and easily crushed.



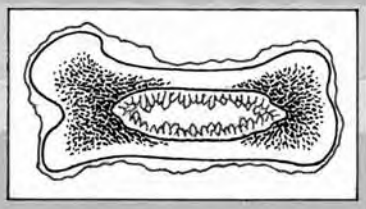
NODULE FORMATION

About 3.5 metres down dissolved minerals (calcium and iron) may come out of solution in layers around the bones to form a hard nodule. This will protect the bones from getting crushed any further.



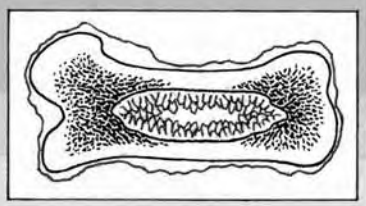
CAVITY FILLING

About 5 meters deep the ground water begins to deposit tiny crystals of silica in all the holes in the bones left when the marrow, nerves and blood vessels rotted away- this stage is known as petrification.



REPLACEMENT

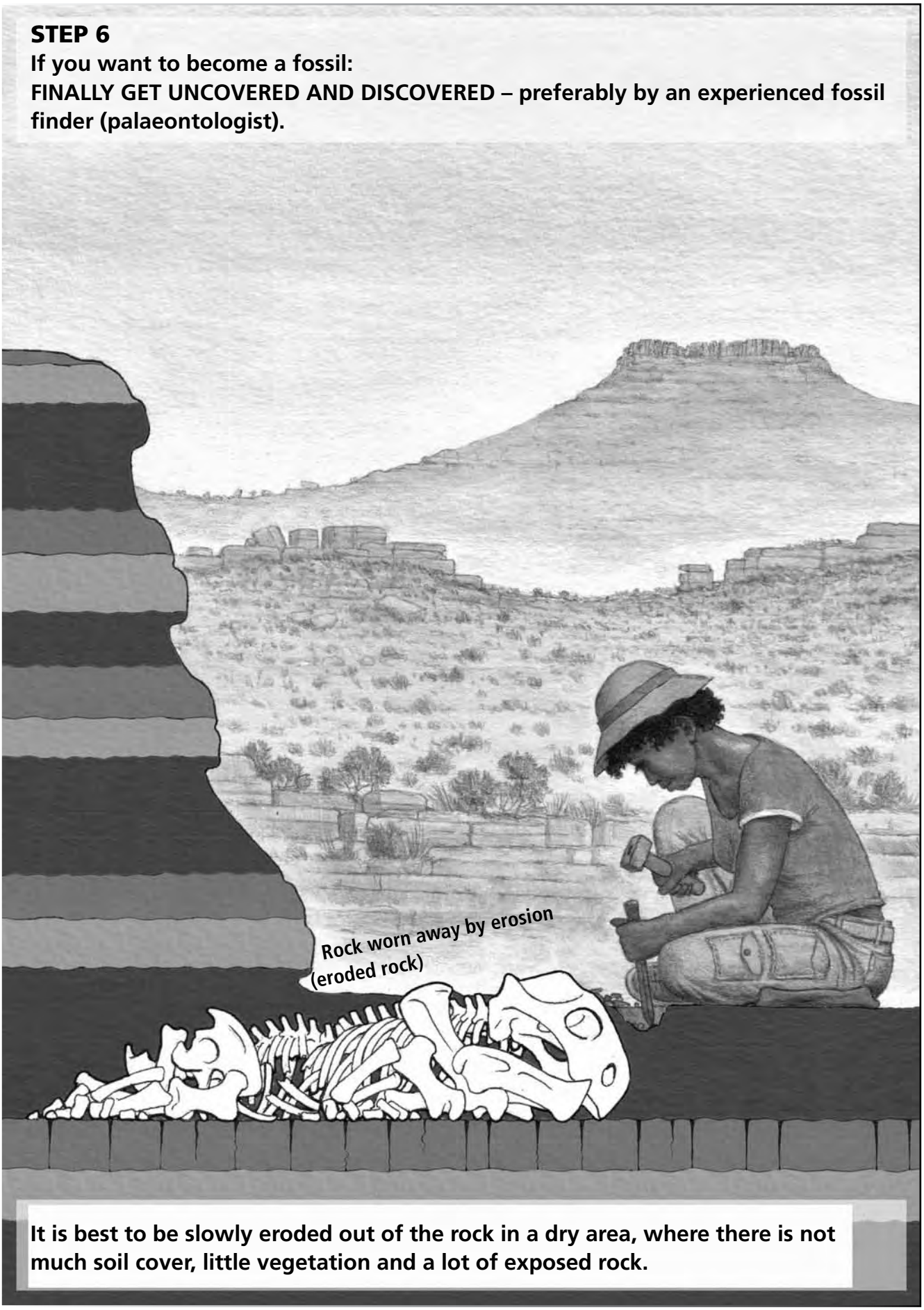
About 10 metres underground the pressure and temperature is high enough to dissolve the actual bone material itself and replace it molecule for molecule with silica dioxide. When this process is complete the bones have become fossils.



It is best to get enclosed in a hard layer of limestone in the soil. This will stop your bones from getting flattened as they get buried deeper and deeper.

The process of becoming a fossil

STEP 6
If you want to become a fossil:
FINALLY GET UNCOVERED AND DISCOVERED – preferably by an experienced fossil finder (palaeontologist).



It is best to be slowly eroded out of the rock in a dry area, where there is not much soil cover, little vegetation and a lot of exposed rock.

Glossary
Woordelys
Uluhlu lweenkcazelo

To adapt: when a species of plant or animal changes over time in response to changes in its environment.

Aanpas: wanneer 'n plant- of dierspesie oor tyd verander in reaksie op veranderinge in sy omgewing.

Ukutshintsha ngokwemeko: kuxa uhlobo lwesityalo okanye lwesilwanyana luguquka lulandela utshintsho olwenzeka kwindalo esingqongileyo.

~~~

Adaptations: the characteristics that a plant or animal has that make it very well suited to its environment, so that it can live and breed there successfully.

Aanpassings: die eienskappe van 'n plant of dier wat veroorsaak dat dit baie goed by sy omgewing aangepas is, sodat dit kan suksesvol daar kan bestaan en voortplant.

Iimpawu zokutshintsha: iimpawu esithi isityalo okanye isilwanyana sibe nazo esenza ukuba kube lula ukuba silungele nayiphi na imeko esingqongileyo, ukuze sikwazi ukuphila nokuzala okanye ukwanda ngempumelelo.

~~~

Archaeologist: a person who studies ancient cultures through the remains left behind by those cultures. The remains studied can be bones, buildings, graves, tools, jewellery and other objects usually dug up from the ground.

Argeoloog: 'n persoon wat antieke kulture bestudeer met behulp van die oorblyfsels wat deur daardie kulture agtergelaat is. Die oorblyfsels wat bestudeer word, kan gebeendere, geboue, grafte, werktuie, juweliersware en ander voorwerpe wees en word gewoonlik uit die grond opgegrawe.

Ingcali yeziphili zamandulo: umntu ofunda iinkcubeko zakudala ngokuthi aphande izinto ezasalela kwezo nkcubeko. Loo masalela ekuphandwa kuwo isenokuba amathambo zizakhiwo, amangcwaba, izixhobo, izacholo amathambo kunye nezinye izinto ezidla ngokugrunjwa emhlabeni.

Body fossils: fossils formed from the hard body parts of a plant or animal, for example, fossils of a pine cone (from a plant); bones from an animal. Body fossils are exact copies of the original body parts.

Liggaamsfossiele: fossiele gevorm uit die harde liggaamsdele van 'n plant of dier, byvoorbeeld, fossiele van 'n dennebol (van 'n plant) of die bene van 'n dier. Liggaamsfossiele is presiese weergawes van die oorspronklike liggaamsdele.

Iifosili zomzimba: iifosili ezenziwe ngokudityaniswa kwamalungu esityalo okanye esilwanyana, umzekelo, iifosili zekhowuni yepayina (ezisuka esityalweni) nezinto ezifana namathambo esilwanyana. Iifosili zomzimba zenziwa ngqo ngamalungu okwenyani omzimba owawukho kuloo ndawo mandulo.

~~~

Cradle of Humankind: the site where in 1924 the celebrated Taung Skull – a specimen of the species *Australopithecus africanus* – was found. Makapan Valley, also in the site, contains in its many archaeological caves traces of human occupation and evolution dating back some 3.3 million years. The area contains essential elements that define the origin and evolution of humanity. Fossils found there have made it possible for researchers to identify several specimens of early hominids, particularly of *Paranthropus* (a kind of hominid living alongside early humans) dating back between 4,5 million and 2.5 million years, as well as evidence of the domestication of fire 1,8 million to 1 million years ago.

The area near the Sterkfontein Caves in Gauteng, South Africa is where the oldest hominid fossils have been found; they date back to 4,5–2,5 million years ago. This fossil evidence indicates that the very first people on Earth developed in southern Africa, long before they spread out to the rest of the world.
~~~

Wieg van die Mensdom: die terrein waar die beroemde Taung-skedel – 'n voorbeeld van die spesie *Australopithecus africanus* – in 1924 gevind is. Makapanvallei, ook in die terrein, bevat in die talle argeologiese grotte spore van menslike bewoning en evolusie wat tot 3,3 miljoen jaar terugdateer. Die gebied bevat noodsaaklike elemente wat die oorsprong en evolusie van die mensdom definieer. Fossiele wat daar gevind is, het dit vir navorsers moontlik gemaak om verskeie voorbeelde van vroeë hominiede te identifiseer, spesifiek van *Paranthropus* ('n soort hominied wat terselfdertyd as vroeë mense bestaan het), wat tussen 4,5 miljoen en 2,5 miljoen jaar terugdateer, asook bewyse van die eerste gebruik van vuur 1,8 miljoen tot 1 miljoen jaar gelede. Die gebied naby die Sterkfontein-grotte in Gauteng, Suid-Afrika, is waar die oudste hominiedfossiele gevind is; dit dateer terug na 4,5 tot 2,5 miljoen jaar gelede. Hierdie fossielbewyse toon dat die heel eerste mense op aarde in Suider-Afrika ontwikkel het, lank voor hulle na die res van die wêreld versprei het.

I-Cradle of Humankind: sisiza ekwathi ngo-1924 kwabhiyozelwa ukufunyanwa koKhakhayi lwaseTaung – icuntswana lwesiphili esithile esasikho kudala i-*Australopithecus africanus* – olwalugronjwe kuso. I-Makapan Valley, ekwafumaneka kwesi siza, inemiqolomba emininzi ekukho kuyo ubungqina bokuba kukho abantu ababephila apho kudala kwiminyaka ezizigidi eziyi-3.3 eyadlulayo. Lo mmandla uqulathe izinto ezingundoqo ezinembali yemvelaphi yobukho babantu bokuqala. Iifosili ezifunyenwe apha zenze ukuba abaphandi bakwazi ukuchonga imizekelo yeenkawu ezazimile oku kwabantu ezaziphila kudala, ingakumbi i-*Paranthropus* (uhlobo lwenkawu ebumnturha eyayiphila nabantu bokuqala) eyayikho phakathi kweminyaka ezizigidi eziyi-4,5 neziyi-2,5 kwakunye nobungqina bokusetyenziswa kunye nokuqheliswa komlilo kwiminyaka ezizigidi eziyi-1,8 ukuya kwisigidi esi-1 seminyaka. Ummandla okufuphi neMiqolomba yaseSterkfontein eGauteng, eMzantsi Afrika ngummandla ekufunyenwe kuwo ezona fosili zindala zoluntu; zindala kangangeminyaka eyi-4,5 ne–2,5 yezigidi eyadlulayo. Obu bungqina beefosili bubonisa ukuba abantu bokuqala abaye baba khona apha eMhlabeni babelapha kuMazantsi eAfrika phambi kokuba bathi saa kwihlabathi lonke.

Dominant: an animal or plant which is dominant is the strongest or most successful animal or plant of that species.

Dominant: 'n dier of plant wat dominant is, is die sterkste of suksesvolste dier of plant van daardie spesie.

Elawulayo: isilwanyana okanye isityalo esilawulayo nesona someleleyo okanye esona sinempumelelo kulo ntlobo yesilwanyana okanye yesityalo.

~~~

Environment: a place with all the right conditions for plants or animals to live successfully. The plants and animals that live there are adapted to that particular environment.

Omgewing: 'n plek met al die regte toestande vir plante of diere om suksesvol te bestaan. Die plante en diere wat daar voorkom, is by daardie spesifieke omgewing aangepas.

OkusiNgqongileyo: indawo enemeko ezilungele ukuphila kwezityalo okanye kwezilwanyana ngokukuko. Izityalo nezilwanyana eziphila apho ziye zilungelane nemo yaloo ndawo izingqongileyo.

~~~

Evolution: the change of living species over time in response to changing environmental conditions through the process of natural selection.

Evolusie: die verandering van lewende dinge oor tyd heen in reaksie op veranderende omgewingstoestande deur die proses van natuulike seleksie.

Ukudaleka / i-ivolushini: kukutshintsha kwezinto eziphilayo emva kwexesha elide kakhulu ngokokuxhomekeka kutshintsho lobume bendawo ngokwenkqubo ye-ivolushini.

~~~

Extinction: the dying out of a whole species of plants or animals either locally or globally.

Uitsterwing: wanneer 'n hele plant- of dierspesie uitsterf.

Ukubhanga: ukufa nokuphela kohlobo oluthile lwesityalo okanye isilwanyana salondawo okanye kuzwelonke jikelele.

~~~

Fossil: the remains of an animal or plant which lived and died long ago, and which have become preserved inside rock. The buried remains usually take up to a million years to become mineralised into a fossil. Fossils are only found in sedimentary rocks.

Fossiel: die oorblyfsels van 'n dier of plant wat lank gelede gelewe het en dood is, en wat in klip of rots bewaar gebly het. Die oorblyfsels wat begrawe is, neem gewoonlik tot 'n miljoen jaar om in 'n fossiel gemineraliseer te word. Fossiele kom net in afsettingsgesteentes voor.

Ifosili: iintsalela zomzimba okanye amalungu ashiyekayo esilwanyana okanye isityalo esasiphila nesafa kudala agcinwe ngaphakathi elityeni. Iintsalela ezigqunyelelweyo zidla ngokuhlala iminyaka ezizigidi phambi kokuba zibe sisimbiwa esiyifosili. Iifosili zifumaneka kuphela kumatye enziwe ngentlenga.

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Fossilization: a natural process by which fossils are formed. The chemicals in a dead animal or plant body are replaced with chemicals from soil and water. This is called mineralisation. It makes the body harden like stone. It takes up to a million years for a plant or animal to become fossilized.

Fossilisering: ' n natuurlike proses waardeur fossiele gevorm word. Die chemikalieë in die liggaam van 'n dooie dier of plant word vervang met chemikalieë uit die grond en water. Dit word mineralisering genoem. Die liggaam versteen en word so hard soos klip. Dit neem 'n plant of dier tot 'n miljoen jaar om te versteen/fossileer.

Ukwenzeka kweefosili: inkqubo yendalo ezenzekelayo yokudaleka kweefosili. Le nto yenzeka ngokuthi kuphume iikhemikhali ezikwisilwanyana okanye isityalo esifileyo ze endaweni yazo kungene iikhemikhali zomhlaba nezamanzi. Le nkqubo ibizwa ngokuba kukujika kwesiphili sibe sisimbiwa. Yenza ukuba umzimba uqine ube ngathi lilitye. Kuthatha iminyaka esisigidi ukuba isityalo okanye isilwanyana sibe yifosili.

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Habitat: an area or place where a plant or animal lives naturally. A habitat can be home to many different plants or animals at the same time.

Habitat: 'n gebied of plek waar 'n plant of dier natuurlik voorkom. 'n Habitat kan tegelykertyd die tuiste van baie verskillende plante of diere wees.

Ikhaya: ummandla okanye indawo ekuhlala kuyo isityalo okanye isilwanyana. Ikhaya elo lingalikhaya kwizityalo okanye izilwanyana ezininzi ngexesha elinye.

Hominids: early human ancestors that developed long ago, and then became extinct. Modern human beings are the only hominid species that still exists.

Hominiede: vroeë menslike voorouers wat lank gelede ontwikkel het, en toe uitgesterf het. Die moderne mens is die enigste hominiedspesie wat nog bestaan.

Izandulela-bantu (hominids): abantu bokuqala ababekhona mandulo baze baphela. Abantu abakhoyo ngoku kuphela kohlobo lwesandulela-mntu olukhoyo.

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Hunter-gatherer: a person belonging to a society in which people live by hunting game and gathering plants to eat.

Jagter-versamelaar: 'n persoon wat deel is van 'n gemeenskap waarin mense bestaan deur wild te jag en plante te versamel om te eet.

Umzingeli: umntu oyinxalenye yoluntu oluphila ngokuzingela izilwanyana nokukha izityalo ukuze lutye.

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Invertebrates: all animals which do not have a backbone e.g. worms, insects, spiders etc.

Ongewerweldes: alle diere wat nie 'n ruggraat het nie bv wurms, insekte, spinnekoppe ens.

Izilwanyana ezingenamqolo: zonke izilwanyana ezinomzimba ongenathambo lomqolo umzk. Iminyiki, iintsekethe, izigcawu njl.

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Karoo: the large semi-desert area in central South Africa, which contains many fossils in its sedimentary rocks.

Karoo: die groot halfwoestyngebied in die sentrale deel van Suid-Afrika, waar die afsettingsgesteentes baie fossiele bevat.

Ikharu (Karoo): Indawo enkulu ebuntlangorha kumbindi woMzantsi Afrika, eneefosili ezininzi ezikumatye entlenga.

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Mineralisation: the process by which the chemicals in a dead animal or plant body are replaced with chemicals from the soil and water. This process leads to the dead plant or animal becoming a fossil.

Mineralisering: die proses waardeur die chemikalieë in die liggaam van 'n dooie dier of plant vervang word met chemikalieë uit die grond en water. Hierdie proses lei daartoe dat die dooie plant of dier 'n fossiel word.

Utshintsho lweekhemikhali: inkqubo yokutshintsheka kwekhemikhali ebikwisilwanyana okanye isityalo esifileyo ze endaweni yayo kungene ikhemikhali esuka emhlabeni nasemanzini. Le nkqubo iye ikhokelele ekubeni isityalo okanye isilwanyana esifileyo sibe yifosili.

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Natural selection: the process of evolution whereby those animals and plants best suited to their environment will survive and reproduce successfully. When the environment changes, different plants and animals will survive if they are well suited to the new environment. These plants and animals will pass on their survival characteristics to the next generation.

Natuurlike seleksie: die proses van ewolusie waardeur die diere en plante wat die beste by hul omgewing aangepas is, suksesvol oorleef en voortplant. Wanneer die omgewing verander, sal sekere plante en diere oorleef as hulle goed by die nuwe omgewing kan aanpas. Hierdie plante en diere dra hulle oorlewingseienskappe aan die volgende geslag oor.

Ukulungela imeko: inkqubo yokudaleka / ye-ivolushini apho izilwanyana kunye nezityalo ezikwaziyo zona ukumelana nemeko ezingqongileyo ziye zikwazi ukuphila nokwanda ngempumelelo. Xa imeko ezingqongileyo itshintsha, izilwanyana nezityalo ziya kukwazi ukuphila ukuba ngaba ziyilungele loomeko intsha. Ezo zilwanyana nezo zityalo ziye zidlulise ezo mpawu zokuphila kwisizukulwana esilandelayo.

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Palaeontology: the study of fossils and ancient environments.

Paleontologie: die studie van fossiele en antieke omgewings.

Iphaliyontoloji: isifundo sophando ngeefosili neendawo zakudala ezaziphila kuzo.

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Palaeontologist: a scientist who studies fossils and the ancient environments in which they lived.

Paleontoloog: 'n wetenskaplike wat fossiele en die antieke omgewing waarin dit voorgekom het, bestudeer.

Isazi-nzulu ngephaliyontoloji: isazi-nzulu esifunda nesiphanda ngeefosili neendawo zakudala ezaziphila kuzo.

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Primates: a group of mammal species that have highly developed brains, eyes facing forward and opposable thumbs (thumbs that can spread out sideways from the rest of the hand which allow them to grip and pick up things very delicately). They usually live in complex social groups and can adapt their behaviour to live successfully in different environments. Lemurs, monkeys, apes and humans are all primates.

Primate: 'n groep soogdierspesies wat 'n hoogs ontwikkelde brein, oë wat vorentoe kyk en opponeerbare duime het (dit is duime wat sywaarts van die res van die hand kan strek en dinge dus stewig kan vasvat en optel). Primate kom gewoonlik in komplekse sosiale groepe voor en kan hulle gedrag aanpas om suksesvol in verskillende omgewings te bestaan. Lemurs, ape en mense is almal primate.

Izilwanyana eziphezulu kwezanyisayo: iqela lohlobo lwezilwanyana ezanyisayo ezinengqondo ephuhlileyo kunezinye namehlo ajonge phambili kunye noobhontsi abavulekayo (oobhontsi abakwaziyo ukunabela emacaleni nokubhekela kweminye iminwe, nto leyo enceda ukuba ezi zilwanyana zikwazi ukuchola nokuthatha izinto). Zidla ngokuhlala ngokokuzalana kwazo yaye ziyakwazi ukutshintsha iimeko zazo ukuze zikwazi ukuhlala kwiindawo ezahlukileyo. Iilimari (lemur), iinkawu nabantu bayinxalenye yezi zilwanyana.

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Population: a group of the same species which live together in the same area and at the same time.

Bevolking: 'n groep van dieselfde spesie wat tegelykertyd saam in dieselfde gebied voorkom.

Abemi: iqela lohlobo olunye lwezinto okanye abantu abahlala kummandla omnye ngexesha elinye.

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Radioactive elements: certain substances that naturally give out high-energy particles; in the process they undergo decay and change into new substances. An example is radioactive uranium which changes to the metal called lead over hundreds of millions of years.

Radioaktiewe elemente: sekere stowwe wat natuurlik hoë-energiedeeltjies afskei; in die proses ontbind dit en verander na nuwe stowwe. 'n Voorbeeld is radioaktiewe uraan wat oor honderde miljoene jare na die metaal wat lood genoem word, verander.

Izinto ezidalwa kukuqhekeka kwe-athom: ezinye izinto ezikhupha i-eneji ephezulu; ekuhambeni kwethuba ziye zibole ze zitshintshe zibe zizinto ezintsha. Umzekelo yi-yureniyam edalwa kukuqhekeka kweathom etshintsha ibe sisinyithi esibizwa ngokuba yilothe esenzeka emva kwezigidi zeminyaka.

Sediment: particles or fragments of rock (clay, silt, sand, pebbles and cobbles) that have accumulated after being deposited by water, wind or ice movements.

Sediment (afsetting): deeltjies of fragmente van rots (klei, slik, sand, klippers en klippies) wat versamel het na dit deur die beweging van water, wind of ys daar afgeset is.

Intlenga: amasuntswana elitye (umdongwe, isanti, iingqalutye) athe ahlangana emva kokuba etyhalwe ngamanzi, umoya okanye umkhenkce.

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Sedimentary rocks: rocks formed from the accumulation of layers of rock fragments such as clay, sand, pebbles and cobbles after they have been transported by water, wind or ice. Over a long time the layers become compacted and harden to form sedimentary rock.

Afsettingsgesteentes: rotse gevorm van die versameling van lae rotsfragmente soos klei, sand, klippies en klippers nadat dit deur water, wind of ys daar afgeset is. Oor 'n lang tyd heen word die lae saamgepers en verhard dit om afsettingsgesteentes (of sedimentgesteentes) te vorm.

Amatye entlenga: amatye entlenga enzeka ngenxa yokuhlangana kwamasuntsu amatye afana nomdongwe, isanti neengqalutye emva kokutyhalwa ngamanzi umoya okanye umkhenkce. Emva kwethuba loo masuntsu ayadibana aqine enze ilitye lentlenga.

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Selective advantage: the specific inherited characteristics that a plant or animal has that allow it to survive better than other plants or animals.

Selektiewe voordeel: die spesifieke oorgeërfde eienskappe wat 'n plant of dier het wat dit beter as ander plante of diere laat oorleef.

Iimpawu zokhetheko: iimpawu esithi isityalo okanye isilwanyana esithile sizalwe nazo ezivumela ukuba sikwazi ukuphila ngcono kunezinye izityalo okanye izilwanyana.

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Species: Living things that look very similar and can successfully breed together all belong to the same species. There are many different species of plants and animals.

Spesie: Lewende dinge wat eenders lyk en suksesvol saam kan voorplant, behoort almal tot dieselfde spesie of soort. Daar is baie verskillende plant- en dierspesies.

Uhlobo: Izinto eziphilayo ezibufana nezizalisanayo nezizezohlobo olunye lwento okanye isilwanyana esithile. Zininzi iintlobo ezahlukileyo zezityalo nezilwanyana.

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Strata: the layers which can be seen in sedimentary rock.

Strata: die lae wat in afsettingsgesteentes gesien kan word.

U**camba lwamatye:** Oomaleko abaye babonakale kumatye enziwe yintlenga.

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Survive: live and reproduce successfully.

Oorleef: om suksesvol te oorleef en voort te plant.

Ukuphila/ukunyamezela: ukuphila nokuzala ngempumelelo.

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Theory: A theory is the way to explain how something works, only after careful observation of that thing. A theory is a way to explain the workings of nature, based on evidence gathered in a scientific way.

Teorie: 'n Teorie is die manier om te verduidelik hoe iets werk nadat daardie ding sorgvuldig waargeneem is. 'n Teorie is 'n manier om te verduidelik hoe die natuur werk, gebaseer op bewyse wat op 'n wetenskaplike manier versamel is.

Ithiyori: Ithiyori yindlela yokucacisa ukuba into isebenza kanjani na, emva kokuba loo nto iphononongisisiwe. Ithiyori yindlela yokucacisa indlela indalo esebenza ngayo, oko ikusekela kubungqina obuphandisiswe ngokwesayensi.

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Trace fossils: A trace fossil is the fossilized remains of anything left behind by an animal, such as a fossilized nest or egg, animal droppings, footprints, marks made by a tail dragging on the ground etc. These provide evidence of animal movements and behaviour in a particular area.

Spoorfossiele: 'n Spoorfossiel is die versteende oorblyfsels van enigiets wat deur 'n dier agtergelaat is, soos 'n versteende nes of eier, mis, spore, merke gemaak deur 'n stert wat op die grond sleep, ens. Dit verskaf bewyse van diere se bewegings en gedrag in 'n spesifieke gebied.

Iintsalela zeefosili: Ifosili eyintsalela yifosili yayo nantoni na eshiywe sisilwanyana, umzekelo indlwane okanye iqanda eliyifosili, ubulongwe bezilwanyana, iinyawo zendawo ebekuhanjwa kuyo, umzila oshiywa kukurhuqwa komsila emhlabeni, njl njl. Ezi zinto zibonelela ngobungqina beentshukumo zezilwanyana neendlela ezaziziphethe ngayo kummandla othile.

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Variations: small inherited differences between individuals of the same species, for example eye colour and the different A, B, O blood types in humans.

Variasies: klein oorgeërfde verskille tussen individue van dieselfde spesie, byvoorbeeld oogkleur en die verskillende A-, B- en O-bloedgroep in mense.

Ukungafani: Ukwahluka kwendalo okuncinci pha naphaya phakathi kwabantu bohlobo olunye, umzekelo, ukwahluka kombala wamehlo kunye neentlobo zamagazi u-A, B, O ezahlukileyo kubantu.

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Vertebrates: classes of animals that have an internal skeleton with a backbone – fishes, frogs, reptiles, birds and mammals.

Gewerweldes: klasse van diere wat 'n interne skelet (geraamte) met 'n ruggraat het – visse, paddas, reptiele, voëls en soogdiere.

Izilwanyana ezinemiqolo: iintlobo zezilwanyana ezinophahla lomzimba lwangaphakathi olunethambo lomqolo – iintlanzi, amasele, izirhubuluzi, iintaka kunye nezidalwa ezincancisayo.

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World Heritage Site: A World Heritage Site is a place of outstanding cultural or natural importance to the common heritage of humanity. The United Nations Organisation helps countries to decide which places are World Heritage Sites.

Wêrelderfenisgebied: 'n plek van besondere kulturele of natuurlike waarde vir die gemeenskaplike erfenis van die mensdom. Die Verenigde Nasies help lande om te besluit watter plekke wêrelderfenisgebiede is.

Indawo eliLifa leMveli leHlabathi: Indawo eliLifa leMveli leHlabathi yindawo enkcubeko yayo okanye endalo yayo ibaluleke kulo lonke uluntu lwehlabathi. Umbutho i-United Nations Organisation uncedisa amazwe ukuba athathe izigqibo zokuba zeziphi indawo ezifanelwe liwonga lokuhlonitshwa liHlabathi ngeMveli yazo.
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