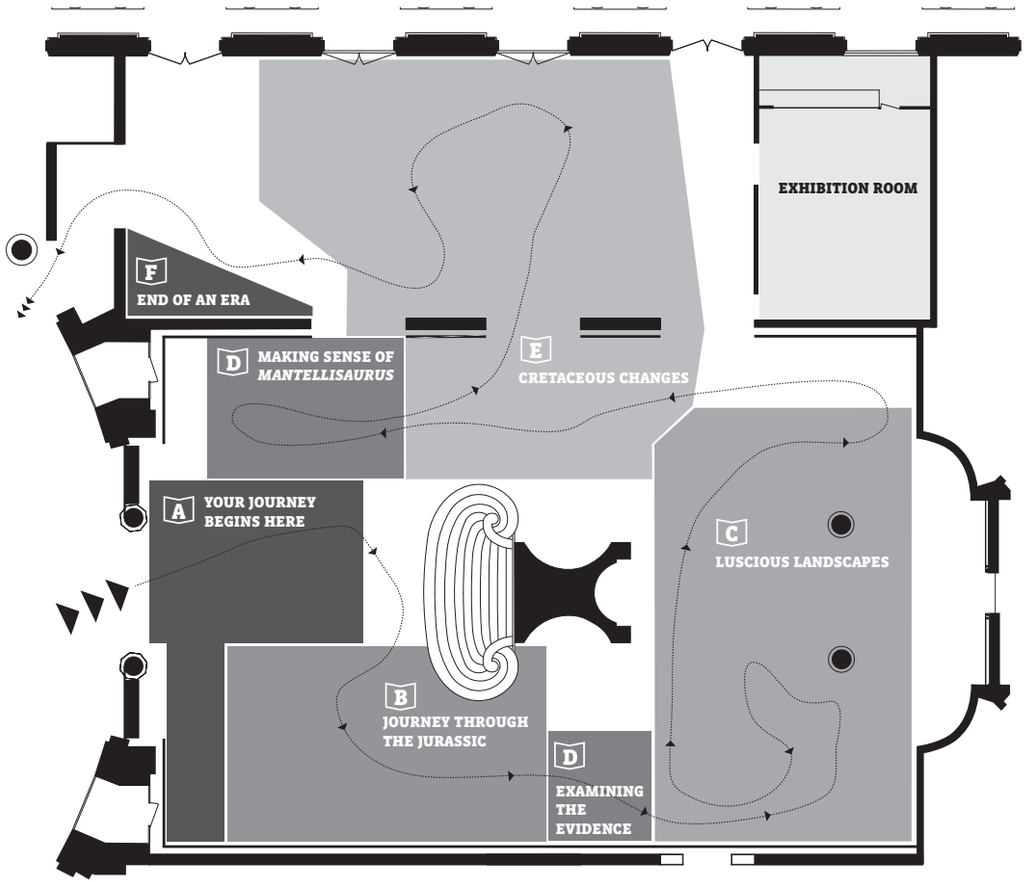


YOUR JOURNEY BEGINS HERE

A1

Step back in time and enter the age of the dinosaur. Flesh-eating or plant-munching, they ruled the world for 250 million years, and you're about to journey back to meet some of them...

Along the way you will investigate fossils and examine evidence to find out what the world looked like when dinosaurs walked on Earth.

Remember to use all your senses to compare the animals and plants you meet with the ones you know today. How are they similar? How are they different?

TYRANNOSAURUS REX
Footprint (replica)

Late Cretaceous, 67–65 million years old, New Mexico, USA

Trace around the three toes of this *T. rex* footprint and compare the size and shape to your feet. Now imagine how big its legs would have been and how fast it could run to catch its prey. *T. rex* grew up to 12 metres long and weighed as much as seven tonnes – the same as 100 people.

Timeline

Walk back in time and see when different animals and plants first appeared on Earth. How long ago did humans appear? What dinosaurs lived at the same time as each other? And when did they die out?

CHANGING CONTINENTS

A2

Hold on – the ground is moving.

Very slowly, Pangaea began to shift. During the Jurassic Period, hot liquid rock moving deep inside Earth caused the massive super continent to begin separating into the seven continents we know today.

Knowing how the continents moved is important because it helps us understand how animals and plants changed over time and how they are related to each other. Even though two similar animals live on different continents, because the continents were once joined together they may share ancient ancestors. Or they may be similar because they fulfil the same role in their environments, for example being the biggest carnivore.

SPECTACULAR SPECIMENS

A3

The plants and animals you are about to see are precious and unique. They are all fossils, the remains of animals and plants that have turned to stone over millions of years.

The Natural History Museum in London looks after these fossils and studies them to uncover more about the world around us and how it came to be the way it is.

Look carefully at the specimens you see. What do they tell you about the animal or plant? Even tiny marks can tell us what something looked like or how it lived and behaved.

PLEUROSTERNON BULLOCKII
Turtle shell

Early Cretaceous, 140–131 million years old, Dorset, UK

The first turtles lived on land, but by the Jurassic Period some had moved into the shallow seas along the coasts. They lived in a similar way to turtles today and this one used its sharp beak to eat shellfish, squid and seaweed. The outer layer of the beautiful shell is made up of horn-like scales that protect it.

CONIFER
Petrified wood that has turned to opal

Early Cretaceous 125–112 million years old
New South Wales, Australia

Not just a rock, this piece of wood has become a fossil made of the precious gemstone opal. It transforms from wood to opal when water rich in silica trickles through buried wood, creating a silica gel.
More than 90 per cent of the world's gem-quality opals come from Australia.

SARCOSUCHUS HARTII
Crocodile jaw (replica)

Lower Cretaceous, 110 million years old, Bahia, Brazil

Crocodiles today are not very different from their Jurassic and Cretaceous relatives. Look closely at this lower jaw bone. Can you see the teeth that are still attached? This was a fearsome predator that ate fish and turtles.
It also grew as long as a bus.

JOURNEY THROUGH THE JURASSIC

B1

Shut your eyes and imagine all the continents on Earth joined together. That's how the world looked 200 million years ago, at the start of the Jurassic Period. It was a world of huge forests. There were conifer trees as tall as houses and plants stretched as far as you could see, but no flowers yet.
The continent was called Pangaea.

Dinosaurs already ruled the land. Giant, long-necked sauropods such as *Diplodocus* roamed in large herds and huge meat-eating dinosaurs such as *Allosaurus* hunted them. But the dinosaurs weren't alone – small mammals and lizards shared the forest floor and a huge variety of insects and flying reptiles flew through the skies. The seas were full of life, too, including large marine reptiles.

Many new species of dinosaurs began to appear such as the armoured Stegosaurus. And an important new dinosaur group had evolved: birds.

AMAZING AMMONITES

B2

Ammonites are one of the most common fossils from the Jurassic. They had already been around for 150 million years when dinosaurs appeared, but died out at the same time. Today, all that's left of them are their hard shells. The animal inside was soft and had tentacles it used for swimming and catching food.

Different species of ammonite lived all over the world and at different depths in the sea. Some species evolved and then became extinct very quickly. These ammonites can help scientists to calculate the age of rocks and other animals preserved alongside them, because each species only lived for a short time.

Dig deeper

CHANGES OVER TIME

B3

Today we are concerned about rising sea levels destroying our homes and crops. Man-made global warming is melting the polar ice caps and causing sea levels to rise and we are seeing effects such as more extreme temperatures around the world.

In the Jurassic and Cretaceous Periods, the climate was hotter and more humid. There was no polar ice, so sea levels were much higher than they are today and more of Earth's surface was under water. After the middle of the Cretaceous Period, so sea levels started to fall.

These changes happened over millions of years and are a natural part of Earth's history. The difference today is that we believe climate change is mostly, if not totally, caused by human activity.

SEA STARS

B4

Many starfish (below), sea urchins and sea lilies today are similar to ones that lived in the sea millions of years ago. Together with feather stars and sea cucumbers, they form a group called echinoderms, which means spiny skin. All of them have five-rayed symmetry. This symmetry is easy to see in five-armed starfish, but in other echinoderms it can be harder to find. Can you find the symmetry in the sea lily photograph on the left?

Look for the fossil echinoderms in the case below. Have you seen similar animals on the beach?

FANTASTIC FISH

B5

How much do you think you have in common with a fish?
Run your fingers along the middle of your back – you both have a spine, or backbone, made of bones called vertebrae. Animals with backbones are called vertebrates, and by the Jurassic they had already been on Earth for around 250 million years.

Some of these fish had soft skeletons, which don't fossilise easily. Shark skeletons are made of cartilage, which is softer than bone, so most of the remains found today are just of their teeth. Because sharks are always growing new teeth to replace old ones, many are found all over the world.

MARINE MONSTERS

B6

While dinosaurs ruled the land, large predators called ichthyosaurs and plesiosaurs were in charge of the seas. At the top of the food chain was a giant plesiosaur known as a pliosaur, called *Liopleurodon*. A terrifying giant as long as a bus, its jaws were packed with dagger-like teeth and it could hunt down and eat anything it wanted.

Ichthyosaurs and plesiosaurs varied in shape and size, but had similarities, too. They both had four flippers and came to the surface to breathe. Scientists know that ichthyosaurs gave birth to live young in the sea because fossils of pregnant ichthyosaurs have been found. No fossils of pregnant plesiosaurs have ever been found, leading to theories that they may have laid eggs instead.

Predator of the seas

This fearsome marine reptile has been nicknamed Predator X as it has not yet been scientifically named. It was similar to another large plesiosaur called *Leopleurodon.*

Ammonites

1 ***LYTOCERAS SP***

Early Jurassic, 190 million years old, Dorset, UK

2 ***CORONICERAS BUCKLANDI***

Early Jurassic, 203 million years old, Bristol, UK

3 ***MANTELLICERAS MANTELLI***

4 ***HYPOTURRILITES TUBERCULATUS***

Both: Early Cretaceous, 120 million years old, Isle of Wight, UK

5 ***CRIOCERAS BOWERBANKII***

6 ***AUSTRALICERAS GIGAS***

Both: Late Cretaceous, 100 million years old, Kent, UK

Ammonites came in many shapes, sizes and patterns. As they grew, new sections of shell developed with individual chambers. Most grew in a flat, coil shape, but look at the variety here. The ones that are not a flat coil are called heteromorphs.

OPHIODERMA EGERTONI Brittle stars

Early Jurassic, 185 million years old, Dorset, UK

We can learn a lot about the last moments of the lives of these brittle stars from the position of their arms. They were all buried by an underwater landslide, which swept the arms of the single brittle star to the bottom left. The position of the arms of the other two shows them trying, unsuccessfully, to dig their way out of trouble.

1 

PTEROCOMA PINNATA
Feather star

Late Jurassic, 150 million years old, Bavaria, Germany

Just like its relatives alive today, this feather star used its feathery arms for catching food and swimming. The arms were usually held to the sides of the animal, but as it decayed the arm muscles contracted, which folded them into the shape you can see now.

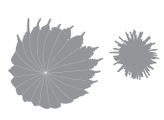
Lamp shells

2 ***CALCIRHYNCHIA CALCARIA***

3 ***SPIRIFERINA WALCOTTI***

All: Early Jurassic, 195 million years old, Gloucestershire and Somerset, UK

Many lamp shells, called brachiopods, became extinct at the end of the Cretaceous Period. But there are some still alive today. Most living brachiopods attach themselves to hard things such as rocks or shells, but these ancient fossil relatives lived on the soft, muddy sea floor. Look closely at the specimens. Can you see any differences between the two species?



ACROSALENIA HEMICIDAROIDES
Round sea urchin

PYGURUS MICHELINI
Oval sea urchin

PENTASTERIA HUXLEYI
Starfish

ISOCRINUS SP
Sea lily

ISOCRINUS SP
Sea lily

PALAEOCOMASTER SP
Feather star

All: Mid Jurassic, 165 million years old, Wiltshire, UK

This jumble of sea creatures was buried alive by an underwater landslide. The sea urchins died so quickly that their spines are still attached to their bodies. Can you spot the remains of the starfish, sea lilies and sea urchins? Look for the dark purple colour on the feather stars. It suggests they were brightly coloured when alive. Examples of fossilised colour like this are very rare.

1 ***ICHTHYOSAURUS COMMUNIS***
Ichthyosaur skull

2 ***PLESIOSAURUS DOLICHODEIRUS***
Plesiosaur skull

Both: Early Jurassic, 213–200 million years old, Dorset, UK

These two well preserved fossil skulls were discovered in different positions. It's easy to see the ichthyosaur's eye sockets and jaws because we can see the skull from the side. The plesiosaur skull has been crushed, making it harder to see the eye sockets. But you can still see its needle-like teeth and count the eight bones in its neck.

3 ***TEMNODONTOSAURUS PLATYODON***
Ichthyosaur tooth

4 ***PLESIOSAURUS ROSTRATUS***
Plesiosaur tooth

Both: Early Jurassic, 206–194 million years old, Dorset, UK

5 ***PLIOSAURUS FEROX***
Pliosaur tooth

Late Jurassic, 156–144 million years old, Peterborough, UK

Look closely at these ichthyosaur, plesiosaur and pliosaur teeth. Each has different ridges and cutting edges, but they all ate other sea creatures, including fish, ammonites and squid. Some big plesiosaurs, called pliosaurs, even ate small ichthyosaurs. Which of these teeth do you think belonged to the ichthyosaur eater?

1 ***PELONEUSTES PHILARCHUS***
Plesiosaur front paddle

Late Jurassic, 151–145 million years old, Peterborough, UK

2 ***ICHTHYOSAURUS SP***
Ichthyosaur front paddle

Early Jurassic, 213–200 million years old, Dorset, UK

What similarities and differences can you see between the ichthyosaur and plesiosaur paddles? Even though the paddles look similar, ichthyosaurs swam by moving their bodies and tail while plesiosaurs moved their more rigid, blade-like paddles up and down in a complex pattern called underwater flying, a bit like the way penguins swim today.

1 

HYBODUS CLOACINUS
Shark skull

Early Jurassic, 190 million years old, Dorset, UK

This jumble of teeth and cartilage is a squashed shark skull. Can you spot the sharp teeth? When it was alive, they were arranged in rows, with new teeth growing at the base of the jaw and moving up to the biting surface. This conveyer-belt type of tooth production is still seen in living sharks.

2 

MACROPOMA LEWESIENSIS
Fish coprolite

Late Cretaceous, 85 million years old, Sussex, UK

This coprolite is from a fish called a coelacanth. It is almost identical to one still alive today. Although thought to have become extinct in the Late Cretaceous, a coelacanth was discovered off the coast of South Africa in 1938. Look closely at the coprolite. Its spiral shape tells us the fish had a spiral-shaped intestine, like living sharks.

Fish

3 ***DAPEDIUM PUNCTATUM***

4 ***CATURUS HETERUS***

Both: Early Jurassic, 190 million years old, Dorset, UK

Fossil fish have been found all over the world. The ancient seas were teeming with different species, including these two. During the Jurassic Period, new types of fish began to appear. Dapedium had thick scales that protected it from predators. The tough scales also meant its fossils were well preserved.

EXAMINING THE EVIDENCE

D1

How do we know what the world looked like millions of years ago? No internet, no books, no people. So scientists have to piece together the evidence from fossils using lots of different techniques, including:

+ looking closely by eye and through a microscope
+ scanning to find out about the structure inside an animal or plant
+ recording information about where a fossil was found and what it was found with
+ examining surrounding areas to learn about environmental conditions
+ looking at coprolites to understand what animals ate
+ comparing fossils to similar animals alive today

Explore this area to find out more.

Dig deeper

WHAT COLOUR WERE DINOSSAURS?

D2

Until recently we didn't know, but a team of scientists in Britain and China discovered small parts of pigment cells, called melanosomes, in the fossilised feathers of birds and dinosaurs living in China during the Cretaceous Period. Using a technique called scanning electron microscopy, they were able to study the melanosomes in great detail.

They found they were the same as those in the feathers of birds alive today. Comparing them can tell us what colours some dinosaurs were.

They now know *Sinosauropteryx*, a small bird-like dinosaur, had dark-coloured stripes along its tail and an orange-coloured crest along its back.

Scientists are studying other fossils in this way but we don't know the colour of most dinosaurs. What colours do you think they were?

LUSCIOUS LANDSCAPES

C1

Jurassic plants and trees included some we recognise today. There were forests full of conifers similar to our Christmas trees and also ones very like monkey puzzles. Under the towering canopy were smaller plants that looked similar to ferns and horsetails. See if you can recognise any from the picture below.

During the Jurassic Period, plants did not have flowers. Instead, many had cones full of seeds and pollen, or tiny capsules containing spores. Today these kinds of plants make up just 20 per cent of all plant species. But in the Jurassic Period they were more common and there was a greater variety.

DINOSAUR DETAILS

C2

Look at the amazing range of dinosaurs that lived in the Jurassic Period. Even though there is a huge variety of shape, diet, size and skeleton structure, scientists divide dinosaurs into just two groups, depending on the shape of their hips.

There are lizard-hipped dinosaurs, called saurischians (say sore-iss-she-ans), such as giants like Camarasaurus and the meat-eaters that walked on two legs like Allosaurus. And there are bird-hipped dinosaurs, called ornithischians (say or-nyth-iss-she-ans), such as Stegosaurus. Look at the picture below to see the difference in bone shapes between the lizard-hipped dinosaur at the top and the bird-hipped dinosaur at the bottom.

WINGED WONDERS

C3

The Jurassic skies were filled with flying reptiles called pterosaurs. They were related to dinosaurs and were the first animals with backbones to be able to fly. Scientists think they flapped their wings as well as gliding, like many big birds do today. More than 100 species of pterosaur have been discovered and new ones are being found all the time.

During the Jurassic, pterosaurs began to share the skies with a related but different group – birds. Birds might look similar to flying reptiles, but they actually evolved from dinosaurs.

Dig deeper

NEW TECHNOLOGY MEETS OLDEST BIRD

C4

New technology is constantly developing and helping us discover more about how animals lived millions of years ago.

Scientists at London's Natural History Museum have been using CT scans to find out how well *Archaeopteryx*, the oldest known bird, could hear.

They discovered that the length of part of the inner ear, called the cochlear duct, is a clue to hearing ability in animals. By scanning *Archaeopteryx*'s ears, and comparing the length of its cochlear duct with those of 59 living species of bird and reptile, they could find out whether it heard more like a reptile or a bird.

The results revealed *Archaeopteryx* had bird-like hearing ability, similar to modern emus.

JURASSIC FIELD GUIDE

C5

Which of these animals and plants have you seen already? Look out for the others during the next part of your journey.

1 ***CYCADEOIDEA MICROPHYLLA***
Trunk

Late Jurassic, 150–142 million years old, Dorset, UK

2 ***ZAMITES GIGAS***
Leaf

Mid Jurassic, 175–160 million years old, North Yorkshire, UK

This is a trunk and leaf imprint from two of the most common types of Jurassic plant. Both these plants had a ball-shaped trunk with fleshy stems and leaves sprouting from the top. Although they look similar to some modern plants, scientists don't think they are closely related. Plants like these lived right across the world throughout the Jurassic and Cretaceous Periods, but are now extinct.

3 ***SAUROPOD DINOSAUR***
Herbivorous dinosaur fossil poo

Upper Cretaceous, 70 million years old, India

Fossil poo, called coprolite, can help scientists understand the relationships between animals and plants.
Inside this coprolite are leaf cuticles – microscopic fragments of the waxy leaf surface – that have survived being digested by the animal that ate them. The fragments give scientists vital information about what the animal ate and which plants and animals lived together.

CONIFER
Fossilised wood

Mid–Late Jurassic, 165–157 million years old, Dorset, UK

This fossil conifer is inside a block of rock called a septarian nodule. The name comes from the Latin word septum, which means partition and refers to the distinctive cracks inside. Septarian nodules don't always have fossils inside them, but in this example the wood forms a circular feature in the centre.

JET

Early Jurassic, 184–180 million years old, North Yorkshire, UK

Almost 200 million years ago, this shiny gemstone was a piece of tree trunk. When the tree died, it washed out to sea and sank to the bottom. The weight of the mud that settled on it and the enormous weight of the water above caused so much pressure that, over millions of years, it became jet.

MEGALOSAURUS SP
Jaw (replica)

Mid Jurassic, 170–165 million years old, Oxfordshire, UK

Megalosaurus was the first dinosaur to be named by scientists in 1824. Feel its teeth. What kind of food do you think it ate? Compare these teeth with others that you find in the exhibition. Which animals ate meat? Which ones ate plants?

ALLOSAURUS SP
Claw (model)

Late Jurassic, 156–144 million years old, USA

Allosaurus was the top predator in the Late Jurassic. It had three huge claws like this one on each of its hands and used them for slashing and holding down prey. It ate other dinosaurs such as *Stegosaurus*, whose armour plates were not always enough to stop the faster and more agile *Allosaurus*

STEGOSAURUS ARMATUS
Tail spike (model)

Late Jurassic, 155–145 million years old, Colorado, USA

Stegosaurus had a fearsome weapon at the tip of its tail – two pairs of large spikes. The dinosaur used its powerful tail muscles to swing the spikes at attackers, aiming for their soft bellies and vulnerable legs.

A direct hit could inflict a lot of damage. Scientists have found a tail bone from *Allosaurus* with a *Stegosaurus*-spike-shaped puncture through the bone.

COMPSOGNATHUS LONGIPES
(replica)

Late Jurassic, 151–145 million years old, Bavaria, Germany

Not all dinosaurs were huge and heavy. *Compsognathus* was one of the smallest: about the size of a chicken. It was an agile hunter and used its razor-sharp claws and blade-like teeth to catch small animals such as lizards and insects. Look carefully near the ribs – can you see the tiny bones wwof a lizard called *Bavarisaurus*? It was probably the dinosaur's last meal.

1 ## *STEGOSAUR*
Skull (model)

Late Jurassic, 151–145 million years old

2 ## *DACENTRURUS ARMATUS*
Stegosaur tail spike

Late Jurassic, 151–145 million years old, Wiltshire, UK

If you were a plant-eating dinosaur, how would you protect yourself from the big meat-eaters? Stegosaurs such as *Dacentrurus* were covered in tough armour plates and had spikes at the tip of their tails, like this one. A well-aimed swipe would have severely injured any attacker.

PETALURA SP
Dragonfly

Late Jurassic, 151–145 million years old, Bavaria, Germany

Dragonflies were just one of many insects buzzing around the Jurassic skies and crawling on the land. They lived alongside the ancient relatives of insects we know today, including moths, earwigs, flies, bees, wasps and ants. Look how clearly the details of the wings have been preserved in this specimen.

CAMARASAURUS SP
Leg and shoulder bones (replica)

Late Jurassic, 156–144 million years old, Wyoming, USA

Stand next to this huge sauropod leg. And *Camarasaurus* wasn't even the largest sauropod... that honour is reserved for *Argentinosaurus*, which weighed in at 70 tonnes. That's heavier than 10 elephants. Look at how the bones of the animal fit together, from the huge shoulder blade to the small toes.

DORYGNATHUS SP
Pterosaur (model)

Early Jurassic, 200–176 million years old, Germany

Can you see the pterosaur above you? Take a closer look at its unusual teeth. The sharp, curving ones at the front helped it grab and hold on to slippery prey, like fish. Its name means spear-jaw.
Dorygnathus lived and fished around sea coasts in the early Jurassic. It was common in the area that is now Germany.

PTERODACTYLUS SP
Pterosaur skeleton (replica) and foot

Late Jurassic, 151–145 million years old, Bavaria, Germany

These rocks have been split in half to reveal a fossil inside. Can you see the bones and imprints in both sides of the rock? The foot is from a larger pterosaur. The complete skeleton, although once thought to be a small species, is now thought to be from an individual not yet fully grown.

ARCHAEOPTERYX LITHOGRAPHICA
(replica)

Late Jurassic, 151–145 million years old, Bavaria, Germany

Scientists think *s* was the first bird. It is especially important because it proves the theory that birds evolved from dinosaurs. It had some bird-like features, such as wings, tail feathers and foot bones for perching on branches. But unlike birds it had long, slim jaws lined with sharp teeth and a long, bony tail like a meat-eating dinosaur. Scientists think its flying muscles may have only been strong enough for it to travel short distances.

CRETACEOUS CHANGES

E1

The world carried on changing during the Cretaceous. It was cooler than the Jurassic but warmer than today, and by the end of the period the continents had broken up so the map of the world looked almost like it does now. The level of the sea was much higher, so more land was underwater.

The variety of dinosaurs increased and changed. Giant sauropods no longer ruled Earth. Instead, duck-billed dinosaurs, called hadrosaurs, roamed the forests and the most feared dinosaur of all, *Tyrannosaurus rex*, ate them. Other new species of animal lived underwater, in the air and on the land. Plants changed, too, developing flowers for the first time.

FIRST FLOWERS

E2

There were no flowers before the Cretaceous Period. Instead plants used seeds, pollen or tiny capsules containing spores to reproduce, a bit like conifers and ferns do now. The first flowers were small, and most stayed that way. But by the end of the Cretaceous, flowering plants had become the most common type and some of the flowers were large, such as magnolias (pictured) and water lilies.

Conifer trees, ferns and other plants that were common in the Jurassic continued to grow. The landscape looked more and more similar to the way it looks today, but there was still no grass.

CRETACEOUS CO-OPERATION

E3

Animals and plants are linked because they share the same environments and also because animals depend on plants for their food.

Sometimes the relationship between animals and plants is so close that it seems like they are becoming successful because of one another. This is called co-evolution.

Flowering plants, called angiosperms, became very successful very quickly during the Cretaceous Period. The spread of flowering plants happened at the same time as insects and mammals became more diverse. The plants depended on animals such as bees and small mammals to spread their seeds, and for pollination.

The animals were attracted to the plants by their flowers and for food. In turn they became food for others such as this early bee-eating beetle preserved in amber.

DINOSAUR DIVERSITY

E4

New kinds of dinosaur evolved during the Cretaceous Period, but some groups were more successful than others. In the northern hemisphere most of the huge sauropods disappeared and were replaced by herds of other herbivores, such as hadrosaurs. Many had different shaped bony crests on their heads, like those below.

There was also a greater variety of armoured dinosaurs. Instead of stegosaurs, the ankylosaurs became successful along with the horned-faced ceratopsian family, including *Triceratops*, with its frills and horns. There were more theropod dinosaurs – meat-eaters that walked on two legs – ranging from the small but vicious *Velociraptor* to the most famous predator of all, *Tyrannosaurus rex*.

Dig deeper

HOW DO YOU CHEW?

E5

Hadrosaurs, like the *Lambeosaurus* you can see here, did not have the complex jaw joint found in mammals, so scientists, including those at the Natural History Museum in London, wondered how they ate. Until now...

They examined tiny scratches on the teeth of *Edmontosaurus* that reveal how the teeth moved while the animal was eating. The results show the teeth moved up and down, side to side and front to back. So we know hadrosaurs were unique and chewed in a completely different way to anything alive today.

TWIN TYRANTS

E6

Look how similar these dinosaurs are: fearsome teeth and claws, walking on two legs, tiny forearms. But they are actually different species – *Tyrannosaurus rex* and *Tarbosaurus* bataar. *Tyrannosaurus* lived in North America and *Tarbosaurus* in Asia. They were both top predators and ate other dinosaurs. Scientists think they are very closely related even though they lived on other sides of the world. Some even think they are really the same species.

But there are differences. *Tyrannosaurus* had eyes that faced forward but *Tarbosaurus* had more sideways facing eyes. And lab tests show that *Tarbosaurus* had a less flexible jaw.

Could you tell them apart? Use the silhouettes here and in the specimen labels as a clue.

Dig deeper

AUSTRALIAN *TYRANNOSAURUS?*

E7

In the past, dinosaurs such as *T. rex* and *Tarbosaurus* have only been found on the northern continents of North America and Asia. But new evidence for the first ever tyrannosaur on the southern continents has been uncovered in Australia.

Scientists found a 30-centimetre-long hip bone they think belonged to an ancestor of *T. rex* that lived 110 million years ago, 45 million years before *T. rex*.

It was much smaller than *T. rex*, at just three metres long. It seems as though tyrannosaurs grew gradually bigger over time.

This dinosaur lived when the southern continents of South America, Antarctica, Africa and Australia had separated from the north but were still joined to each other.

CRETACEOUS FIELD GUIDE

E8

It's time to put your observation skills into action. Which of the fossils here have been brought back to life? As you walk through the Cretaceous, will you be able to spot them all?

1 ***PROTOPTERIS PUNCTATA***
Tree fern trunk

Early Cretaceous, 112–100 million years old, Dorset, UK

2 ***ARAUCARIA MIRABILIS***
Cones

Mid Jurassic, 176–161 million years old, Patagonia, Argentina

There are still tree ferns with trunks similar to these around today, and cones appear on many different species of tree. These ones are from an ancient monkey puzzle tree. Both kinds of plants were common across the world during the Jurassic and Cretaceous Periods.

3 ***SALIX PROTEAIFOLIA***
Flowering plant leaves

4 ***SASSAFRAS LANCEOLATA***
Flowering plant leaves

5 ***ARALIOPSOIDES CRETACEA***
Flowering plant leaves

All: Late Cretaceous, 100–93 million years old, Kansas, USA

Look closely at these leaf fossils. The leaves all come from flowering plants that first appeared in the Cretaceous Period. Can you see any that remind you of modern plants? Identifying plants by leaf shape alone can be difficult,

and the relationships of ancient fossil leaves to modern leaves are often tricky to work out.

6 

MENISCOESSUS SP
Mammal tooth

Late Cretaceous, 67 million years old, Wyoming, USA

Mammals became more varied during the Cretaceous, although most were still small and probably nocturnal. This one was a member of a now extinct group called *Multituberculata*. Most of the fossil evidence we have of mammals is of teeth such as this one, because they are the most durable parts of the animal. Complete skeletons are very rare.

PROTOCERATOPS ANDREWSI
Skull (replica)

Late Cretaceous, 80–73 million years old, Mongolia

Protoceratops lived in the desert, so it had to be tough to survive. Look at its jaws from the side, they're like a pair of gardener's shears and were used in exactly the same way. The strange triangular shape of its head may have helped individuals to recognise each other, or may have been used for defence.

1 

LAMBEOSAURUS LAMBEI
Skull (replica)

Late Cretaceous, 80–73 million years old, Alberta, Canada

Lambeosaurus had a long beak and jaws with teeth that were constantly replaced during the animal's life. It could have had up to 700 teeth – 22 times more than a human. The special crest on this dinosaur's head was connected to the back of its nose and throat. Scientists think it was used for communicating with other duck-billed dinosaurs and enhanced their sense of smell.

2 

GALLIMIMUS BULLATUS
Skull (replica)

Late Cretaceous, 97–65 million years old, Mongolia

Look at this skull and see how high the large eye sockets are. Because of this, *Gallimimus* probably had good all round sight that helped it to see approaching predators and escape before it became dinner. *Gallimimus* didn't have any teeth. Instead its long jaws were probably covered by a horny beak that it may have used to crack open the eggs of other dinosaurs.

1 

ANKYLOSAURUS SP
Armoured plates

Late Cretaceous, 68–65 million years old, Montana, USA

These plates, called scutes, were part of the heavy armour coating that covered *Ankylosaurus* and protected it from attack. However, predators would be lucky

to get that close because *Ankylosaurus* had a club-like bone at the end of its tail that was powerful enough to send unwanted attention flying. It was also armed with spines on the back of its skull and along its back.

2 *MARGARITIFERA VALDENSIS*
Freshwater mussel

Early Cretaceous, 125 million years old, Isle of Wight, UK

3 *VIVIPARUS CARINIFERUS*
Pond snails

Early Cretaceous, 120 million years old, Surrey, UK

Snails and mussels are molluscs – animals that have a shell and use a type of foot to hold on with. They first appeared millions of years before the Jurassic Period and have hardly changed since. In fact, the descendants of these molluscs are still alive today. Finding mussels like this shows the environment in the area was probably an ancient freshwater pond or river.

TYRANNOSAURUS REX
Half skull (replica)

Late Cretaceous, 68–65 million years old, Montana, USA

Tyrannosaurus rex had jaw muscles that were so big its skull was extra wide at the back to make space for them. These powerful muscles crunched so hard on prey that it needed special links between its skull bones to act as shock absorbers.

TYRANNOSAURUS REX
Tooth (model)

Late Cretaceous, 68–65 million years old, USA

Feel this tooth and imagine a whole mouthful of them bearing down on an unfortunate victim. *T. rex* was a top predator, and its teeth were wider than those of other meat-eaters. They had serrated edges at the front and back, like a knife – perfect for ripping through the flesh of other dinosaurs.

TARBOSAURUS BATAAR
Claw (model)

Late Cretaceous, 70 million years old, Mongolia

Pinned down by sharp claws like this one, it would be difficult to get away from *Tarbosaurus*. The top predator in Mongolia, it lived in a desert environment. Of all dinosaurs from this group, *Tarbosaurus* had the shortest arms compared to its huge body, head and legs.

MAKING SENSE OF *MANTELLISAURUS*

D3

Look at these *Mantellisaurus* bones in the case, which were found in Surrey, UK. They are just the beginning of the story. Painstaking research was done over many years to learn more about the environment *Mantellisaurus* lived and died in.

Scientists studied rock samples collected nearby to discover more about the environment, plants and animals at the time *Mantellisaurus* lived.

Results showed there were many algae and small shrimp-like animals called ostracods around, along with pollen from early flowering plants, photographed below.

From the evidence, we know this *Mantellisaurus* came to rest in a pool on a warm, subtropical floodplain that was surrounded by ferns and conifers.

GIANT JIGSAW

D4

This photo shows more than 100 pieces of fossil wood that make up a single tree. When it was put back together, like a huge jigsaw puzzle, it was more than 12 metres tall: twice as tall as a giraffe. The tree is very special because it is so complete and helps scientists understand how trees like this one grew. By looking at the way the tree fell, scientists were able to tell it died because of an earthquake.

Laser scans were taken of each section. From these a virtual model was built that shows what the surface looked like and where the branches were. It can be rotated so scientists can look at how the different parts work together.

MANTELLISAURUS ATHERFIELDENSIS

1 **Toe bone**

2 **Thumb spike**

Early Cretaceous, 130–125 million years old, Surrey, UK

Dinosaurs might have lived hundreds of millions of years ago, but the first fossils were not discovered until about 200 years ago. One of the first dinosaurs to be found was *Iguanodon*, now called *Mantellisaurus*, but discoveries are still being made today. These two bones are part of a skeleton found in 2001. Look at the thumb spike – *Mantellisaurus* may have used it to defend itself against attackers.

END OF AN ERA

F1

Your journey began in the Jurassic and now you have reached the end of the Cretaceous Period. About 150 million years have passed.

The end of the Cretaceous marks the extinction of dinosaurs, pterosaurs, plesiosaurs, ammonites and many other groups. But not all animals died out – the ones that survived evolved into the ones we know today. That makes some of them your earliest ancestors. But it was nearly 65 million years after the end of the dinosaurs before the first modern human.

Dig deeper

EXTINCT THEORY?

F2

Many people think an asteroid impact wiped out the dinosaurs and many other animals in an event called the KT extinction. But scientists have now proved dinosaurs began to decline millions of years earlier.

The asteroid may have been just one factor in the mass extinction, along with increased volcanic activity, areas that used to be underwater being exposed and changes in the climate.

By looking at evidence, we know volcanoes have been a cause of the other big extinctions in Earth's history. But there is no evidence that objects from space have caused extinctions before.

But did you know there is a mass extinction happening right now? Most scientists believe this one is caused by man-made factors such as climate change.

SUPER SURVIVORS

F3

Many species have become extinct over the 65 million years since the end of the Cretaceous. But some that lived with the dinosaurs are still around today. Maidenhair trees, Gingko biloba, have leaves and trunks that are very similar to the many species of Gingko that lived in the Jurassic and Cretaceous Periods.

MULTIPLYING MAMMALS

F4

When dinosaurs died out, the way was clear for other species to take their place. The mammals that lived during the Cretaceous evolved into many different groups – from shrew-like insect-eaters to early ancestors of whales and apes. And mammals have thrived on Earth ever since.

FUTURE FOSSILS?

F5

Humans are the most dominant species on our planet today.
But we've only been around for 100,000 years. What will the dominant plant and animal groups be in another 65 million years? Mammals? Reptiles? Or a group that hasn't even evolved yet? What do you think?

GOING GREEN

Our green credentials

We work hard to make our exhibitions as sustainable as possible. We consider environmental impact and sustainability when selecting materials in constructing exhibitions and ensure they have as long a lifetime as possible. The showcases from this exhibition will be reused on other exhibitions. Hardware and AV equipment will be reused where possible.

Our graphic panels use low-energy LED lights, which reduces energy consumption by up to 30 per cent. The LED light units are expected to last around 100,000 hours, which is four times longer than fluorescent lamps. After closing here, the exhibition will tour for at least five years. At the end of its life, all the exhibition materials will be recycled where possible.
All this contributes to our commitment to care for the natural world.

CREDITS

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