For Penny – H. G.

For my family and friends – R. M.

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Henry Gee
Raxenne Maniquiz

THE WONDER OF LIFE ON EARTH

The story of our planet, evolution and you

TWO HOOTS

PHANEROZOIC EON 539 mya – now

CENOZOIC ERA 66 mya – now

Quaternary Period 2.6 mya – now

Holocene Epoch 11,000 years ago – now

Pleistocene Epoch 2.6 mya – 11,000 years ago

Neogene Period 23–2.6 mya

Pliocene Epoch 5.3–2.6 mya

Miocene Epoch 23–5.3 mya

Palaeogene Period 66–23 mya

Oligocene Epoch 34–23 mya

Eocene Epoch 56–34 mya

Palaeocene Epoch 66–56 mya

MESOZOIC ERA 252–66 mya

Cretaceous Period 145–66 mya

Jurassic Period 201–145 mya

Triassic Period 252–201 mya

Timeline

PALAEOZOIC ERA 539–252 mya

Permian Period 299–252 mya

Carboniferous Period 359–299 mya

Devonian Period 419–359 mya

Silurian Period 444–419 mya

Ordovician Period 485–444 mya

Cambrian Period 541–485 mya

PROTEROZOIC EON 2.5 bya – 539 mya

NEOPROTEROZOIC ERA 1 bya – 539 mya

Ediacaran Period 635–541 mya

Cryogenian Period 720–635 mya

Tonian Period 1 bya – 720 mya

MESOPROTEROZOIC ERA 1.6–1 bya

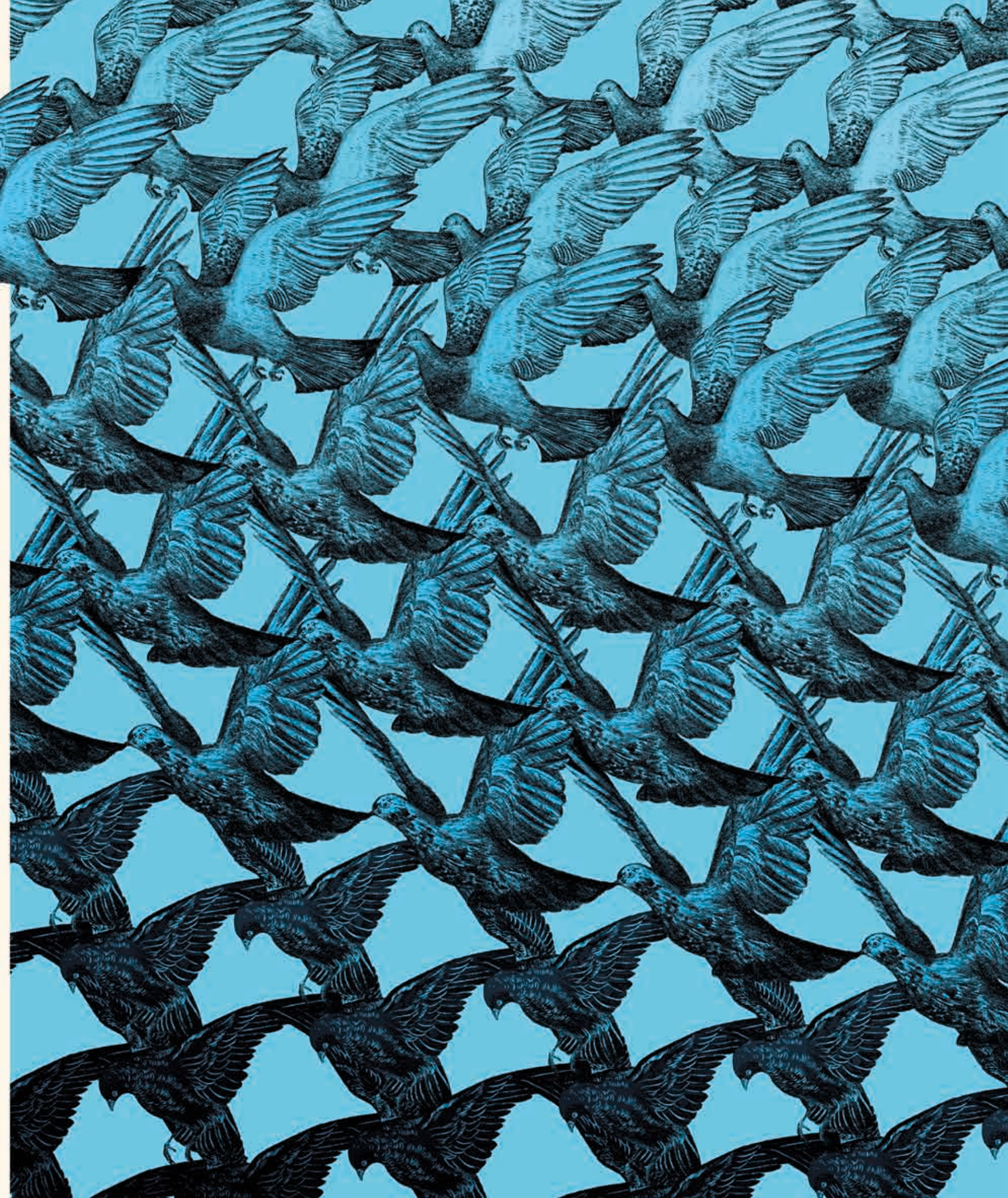
PALAEOPROTEROZOIC ERA 2.5–1.6 bya

ARCHAEAN EON 4–2.5 bya

HADEAN EON 4.6–4 bya

Billion years ago – bya • Million years ago – mya

Evolution



In the nineteenth century, a naturalist called Charles Darwin developed a theory about life on Earth: the theory of evolution.

During a voyage around the world between 1831 and 1836, Darwin was astonished by the variety of life on Earth. There were so many different species of birds, plants, and other life forms. He wondered why. Could one species be descended from another species, like children from parents?

Back at home in England, Darwin started thinking about how farmers often bred together very woolly sheep, or cows that produced a lot of milk. A lamb whose parents were both very woolly would be more likely to grow up to be woolly as well. This was called artificial selection. Properties of parents could be passed on to the child – or inherited. And, with time, those features could be enhanced even more.

Darwin himself demonstrated the theory by breeding fancy pigeons. He showed that the common pigeon could be bred over time to develop a dramatic collar of feathers, or to grow a longer neck.

Darwin wondered whether something similar might be happening in the wild, too – a process he called natural selection. This time, it wouldn't be farmers doing the selecting, but the natural environment around us.

Take the frogs in my garden pond. Hundreds of tadpoles are born, but only a few will live to become frogs. These will be the tadpoles that are best at avoiding being eaten. If one tadpole has a particularly strong tail that helps it escape, then when it has its own offspring, those tadpoles will also be more likely to have strong tails.

The animals that are most successful at breeding and surviving are the ones that pass on their traits. Over millions of years, the traits that are passed down will change in tiny ways, leading eventually to bigger changes – even whole new species. This is called evolution.

In Darwin's day, people thought that the Earth was only a few thousand years old at most. But scientists gradually discovered that the Earth is billions of years old – long enough to create a stage for evolution's great drama. This is why there are so many different creatures on Earth today.

The early Earth was a hostile place. There was no oxygen in the air. It was very hot. Imagine yourself on the early Earth – you could never predict the amazing range of life forms that would eventually evolve on this small, rocky planet.

Fossils

A word about fossils.

Fossils are the remains of ancient life forms that were buried soon after death and have become preserved in rocks. The earliest fossils are the remains of cyanobacteria preserved in stromatolites (see page 20).

Most fossils are formed from the hard parts of living things, such as shells, teeth and bones, because the soft parts usually rot away over time. This is why the dinosaurs you see in museums are skeletons.

Sometimes, though, softer parts such as skin, feathers and hair are preserved too, allowing a more complete picture of what ancient life was like.

Fossils are rare, and often hard to understand. But without them, we would know very much less about the history of life on Earth, and nothing at all about the vast range of incredible organisms that died out long ago.

Thanks to fossils, we can begin to imagine what some of these long-vanished creatures looked like. Without fossils, for example, we'd know nothing at all about the amazingly weird animals of the Ediacaran Period (page 36); the Cambrian creatures found in the Burgess Shale (page 40); or the wonders of the Triassic Period (page 56). And imagine a world in which we knew nothing about dinosaurs . . . if you can.

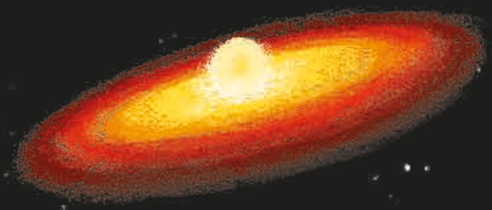
A Sun is born

Long ago, a huge star was burning. It was many times bigger than our own Sun.

Nuclear fusion is what makes stars burn. It is fuelled by gases which are squashed under great pressure. This creates huge amounts of energy, which we see as light. Nuclear fusion is the heart of every glowing star you see in the night sky. But it does more than make stars shine. It also creates enough energy to stop a huge star from collapsing under its own weight.

This particular star was very old, and had been burning for so long that it was running out of fuel. The process of nuclear fusion was beginning to slow and fade. The star gradually began to produce less light, and less heat. It turned from white, to yellow, to a deep, sullen red.

Eventually, the fuel ran out. After millions of years of shining, the great star gave in to its own weight, and collapsed. This took a split second. There was an explosion so violent that it briefly lit up the whole galaxy – a supernova.

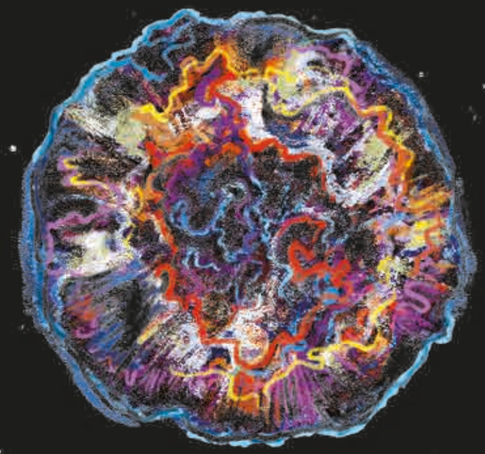


Materials created in the star's dying moments – such as silicon, carbon, oxygen, iron and uranium – surfed the wave made by the supernova.

After travelling through space for millions of years, the wave of stardust disturbed a cloud rich in dust, gas and ice. The centre of this cloud became so hot and dense that nuclear fusion began, creating heat and light. A new star was born – the Sun.

Circling the Sun, the rest of the cloud of dust, gas and ice came together over a period of millions of years to form planets. All this happened more than 4.6 billion years ago.

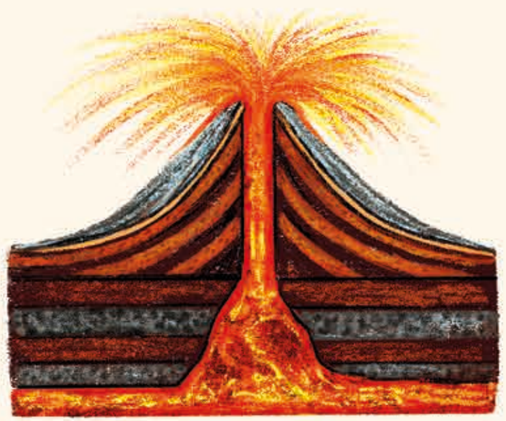
One of those planets was our Earth.



Planet Volcano

The Earth is a huge mass of rock made of layers, like a cake. At the core is a ball of hot, liquid metal.

Around the core is a layer of molten rock, called the mantle. It is thousands of kilometres thick and the consistency of warm treacle, forever kept moving by the heat from the core below. The rocky outer layer is only a few kilometres thick. This is the crust, which moves as it is caught and nudged by the mantle below. This movement breaks the crust into separate pieces, called tectonic plates. Earthquakes can happen when these plates rub against each other.



Volcanoes are places where hot, molten rock (or lava) gushes through the Earth's crust to the surface.

The infant Earth was very different from the peaceful planet we know today. It was a ball of magma, constantly bombarded by other, smaller planets. One of them, a planet the size of Mars, struck the young Earth. The crust was ripped off into space. For a while, our Earth was surrounded by a ring of rocks, like the planet Saturn today. These rocks came together to form our Moon.

Around the Earth is a thin layer of gases called the atmosphere. The atmosphere of the early Earth was very different from the atmosphere we breathe today. For a start, there was no oxygen. Instead, there were gases such as carbon dioxide and methane. The air was foggy with water vapour.

After millions of years, the Earth cooled enough for the water above to become liquid and fall as rain. It rained for millions of years – enough to make the first oceans. Icy comets fell from space, adding more water.

Once a ball of fiery magma, the Earth became a world of water. Magma spewed out into the ocean from underwater volcanoes. It was volcanoes that built the first land.

In the depths of the earliest oceans, it was jets of volcano-heated water squirting from cracks in the crust that would fuel the first life.

Bubbles

The early Earth was a violent place.

Among all the volcanoes and comets, life began, around 4.1 billion years ago. Small membranes like soap bubbles stretched across tiny holes in rocks on the ocean floor. Boiling-hot water filled with particles of iron, and sulphur from deep in the Earth gushed out of cracks in the crust.

Cooling and slowing as they met the cold seawater, streams of water dropped their cargo into the rock holes. These holes became tiny caves of peace and order, protected by their membranes from the chaos outside.

Membranes are barriers. They separate an inside from an outside. The earliest membranes were leaky, letting some things in and out. Gradually, the insides of these little caves became very different from the world outside.

DNA (deoxyribonucleic acid)

At first, the membranes protected the rock holes, meaning atoms could mix together and create more complicated substances. These substances included proteins, which make up the bodies of living things; and deoxyribonucleic acid, or DNA.

DNA is a key ingredient of life: it contains instructions for making proteins. These instructions are called genes and they are passed down from one life form to another. DNA and genes are the building blocks of life.

The soap-bubble membranes would sometimes float off into the sea, each a package of proteins and DNA. These bubbles were the first living things**.**

Evolution had begun.