TIMELINE

*mya = million years ago

4560 mya* Earth develops.

3800 mya Oceans develop.

3800 mya Early simple (prokaryotic) cells appear.

2700 mya Evidence for complex (eukaryotic) cells.

2400 mya Photosynthetic bacteria start producing oxygen.

2400–2100 mya Oxygen replaces methane in Earth's atmosphere.

1500 mya The first multicellular organisms (mats of algae) form.

700 mya The first animals (sponge-like) develop.

600 mya Ozone layer develops, protecting earth from UV radiation and allowing life to move onto land.

538–510 mya Cambrian explosion of marine life.

500–450 mya The first land plants appear.

500–450 mya Early vertebrates (bony fish) appear.

444 mya The first mass extinction event (Ordovician-Silurian) occurs.

420 mya Early shark-like fish develop.

385 mya Evidence for the first insects.

365–350 mya Early land vertebrates (amphibians) develop.

370–360 mya The second mass extinction events occurs (Late Devonian).

300 mya Early reptiles appear.

252 mya The third mass extinction event, 'The Great Dying,' occurs (Permian-Triassic).

240–230 mya The first dinosaurs appear.

210–200 mya Early mammals appear.

210 mya The fourth mass extinction event (Late Triassic).

150 mya The earliest birds appear.

66 mya The fifth mass extinction event (the Cretaceous–Paleogene).

66 mya The 'Age of Dinosaurs' ends.

65–60 mya Early primates appear.

7 mya Early hominins appear on the human lineage.

4 mya Australopithecus appears.

2.5–2.3 mya Evolution of Homo habilis.

0.3–0.25 mya The first members of our species, modern humans, Homo sapiens appear.

MYTHS AND LEGENDS

Many cultures have their own creation myths. Here are a few from around the world.



EGYPTIAN

In the beginning there was only watery chaos, called Nun. The sun god, Ra, emerged from this, bringing light with him. Ra created Shu, the god of air, and Tefnut, the goddess of moisture. Their children – the sky goddess Nut and the Earth god Geb– created the rest of the universe.



MAYAN

The creator gods and Gucumatz, the feathered spirit, made the world from their thoughts. They created humans so there were creatures with hearts and minds. They used clay to create a man, but he crumbled; they tried wood, but the man was heartless. Finally, they made humans from corn, and these were intelligent and empathetic.



MĀORI

Ranginui, the sky god, and Papatūānuku, the Earth goddess, held each other so tightly that no light could get between them. Their children wanted to let light into the world and eventually one of them forced the sky and earth apart. The children became gods of various parts of the Earth and created the other creatures.



YORUBA

Olódùmarè the Supreme God, sent 17 orishas (gods) to populate the Earth. The 16 male gods failed at this task, and it only succeeded when Oshun, goddess of life and fertility, sent the water she ruled to bring life to the Earth. From this, all living things were created.



CHRISTIAN AND JEWISH

God created the heavens and the Earth. He shaped the planet and gave it mountains and seas, light and darkness. In six days he created all the plants and animals and Adam and Eve, the first humans. On the seventh day, God looked at what he had made, and was pleased. He rested, and declared the day holy.



ISLAMIC

Allah created the universe and all the living and non-living things in it. He sent the angels he had created to Earth to collect seven handfuls of soil and from these, Allah made Adam, the first man. Eve, the first woman, was created from Adam by Allah.



CHINESE

The universe was a huge chaotic egg. Inside it was the giant, Pang Gu. When he broke out, the light part of the egg rose to form the sky and the heavy part sank to form the Earth. Pang Gu stood between them to keep them apart for 18,000 years. When he died, his eyes became the sun and moon, his hair the stars, his body the mountains and his blood, water.

THE GIANT WHO FORMED THE WORLD

In Norse mythology, the giant Ymir was the first being, who formed when the ice of Niflheim met the fire of Muspelheim. He was eventually killed by the gods who were descended from him. They cut up his body and used his flesh to make the Earth. His bones became mountains, his teeth became stones, his blood became the sea. His skull formed the sky, with his brains as the clouds. His eyebrows and eyelashes became a fence surrounding Midgard, the home of humans.



HOW OLD IS THE EARTH?

Today, we have a good understanding of the age of the Earth, and increasingly sophisticated ways of measuring it. But when people first began to wonder how old the planet was, what did they think?



ANCIENT GREEKS AND ROMANS

The Greek philosopher **Aristotle**, like most people of his time, thought that the Earth had existed eternally. Over the next centuries, people based estimates of its age on how far back their written records went. Roman poet **Lucretius** thought it began shortly before the Trojan war. Some people used family lineages and dates of reigns in religious texts to estimate the age. Famously, in the 1650s Archbishop **James Ussher** calculated that the creation of Earth had taken place at nightfall on the 23rd October, 4004 BCE.





18TH CENTURY

In the 18th century, **James Hutton**, Scottish 'father of geology', suggested that some rocks were continuously broken down by erosion caused by ice, water and wind. At the same time, others were formed by volcanic eruption and the internal heat of the planet which solidified sediments into sedimentary rock. He realised that the accepted age of the Earth at the time (around 6,000 years) wasn't nearly long enough to allow the processes involved to produce the types of rock he saw. Hutton believed the planet must be millions of years old.



19TH CENTURY

In the 19th century, **Sir Charles Lyell's** book *Principles of Geology* backed up Hutton's conviction that the Earth must be many millions of years old. This was extremely important to the work of his friend, **Charles Darwin** (see page 55), whose theory of evolution required a very long time span in order to account for changes in species.



17TH CENTURY

Around the same time, Danish geologist **Nicolas Steno** suggested that the layers of rock in the Earth's crust were a chronological history of the planet. He also proposed that fossils were the remains of living things and that some rocks formed from sediments like mud and silt. These were revolutionary ideas which would be confirmed over the next two centuries.

TODAY'S ESTIMATE

In 1896, French engineer **Henri Becquerel** discovered radioactivity – a process where atoms break down spontaneously, releasing particles or energy. In 1898, **Marie and Pierre Curie** investigated the radioactivity of uranium ore. Later, **Sir Ernest Rutherford** realised that radiactivity could be used to date rocks. Radioactive dating compares the proportions of a radioactive substance and the substance formed by its decay. Since decay happens at a constant rate, this means the age of the rock can be calculated. Using this technique, the age of the Earth has increased to today's estimate of 4.567 billion years.



THE CAMBRIAN EXPLOSION

The Cambrian explosion saw a huge increase in the variety of animal life in the seas. Fossils of many of these were found in an area called the Burgess Shale in the Canadian Rocky Mountains in 1909, and some were very odd indeed...



Some of these species – trilobites, for instance – were hugely successful for hundreds of millions of years, though they died out eventually. By the end of the Cambrian period however, most of the invertebrate groups that exist today had been established, along with the possibly the earliest types of vertebrates, such as the wormlike *Pikaia gracilens*.

Hallucigenia walked on seven pairs of legs and was protected by seven pairs of spines on its back. It had simple eyes and a ring of teeth round its mouth. It was about 5cm long.

Wiwaxia was a small, (up to 5cm long) soft-bodied marine animal. Its back was protected by armour plates and spines, and it likely moved slowly along the seabed.

Opabinia had five simple eyes and a long, flexible proboscis with pincers to move food into its backward-facing mouth. Its soft, segmented body was up to 7cm long, with flaps on the sides and a fan-shaped tail.

Anomalocaris, was a large shrimp-like animal with good eyesight, spiked claws to catch its prey and teeth to break them up. It was the top predator, and could reach 1m in length.

Trilobites had a segmented body with three distinct sections, protected by a hard external skeleton. There were many species, ranging in size from a few millimetres to 60 centimetres.

SPONTANEOUS GENERATION
(WHERE *DID* THEY COME FROM?)

You might imagine that seeing how farm animals and pets breed would have given people an idea how other animals reproduced, but apparently not. Many species were thought to somehow create themselves from non-living matter. Here are some of the wilder ideas of where living things came from...



Roman architect **Vitruvius** recommended that libraries shouldn't face south or west as winds from those directions generated bookworms.



It was also accepted that anchovies were made of sea foam and swallows made of mud. In Egypt, it was thought that snakes and crocodiles sprang from the mud of the Nile river.



Barnacle geese, which were sometimes known as tree geese, get their name from the old belief that they emerged from goose barnacles (a type of shellfish) growing on wood. Some medieval churchgoers claimed that this meant that the goose counted as a type of fish, so could be eaten during Lent.



During the 16th century, **Jan Baptist van Helmont** wrote that a piece of dirty cloth and some wheat, left for 21 days, would produce mice.



The geographer **Zeigler** of Strasbourg claimed that lemmings – small vole-like rodents – fell from the sky during stormy weather.



William Harvey suggested that all animals developed from eggs, some of which were too small to be seen, rather than spontaneously generating.

MULTIPLYING MAGGOTS NO MORE!

In the 17th century, **Francesco Redi** carried out an experiment to show that maggots did not spontaneously generate in rotting meat. He covered some jars of meat with fine gauze, and left others open. Maggots only appeared in the open jars because the gauze prevented flies laying eggs on the meat.



During the 19th century, scientists gradually showed that animals and plants did not spontaneously generate, but little was known about microbes as they were so small. French chemist **Louis Pasteur** showed that if beef broth was boiled inside a special 'swan-necked flask' it would stay fresh for a long time. The boiling killed any microbes in the broth, and the shape of the neck trapped microbes from the air before they could reach the broth.

