

PART ONE

# PREHISTORY

How Everything Got Started







## How Did the Universe Begin?



To understand you and us we have to start far, far back in time. Think about where you are. Below you there's the Earth and above you there's the sky. If you kept going up you'd reach space and then the planets and the sun. Keep going and you'd come to the billions of stars that make up our galaxy. Beyond that there are billions of other galaxies, each with billions of stars in them. The whole of this is the universe. Let's ask an amazing question: where did *everything* come from?

The answer is incredibly strange. At first the immense universe was tiny: it was so small you couldn't even see it with the strongest microscope. Everything that exists was crammed together into a minute point.

But the universe only stayed tiny for a fraction of a moment; it was filled with such a vast amount of energy that it immediately burst apart in the biggest explosion of all time, called the Big Bang. The newborn universe started expanding very, very quickly and it is still expanding today. The universe is getting bigger every second.

The Big Bang was very creative. It produced the most basic material out of which everything is made. Eventually some of that material came together to make the first stars.



As they heated up, they began to emit light, and the dark universe was lit by millions and then billions of glowing suns. The Big Bang happened about 13 or 14 billion years ago. That is such a big number that it is not very easy to grasp what it means.

Imagine a whole year could pass in just one second: on your birthday you would blink and it would already be your next birthday! After just two minutes you would be 120 years older – older than anyone who has ever lived. Now imagine blinking 14 billion times: it would take 444 years if you kept blinking while you were asleep.

We know that the Big Bang happened, but we don't know *why*. Where did that first minute speck come from? Did it just come from nothing or was there something there before? Are there other universes outside our own? There's no way of telling, because we can't get outside our universe to have a look. Even the cleverest grown-ups don't know the answers to these big questions. And maybe no one will ever know.

It's very odd (and maybe quite exciting) to think about how *everything* started. In a way it makes you feel very small: your body is tiny compared to the whole universe. But at the same time, it maybe makes you feel big: your mind is able to know about the largest possible things. This is part of why it's so interesting being alive: even though our bodies are stuck in a small, remote corner of the universe our minds can leap and soar across gigantic distances in time and space.



## How Did the Earth Get Made?

Once the universe and the stars got going, it still took an extremely long time for our planet, the Earth, to form. When the first stars got old (which takes a few billion years), they became smaller and heavier, the pressure built up inside them and eventually some of them exploded. There's a beautiful name for an exploding star: it's called a *supernova*.



A supernova shoots out immense clouds of dust and gas and tiny particles of iron and copper and other elements. One of these clouds ended up travelling around our star, the sun. Every so often, two specks in the cloud would collide and stick together (a bit like pieces of fluff do). This kept happening for millions of years until eventually practically all the dust had joined together to make the Earth.

It's really amazing that all the material that the Earth is made up of came originally from an exploding star. And not just the Earth: most of the atoms in your body were made inside a star or when it exploded. The calcium in your teeth, which makes them hard and white, came from a star. So did the potassium that helps your brain work and so did the carbon that's in your hair.

The Earth was formed about 4.5 billion years ago (that's more than a century of blinking) so it's roughly one third as old as the universe. At that point, the Earth was completely lifeless, just a spinning lump of rock, but in its middle, pressure and movement made the rocks heat up. They started to boil and erupted on the surface as volcanoes. There wasn't a single plant, just rocks and (eventually) water. You wouldn't have been able to breathe because there was no oxygen in the atmosphere.

At first there wasn't much water on Earth. So where did all the oceans, seas, rivers and lakes come from? Every so often, a comet (which is a big lump of ice and rock flying through space) hit the Earth. In the explosion all the ice would melt and become water. This happened billions of times, and that's how most of the water on Earth got here. Next time you have a glass of water, you'll be drinking melted comet ice!



## How Does Evolution Work?



If you had a time machine and could visit the Earth about 3.5 billion years ago, you wouldn't find any people (or even any dinosaurs); the only living things were bacteria, living in the ocean. It took about another billion years before there was anything you could recognise as being alive: thick strands of billions of tiny creatures called blue-green algae.

You can still see this kind of algae today in some ponds and rivers. They do not seem to do much, but they were actually up to something very important: when they warmed up in the sunshine they emitted a gas called oxygen, which we (and all other animals) need to breathe. It's only thanks to the algae that you're able to take your next breath. Thanks, algae!

You'll have to wait a very long time (more than two *billion* years) before you start to see other creatures developing in the oceans: little worms, coral, sponges and things that looked like jellyfish. So here's a big question: where did all the animals come from?



The answer is very strange: the tiny organisms wriggling about in the sea *became* dinosaurs and spiders and elephants and birds and sharks and all the other creatures that have ever lived. It's strange because if you had one of those worms as a pet today, your mum wouldn't need to worry that one morning she'd find it had turned into a *Tyrannosaurus rex* or a Giant

Sloth. Mum's not going to get a shock because it takes a very, very long time for this to happen.

To see why, we need to think about a tricky, important word: *evolution*. When any creature reproduces, its children aren't exactly the same as it. They're different in small ways that don't seem important. There might be one worm that has a little patch of skin that becomes sensitive to light. When there's more light, the worm gets agitated and wriggles around a lot and that, by chance, nudges it closer to the surface of the sea, where there's more for it to eat. So it thrives and has lots of baby worms and they all have this sensitivity to light as well. So they stay at the top of the sea and they thrive as well.

It might take thousands of generations of worms, but then one day there's another important change: one of these worms develops, by chance, a little dip in its skin where the light-sensitive patch happens to grow. This means the light only reaches it from certain angles so the worm gets better at 'seeing' where the surface of the sea is. It doesn't just respond to light but to the *direction* the light is coming from. And its worm children inherit this useful dip with a light-sensitive patch in it. And so do their children. After thousands more generations, there's a worm that happens to have a tiny bit of very thin skin over the light-sensitive patch that helps focus the light. It reacts to the precise angle the light is coming from. Very, very gradually the first eye is starting to develop. As it does, the little worm gets a huge advantage. It can avoid bits of sharp coral that might injure it. It passes on this advantage to its offspring and the process of development keeps going. It takes all these slow steps just to start to develop an eye. You can see that it's going to take just as long for another little bump of skin to start to develop into a fin and for a fin to start to change into a leg and for a leg to grow toes.





Evolution has been happening in millions of ways for billions of years as creatures developed odd little differences that helped them survive. Slightly harder skin means you might not be so tempting to eat – so eventually we get crabs and armadillos. Legs help you move faster so you can escape danger or chase things – so we get spiders and cheetahs. Ears help you be aware of things that you can't see that might be dangerous or good to eat, so we get mice and elephants. A brain helps you do complicated things – like build a nest that keeps you safe or group together to hunt – so we get birds and wolves.

If your brain becomes really big, things start to change dramatically: you can control fire and use tools, and that gives you a huge advantage over all other creatures. And that's how – eventually – humans appeared.

## Your (Enormous) Family Tree

Have you ever seen a family tree? It's not an actual tree – it's a kind of map of the different generations of your family.

You can make one by putting yourself at the top and any brothers and sisters, if you have them. Below that you put your parents, below them, your grandparents, and then great grandparents and great-great grandparents

(that's four generations ago). And there are different branches and twigs for cousins and second cousins.

If you go five generations back, your great-great-great grandparents might have been born around the end of the 1800s. They didn't have electricity or television and there weren't any aeroplanes; cars were just being invented and only went about 10 miles an hour. But what if you keep going back?

If you go back ten generations, you get to your great-great-great-great-great-great-great-great-grandparents; they were maybe born in the early 1700s. They wore very different clothes (trousers hadn't really been invented); lots of men had swords, and even if they spoke the same language as you they'd sound very strange and use lots of words you don't use anymore. But let's not stop. What happens if we keep going back?

A hundred generations ago, your family was living at the time of the Roman Empire: in Europe and North Africa, some people are wearing togas and speaking Latin.

If you go back 500 generations, it's still your family but it's about 10,000 years ago. The very first cities are just being built, but they are tiny – about the size of a modern village – and there are hardly any of them. A few people are starting farms but most people live by hunting and gathering.



Seven thousand generations takes you back 100,000 years (generations get shorter as you go back in time because people had babies much younger than they do today). Your ancestors don't have clothes, they can only say a few simple words and they can't tell stories; the only tools they have are made of stone. But their bodies look pretty much like ours.

But let's not stop here. Suppose we can trace your family back a *million* generations. You could try to say all the 'greats' but it would take about two weeks before you could add 'grandparents' (or a month if you stopped to eat and sleep). That would be maybe 10 million years ago. Now our ancestors are living in trees, they have tails and their brains are much smaller. Not all their descendants become human beings – they were also the ancestors of today's gorillas and chimpanzees and bonobos. So we're related to them as well.

Going back about 70 million years, your family is living at the time of the dinosaurs. Watch out! There could be a *Tyrannosaurus rex* around the corner – they'd better be careful. It's not so hard, though, because your ancestors are only about the size of a mouse and they live in a burrow.

But of course your family goes back much further than that. Around half a billion generations ago, they were just starting to make their way out of the oceans to explore the land. It wasn't easy: they didn't have proper lungs for breathing air and their legs still looked a lot like fins. But there were lots of good things to eat on land so your family stayed there.

Finally, if you go back maybe two billion generations, your family would be made up of the first tiny creatures bobbing about in the sea. We can keep on going back – but then we wouldn't be talking about living things, just chemicals. Because our very first living ancestors didn't come from nowhere. They started when complicated chemicals joined together in the hot water next to volcanoes. And those chemicals were made from atoms; and those atoms (remember) were made in exploding stars; and the stars were made of the material that erupted in the Big Bang at the very first moment when the universe started to exist. And that's as far back as we can go, because we don't know what happened before the Big Bang.

