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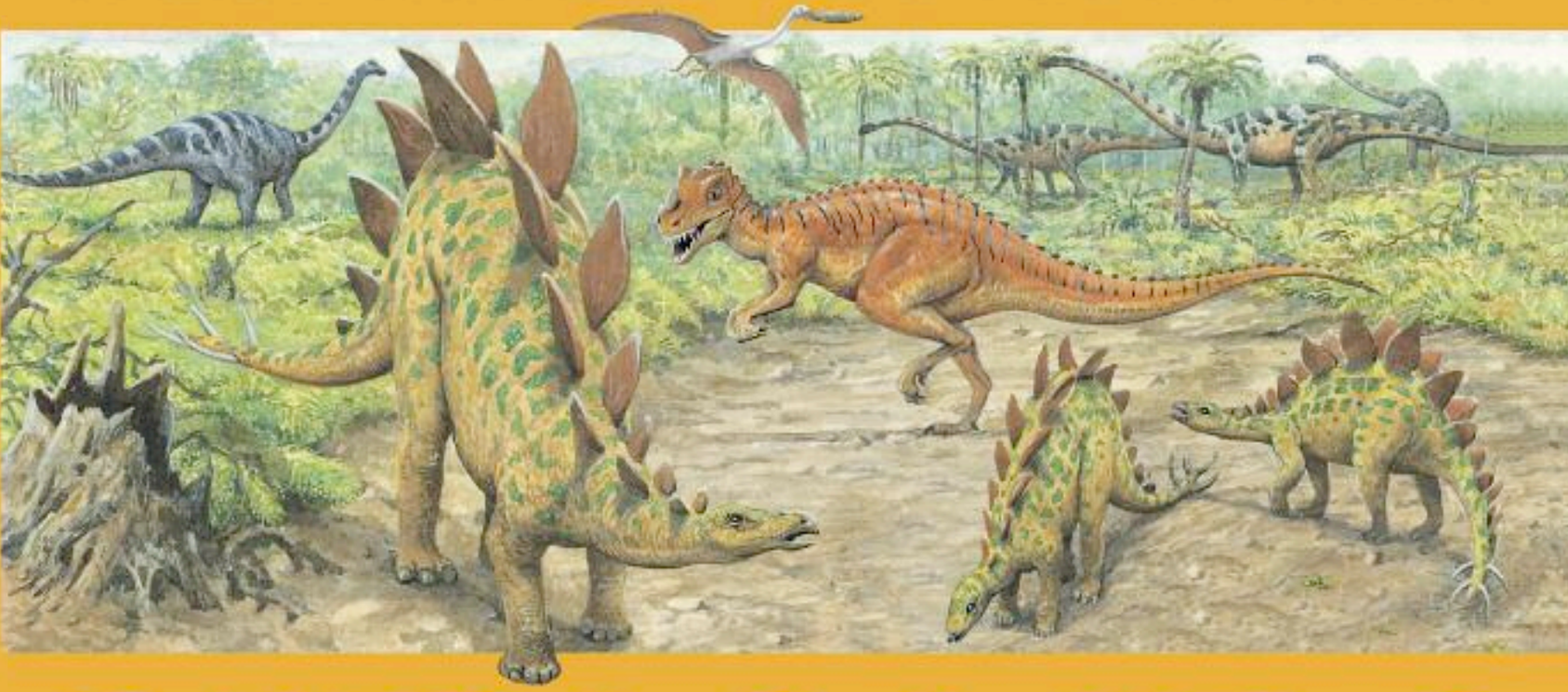
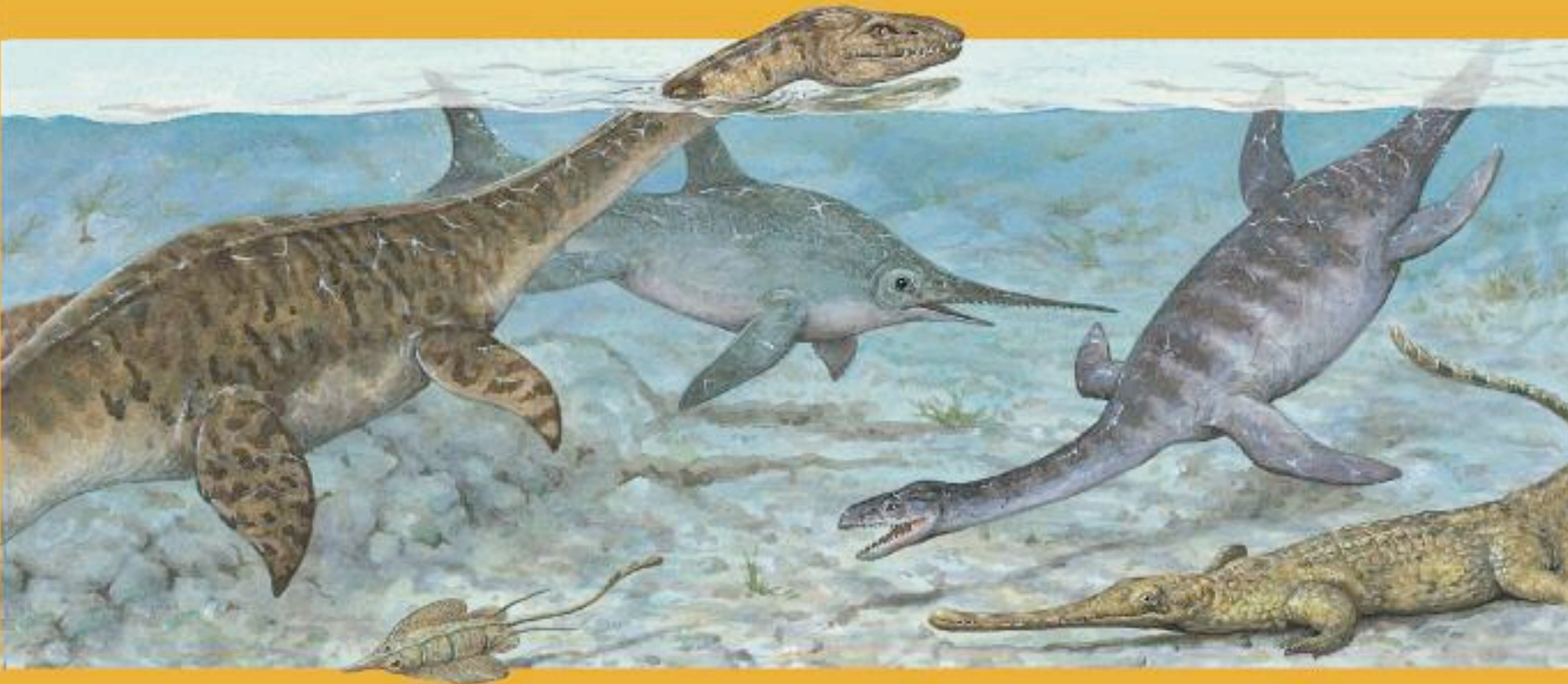


DINOSAURS

AND PREHISTORIC LIFE



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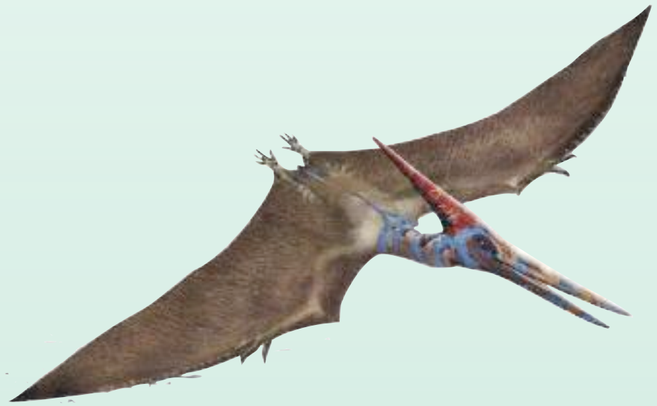

First published in 2012 by Orpheus Books Ltd.,
6 Church Green, Witney, Oxfordshire, OX28 4AW, England
www.orpheusbooks.com

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ISBN 978 1 7418 3761 9

Printed and bound in Singapore

ILLUSTRATED ENCYCLOPEDIA

DINOSAURS
AND PREHISTORIC LIFE

Orpheus

Contents

About this book

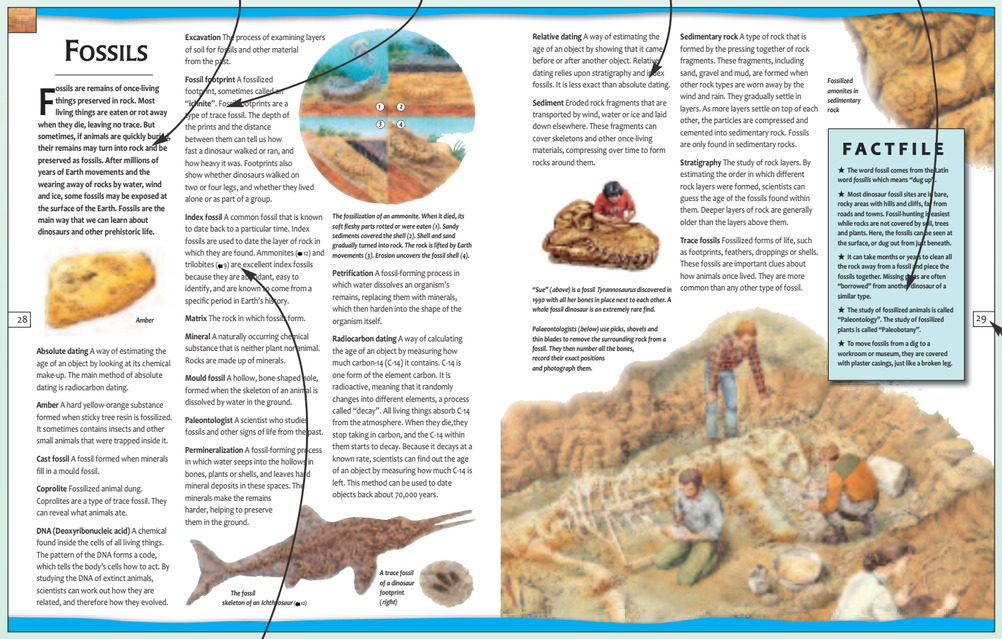
Each double page contains a brief introduction, explaining the general subject, followed by key words arranged in alphabetical order. To look up a specific word, turn to the index at the back of this book: this will tell you which page to go to. If you want to learn more about a subject, take a look at the factfile, or follow the arrows to read related entries.

INTRODUCTION
This explains the general subject and provides some basic knowledge.

BOLD WORDS
These highlight useful words that do not have their own entry.

KEY WORDS AND ENTRIES
Key words are arranged alphabetically across each double page. Each entry provides a short explanation of what the key word means.

FACTFILE
The factfile provides extra information on the subject. Facts are presented in easy to read bullet points.



ARROWS
These arrows show you where to look up other words mentioned in the entry. For example, (➡26) tells you to go forward to page 26 and (⬅6) tells you to turn back to page 6.

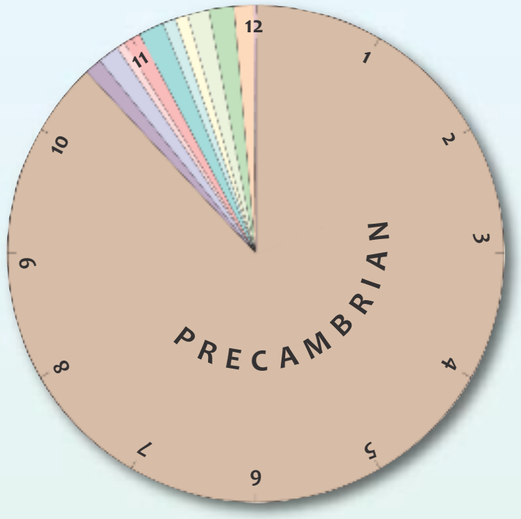
PAGE NUMBER
Page numbers are easy to find at the side of the page.

Geological time

The Earth is 4500 million years old. Events in the Earth's history are measured in what is called geological time. A "recent" event in geological time, for example, may have happened in the last million years. Geologists divide time into three eons: the Archaean ("ancient"), from the origin of the Earth to about 2500 million years ago (Ma); the Proterozoic ("first life") to 542 Ma; and the Phanerozoic ("visible life") to the present. The Archaean and Proterozoic are often referred to together as the Precambrian. The Phanerozoic is subdivided into eras: the Palaeozoic (542-251 Ma), the Mesozoic (251-65 Ma) and the Cenozoic (65 Ma to present). The eras are split into periods, shown on the right hand page. The Tertiary and Quaternary periods are themselves divided into epochs.

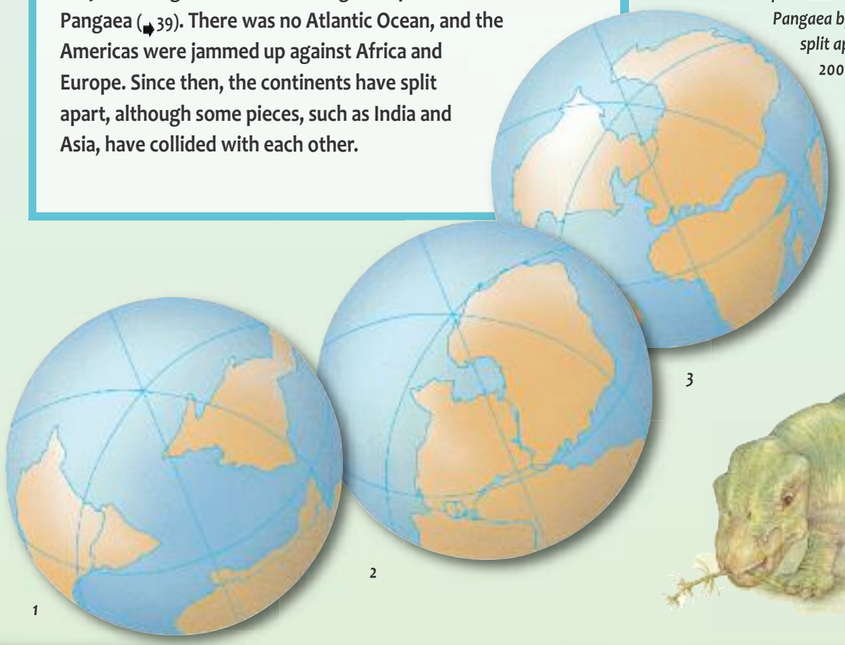
DRIFTING CONTINENTS

The outer shell of the Earth is divided up into large slabs, called tectonic plates. These plates, which include both the continents and the floors of the oceans, move slowly: at an average rate of about 2.5 cm a year. Over geological time, entire continents have wandered around the globe, colliding into one another, drifting apart or sliding past one another. About 200 million years ago, they came together to form a single "supercontinent" called Pangaea (➡39). There was no Atlantic Ocean, and the Americas were jammed up against Africa and Europe. Since then, the continents have split apart, although some pieces, such as India and Asia, have collided with each other.



A way to understand geological time is to imagine 4500 million years of Earth's history taking place in just 12 hours. The Precambrian would take up the first 10 ½ hours. From the Cambrian "explosion" of life, to the present day would take up 90 minutes. The dinosaurs became extinct only nine minutes ago. The entire history of humankind would make up the very last second.

These three globes show the movement of the continents over geological time. Still widely separated 4000 million years ago (1), they had collided to form Pangaea by 250 million years ago (2). They began to split apart during the Age of Dinosaurs, about 200 million years ago (3).



We know that continental drift took place because fossils of Lystrosaurus *(below), a Triassic reptile, have been found in lands as far apart as Africa, India and Antarctica. This proves that these continents were once joined together and have since drifted apart.*

			started (Ma)	
Cenozoic	Quaternary	Holocene	0.0117	★ The first human-like animals appear ★ Several ice ages (➡24) grip the world, interupted by warmer periods, or interglacials
		Pleistocene	2.58	
	Tertiary	Pliocene	5.32	★ Mammals replace reptiles as the dominant land-animals ★ The continents drift to approximately their present positions. Mammals evolve separately on their own island continents, for example marsupials develop in Australia. ★ Modern families of flowering plants develop ★ Vast areas of grassland open up, which leads to the evolution of horses and antelopes
		Miocene	23.03	
		Oligocene	34	
		Eocene	56	
		Palaeocene	65.5	
Mesozoic	Cretaceous	Late Cretaceous	89.3	★ The dinosaurs become extinct at the end of the Cretaceous in the K-T extinction (➡13) ★ The first grasses and flowering plants appear ★ The sauropods (➡16) die out ★ The hadrosaurs (➡18) first appear
		Middle Cretaceous	130	
		Early Cretaceous	146	
	Jurassic	Late Jurassic	161	★ Pangaea begins to split in two ★ Plants, especially conifers, become abundant ★ Sauropods (➡16) grow even larger, and theropods (➡14) become more powerful hunters ★ The first ornithischian (➡18) dinosaurs appear
		Middle Jurassic	176	
		Early Jurassic	200	
	Triassic	Late Triassic	228	★ The first dinosaurs and pterosaurs (➡20) appear ★ The first large marine reptiles appear(➡22) ★ The first mammals appear ★ Ferns dominate Triassic plant life ★ The first turtles appear
		Middle Triassic	245	
		Early Triassic	251	
Palaeozoic	Permian		299	★ The continent of Pangaea forms ★ Reptiles dominate the land ★ The first archosaurs (➡10) appear
	Carboniferous	Pennsylvanian	318	★ The first reptiles appear (➡10) ★ Hot, steamy coal swamps (➡10) of mosses and ferns cover parts of the Earth
		Mississippian	359	
	Devonian		416	★ The first amphibians appear (➡10) ★ The first lobefin fish appear (➡9) ★ The first insects appear
	Silurian		443	★ The first plants with stems and roots appear ★ The first fish with jaws appear ★ Warm, shallow seas cover much of the Earth
	Ordovician		488	★ The first land plants evolve ★ The first coral reefs form ★ Sea levels were high
	Cambrian		542	★ An "explosion" of life takes place (➡8) ★ The first shellfish evlove ★ The first jawless fishes appear
Precambrian	Proterozoic		2500	★ The first known animals develop
	Archaean		4000	★ The earliest life-forms appear: bacteria
	Hadean		4500	★ The formation of the Earth

First life

The first life on Earth appeared not on land but in the oceans. Life on the land was still not possible because there was not enough oxygen in the atmosphere, and lethal ultraviolet radiation was still at dangerous levels. Neither factor affected life underwater. The first living things probably developed about 3800 million years ago. The very earliest life-forms were simple, single-cell organisms. More complex life-forms did not evolve until 580 million years ago.

Anomalocaris The largest and fiercest of all the known Cambrian creatures. It was 60 cm long, with a wide cloak-like body, two large eyes set on stalks and a pair of pincer-like arms.

Arandaspis One of the earliest fish. It had no jaws, but fed by sucking in scraps of other dead animals floating in the water. It first appeared in the Cambrian period and dominated the seas for 130 million years.

Trilobite

Burgess Shale A layer of rocks in the Rocky Mountains in Canada that is rich in fossils from the Cambrian period. It is named after the nearby Mt. Burgess.

Cambrian period The period of Earth's history from 530 to 505 million years ago. A great "explosion" of life took place at the beginning of this period. The first animals with hard parts began to appear.

The animals of the Burgess Shale (above)

Cyanobacteria A type of bacteria, dating back about 2800 million years. It is one of the earliest life-forms for which we have fossil evidence. Like plants, cynobacteria make energy from the Sun through the process of photosynthesis. The spread of cynobacteria probably increased the amount of oxygen in the early atmosphere.

Devonian period The period of Earth's history from 416 to 359 million years ago. During this period the first amphibians appeared (➧10) and fish were abundant. Two distinct types of fish emerged: those with skeletons made of soft cartilage (like sharks), and those that had bony skeletons.

Dunkleosteus A huge fish from the Late Devonian period. It was more than nine metres long and, instead of teeth, its jaws were lined with massive plates of bone that sliced through its prey like guillotine blades. It was a member of the **placoderms**, a family of armoured, jawed fish.

Ediacaran fauna A group of simple, worm-like and jellyfish-like life-forms from the Ediacaran period, a part of the Precambrian that lasted from 645 to 542 million years ago. It is named after the Ediacara Hills in South Australia, where many fossils from this time have been found.

Eusthenopteron A long, slender lobefin from the Devonian period. It could spend some time out of the water, "crawling" on its fins in pursuit of insects and spiders. These fish may have been ancestors of the amphibians (➧10).

Eurypterid A large scorpion-like marine creature from the Ordovician period. It was about two metres long.

Evolution The process by which life-forms change over millions of years, gradually adapting to make the best use of their environment.

Plants from the Late Silurian period

Hallucigenia A marine life-form from the Cambrian period. It moved about on the seabed on seven pairs of stilts and had a row of defensive spines on its back to protect itself from predators.

Lobefins A species of bony fish with fleshy lobes at the base of their fins. The lobes contain jointed bones, which may have evolved into legs when fish evolved to move out of the water and on to the land.

Opabinia A marine creature from the Cambrian period. It had five mushroom-like eyes and a long clasping "nozzle", which it used to catch its prey.

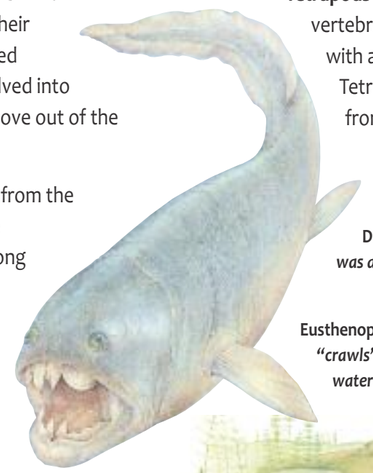
Ordovician period The period of Earth's history from 488 to 443 million years ago. During this period, the first plants began to appear on land, and the first fish began to adapt and become more complex.

Pikaia A small, worm-like marine creature from the Cambrian period. It had a stiffening rod running the length of its body, a little like a backbone. It also had muscles arranged in V-shaped segments, similar to modern fish. It may have been an early ancestor of the vertebrates (animals with backbones).

Precambrian The span of time from the beginning of the Earth to 530 million years ago. It makes up about seven-eighths of the Earth's history.

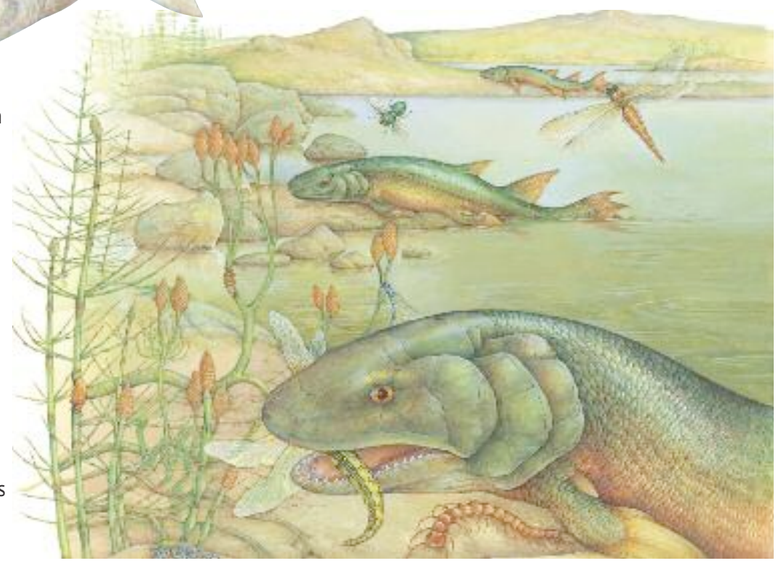
Silurian period The period of Earth's history from 443 to 416 million years ago. During this period, the first jawed fish appeared, and plants with roots and stems began to grow on land.

Tetrapods Four-legged vertebrates (animals with a backbone). Tetrapods evolved from lobefins during the Devonian period.



Dunkleosteus (left) was a fierce predator.

Eusthenopteron (below) "crawls" out of the water on its fins.



FACTFILE

★ No one knows how life began, but scientists think that shallow, warm water pools at the edges of the first oceans would have been the ideal environment for the formation of chemicals that would eventually become the building blocks of life.

★ There were more than 17,000 different species of trilobite—more than any other known extinct creature.

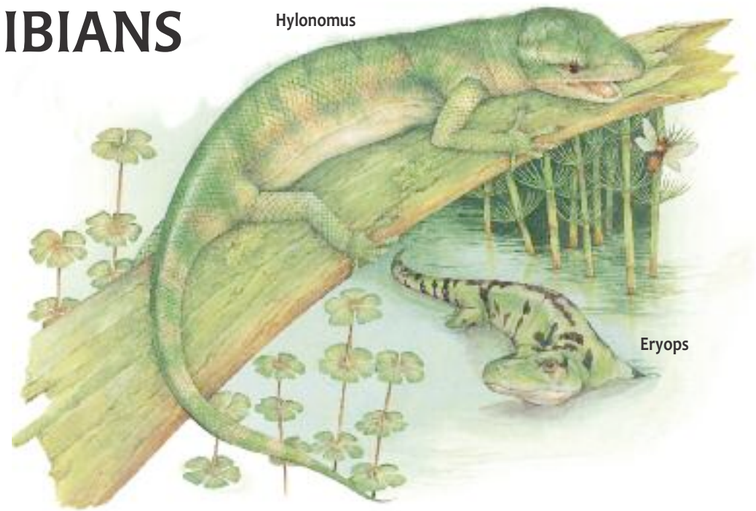
★ The Cambrian period ended with a mass extinction that wiped out many species. It may have been brought about by a severe drop in temperature.

★ The first land animals were giant millipedes. They lived around 442 million years ago.

Trilobites Marine creatures with a hard, jointed shield divided into three lengthwise parts. They first appeared in the Cambrian period and thrived for the 250 million years. Their legs allowed them to scuttle along the seabed, or to paddle through the water and could also carry food to their mouths.

Wiwaxia A marine creature with two rows of dagger-like blades on its back that may have served to ward off predators.

Early amphibians & reptiles



By 375 million years ago, amphibians, the first four-legged animals, had developed. Their limbs had evolved from the strong fins of certain fish. But amphibians had to keep their skin moist, and go back to water to lay their eggs (as they do today). About 315 million years ago, another new group of creatures appeared. They had scaly skin and could reproduce on land, avoiding the need to return to the water. They were the first reptiles.

Amniotes A group of animals whose young develop within a protective liquid casing called the amnion. The first amniotes developed in the Cambrian. Their eggs could survive out of the water, meaning they could permanently live on the land.

Anapsid reptiles A group of reptiles from the Permian period. Unlike other reptiles, they did not have openings behind the eye socket on the side of their skulls. This group gave rise to the diapsid reptiles.

Anthracosaurs An early group of amphibians from the Carboniferous and Permian periods. They had large, barrel-shaped bodies and spent most of their time on the land.

Archosaurs A group of reptiles that evolved in the Permian period. They were diapsid reptiles with powerful jaws, bony armour and a low, sprawling gait. They later gave rise to the dinosaurs.

Carboniferous period The period of Earth's history from 359 to 299 million years ago. The first reptiles emerged during the this period.

Coal swamp Swamps of ferns, horsetails and moses that covered parts of the Earth in the Carboniferous period. When the plants died, their remains sank to the bottom of the swamp and turned to peat, a dark, dense soil. Over millions of years, the peat was compressed and solidified to form the rock we know as coal.

Diapsid reptiles A group of reptiles that have two openings behind the eye socket on the side of their skulls. This group gave rise not only to the dinosaurs, but also to modern crocodiles, lizards and snakes.

Eryops A two-metre-long amphibian from the Carboniferous period. It had a flat skull, large eyes and nostrils on the top of its head. It may have hunted like a modern crocodile, lurking submerged in the water.

Euparkeria A small reptile from the Early Triassic. It was one of the first reptiles able to walk on two legs for short bursts.

Horsetail A type of large, fern-like plant, that dominated the coal swamps.

Hylonomus A small, lizard-like reptile from the Carboniferous period. It was one of the very first reptiles. It was only 20 cm long. Its name means "forest mouse".

A group of Eryops *relax by the water. The giant dragonfly* Meganeuropsis *hunts for food.*

Ichthyostega An amphibian from the Devonian period with a fish-like head and tail. It may have sometimes ventured on to land, but spent most of its time in the water. It had fingers and toes, but its limbs were not well adapted for walking.

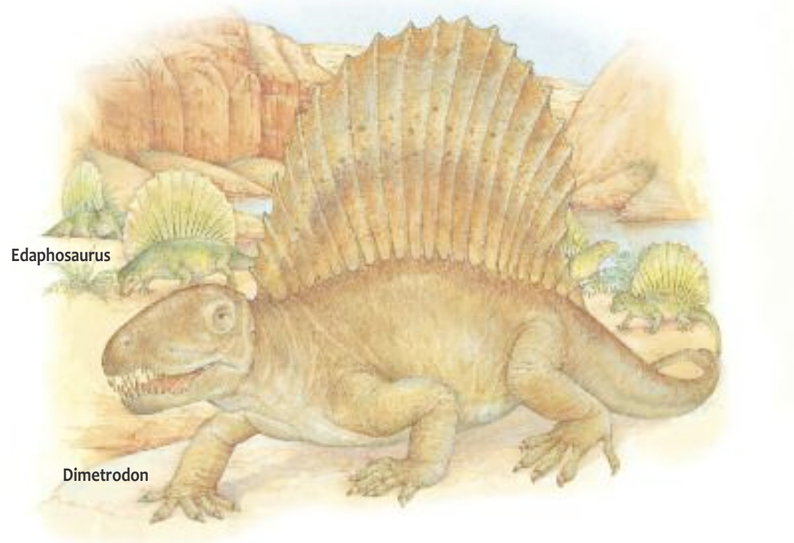
Labyrinthodonts A family of extinct amphibians. Their name means "maze-toothed", referring to the complex layers of enamel on their teeth. They include ichthyostegalia, temnospondyls, anthracosaurs and lepospondyls.

Lepospondyls A group of small, slim amphibians from the Carboniferous and Permian periods. The snake-like *Ophiderpeton* and *Phlegethontia* and the newt-like *Diplocaulus* and *Keratopeton* were all lepospondyls.

Meganeuropsis A giant dragonfly with a wingspan of up to 75 cm. It was the largest known insect that ever lived.

Pangaea A huge "supercontinent" made up of all the Earth's landmasses. It formed in the Permian period when all of the Earth's continents drifted together.

Pelycosaurs A group of large reptiles from the Early Permian period. Some, such as *Dimetrodon*, had large sails on their backs. The sails were made of skin and supported by thin spines sticking up from the backbone. They may have helped the reptiles to heat up and cool down. *Dimetrodon* was a two-metre-long carnivore, feeding on large insects and other pelycosaurs. Its relative, the three-metre-long *Edaphosaurus*, also had a sail but only ate plants.



Permian period The period of Earth's history from 299 to 251 million years ago. During this period, the climate was very dry. Reptiles began to outcompete amphibians as their habitats dried out.

Scutosaurus A large armoured reptile from the Permian period. It was a three-metre-long plant-eater, covered with bony spikes and horns to protect it from predators.

Synapsid reptiles A group of reptiles with one opening behind the eye socket on each side of their skulls. They dominated the Permian landscape. The earliest kinds to evolve were pelycosaurs, such as *Dimetrodon* and *Edaphosaurus*.

Temnospondyls A group of amphibians from that first appeared in the Devonian period. They ranged from 15 cm creatures to 10 m long armoured amphibians. They all had four toes on their fore-feet and five on their hind-feet.

Therapsids A group of synapsid reptiles from the Permian period. They were distinguished by their powerful jaws and large canine teeth. They included the five-metre-long *Moschops*, a lumbering plant-eater. They gave rise to the mammals.

FACTFILE

★ Giant insects flourished in the hot, damp forests of the Carboniferous period. There were dragonflies with wingspans equal to those of seagulls and centipedes that grew up to two metres long.

★ Sharks were the dominant predators in the Carboniferous seas.

★ The Permian period was so dry because much of the Earth's water was "locked up" in huge ice caps at the South pole.

★ At the end of the Permian period, a vast number of animals were wiped out by the biggest mass extinction ever, referred to as the "Great Dying". Scientists are unsure why it occurred, although the extreme hot and dry climatic conditions across the globe may have been responsible. It is thought that 70% of all land animals and plants, and up to 95% of all marine life-forms were wiped out.

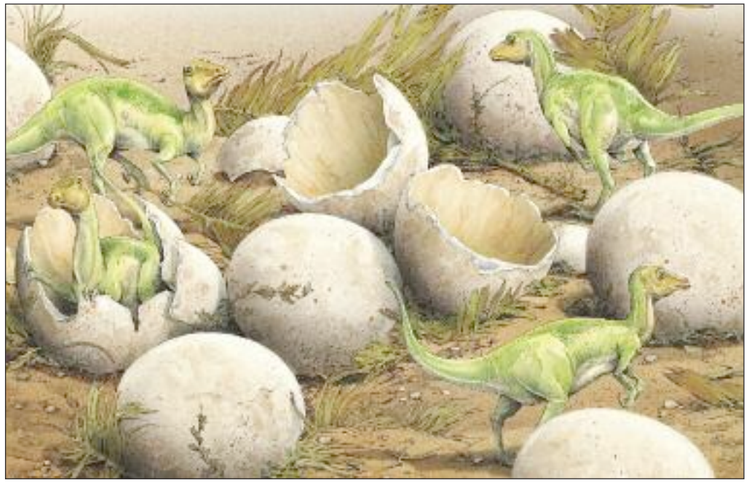
The Age of Dinosaurs

The dinosaurs were a group of reptiles that lived on the land during the Mesozoic era (250-65 million years ago). Unlike other reptiles, they walked upright on legs held beneath their bodies. The word dinosaur means "terrible lizard". It refers to the terrifying appearance of the first dinosaur finds, which were very large, but in fact dinosaurs came in all shapes and sizes. The dinosaurs spread out across the world and ruled the land for 160 million years until 65 million years ago, when they suddenly died out.

Bipedal Walking on two legs only. Some types of dinosaur were bipedal. Others could only walk on two legs for short periods of time, perhaps to reach treetops or to run away. Bipedal dinosaurs were generally much faster than their quadrupedal relatives.

Carnivores Meat-eating animals. All carnivorous dinosaurs were theropods.

Cretaceous period The period of Earth's history from 145 to 65 million years ago. During this time, much of the Earth was covered by shallow seas and temperatures were very warm. Flowering plants, which had evolved during the Jurassic, replaced more ancient plants, and grasses appeared.



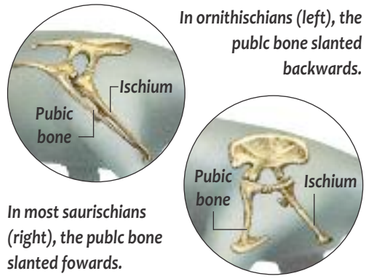
Like most reptiles today, female dinosaurs laid eggs. Some species made nests for their young.

Extinction The dying out of a species.

Gondwanaland A huge southern continent. It was once part of the "supercontinent" Pangaea, but drifted away during the Jurassic period. It included the modern continents of Australia, Africa, southern Europe, Antarctica and South America.

Herbivores Plant-eating animals. The sauropodomorphs and ornithischians were all herbivores.

Iridium A metal that is believed to be present only in the core of the Earth and in asteroids (rocky objects from space). A layer of iridium discovered by scientists is used as evidence that the K-T extinction was brought about by an asteroid impact.

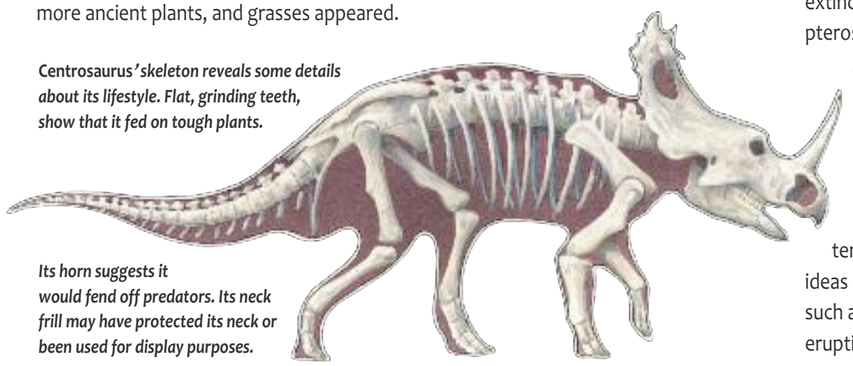


In ornithischians (left), the pubic bone slanted backwards.

In most saurischians (right), the pubic bone slanted fowards.

Jurassic period The period of Earth's history from 200 to 145 million years ago. During the Jurassic period, the climate became wetter. Plants became abundant and dinosaurs began to grow much larger.

K-T extinction The mass extinction that took place 65 million years ago, between the Cretaceous and Tertiary periods. (The letter K stands for the German word *Kreidezeit*, meaning "Cretaceous".) The extinction wiped out all dinosaurs, pterosaurs and marine reptiles. Most scientists now agree that the extinction was caused by the impact from an asteroid (a rocky object from space). The atmosphere would have been filled with dust, blotting out the Sun and lowering temperatures for many years. Other ideas have been suggested over the years, such as the theory that a massive volcanic eruption could have caused the extinction.



Centrosaurus' skeleton reveals some details about its lifestyle. Flat, grinding teeth, show that it fed on tough plants.

Its horn suggests it would fend off predators. Its neck frill may have protected its neck or been used for display purposes.

Laurasia A huge northern continent. It was once part of the "supercontinent" Pangaea, but broke away during the Jurassic period. It included the modern continents of Asia, North America and Europe.

Mesozoic era The span of time in Earth's history from 248 to 65 million years ago. It is divided into the Triassic, Jurassic and Cretaceous periods. During the Mesozoic era, dinosaurs ruled the land. For this reason, it is sometimes known as the "Age of Dinosaurs".

Ornithischians The "bird-hipped" dinosaurs, one of two major types of dinosaur (the other were the saurischians). Ornithischians had backward-slanting pubic bones—the lower part of the hip bone.

Dinosaur skin (above) was similar to that of modern reptiles. Their scales did not overlap, but were separated from one another by thin areas of skin.

Two possible causes of the K-T extinction: an asteroid smashes into Earth (top) and a massive volcano erupts (bottom).

Quadrupedal Walking on four legs. Most quadrupedal dinosaurs were large animals that needed all four legs to support the weight of their bodies. They were slower than their bipedal relatives, and had to rely on tough hides and sheer size as defence against meat-eating predators. Some species also developed protective body armour.

Saurischians The "lizard-hipped" dinosaurs, one of two major types of dinosaur (the others were the ornithischians). They had forward-jutting pubic bones—the lower part of the hip bone. Saurischians included the theropods and the sauropodomorphs.

FACTFILE

★ There were dinosaurs of almost every size, from tiny hunters no larger than a pet cat to giants that were the biggest creatures ever to set foot on Earth.

★ Some dinosaurs nested in huge colonies, like gannets and other birds do today, probably for protection against predators.

★ Dinosaurs were the only reptiles ever to walk with their legs directly beneath them. Modern lizards, such as the Komodo dragon *(below)*, walk with a sprawling gait. The bone structure of a dinosaur's limbs was more like that of a mammal's. It allowed dinosaurs, such as *Compsognathus (right)* to walk and run more efficiently.

Compsognathus

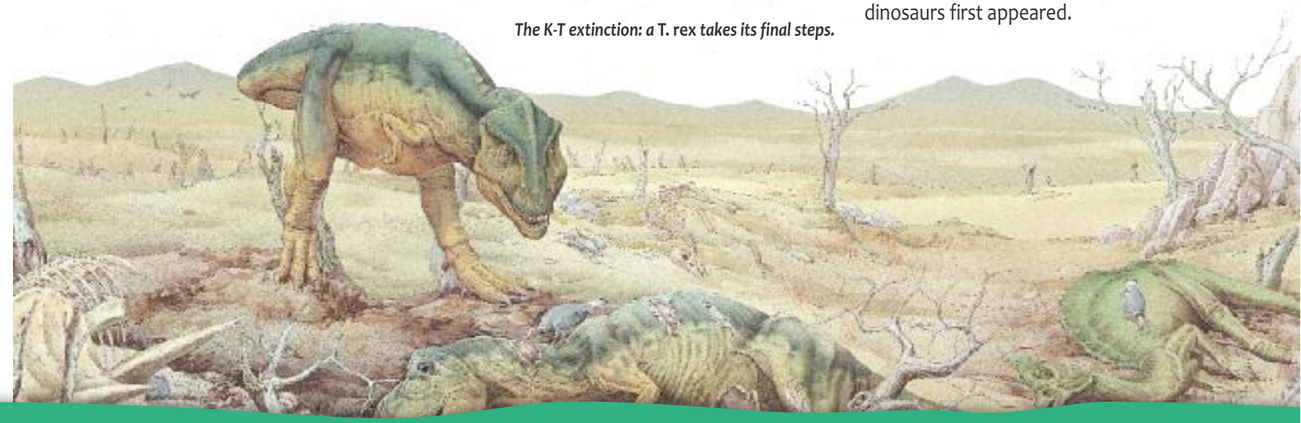
★ As well as the K-T extinction, there were large extinctions at the end of the Triassic and Jurassic periods.

Komodo dragon

Sauropodomorphs A group of large, plant-eating saurischian dinosaurs. They had very long necks and tails. This group includes the prosauropods and the sauropods.

Theropods A group of mostly meat-eating dinosaurs. They all had three toes.

Triassic period The period of Earth's history from 248 to 200 million years ago. This is the period when the dinosaurs first appeared.



The K-T extinction: a T. rex takes its final steps.

THEROPODS

Theropods were a group of mostly meat-eating saurischian (13) or "lizard hipped" dinosaurs. They all had three toes and their name means "beast-footed". Theropods were the first kind of dinosaur to evolve. They had large eyes and long tails.They ran on their two strong back legs, leaving their arms free to grasp or pin down their prey. They ranged in size from tiny *Compsognathus*, the size of a chicken, to 18 m long *Spinosaurus*. Most experts believe that birds evolved from theropods during the Jurassic period.

Allosaurus A large meat-eating dinosaur from the Late Jurassic. It grew up to 12 m long. It had sharp teeth and three big, clawed toes on each foot. It probably hunted in packs to bring down large prey.

Archaeopteryx A bird-dinosaur from the Jurassic period. It is the earliest known bird. Like birds, it had feathers, wings and a small, light body. However, it had much more in common with theropods. Like them, it had strong jaws and sharp teeth, a long neck and stiff tail and three clawed fingers. It fed on meat, fish and insects.

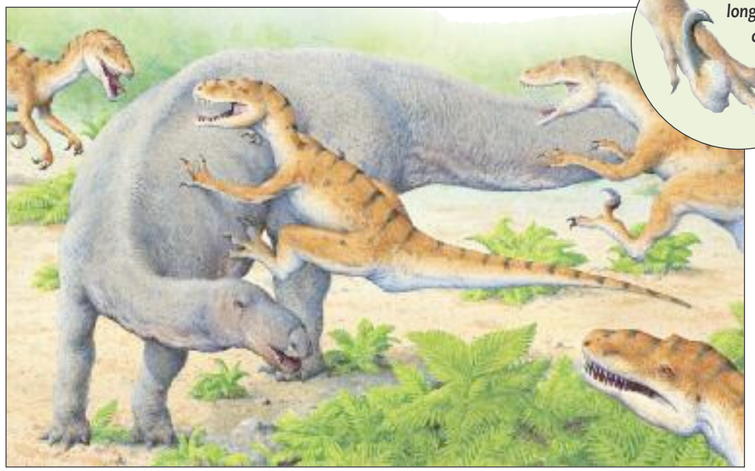
Baryonyx A meat-eating dinosaur from the Cretaceous period. It had the body of a large carnivore, about eight metres long, but its skull was long and narrow, with small, sharp teeth, a bit like a crocodile. It probably fed on fish, wading through the shallows and hooking them out with its long thumb-claw.

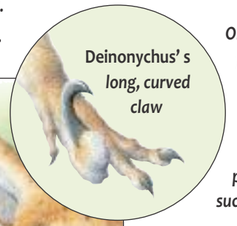
Ceratosaurs An early group of theropods that usually had horns or ridges on their snouts. Their name means "horned lizards". They had four digits on each hand and a gap between their front and back teeth. They included *Coelophysis*, *Ceratosaurus* and *Dilophosaurus*.

Coelophysis A small meat-eating dinosaur from the Late Triassic. It grew up to three metres long. It had a long, narrow head and sharp teeth, which it used to eat lizards and other small prey. It probably hunted in packs.

Compsognathus A tiny meat-eating dinosaur from the Late Jurassic. It was about the size of a chicken and preyed on insects and lizards. It was probably the fastest bipedal animal of all time, running at speeds of about 65 km per hour.

One fossil find shows a feathered **Velociraptor** *and a* **Protoceratops** *locked in battle (above).*





Deinonychus *(left) would work as a pack to bring down large dinosaurs, such as this* **Tenontosaurus.**

Deinonychus A large meat-eating dinosaur from the Early Cretaceous. It was about three metres long, with a large head, powerful jaws and a relatively large brain. Its name means "terrible claw", and refers to its lethal, scythe-shaped toe-claws. These were so long that *Deinonychus* had to raise them up while it ran. *Deinonychus* probably hunted in packs, in order to bring down prey much larger than themselves.

Tyrannosaurus rex *(above)*

Ornithomimids A group of fast-running dinosaurs from the Cretaceous period. Their name means "bird-mimic lizards" and refers to their ostrich-like appearance. They fed on plants and small animals such as insects and lizards. They had long beak-shaped mouths and most species had no teeth at all. They included *Ornithomimus*, *Struthiomimus* and *Gallimimus*.

Oviraptor A 2.5-metre-long meat-eater from the Cretaceous period. Its name, meaning "egg thief", refers to the theory that it ate eggs from the nests of other dinosaurs. A fossil of an *Oviraptor* has been found sitting on its nest with its forelimbs folded, like those of a bird. It probably had feathers, which would have helped to keep both the eggs and the young warm.

Raptors A group of meat-eating dinosaurs from the Jurassic and Cretaceous periods. They had a huge curved claw on each foot, used to slash their victims. Raptors included the five-metre-long *Utahraptor* and the two-metre-long *Velociraptor*.

Spinosaurus A large meat-eating dinosaur from the Cretaceous period. It was the largest of the theropods, growing up to 18 m long. It had a large sail of skin on its back, held up be spines projecting outwards from its backbone.

Tetanurans A group of theropods with straight tails. Their name means "stiff tails". They had only three digits on each hand. The group included raptors, rnithomimids, tyrannosaurs and therizinosaurs.

FACTFILE

★ *Tyrannosaurus Rex*'s head was about 1.5 m long. Its lower jaw was hinged in such a way as to maximize its gape. An eight-year-old child could have squatted in its jaws.

★ *Compsognathus*, discovered in Germany in the 1850s, was the first ever dinosaur to be found as a complete skeleton.

★ Most experts agree that birds evolved from small dinosaurs. *Archaeopteryx*, the first known bird, is closely related to the raptors and may have evolved directly from them. The presence of small bumps or quill bones on a *Velociraptor* fossil indicate that it definitely had feathers.

Archaeopteryx

Therizinosaurus A large meat-eater from the Late Cretaceous. It grew up to 12 m long. It had a small head with a toothless beak and three gigantic, curved finger-claws. The biggest of these claws may have been more than one metre long. Although technically a theropod, it mostly fed on plants and termites. It was probably covered with feathers.

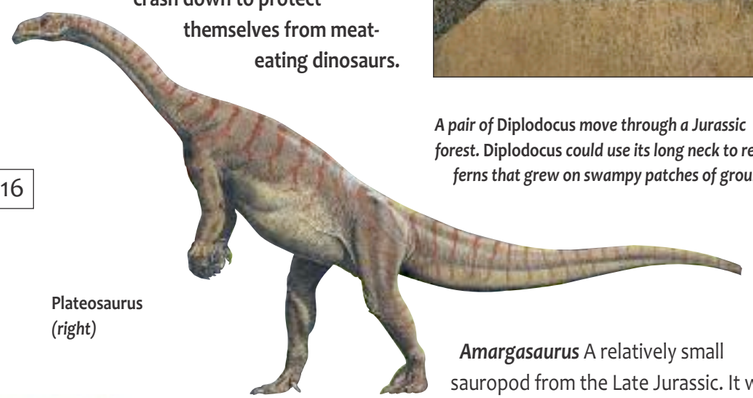
Tyrannosaurus rex A large, flesh-eating dinosaur from the Late Cretaceous. It grew up to 12 m long. Some of its saw-edged teeth were 18 cm long. *Tyrannosaurus rex* may have hunted by ambushing its prey or it may have scavenged on carrion. It belonged to the tyrannosaur family, which included the smaller *Albertosaurus* and *Daspletosaurus*.

Compsognathus, ***a quick hunter, was just 75 cm long.***

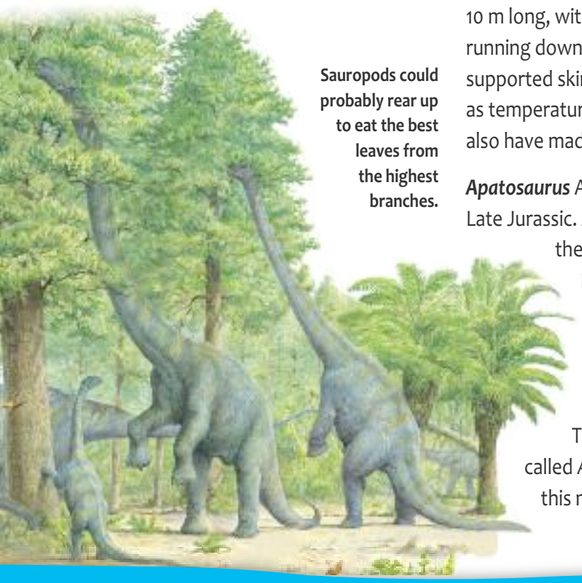
SAUROPODS

The sauropods were a group of large plant-eating saurischian or "lizard-hipped" dinosaurs (◀ 13). They first emerged towards the end of the Triassic. They had tiny heads, enormously long necks and tails, barrel-shaped bodies and elephant-like legs. They used their long necks to reach leaves in the treetops or to reach down to drink from rivers. To nourish their great bulk, they spent all day eating. Sauropods walked on four legs, but may have been able to rear up to reach the very highest branches, or crash down to protect themselves from meat-eating dinosaurs.

A pair of **Diplodocus** *move through a Jurassic forest.* **Diplodocus** *could use its long neck to reach ferns that grew on swampy patches of ground.*



Plateosaurus *(right)*



Sauropods could probably rear up to eat the best leaves from the highest branches.

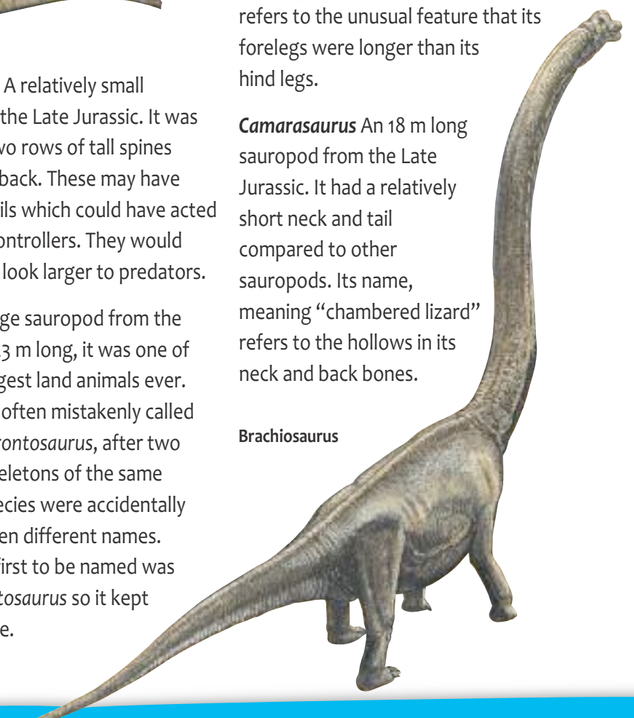
Amargasaurus A relatively small sauropod from the Late Jurassic. It was 10 m long, with two rows of tall spines running down its back. These may have supported skin sails which could have acted as temperature controllers. They would also have made it look larger to predators.

Apatosaurus A large sauropod from the Late Jurassic. At 23 m long, it was one of the largest land animals ever. It is often mistakenly called *Brontosaurus*, after two skeletons of the same species were accidentally given different names. The first to be named was called *Apatosaurus* so it kept this name.

Brachiosaurus A very large sauropod from the Jurassic period. At 25 m long and 14 m tall, it would have been able to look into the top-floor window of a four-storey-building. Its name, meaning "arm lizard", refers to the unusual feature that its forelegs were longer than its hind legs.

Camarasaurus An 18 m long sauropod from the Late Jurassic. It had a relatively short neck and tail compared to other sauropods. Its name, meaning "chambered lizard" refers to the hollows in its neck and back bones.

Brachiosaurus



Diplodocus A 27-metre-long sauropod from the Late Jurassic. It is the longest known dinosaur from a complete skeleton. It belonged to the diplodocid family, which included *Apatosaurus* and *Seismosaurus*.

Gizzard stone A pebble swallowed to help with digestion. Massive plant-eaters like *Diplodocus* had no chewing teeth, so they swallowed food whole, along with gizzard stones, or **gastroliths**. These helped to mash the food in the dinosaurs' stomachs.

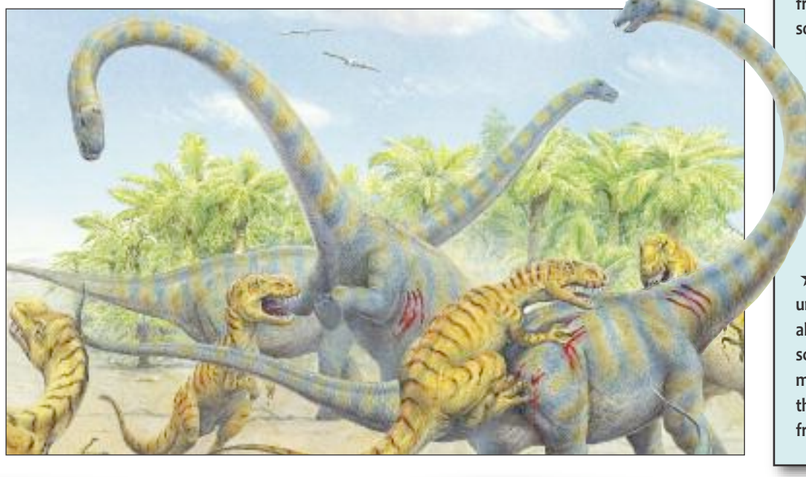
Mamenchisaurus A typical sauropod from the Jurassic period. It was 25 m long, with a huge, 15 m long neck. It had 19 vertebrae in its neck—more than any other known dinosaur.

Plateosaurus A large prosauropod from the Triassic period. It probably spent most of its time on its two powerful back legs. This allowed it to reach leaves on high branches. It had large thumb-claws, which it could use to pull down branches or lash out at predators.

Prosauropods A group of plant-eating dinosaurs from the Triassic and Early Jurassic periods. They all had long necks and tails and small heads. Many of them walked on two legs, but some walked on four. Prosauropods were once thought to be the ancestors of larger four-legged sauropods but are now considered to be a distinct group. They include *Plateosaurus* and *Riojasaurus*.

Saltasaurus An armoured sauropod from the Late Cretaceous. It grew to about 12 m long and had bony studs set into the skin on its back and sides. These would have made it hard for predators to bite it.

A pack of **Yangchuanosaurus** *attack a* **Mamenchisaurus** *herd. The* **Mamenchisaurus** *rear up and crash down on their attackers. They also flick their whiplike tails in their faces.*



Brachiosaurus *(top) had spoon-shaped teeth, well suited to its diet of tough leaves.* **Seismosaurus** *(above) had peg-shaped teeth, ideal for eating softer plants and stripping leaves off brahcnes.*

Shunosaurus A sauropod from the Jurassic period. It had a short neck, and a spiky tail-club it could swing at its enemies.

Titanosaurs A group of sauropods that lived in the Late Cretaceous period. They include the largest dinosaur known, the 18 m long *Argentinosaurus*.

FACTFILE

★ *Brachiosaurus* **is the tallest and heaviest dinosaur known from a complete skeleton, while** *Diplodocus* **is the longest. However, from studying bones of other dinosaurs, some scientists think the heaviest dinosaur may have been** *Argentinosaurus*, **a titanosaur from Cretaceous Argentina.**

★ **Most sauropods walked on their toes. They had wide feet with toes and a round heel bone cushioned by a pad of flesh. Almost all sauropods had a thumb-claw, though no-one knows what this was used for.**

★ **Sauropods would have needed unbelievably large hearts to pump blood along their long necks to their heads. Some scientists have suggested that sauropods may have had as many as eight hearts in their chest and neck, each pumping blood from one heart to the next.**

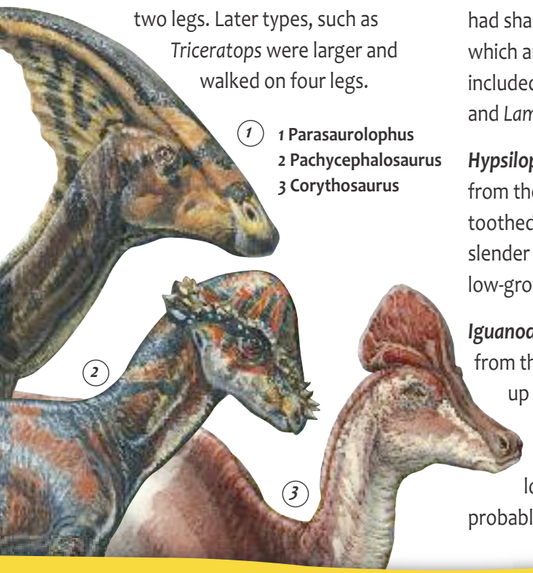
Ornithischians

The ornithischians were a group of plant-eating dinosaurs that first appeared in the Jurassic period. They were one of the two major groups of dinosaurs—the other was the saurischians (⬅ 13). The ornithischians had strong jaws and teeth, well-suited to chewing tough plant material. They came in all shapes and sizes. Many ornithischians had plates, horns, armour or spikes, probably for defensive purposes.

Maiasaura *babies being fed by their mother*

Ankylosaurs A group of armoured dinosaurs from the Jurassic and Cretaceous periods. They were covered with rows of bony plates and spikes and had large, barrel-shaped bodies, supported by four sturdy legs. The group included *Ankylosaurus*, *Euoplocephalus* and *Scelidosaurus*. *Ankylosaurus* could swing its bony tail-club into an attacker.

Ceratopsians A group of plant-eating dinosaurs with large neck-frills and parrot-like beaks. Their name means "horned-faces". Early types, such as *Psittacosaurus* were small and walked on two legs. Later types, such as *Triceratops* were larger and walked on four legs.



1 Parasaurolophus
2 Pachycephalosaurus
3 Corythosaurus

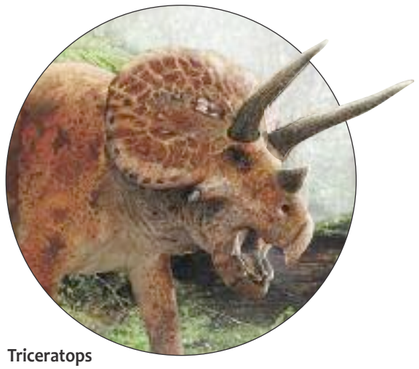
Euoplocephalus A large ankylosaur from the Late Cretaceous period. It had large spines on its shoulders and a heavy club at the end of its tail. It could grow up to seven metres long.

Hadrosaurs A group of plant-eating dinosaurs from the Late Cretaceous. They are sometimes called **duck-billed** dinosaurs because their mouths were wide and flat like a duck's. Some hadrosaurs had shapes of hollow bone on their head, which amplified their calls. Hadrosaurs included *Maiasaura*, *Parasaurolophus* and *Lambeosaurus*.

Hypsilophodon A two-metre-long dinosaur from the Cretaceous period. It had a horny, toothed beak and ran quickly on two long, slender legs. It moved in herds, nibbling on low-growing plants.

Iguanodon A large plant-eating dinosaur from the Early Cretaceous. It could grow up to nine metres long. It walked on four legs but probably ran on two. Its most distinctive feature was a long, spiked thumb, which it probably used as a defensive weapon.

Lambeosaurus A large duck-billed dinosaur from the Late Cretaceous. It had a hollow bony crest on its head, which may have amplified warning calls to other members of its herd. Different types of lambeosaurs had differently-shaped crests.



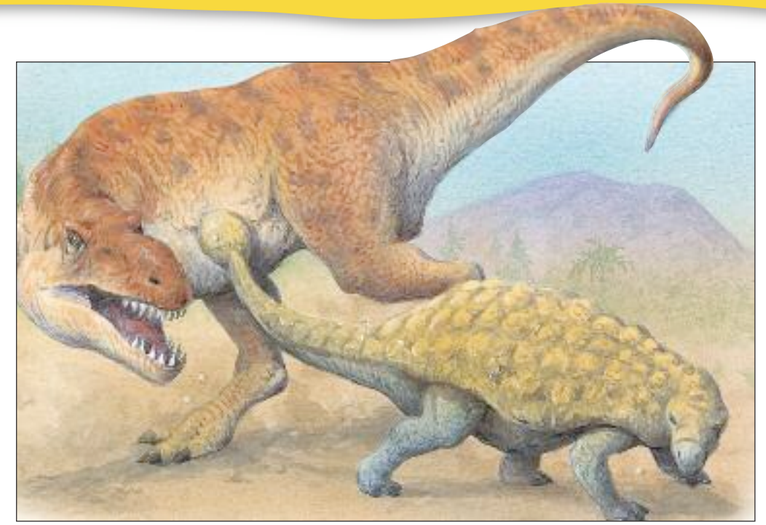
Triceratops

Maiasaura A plant-eating dinosaur from the Late Cretaceous. It had a flat snout and toothless beak. *Maiasaura* means "good mother lizard". This is because the first fossil remains of Maiasaura were discovered alongside those of nests, egg-shells and hatchlings. This was the first evidence that some dinosaurs raised and fed their young.

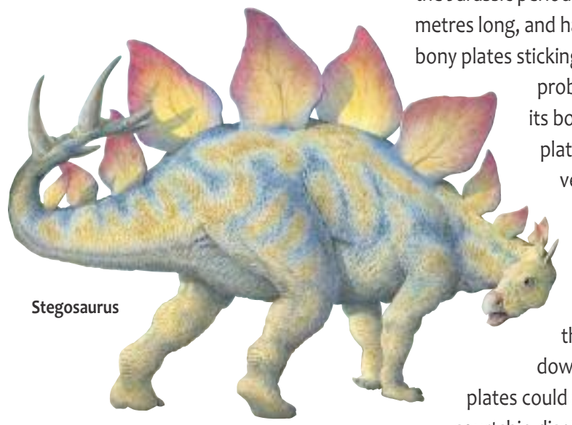
Ornithopods A group of plant-eating dinosaurs that could move about on two feet. Some, such as *Hypsilophodon*, were small, fast runners, while others, such as *Iguanodon*, were large and slow.

Pachycephalosaurus A five-metre-long plant-eater from the Late Cretaceous. The males probably used their thick, rounded skulls to intimidate rival males.

Parasaurolophus A large plant-eating dinosaur from the Late Cretaceous. It had a long crest curving backwards from the top of the skull. This was used to amplify calls, for example to warn the herd of approaching predators.



Anklyosaurus *defended itself with its tail club.*



Stegosaurus

Stegosaurus An armoured dinosaur from the Jurassic period. It grew up to nine metres long, and had two rows of flat, bony plates sticking out of its back. These probably helped to control its body temperature. Each plate was filled with blood vessels that would take in or give off heat, depending on whether the dinosaur needed to warm up in the morning sun or cool down later in the day. The plates could also have been used in courtship display by males.

Protoceratops A two-metre-long ceratopsian from the Cretaceous. Its name means "first horned face", and refers to the fact that it was one of the earliest ceratopsian dinosaurs.

Scelidosaurus An armoured dinosaur from the Early Jurassic. It was about four metres long, and covered in bony studs, which ran down its back and tail. These studs would have protected it from the teeth and claws of meat-eaters.

Scute A bony lump found on the skin of some dinosaurs. Scutes were set into the skin in rows. They protected dinosaurs from the teeth and claws of predators.

Styracosaurus A six-metre-long ceratopsian with a nose horn and six long bony spikes extending from its neck-frill. Its name means "spiked lizard".

Triceratops A nine-metre-long plant-eater from the Late Cretaceous. It had two long horns on its forehead and a shorter horn on its nose. Its name means "three-horned face". It also had a neck frill made of solid bone, which may have been used for display in courtship, to protect the back of its neck or make it look bigger.

Iguanodon *might have attacked a meat-eater with its thumb spike.*

FACTFILE

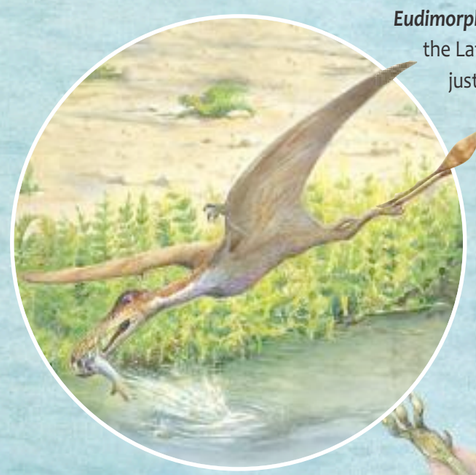
★ Some hadrosaurs had more than 1000 teeth, with new ones continually replacing old, worn ones. These dinosaurs could both crop and grind up the toughest of plant material in their mouths. This meant that, unlike sauropods, hadrosaurs would not have had to consume so much plant material or swallow pebbles to help with digestion.

★It was once thought that some crested hadrosaurs like *Parasaurolophus* were acquatic animals. The crest was thought to have acted as a snorkel, allowing the dinosaurs to breathe under water.

★ *Hypsilophodon* was once thought to be a tree-dweller, like the modern tree kangaroo whose build it was said to resemble.

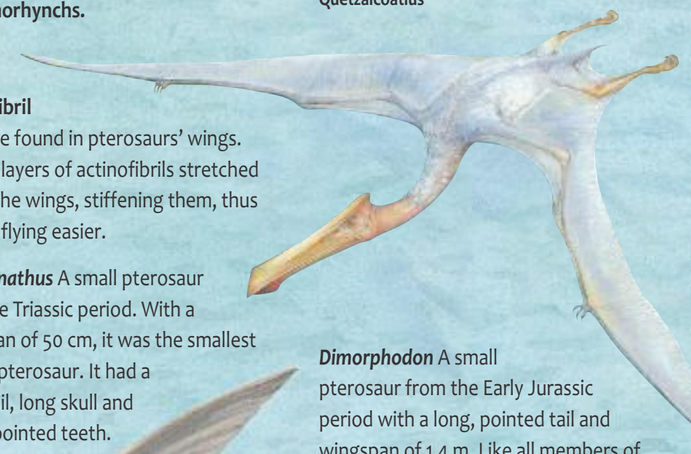
Flying reptiles

Flying reptiles, known as pterosaurs, first took to the air in the Triassic period. They dominated the skies for nearly 100 million years. They ranged in size from a few centimetres to nearly 11 m across. Their wings were formed from sheets of skin stretched between their fourth fingers and their bodies. Their bones were hollow, making them light enough to fly. Many had powerful, toothed beaks, perfect for seizing fish. There were two main types of pterosaur: short-tailed pterodactyls and long-tailed rhamphorhynchs.



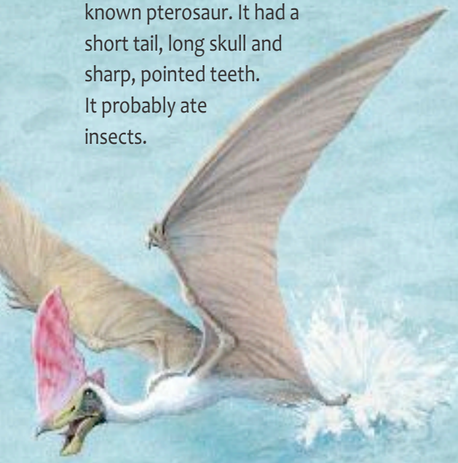
Rhamphorhynchus *(above) had sharp teeth and could easily catch fish from just below the water's surface.*

Quetzalcoatlus



Actinofibril
The fibre found in pterosaurs' wings. Several layers of actinofibrils stretched across the wings, stiffening them, thus making flying easier.

Anurognathus A small pterosaur from the Triassic period. With a wingspan of 50 cm, it was the smallest known pterosaur. It had a short tail, long skull and sharp, pointed teeth. It probably ate insects.



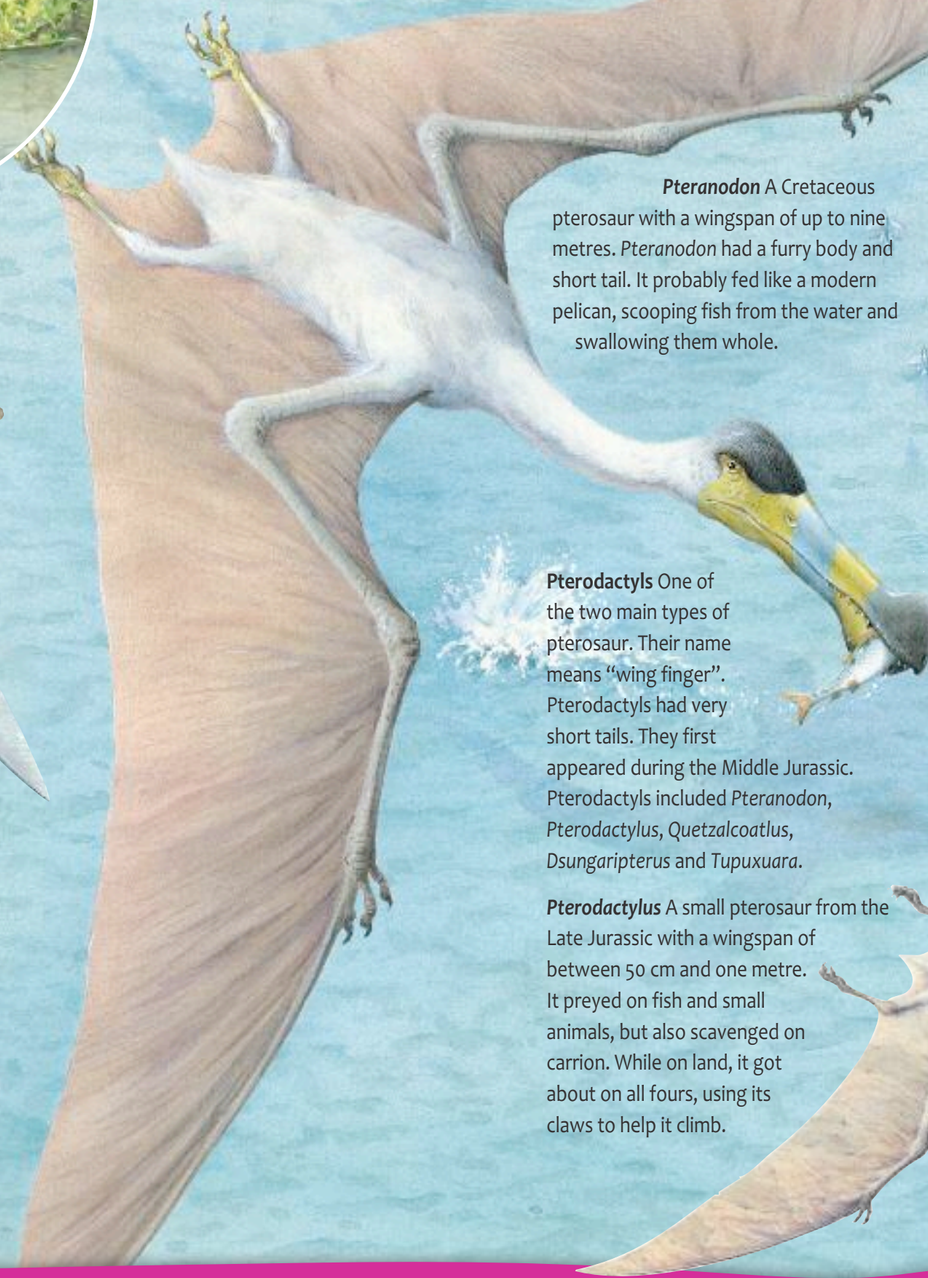
Tapejara (above)

Dimorphodon A small pterosaur from the Early Jurassic period with a long, pointed tail and wingspan of 1.4 m. Like all members of the rhamphorhynch family, it had a disproportionately large head, which was also deep and narrow like a puffin's. For a male, the size and colouring of its head may have played a crucial role in impressing a female during courtship.

Dsungaripterus A pterosaur from the Early Cretaceous period with a wingspan of about three metres. It had a bony crest on its snout and an upward-curving beak, probably used to prise shellfish off rocks. Blunt teeth at the back of its jaws would have been used to break shellfish open.

Eudimorphodon A small pterosaur from the Late Triassic with a wingspan of just under a metre and a long, pointed tail. It used its sharp teeth to eat fish.

Ornithocheirus *(below)*



Ornithocheirus A pterosaur from the Cretaceous period with a wingspan of 2.5 metres. It had a "keel" at the end of its toothed beak, which may have helped it to trap fish or crush crustaceans.

Pteranodon A Cretaceous pterosaur with a wingspan of up to nine metres. *Pteranodon* had a furry body and short tail. It probably fed like a modern pelican, scooping fish from the water and swallowing them whole.

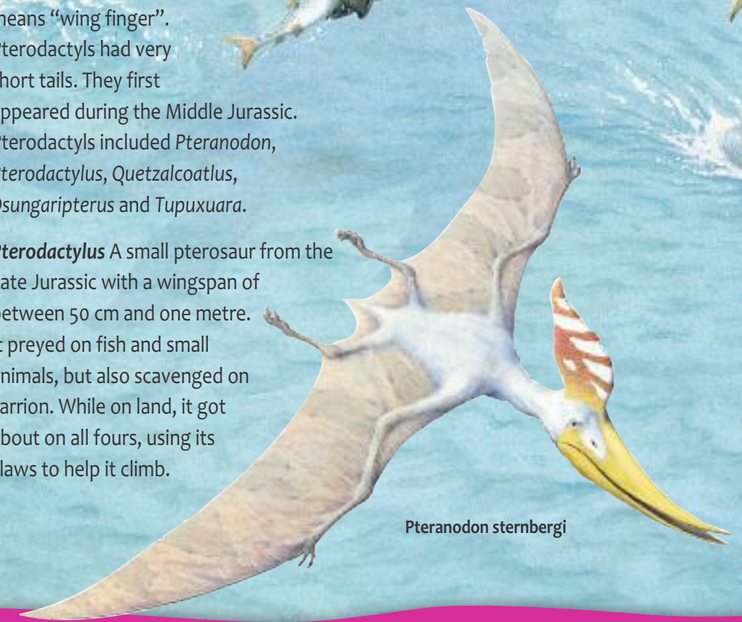
Pterodactyls One of the two main types of pterosaur. Their name means "wing finger". Pterodactyls had very short tails. They first appeared during the Middle Jurassic. Pterodactyls included *Pteranodon*, *Pterodactylus*, *Quetzalcoatlus*, *Dsungaripterus* and *Tupuxuara*.

Pterodactylus A small pterosaur from the Late Jurassic with a wingspan of between 50 cm and one metre. It preyed on fish and small animals, but also scavenged on carrion. While on land, it got about on all fours, using its claws to help it climb.

Pteroid bone A bone found only in the wrist joints of pterosaurs. It pointed forwards and inwards to support the pterosaur's wings and assist with steering in flight.

Quetzalcoatlus A large pterosaur from the Late Cretaceous. With a wingspan of about 11 m, it was the largest known flying creature of all time. It had a long, toothless jaw, a curved neck and a hard crest on its head. *Quetzalcoatlus* lacked the muscle power to take off by running quickly. Instead it have may become airborne by launching itself from a cliff edge.

Rhamphorhynchs One of the two main types of pterosaur. Their name means "beak snout". Rhamphorhynchs had long tails, ending in a diamond-shaped flap of skin. Their long, narrow jaws were filled with sharp teeth that pointed outwards. They first appeared in the Triassic period. They included *Rhamphorhynchus*, *Eudimorphodon* and *Dimorphodon*.



Pteranodon sternbergi

Tapejara A medium-sized pterosaur from the Cretaceous period. *Tapejara* had a short tail and a wingspan of up to five metres. There was a large, bright crest on its head, made of skin stretched across two bones. This crest may have been used for courtship displays, to attract a mate or ward off rivals.

Tupuxuara

FACTFILE

★ *Pteranodon*'s long wings were ideally suited for gliding on air currents above the oceans, just as an albatross flies today. It coud travel for many kilometres without needing to flap its wings, a flight pattern known as "dynamic soaring".

★ *Quetzalcoatlus* lacked the muscle power to take off by running quickly. Instead it have may become airborne by launching itself from cliff edges.

★ Many pterosaurs had huge eye sockets, indicating that their eyes were large and their eyesight sharp. This would have enabled them to spot prey on land or at sea from high in the air.

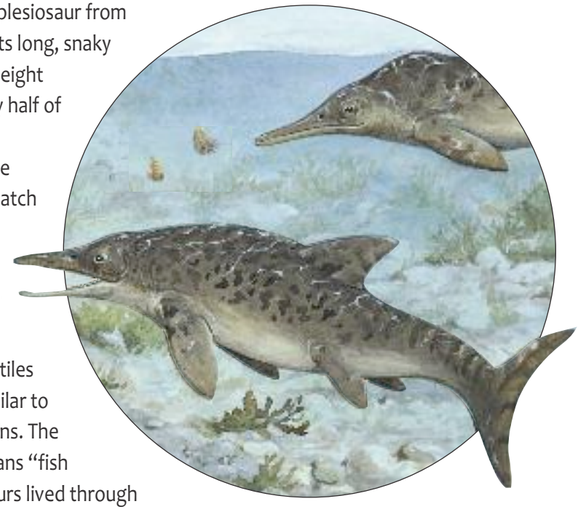
Marine reptiles

While the dinosaurs ruled the land, other kinds of reptiles dominated the seas and oceans. These marine reptiles had scaly skin, sharp teeth, four flippers and a tail. Most were fierce hunters, chasing prey, such as fish, squid and shellfish. Like the dinosaurs, the sea reptiles breathed air, which meant that they regularly had to come to the water's surface. Marine reptiles first emerged in the Triassic period.

Ammonite A Cretaceous cousin of the modern octopus and squid. Ammonites protected their soft bodies inside hard, coiled shells. They snared their tiny prey with their long tentacles. They were a favourite food of marine reptiles such as the ichthyosaurs.

Champsosaurus A two-metre-long, crocodile-like marine reptile from the Cretaceous period. Like modern crocodiles, it had a long snout lined with sharp teeth, four short legs and a long tail.

Elasmosaurus A large plesiosaur from the Late Cretaceous. Its long, snaky neck measured about eight metres and was nearly half of its body length. *Elasmosaurus* may have used its long neck to catch fish by surprise. It could catch the fastest fish of its time.

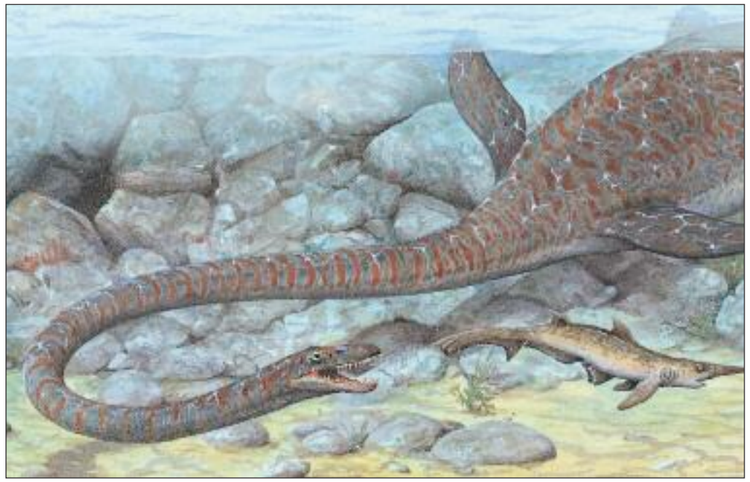


Ichthyosaurus *was abundant during the Jurassic, when shallow waters covered much of the Earth.*

Ichthyosaurs
A group of marine reptiles with a body shape similar to that of modern dolphins. The name ichthyosaur means "fish lizard". The ichthyosaurs lived through the Jurassic and Cretaceous periods. They varied greatly in size: *Mixosaurus* was only one metre long, *Ichthyosaurus* was about two metres long, while *Shonisaurus* grew to more than 21 m. They all had large eyes, smooth, streamlined bodies and sharp, closely-set teeth.

Kronosaurus A 10-metre-long pliosaur from the Cretaceous. It had a huge head, about a quarter of its whole body length, and a short neck. It preyed on turtles, plesiosaurs, fish, ichthyosaurs, squid and ammonites.

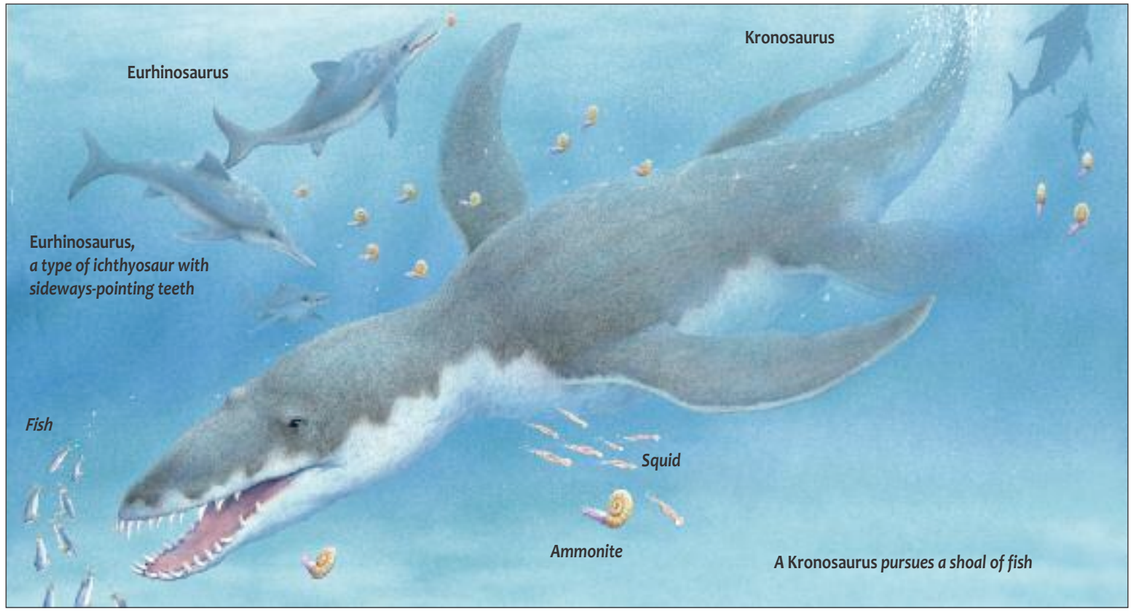
Elasmosaurus *hunting a shark*



Liopleurodon The largest of the pliosaurs. At 25 m long, it was the biggest predator in the Jurassic seas.

Mosasaurs A family of giant sea lizards from the Cretaceous period. Some mosasaurs could grow up to 15 m long. They had huge teeth and long, strong jaws. They probably preyed on fish and other marine reptiles, though some species may have eaten shellfish. Members of the family include *Platecarpus*, *Tylosaurus* and *Mosasaurus*.

Nothosaurs A group of Triassic marine reptiles with long necks and tails. Nothosaurs ranged in size from 60 cm to four metres long. They had legs and claws adapted for living on land as well as flippers suited for swimming, so they lived both on land and in the sea. Like modern seals, nothosaurs probably dived to catch fish, then dragged themselves on to the shore to rest. Members of this group include *Nothosaurus*, *Lariosaurus*, *Ceresiosaurus* and *Pistosaurus*.



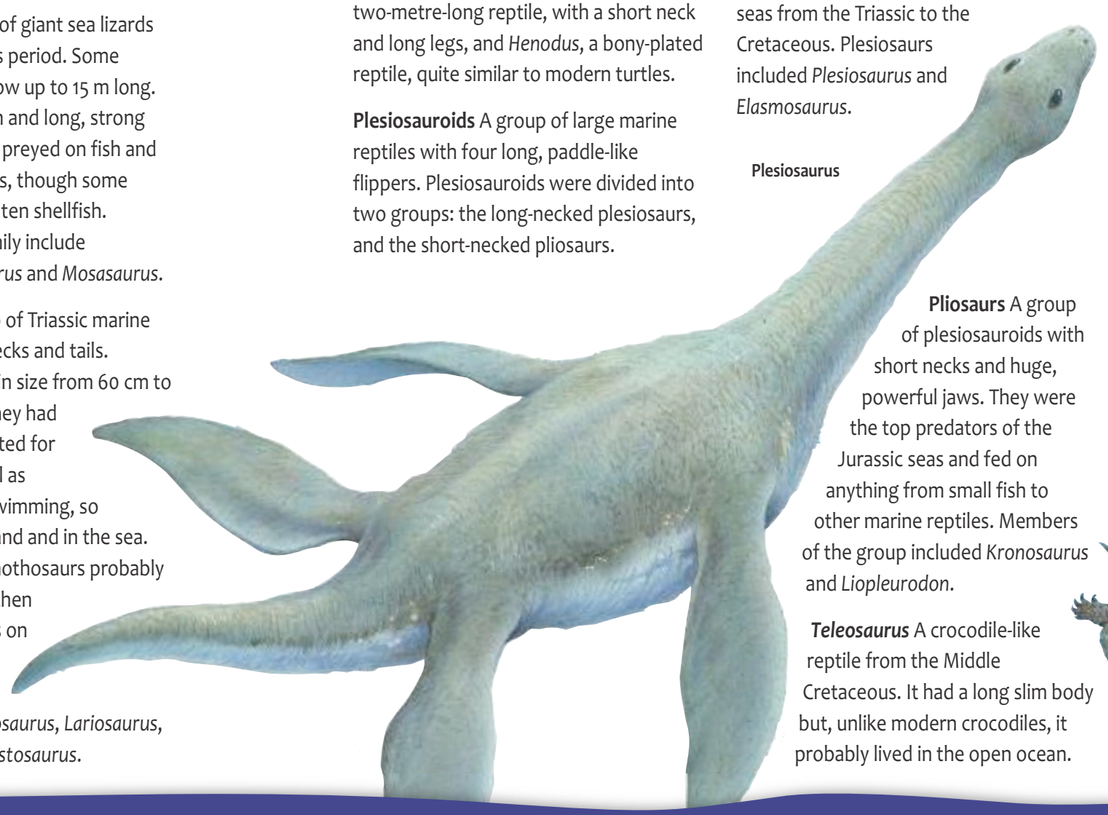
A Kronosaurus *pursues a shoal of fish*

Placodonts A group of small, armoured marine reptiles from the Triassic period. Members of this family include *Placodus*, a two-metre-long reptile, with a short neck and long legs, and *Henodus*, a bony-plated reptile, quite similar to modern turtles.

Plesiosauroids A group of large marine reptiles with four long, paddle-like flippers. Plesiosauroids were divided into two groups: the long-necked plesiosaurs, and the short-necked pliosaurs.

Plesiosaurs A group of plesiosauroids with long, snake-like necks, small heads and four large flippers. They roamed the seas from the Triassic to the Cretaceous. Plesiosaurs included *Plesiosaurus* and *Elasmosaurus*.

Plesiosaurus



Pliosaurs A group of plesiosauroids with short necks and huge, powerful jaws. They were the top predators of the Jurassic seas and fed on anything from small fish to other marine reptiles. Members of the group included *Kronosaurus* and *Liopleurodon*.

Teleosaurus A crocodile-like reptile from the Middle Cretaceous. It had a long slim body but, unlike modern crocodiles, it probably lived in the open ocean.

FACTFILE

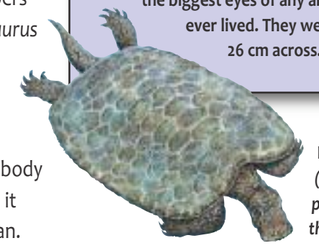
★ ***Liopleurodon*** **was the largest carnivore of all time.**

★ **The name** ***Kronosaurus*** **means "lizard of Kronos". Kronos was the Greek god of time who ate his five children as they were born in order to keep power for himself.**

★ **The name** ***Plesiosaurus*** **means "near lizard". It was given this name in 1821, to show that it was more closely related to land reptiles than to** ***Ichthyosaurus*****, whose fossil had also been found in nearby rocks.**

★ ***Ichthyosaurus*** **is one of the few prehistoric animals whose fossils contain evidence of skin colour. Pigment cells that were preserved suggest that Ichthyosaurus had a smooth, scale-less, skin that was dark red or brown in colour.**

★ **The ichthyosaur** ***Temnodontosaurus*** **had the biggest eyes of any animal that ever lived. They were about 26 cm across.**



Henodus *(left), a placodont from the Late Triassic*

PREHISTORIC BIRDS & MAMMALS

By the time the dinosaurs became extinct, several different groups of mammals had already evolved around the world. The first mammals evolved during the Early Jurassic. They were furry, warm-blooded animals that give birth to live young and suckled them with milk. But while dinosaur predators were about, they remained tiny, shrew-like animals, venturing out of their burrows only at night. The extinction of the dinosaurs enabled mammals to become the dominant land animals. Birds also developed into a wide variety of species, including some terrifying predatory giants.

Shrew-like Alphadon *was one of the first mammals.*

Andrewsarchus A huge flesh-eating mammal from the Eocene epoch. It was four metres long and had a skull nearly one metre long. It may have been more of a scavenger than a hunter. *Andrewsarchus* was the largest known flesh-eating land mammal.

Diatryma A two-metre-tall bird from the Eocene epoch. It could not fly, but hunted on the ground, using its enormous, bone-crushing beak to crunch up mammals, including small, primitive horses.

Eocene epoch The span of time in Earth's history from 56 to 34 million years ago. During this time, the climate was warm and tropical rainforest was widespread, even at the poles.

Eohippus A sixty-centimetre-long prehistoric horse from the Eocene epoch.

Gigantopithecus A three-metre-tall ape that lived in the forests of the Pleistocene.

Glyptodon A large armoured mammal from the Pleistocene epoch. It looked a lot like a modern armadillo.

Holocene epoch The span of time in Earth's history that started 12,000 years ago and continues to this day.

Hyaenodon A flesh-eating, cat-like predator from the Eocene. It measured up to three metres long and had strong jaws with sharp, knife-like teeth.

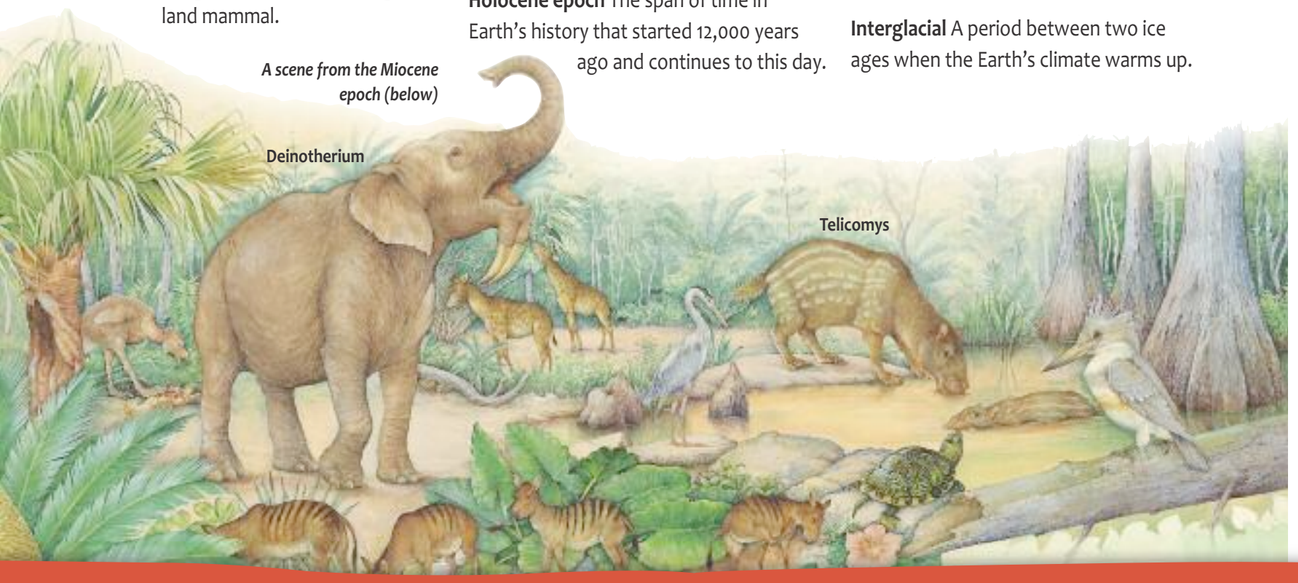
Ice age A period when the Earth's temperature drops significantly and ice sheets spread out from the poles. It is not quite certain what causes this to happen. The last ice age occurred in the Pleistocene epoch, starting about 20,000 years ago.

Indricotherium A massive plant-eater from the Eocene and Oligocene epochs. It measured five metres high at the shoulder, making it the largest land mammal ever. It used its flexible lips and tusk-like teeth to strip leaves from trees.

Diatryma *snatching a primitive horse.*

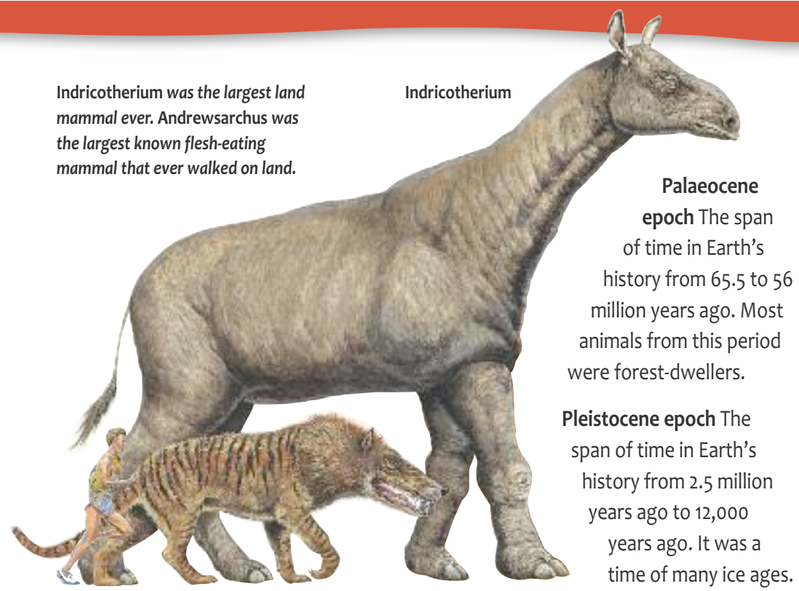
Interglacial A period between two ice ages when the Earth's climate warms up.

A scene from the Miocene epoch (below)



Indricotherium was the largest land mammal ever. Andrewsarchus was the largest known flesh-eating mammal that ever walked on land.

Indricotherium



Human (*to scale*) Andrewsarchus

Mammoth A large, elephant-like animal from the Pleistocene epoch. They only ate grass. Mammoths roamed the Earth until about 10,000 years ago. They may have started to die out because of climate change. Prehistoric humans then hunted them to extinction. The **woolly mammoth** was a species from the far north with a shaggy coat and long, curved tusks

Mastodon A mammal with tusks, trunks and thick hair. Mastodons roamed the Earth from the Oligocene to the Pleistocene. They were slightly smaller than mammoths, and had teeth adapted to eating leaves.

Megatherium A six-metre-long sloth from the Pleistocene epoch. It probably moved about the ground on all fours.

Miocene epoch The span of time in Earth's history from 23 to 5 million years ago. During this period, vast areas of grassland started to appear, leading to the evolution of horses and antelopes, as well as dogs, cats and hyenas to prey on them.

Oligocene epoch The span of time in Earth's history from 34 to 23 million years ago. During this time, the climate began to cool. Ice caps formed at the poles and forests were replaced by more open woodland.

Palaeocene epoch The span of time in Earth's history from 65.5 to 56 million years ago. Most animals from this period were forest-dwellers.

Pleistocene epoch The span of time in Earth's history from 2.5 million years ago to 12,000 years ago. It was a time of many ice ages.

Quaternary period A period of Earth's history from 1.8 million years ago to the present. It followed the Tertiary period and includes the Pleistocene and Holocene epochs.

Sabre-toothed cat A two-metre-long cat from the Eocene and Pleistocene. It had huge canine teeth at the front of its mouth and probably hunted in packs.

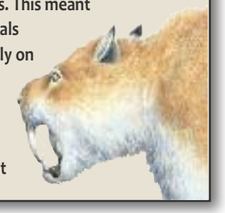
Tertiary period The period of Earth's history from 65 to 1.8 million years ago. During this period, mammals replaced reptiles as the dominant group of animals.

FACTFILE

★ Complete woolly mammoth carcasses, preserved in ice, are still being found today.

★ Today's climates are generally cooler than on many occasions in prehistory, so it is quite possible that we are living through an interglacial. Another ice age may one day grip the world.

★ By the beginning of the Tertiary period, the continents had drifted to approximately their present positions, although North and South America were still separated. Each continent, with the exception of Australia and Antarctica which were still linked together, had become an isolated landmass. This meant that early mammals evolved separately on their own island continents.

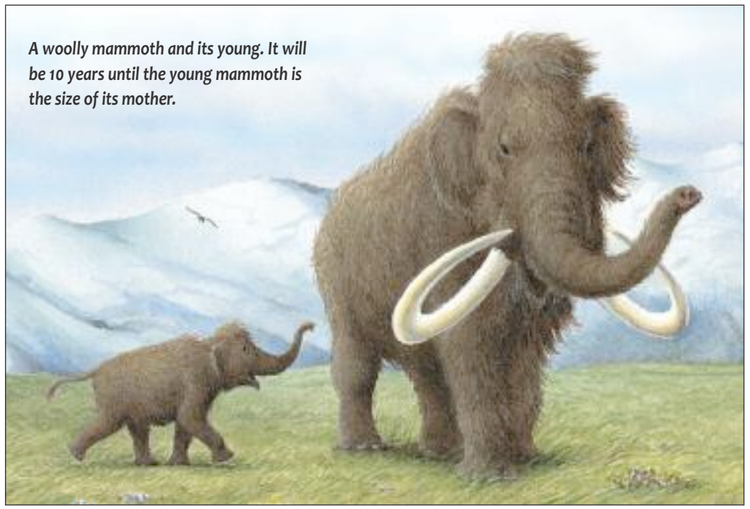


Sabre-toothed cat

Warm-blooded Warm-blooded animals are kept warm by energy taken from food. They can maintain their temperature regardless of their surroundings.

Woolly rhinoceros A large, woolly, rhinoceros-like animal from the Pleistocene epoch.

A woolly mammoth and its young. It will be 10 years until the young mammoth is the size of its mother.



First humans

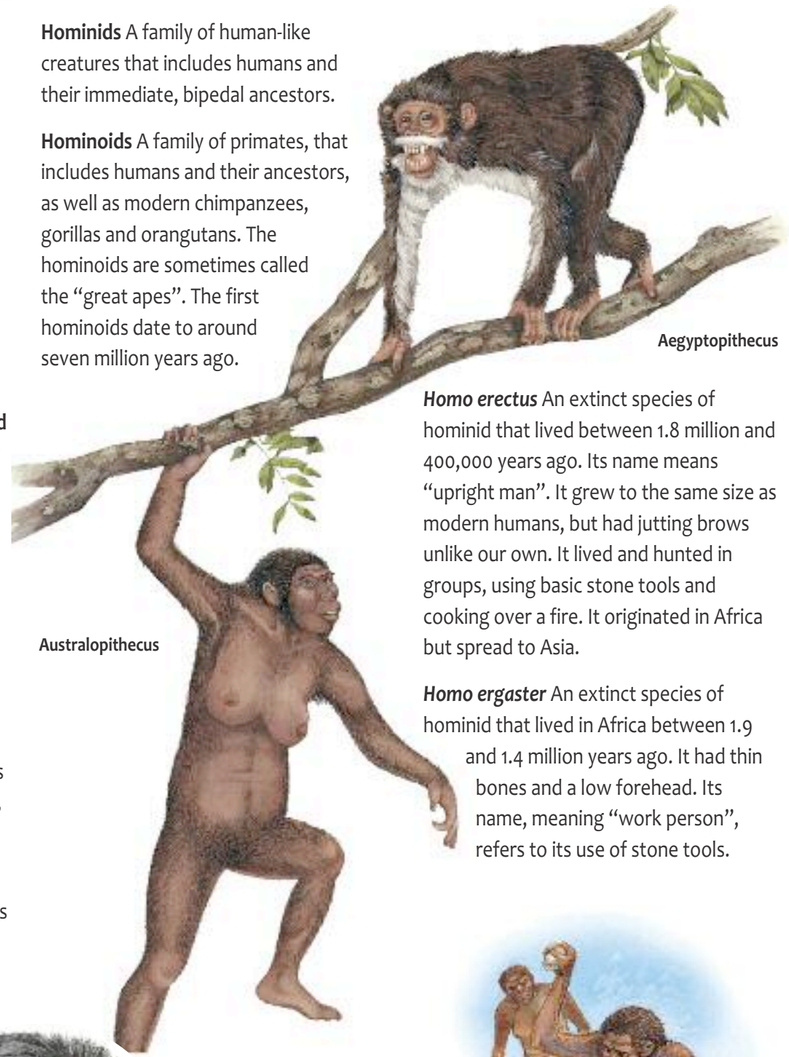
Scientists know that humans, apes and monkeys all share a common ancestor but they have not yet identified which species that was. However, of all its descendents, only the human-like creatures, or hominids, developed the ability to walk upright and on two feet. The first hominids probably appeared over five million years ago. Modern humans, *Homo sapiens*, did not appear until relatively recently: about 125,000 years ago.

Aegyptopithecus An extinct ape that lived in Egypt 33 million years ago. It was about 1.2 m long and walked on four legs. It is believed to be an ancestor of today's Old World monkeys—monkeys from Africa and Asia with relatively short, inflexible tails and nostrils that are very close together.

Australopithecus An extinct family of apes that lived in Africa between four and two million years ago. Most species were about one metre tall, with long arms, short legs and a small brain. They looked ape-like but probably walked upright. Fossils of several kinds, including *afarensis*, *anamensis*, *africanus* and *garhi*, have been discovered. Some may have been ancestors of humans.

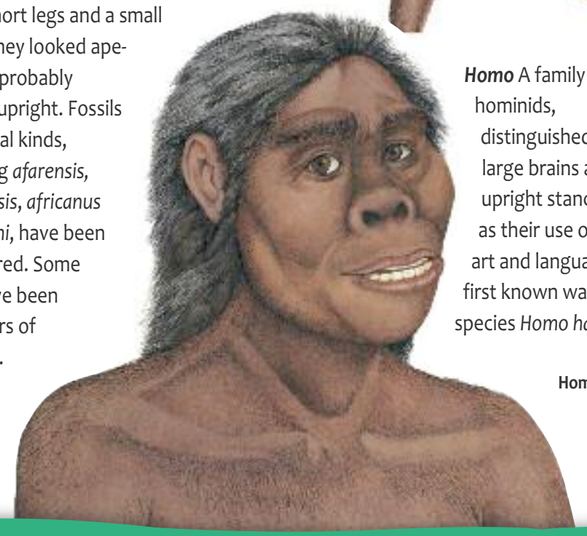
Hominids A family of human-like creatures that includes humans and their immediate, bipedal ancestors.

Hominoids A family of primates, that includes humans and their ancestors, as well as modern chimpanzees, gorillas and orangutans. The hominoids are sometimes called the "great apes". The first hominoids date to around seven million years ago.



Aegyptopithecus

Australopithecus



Homo A family of hominids, distinguished by their large brains and upright stance, as well as their use of tools, art and language. The first known was the species *Homo habilis*.

Homo habilis

Homo erectus An extinct species of hominid that lived between 1.8 million and 400,000 years ago. Its name means "upright man". It grew to the same size as modern humans, but had jutting brows unlike our own. It lived and hunted in groups, using basic stone tools and cooking over a fire. It originated in Africa but spread to Asia.

Homo ergaster An extinct species of hominid that lived in Africa between 1.9 and 1.4 million years ago. It had thin bones and a low forehead. Its name, meaning "work person", refers to its use of stone tools.

Homo habilis *using a rock to smash open bones.*

Homo habilis An extinct species of hominid that lived in Africa two million years ago. Its name means "handy man". *Homo habilis* made simple tools by striking one stone against another to make a sharp edge. It was probably a scavenger rather than a hunter.

Neanderthal hunters trap a huge woollly mammoth (⬅ 25) in a pit.

Homo heidelbergensis An extinct species of hominid that lived in Europe between 780,000 and 200,000 years ago. It stood about 1.8 m tall and hunted using basic tools made of stone or bone. Evidence of group hunting suggests that *Homo heidelbergensis* could communicate with each other, probably using gestures. *Homo heidelbergensis* was probably descended from *Homo ergaster* and was likely to be the ancestor of both Neanderthals and *Homo sapiens*.

The hammer (left) was carved from a deer's antler. It was used to make hand-axes (right) from flints.

Homo rudolfensis An extinct species of hominid that lived in Africa 2 million years ago. About 1.2 m tall, it had a bigger brain than any previous hominid. It made rough tools and possibly lived in simple shelters.

Homo sapiens Modern-day humans. Its name means "wise man". *Homo sapiens* appeared about 250,000 years ago. Their brains were larger than any of their ancestors, apart from the Neanderthals. They used tools, hunted large game, and created works of art such as cave paintings.

Land bridge A small strip of land that joins two larger land-masses. Land bridges, formed as the continents shifted, allowed the early humans to move to lands such as the Americas, Australia and Japan.

Neanderthals (*Homo neanderthalensis*) A species of *Homo* that first appeared in Europe and the near East more than 250,000 years ago. The Neanderthals had short, muscular bodies, overhanging brows and heavy, chinless jaws. Their brains were larger than those of modern humans. They lived in groups and hunted wild animals. They died out about 30,000 years ago, possibly because of competition for food with *Homo sapiens*.

FACTFILE

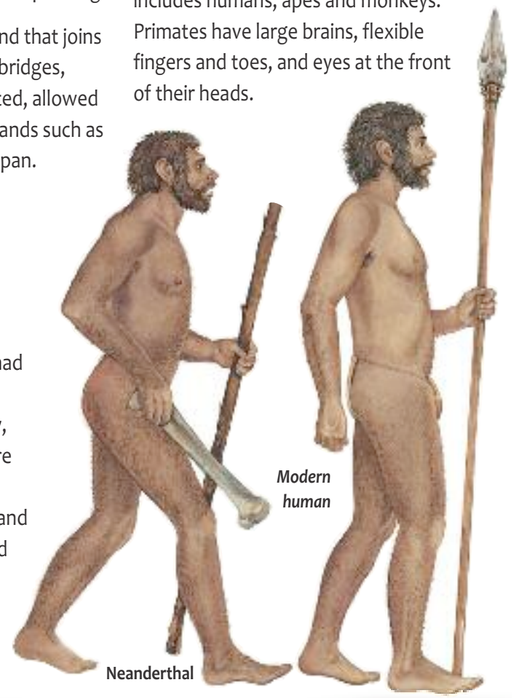
★ Modern humans share about 96% of their DNA with apes, such as chimpanzees.

★ A site that has provided a great deal of evidence about early humans is La Sima de los Huesos (the Pit of Bones) in northern Spain. Here the remains of at least 32 humans, dating to 400,000 years ago, have been found at the bottom of a 15-m shaft. The humans may have been ancestors of the Neanderthals.

★ Humans arrived in North America between 35,000 and 15,000 years ago. They crossed from Asia at a time when the Bering Sea, which divides the two continents, was dry land. They then spread through the Americas, reaching the southern tip of South America 11,000 years ago.

Out-of-Africa theory The widely-accepted theory that all modern humans are descended from a group of *Homo sapiens* that left Africa about 70,000 years ago.

Primates A group of mammals (⬅ 24) that includes humans, apes and monkeys. Primates have large brains, flexible fingers and toes, and eyes at the front of their heads.



Fossils

Fossils are the remains of once-living things preserved in rock. Most living things are eaten or rot away when they die, leaving no trace. But sometimes, if animals are quickly buried by sediments, their remains may turn into rock and be preserved as fossils. After millions of years of Earth movements and the wearing away of rocks, some fossils may come to be exposed at the surface of the Earth. Fossils are the main way that we can learn about dinosaurs and other prehistoric life forms.

An insect trapped in amber

Absolute dating A way of estimating the age of an object by looking at its chemical make-up. The main method of absolute dating is radiocarbon dating.

Amber A hard yellow-orange substance formed when sticky tree resin is fossilized. It sometimes contains insects and other small animals that were trapped inside it.

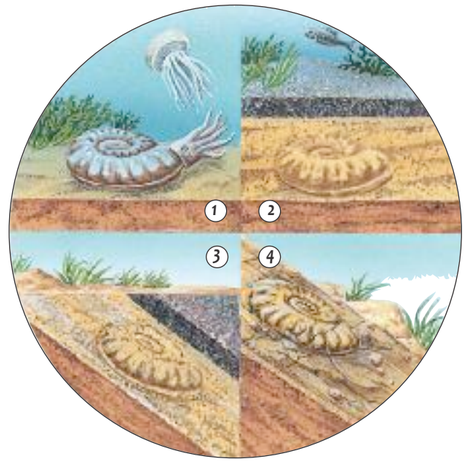
Cast fossil A fossil formed when minerals fill in a mould fossil.

Coprolite Fossilized animal dung. Coprolites are a type of trace fossil. They can reveal what animals ate.

DNA (Deoxyribonucleic acid) A chemical found inside the cells of all living things. The pattern of the DNA forms a code or blueprint for how the body's cells are built. By studying the DNA of extinct animals, scientists can work out how they are related, and therefore how they evolved.

Excavation The process of examining layers of soil for fossils and other material from the past.

Fossil footprint A fossilized footprint, sometimes called an **ichnite**. Fossil footprints are a type of trace fossil. The depth of the prints and the distance between them can reveal how fast an animal walked or ran, and how heavy it was. Footprints also show whether an animal walked on two or four legs, and whether it lived alone or as part of a group.



The fossilization of an ammonite. After it dies, its soft fleshy parts rot or are eaten (1). Sandy sediments cover the shell (2). Shell and sand gradually turn into rock. The rock is tilted by Earth movements (3). Erosion reveals the fossil shell (4).

Index fossil A common fossil that is known to date back to a particular time. Index fossils are used to date the layer of rock in which they are found. Ammonites (⬅22) and trilobites (⬅9) are excellent index fossils because they are abundant, easy to identify, and are known to come from a specific period in Earth's history.

Matrix The rock in which fossils form.

Mineral A naturally occurring solid substance that is neither plant nor animal. Rocks are made up of minerals.

Mould fossil A hollow, bone-shaped hole, formed when the skeleton of an animal is dissolved by water underground.

Palaeontologist A scientist who studies fossils and other signs of life from the past.

Permineralization A fossil-forming process in which water seeps into the hollows in bones, plants or shells, and leaves hard mineral deposits in these spaces. The minerals make the remains harder, helping to preserve them in the ground.

Petrification A fossil-forming process in which water dissolves an organism's remains, replacing them with minerals. These then harden into the shape of the organism itself.

Radiocarbon dating A way of calculating the age of an object by measuring how much carbon-14 (C-14) it contains. C-14 is a special form of the element carbon. It is radioactive, meaning that it regularly changes into different elements, a process called **radioactive decay**. All living things absorb C-14 from the atmosphere. When they die,they stop taking in carbon, and the C-14 within them starts to decay. Because it decays at a known rate, scientists can find out the age of an object by measuring how much C-14 is left. This method can be used to date objects back about 62,000 years.

The fossil skeleton of an Ichthyosaur (⬅22)

A trace fossil of a dinosaur footprint (right)

Relative dating A way of estimating the age of an object by showing that it came before or after another object. Relative dating relies upon stratigraphy and index fossils. It is less exact than absolute dating.

Sediment Eroded rock fragments that are transported by wind, water or ice and laid down elsewhere. These fragments can cover skeletons and other once-living materials. This is the first stage in the formation of fossils.

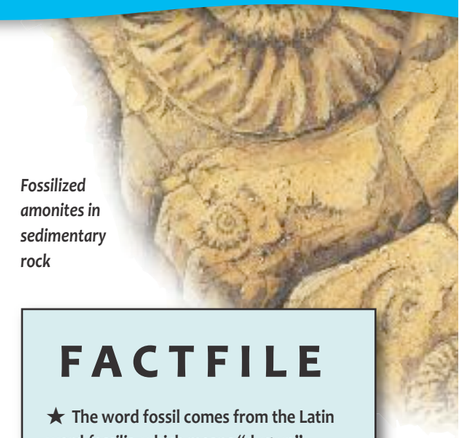
"Sue" (above) is a fossil Tyrannosaurus rex *discovered in 1990 with all her bones in place next to each other. A complete fossil dinosaur is an extremely rare find.*

Palaeontologists (below) use picks, shovels and thin blades to remove the surrounding rock from a fossil. They then number all the bones, record their exact positions and photograph them.

Sedimentary rock A type of rock that is formed by the pressing together of rock fragments. These fragments, including sand, gravel and mud, are formed when other rock types are worn away by the wind and rain. They gradually settle in layers. As more layers settle on top of each other, the particles are compressed and cemented into sedimentary rock. Fossils are only found in sedimentary rocks.

Stratigraphy The study of rock layers. By estimating the order in which different rock layers were formed, scientists can guess the age of the fossils found within them. Deeper layers of rock are generally older than the layers above them.

Trace fossil The fossilized form of objects such as feathers, footprints, droppings or shells. These are important clues about how animals once lived. They are more common than any other type of fossil.



Fossilized amonites in sedimentary rock

FACTFILE

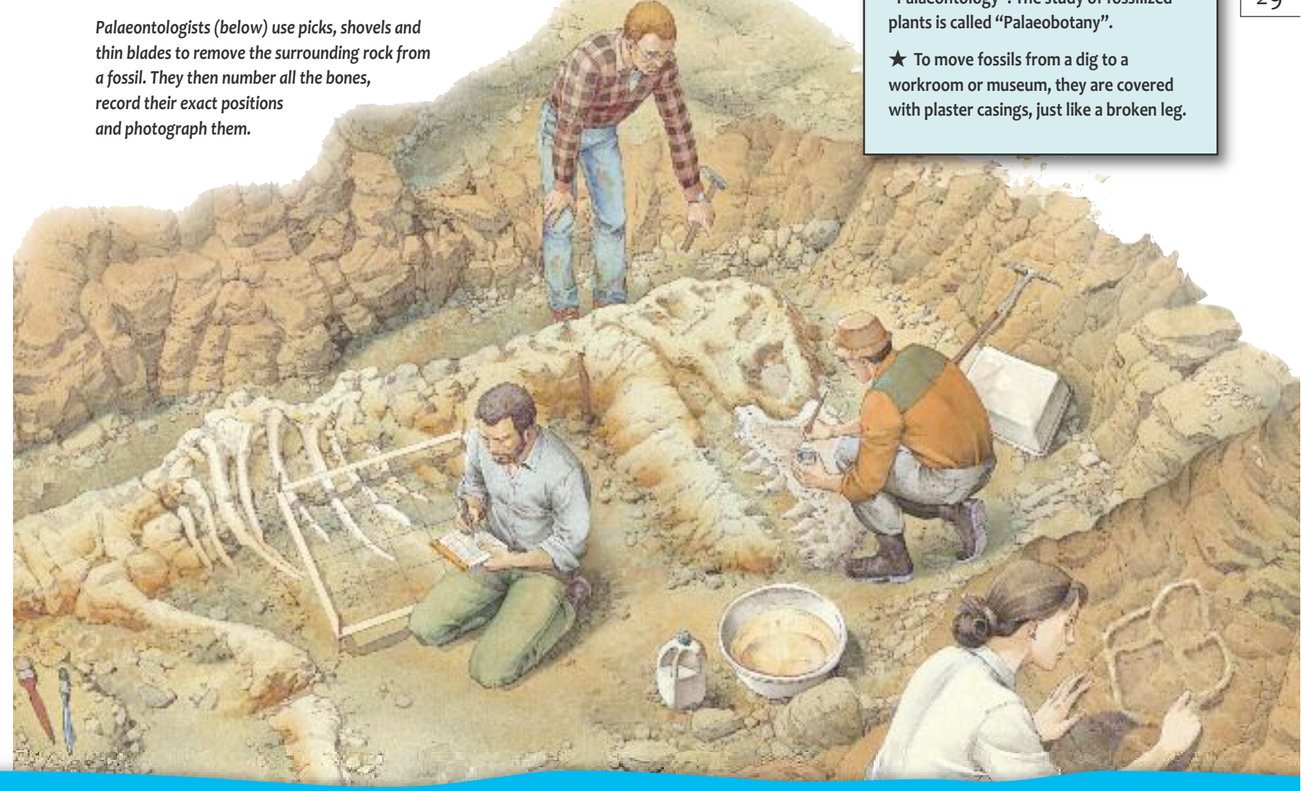
★ The word fossil comes from the Latin word *fossilis*, which means "dug up".

★ Most dinosaur fossil sites are in bare, rocky areas with hills and cliffs, far from roads and towns. Fossil-hunting is easiest where rocks are not covered by soil and plants. Here, the fossils can be seen at the surface, or dug out from just beneath.

★ It can take months or years to clean all the rock away from a fossil and fit the various pieces together to form a skeleton. Missing parts are often "borrowed" from another dinosaur of a similar type.

★ The study of fossilized animals is called "Palaeontology". The study of fossilized plants is called "Palaeobotany".

★ To move fossils from a dig to a workroom or museum, they are covered with plaster casings, just like a broken leg.



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