Slide 1 – Fossils

**Teacher and presenter guidance**

* This presentation is broken down into 5 main sections with the final section being an activity idea. Each slide has some suggested guidance in the notes section on how to explain the slide, with **possible questions to ask highlighted in bold.**
* The Geological Society gives permission for individuals to adapt the presentation however they see fit.
* Factsheet and activity sheet on fossils suitable for KS2 pupils available at [www.geolsoc.org.uk/resources](http://www.geolsoc.org.uk/resources)

Slide 2 – What is a fossil?

* **What is a fossil?** Have children guess (may suggest things like shells, ancient animals, dinosaurs, bones, teeth, insects in amber, might know specific names such as tyrannosaurus rex, woolly mammoth, ammonites, trilobites etc. ) - click to get rid of question marks
* Click to appear **-** Fossils are the preserved remains or preserved traces of plants and animals which once lived on Earth. Fossils come in all shapes and sizes. They can be whole animal skeletons, parts of bones, shells, teeth, leaves, wood, bacteria, feathers, scales or they can be traces of animal activity such as burrows, footprints and even poo (known as coprolites). Fossils can be huge like the skull of a T. rex or so tiny that you can only see them by using very powerful microscopes in a laboratory. The only reason we know that animals such as dinosaurs, pterodactyls, sabre tooth cats, ammonites and trilobites ever existed is because their remains were preserved as fossils.
* **What do we call scientists that study fossils?** palaeontology is the study of the history of life so scientists that study fossils are called palaeontologists – click to appear
* **Why do you think palaeontologists want to study fossils?** Many different answers, could include - to discover what animals and plants used to live on Earth, to study how life has changed (or evolved) over time, to study mass extinctions and past climates, to discover what ancient animals used to eat, where they lived and how they behaved etc.
* There are many different types of palaeontologist because there are many different types of fossils. Palaeontologists don’t all study dinosaur bones. Some might study fossil fish, fossil mammals, fossil plants, fossil invertebrates like insects and crustaceans, or microfossils - tiny fossils that can only be seen under the microscope.
* Palaeontology is a combination of geology – the study of rocks, and biology – the study of life. Palaeontologists also use many other types of sciences to help them understand the past. For example to figure out how hard a Tyrannosaurus Rex could bite, palaeontologists used maths and engineering. To work out how warm or cold the oceans would’ve been millions of years ago, palaeontologists use chemistry to analyse the shells of tiny fossil microorganisms called foraminifera.

Slide 3 - Trace fossils

* Fossils don’t always have to be parts of animals or plants. They can instead be evidence for their activity, these types of fossils are called trace fossils. Palaeontologists can use trace fossils as clues for how animals used to live.
* **What do you think these trace fossils are?**
* Dinosaur footprint
* Borings, when animals burrow into solid rock – boring can be made by animals called piddocks - you might have heard of cockles, mussels, scallops, clams and oysters – these are all related to piddocks (bivalves).
* Burrows – are usually made by fish, bivalves and crustaceans on the sea floor
* Coprolite – fossil poo thought to be from a Tyrannosaurus rex

Click for names and example of modern borings in rock

Slide 4 – Moulds and Casts

* Sometimes when fossils form, the actual animal or plant completely dissolves away leaving only an outline of its shape in the rock. This impression or hollow shape is called a mould.
* **You could demonstrate forming a mould using playdough/plasticine and a cheap fossil/shell/toy dinosaur.**
* If this mould gets filled in with minerals it creates a replica of the organism’s original shape. This replica is called a cast and does not contain any material from the original animal or plant.

Moulds and casts are not always trace fossils! Remember that trace fossils show evidence of animal behaviour like burrows and footprints whereas moulds and casts can just be imprints of the original animal or plant.

Slide 5 - How are fossils formed?

* Most plants and animals that die do not become fossils. **Why do you think most living things don’t become fossils?**
* When animals and plants die they are usually be eaten by scavenging animals, are broken up and weathered by wind, ice and waves, or they simply decay away. However there are a number of different ways that fossils can form if the conditions are right. The most common way for a fossil to form is for it to be buried quickly in soft sediment like mud or sand in a calm watery environment such as the bottom of a lake or sea floor.

Slide 6 – Stage 1 - Animal dies

* In this example a marine reptile called a plesiosaur dies and its body falls to the sea floor.

Slide 7 – Stage 2 – Rapid Burial

* Normally other animals would eat the dead animal or it would rot away, however in this case a submarine landslide occurs nearby burying the plesiosaur in soft muddy sediment and protecting it from being gobbled up or damaged.

Slide 8 – Stage 3 – Decay of Soft Parts

* The muscles, skin and other soft parts of the plesiosaur are then digested by bacteria in the sediments. Only the hardest parts such as the bones and teeth are left.

Slide 9 – Stage 4 – Build-up of sediments and fossilisation

* As time passes, more and more sediment builds up in layers on the sea floor. The weight of the overlying layers squashes the soft mud and it begins to turns into rock. This is called lithification.
* Water is squeezed out of the mud and seeps into the plesiosaur bones. Minerals and chemicals in this water gradually change the bones and teeth into stone. The plesiosaur bones are now fossilised but they are buried under layers and layers of rock under the ocean.

Slide 10 – Stage 5 – Uplift

* Over millions of years, sections of the Earth’s crust called tectonic plates move around. Continents can crash into each other and shove rocks upwards during mountain building, earthquakes and other processes. Sea levels can also rise and fall over time exposing or covering up new areas of rock. Over time rocks that were previously at the bottom of the ocean can be uplifted onto land.
* The rocks at the top of Mount Everest in the Himalayas contain lots of marine fossils meaning that although now they over 8km above sea level, these rocks were actually formed under the sea.

Slide 11 – Erosion and Exposure

* Over, millions of year the rock layers on the Earth’s surface are gradually stripped away by weathering and erosion, wind, water and ice break down the rock into smaller fragments and they are then transported away by river, glaciers and wind.
* Part of the plesiosaur skeleton has now been revealed at the surface and can be discovered by a lucky fossil hunter!
* It is very rare to find full skeletons as fossils, in reality it is much more likely that you would find a small piece of bone or tooth.

Slide 12 – Other ways fossils can form – Amber

* Another way fossils can form is by getting trapped in amber. **What is amber? (Jurassic Park!)**
* Amber is fossilized tree resin, a sticky substance produced by plants in order to protect them from pests and predators. Small animals such as insects, spiders and even lizards can get stuck in this resin and be preserved almost perfectly for millions of years. Because amber preserves animals so well it allows palaeontologists to study tiny fragile structures that ordinarily would not be preserved.
* In 2011 palaeontologists managed to find 80 million year old dinosaur feathers preserved in amber from Canada. The feathers are preserved in 3D and grey, white, brown and red colours can even be seen. These feathers are thought to be some of the earlier forms of feathers that dinosaurs had, and are extremely rare in the fossil record.

Slide 13 – Other ways fossils can form – Tarpits

* Fossils can also form when animals and plants become trapped in tar, or asphalt. Tar is a thick, black, sticky liquid that is often used to make roads and school playgrounds. However naturally, it occurs in rocks deep within the Earth’s crust. It can sometimes bubble up through cracks in the crust to form large pools on the surface.
* A good example of this can be seen in the La Brae tar pits in California. Fossils of large mammals such as mammoths, giant sloths, sabre tooth cats, dire wolves and short faced bears have been found in the La Brae tar pits, but the tar can also preserves things like wood and plant remnants, rodent bones, insects, molluscs, seeds, leaves, and even tiny pollen grains.
* Palaeontologists think that the reason tar pits preserve so many fossil is because the surface of the tar would become covered in dust, leaves and water so would not be an obvious danger to animals. Animals such as mammoths would then wander in, become trapped, and eventually die. Predators such as dire wolves and sabre tooth cats would then enter the tar pits to try and eat the trapped animals and would become stuck themselves!
* The painting shows what the La Brae tar pits may have been like 10,000 years ago. **What different living things can you see in the painting?** Giant sloths, sabre tooth tiger, condors (vultures), mammoths (in background) and cypress tree.

Slide 14 - Other ways fossils can form – Ice

* Ice can also preserve animal and plant remains. When they are frozen, animal bodies tend to dry out and shrink to become mummified.
* **What animal do you think this would have been?**
* This fossil is a female mammoth calf found in the Russian arctic peninsula in 2007. It was given the name Lyuba which means ‘love’ in Russian. Lyuba lived 42,000 years ago and was about the size of a large dog when she died at one month old. Palaeontologists studying Lyuba have found that her truck is full of mud. They think that she died in a mud pool which then froze and preserved her body for thousands of years.

Slide 15 – Exceptional preservation – Fossil Colours

* If the conditions are perfect, the soft parts of animals such as muscles, feathers, skin can sometimes be preserved as fossils. Sometimes even entire animals made of soft tissue, like jellyfish and worms, can be preserved. Palaeontologists call this exceptional preservation because it is so rare to find fossils preserved in such detail.
* Exceptional preservation can sometimes even show us prehistoric animal colours. Feathers, scales and hair all contain tiny microscopic structures called melanosomes. Humans have melanosomes in their hair and skin. These melanosomes have different shapes depending on their colour. Melanosomes can be sausage shaped or round. Sausage shaped melanosomes give black, brown and yellowy colours whereas round melanosomes are a reddish orange colour.
* In extremely rare cases melanosomes can be preserved in fossils and by using powerful microscopes, palaeontologists can work out some of the colours of fossil feathers and scales.
* Palaeontologists have recently been studying the melanosomes in the feathers of a fossil dinosaur called Sinosauropteryx (bottom image). They think that it would have been covered in orange feathers with a white and orange striped tail! If you look closely at the fossil you can see feathers running all the way down its back and you can even see where the stripes would’ve been on its tail.
* Another dinosaur called Microraptor (top image) also has extremely well preserved feathers. From studying the melanosomes in the Microraptor feathers, palaeontologists think that this dinosaur it would’ve been covered in glossy black iridescent feathers like a starling.

Slide 16 – Mary Anning – may be more suited to history lesson

* **Does anyone know who this famous palaeontologist is?** Click for Mary Anning
* Mary Anning was born on 21 May 1799 in Lyme Regis in Dorset. At this time, geology and palaeontology was a very new science. People did not know how fossils were formed and it was thought that the Earth was 6000 years old (when we now know that it is in fact 4.5 billion years old).
* Mary’s father Richard Anning was a carpenter but he spent a lot of his time collecting fossils and often sold these to tourists who visited Lyme Regis. He would often take Mary and her brother Joseph along the sea shore to search for fossils.
* Sadly Mary’s father died in November 1810 when Mary was 11 years old. He left his family with £120 of debts which was a huge amount of money in these days.
* Mary Anning did not go to school because her family could not afford to pay for it. Instead she taught herself to read and write at home, and she became very interested in learning about geology and anatomy (the structure of human and other animal bodies). She would often hunt for fossils on the sea shore with her dog Tray, and she particularly liked to go out after big storms when the wind and waves would break up the rocks and expose new fossils.

Click for ichthyosaurus

* In 1811 when Mary was 12 years old, her and her brother Joseph were hunting fossils on the sea shore and they found something very interesting sticking out of the cliff. It looked a bit like a crocodile skull and with careful excavation they managed to extract the whole skeleton in two parts. It turned out to be a marine reptile called an Ichthyosaurus. This was the first complete skeleton of an Ichthyosaurus ever found and it had a lot of attention from scientists of the day. However because Mary and her brother were uneducated and from a poor family they did not receive any credit for finding the Ichthyosaurus.
* Mary continued to hunt for fossils throughout her life and became famous for her knowledge and ideas about palaeontology. Scientists would often visit her in Lyme Regis to seek her opinions on their work.
* Because she was female and working class, Mary was not allowed to join any of the country’s prestigious scientific groups during her lifetime. At this time women were not allowed to vote or attend university. Working class women like Mary were supposed to work on farms, in a factories or as maids, but this was not what Mary wanted to do. Instead she opened a small shop in Lyme Regis to sell her fossils and make a small amount of money for her family.

Click for plesiosaurus fossil

* In 1821 Mary discovered another exciting fossil. It was a nine foot long animal, with a smallish head like a turtle but very long neck and paddle like limbs. **Does anyone know what this animal might be called?**

Click for name

* This was the first ever fossil *Plesiosaurus* which is now on display at the Natural History Museum in London.
* Mary Anning made lots of other important discoveries throughout her life she found the first complete pterosaur fossil, which is a flying reptile, found many important Jurassic fish fossils and she discovered that that squid-like animals called belemnites had ink sacs like modern squids.
* Mary’s work was extremely important to palaeontology and by the time she died in 1847 she had gained a lot of respect from the scientific community.

Slide 17 - Charles Darwin

* **Does anyone know who this famous scientist is?** Click for Charles Darwin
* Charles Darwin was a geologist, palaeontologist and biologist. He is most famous for developing the theory of evolution that showed that over many generations, animals and plants can change to become new species.
* (More in depth information) Darwin was born in 1809 in Shropshire a town in England. As a child he was very interested in the natural world he would spend a lot of his time bird watching and he liked to collect birds' eggs, sea shells, beetles, moths and minerals. After completing his school education, he went to the University of Edinburgh to become a doctor. However Darwin wasn’t a very good medical student, he found his lectures boring and he hated watching surgery - he spent most of his time learning about plants, animals and geology instead of learning about medicine.
* Darwin’s father wasn’t very pleased about this and moved him to the University of Cambridge where he was to study to become a church priest instead. Darwin didn’t mind this so much as it gave him a lot more free time, which he spent studying plants, animals and geology.
* In 1831 after he had completed his studies, Darwin set sail on the HMS Beagle, a naval survey ship that voyaged around the coast of South America and Australia. His main job on the voyage was to collect plant and animal specimens from all of the countries and islands the ship visited, but he also took a keen interest in the geology and fossils of these different places.
* When he came back to England, Darwin studied the specimens he had collected and started to notice some very interesting things about the finches, a type of bird, he collected from the Galapagos Islands. The finches on each island were very similar except that they had differently shaped beaks.

Click for finch

* Darwin came up with a famous theory called ‘natural selection’. This theory says that every living thing has slightly different characteristics to its parents. If these characteristics help it to survive, then it will be more likely to pass these on to its own young. Over many generations these successful characteristics may lead to the evolution of a new species. The finches Darwin had found on the Galapagos islands – were all different species, they had evolved over many generations to have different shaped beaks so that they could eat different types of food such as seeds, fruit, cacti, insects.
* In the late 1830 Darwin began to write up his ideas in a book on this theory called ‘On the origin of species by means of natural selection’, however he did not publish it until 1859, over 20 years later. His book was extremely controversial at the time and a lot of people did not like his ideas. His theory challenged the Christian idea that all animals were placed on the Earth by God, and instead suggested that animals have evolved over time into new species.
* Evolution is now accepted widely as a scientific fact and has been one of the most important discoveries ever made in palaeontology and biology.

Slide 18 – Excavate your own fossils

You could either prepare the plaster of Paris block beforehand so that children can excavate their fossils during the lesson OR get the children to ‘bury’ their fossils in the plaster of Paris sand mix in one lesson, then later on (next day/week) have children excavate each other’s fossils.

Ingredients:

* Plaster of Paris
* Sand/soil
* Water
* Cheap fossils/shells/toy dinosaurs
* Magnifying glass/hand lens
* Excavating tools (plastic scalpels, knifes etc.)
* Foil baking tray

Instructions:

1. Mix equal amounts of plaster of Paris and water together in a bucket until smooth

2. Mix in some sand or soil – this is now your sediment

3. Place fossil/shell/toy dinosaur in baking tray and pour over the sediment

4. Leave to set (at least 2 hours)

5. Use your tools to chip away at your sedimentary rock (plaster) and excavate your fossil like a palaeontologist!