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WELCOME TO PLANET EARTH

We live on a small planet, going around a medium-sized star, in a fairly average spiral galaxy whirling through the universe. Although it's only a speck in the vastness of space, everything we know is rooted here. Our home, Earth, is the only place we know that life exists, and it's the only planet whose history we can trace.

Once upon a time ...

For thousands of years, people have wondered how Earth came into being and what causes strange and frightening events like earthquakes and volcanic eruptions. In the past, people made up stories to explain these mysteries. The stories became myths, legends, and religions.

Many cultures have creation stories to explain Earth's origins. A Cherokee myth, rooted in the landscape of North America, claims that Earth was created at a time when there was only water and sky. All the animals lived in the sky realm, known as Gälûñ'lätï. The sacred Little Water Beetle, Dayuni'si, came down to see what was below the water. It brought up mud, which expanded to make the world. Other animals wanted to explore, but the buzzard flew down first to check whether the soil was dry. His giant wings brushed against the smooth surface of the damp soil, forming mountains and valleys. When the surface dried, the other animals settled on land. It was entirely dark, so they set the Sun in the sky, and set the Sun in the sky to light and warm Earth.

Disasters tamed by stories

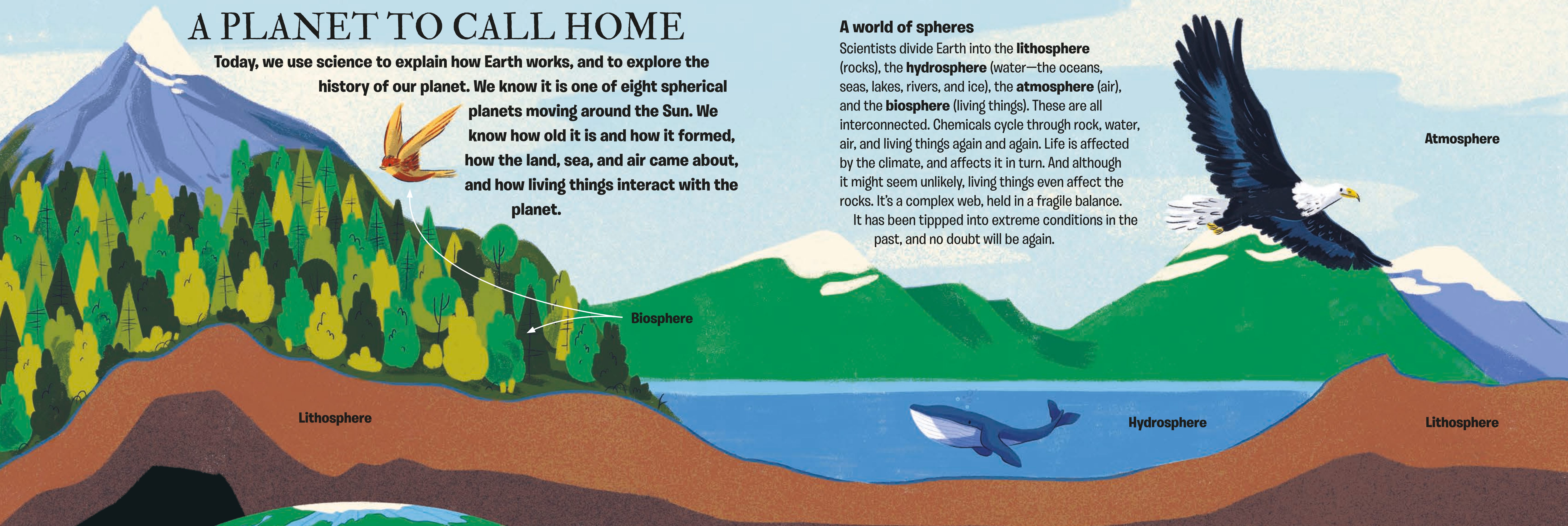
People also explained frightening and destructive natural events, such as earthquakes and floods, with fantastic stories. Finding a cause helped them deal with the seemingly senseless death and destruction these events brought.

Chinese and Indian myths describe a world supported by several elephants standing on the back of a turtle. When one of the animals moves, the Earth trembles and shakes, producing the terrifying earthquakes that are common in parts of China and India.

In the Pacific North West, traditional stories speak of a struggle between a whale and a large bird—the Thunderbird—that causes the ground to shake and the sea to flood the land. Many cultures have explained volcanic eruptions in terms of the actions of supernatural beings, such as the godess Pele in Hawai'i or the devil Guayota among the Guanche of Tenerife.

A PLANET TO CALL HOME

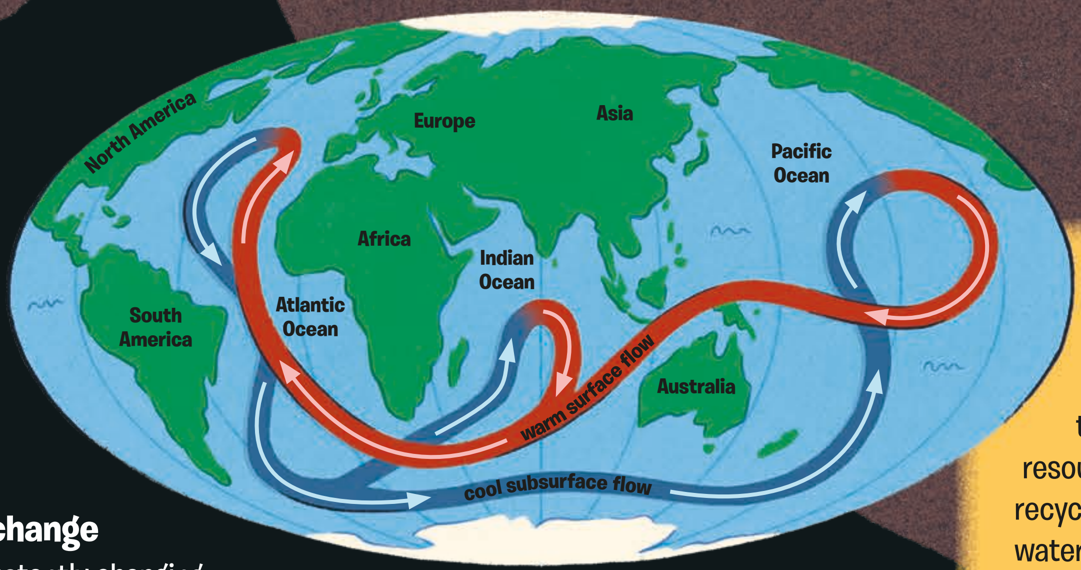
Today, we use science to explain how Earth works, and to explore the history of our planet. We know it is one of eight spherical planets moving around the Sun. We know how old it is and how it formed, how the land, sea, and air came about, and how living things interact with the planet.



A world of spheres

Scientists divide Earth into the **lithosphere** (rocks), the **hydrosphere** (water—the oceans, seas, lakes, rivers, and ice), the **atmosphere** (air), and the **biosphere** (living things). These are all interconnected. Chemicals cycle through rock, water, air, and living things again and again. Life is affected by the climate, and affects it in turn. And although it might seem unlikely, living things even affect the rocks. It's a complex web, held in a fragile balance.

It has been tippped into extreme conditions in the past, and no doubt will be again.



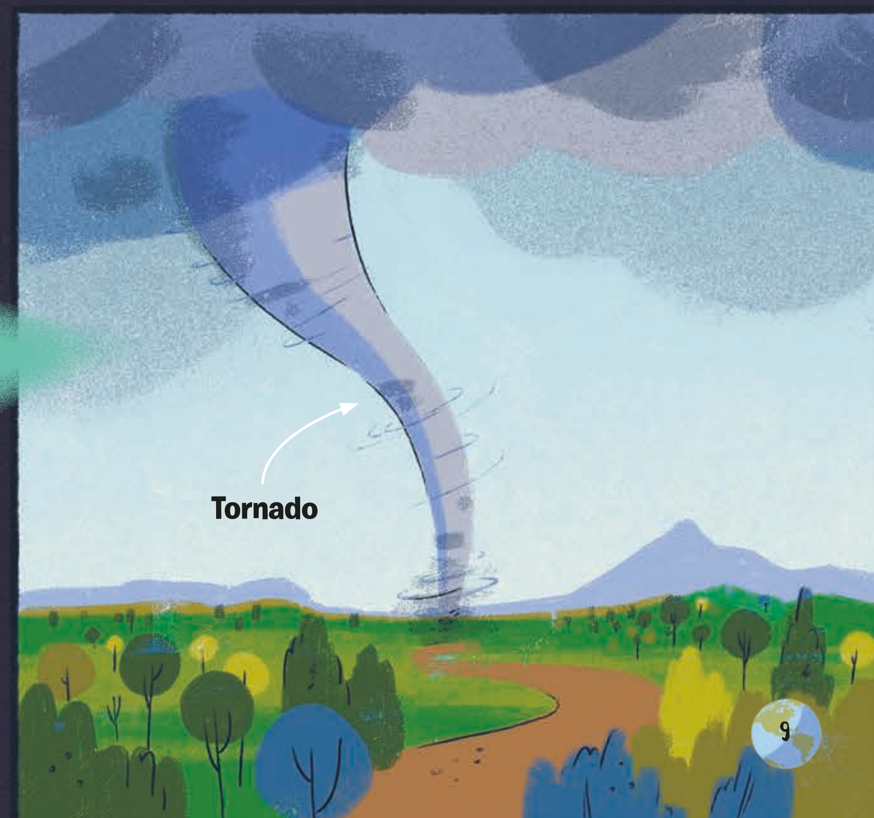
Endless change

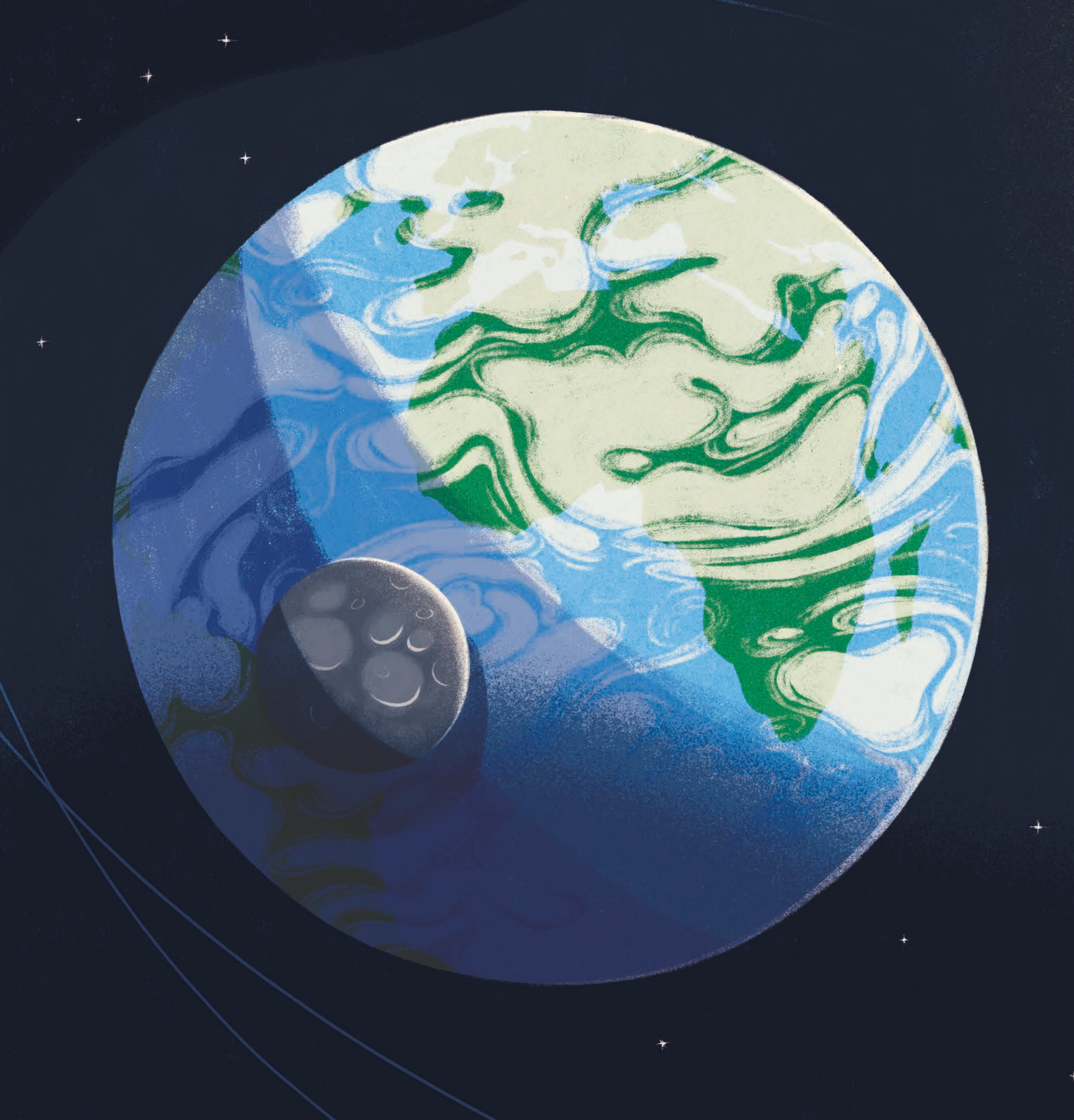
Earth is constantly changing. The landscape of the planet today has developed over billions of years. The current map of land, oceans, islands, and ice caps is just a snapshot in Earth's history. Things have been arranged differently in the past and will be again in the future. The sea and land move around, mountains rise and fall, the atmosphere changes, and the climate shifts from hot to cold and back again. It's a dynamic system in which all the parts work together, each one changing the others.

Over a shorter timescale, from days and weeks to centuries, Earth's resources are naturally recycled and renewed. The water of the oceans flows around the world, and moves between the top and bottom of the sea in a cycle that takes around 2,000 years, but the tides ebb and flow each day.

The currents of air in the atmosphere follow their own cycles. The weather and ocean currents follow complex patterns that we have still not fully unpicked—which is why the weather forecast is often wrong!

The more scientists investigate, the more we learn about how our planet has grown and how it works. Earth's story is a fascinating saga of building a beautiful system that supports us, and all other living things. It's far from over—the Sun is only about halfway through its life, so a lot lies ahead for our planet.





A WORLD FROM THE STARS

Our planet and its seven companions formed from a cloud of matter whirling around the new Sun. As the specks of rock dust and ice hurtled through space, they crashed into each other, some sticking together and some smashing apart. Clumps grew larger and larger until, after thousands of years, one of the rockier lumps became the start of Earth. Four and a half billion years later, our planet is teeming with life, active both at its surface and deep within. It is still whizzing around the Sun, and now it has the Moon, too, which is vital to Earth in its current form.

FROM DARKNESS TO LIGHT

Our Earth and even the Sun are late arrivals on the cosmic scene. The universe is far older than the solar system. It probably began 13.8 billion years ago with the "Big Bang" when space-time burst into existence as an infinitely tiny, infinitely hot and infinitely dense point. There was nothing recognizable in this baby universe—no stars, matter, or even space.

Really big, really fast

Instantly, the tiny universe expanded at unimaginable speed. It was as if a single grain of rice grew to be 1,000 times as long as the entire galaxy—in less than a second! It was so tiny to start with, that even after all that growth it was still smaller than an orange.

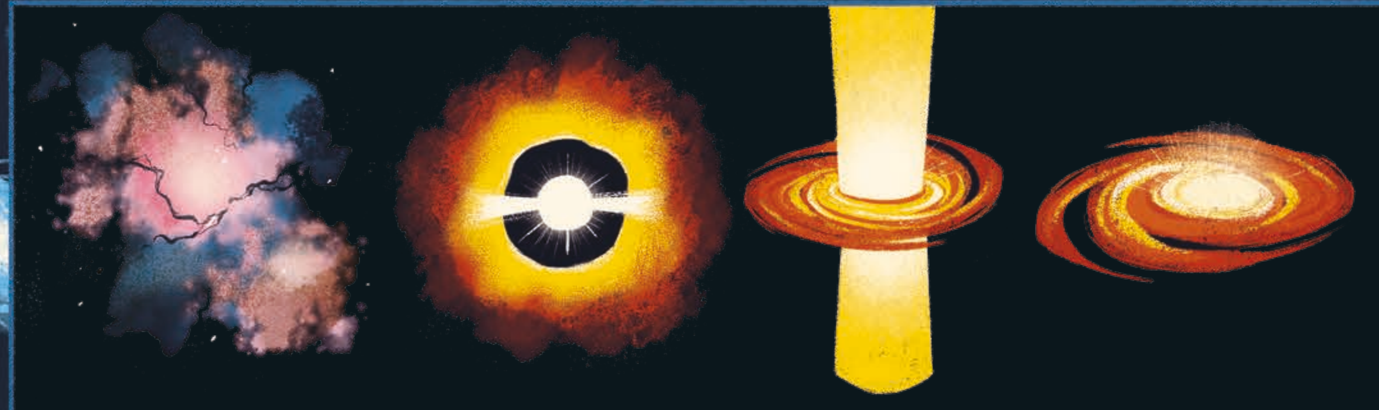
The universe is all there is. There is nothing outside it (as far as we know), not even empty space. This has always been true, so even when the universe was really tiny, it was all that existed, and there was nothing outside it.

GRAVITY

Gravity works between objects that have mass, drawing them toward each other. You are held on Earth by Earth's gravity, but you also exert a tiny bit of gravity that pulls Earth toward you!

Holding on

The universe continued to grow, though not as quickly, and to cool. After a few minutes, the first matter came into being. This matter was the nuclei (middles) of atoms of the gases hydrogen and helium. Gravity made the new matter clump together. Areas where, randomly, there was a little more gas than elsewhere attracted more and more gas. After 100 million years, some areas had so much gas squashed together that the intense gravity at the middle crushed the nuclei, creating the first stars. They began to pour light and other types of energy into space.



Nebula collapse
A huge cloud (nebula) of concentrated gas collapses inward.

Protostar
The middle of the collapsing nebula begins to glow as it gets hotter and hotter.

Outflow
Jets of super-heated gas pour from the poles of the protostar.

A star starts!
Finally, the middle is so dense it starts to fuse hydrogen, becoming a star.

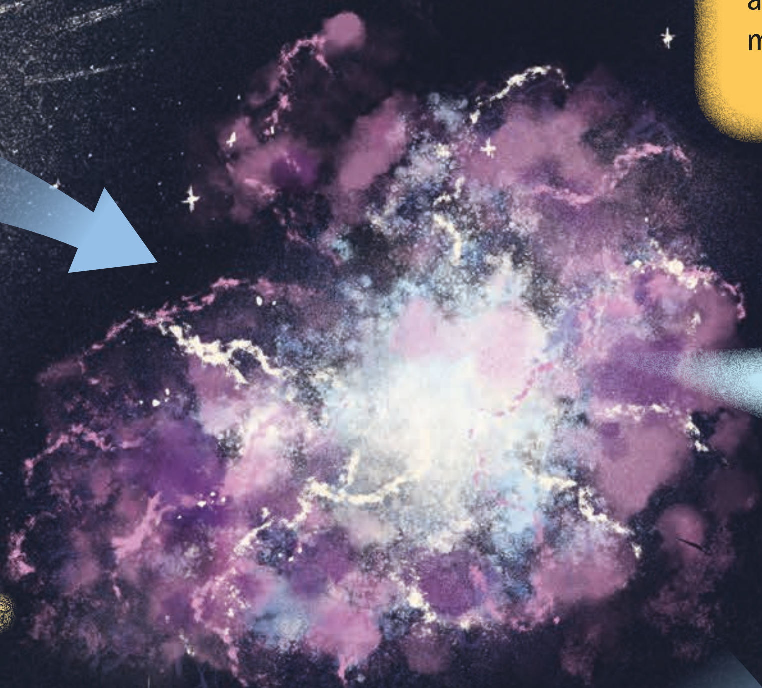
Stars are energy factories

In a star, hydrogen is crushed together under the immense pressure created by gravity. There is so little space that the hydrogen nuclei fuse and make helium nuclei. It takes four hydrogen nuclei to make a helium nucleus, but one helium nucleus takes up less space than the four hydrogen nuclei. Energy is released as the nuclei fuse, and this is the heat and light we get from the Sun.

A star like the Sun has so much hydrogen inside that it can "burn" for billions of years. Our Sun is only in the middle of its life and will produce energy for another four billion years.

MAKING THE MATERIALS FOR PLANET-BUILDING

The first stars lived fast and furious lives and died young. After them came generations of new stars, including—eventually—our own Sun.



Out with a bang

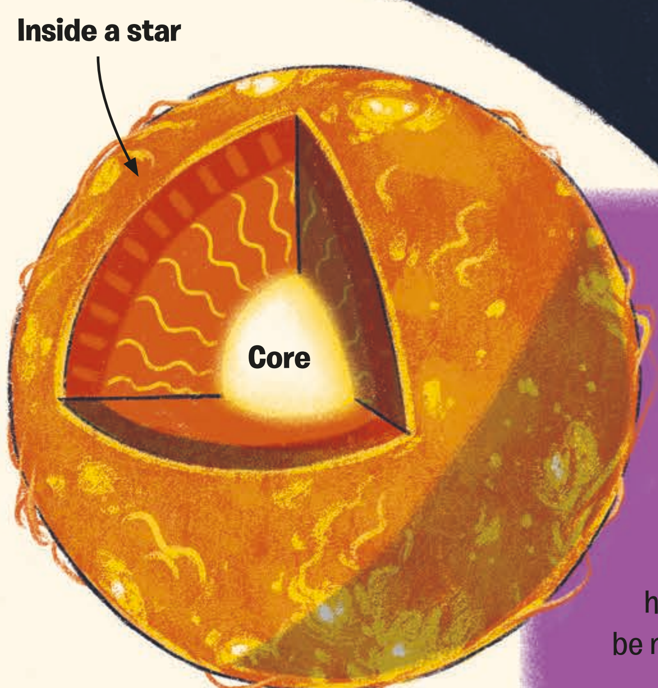
The energy escaping from an active star produces an outward pressure. This balances gravity pulling inward, so the star stays the same size. Once a large star has a core of iron, it can no longer produce energy. The pull of gravity makes it collapse inward in a catastrophic crash. But there is no space in the middle, so it all bounces back out in a massive explosion called a supernova. This has so much energy it fuses iron to form heavier elements, such as gold and platinum. The supernova blasts all the elements made in the star and its destruction out to space.

CHEMICAL ELEMENTS

There are 98 naturally occurring chemical elements, all made in stars or supernovas. Each has a different design of atom. All other chemicals in the universe are made by combining the elements, which form the building-blocks of all matter.

Now you see it ...

Supernovas make the largest explosions in the universe. The explosion itself lasts only seconds, but pours out more energy than the star has released in its entire life. The remains of an exploded star spread out into space in an ever-growing and thinning cloud of material. The last supernova in our galaxy, in 1604, was visible in Earth's sky even in daylight, and shone for months. The remains of it can still be seen with a telescope.



Making metals

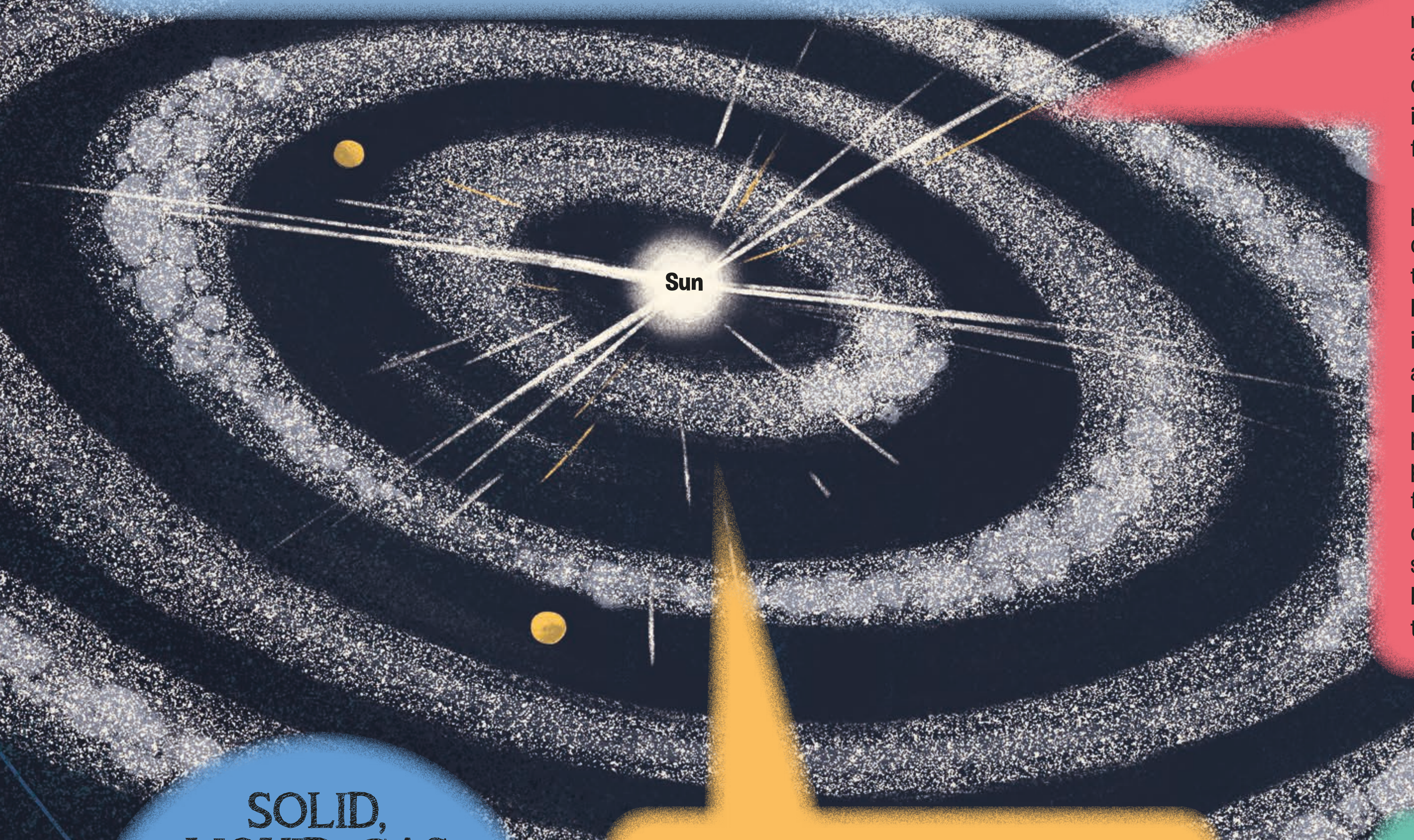
Stars create helium until they start to run out of hydrogen. Then the middle of the star starts to fuse the helium to make heavier chemical elements, such as carbon and oxygen. (Elements are the fundamental ingredients of all other chemicals.) The heaviest element a star can make in this way is iron. The process of creating elements up to the weight of iron releases energy, producing the star's light and heat. To make an element heavier than iron, extra energy would be needed to fuse nuclei, so this doesn't happen.

Get set for planets

The extra elements hurled out into space can be swept up in the next set of forming stars. But stars only need hydrogen to burn—they can't use the extra material. Instead, it can be used to make planets.

FROM DISK TO GLOBE

For billions of years, stars formed and died, adding more and more chemical ingredients to the cosmic soup. They clustered into massive galaxies that included large and small stars. About 4.6 billion years ago, in one arm of the spiral galaxy we call the Milky Way, our own cloud of hot gas and dust formed.



SOLID, LIQUID, GAS

Any substance can exist as a solid, a liquid, or a gas, depending on the pressure and temperature. We are used to water in all three forms—as ice (solid), water (liquid), and as water droplets in the air (gas). The state depends on how the particles are spaced out.

Making a solar system

Most material in the cloud was pulled to the middle where it was under such pressure it began to fuse hydrogen, lighting up a star—our Sun—just as billions of stars had lit up before it. Extra material whirling around the new Sun flattened into a disk-shaped cloud. This included all the elements that had been thrown out of dying stars over billions of years. From this, the planets, moons, and asteroids of the solar system would form.

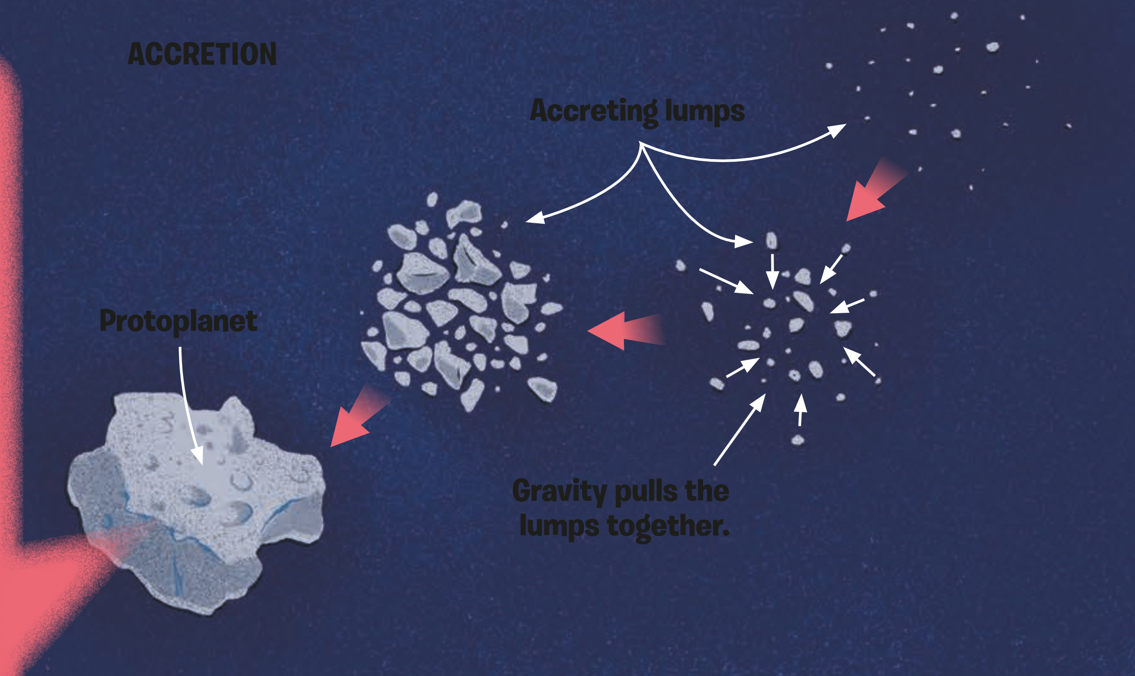
Hot and cold

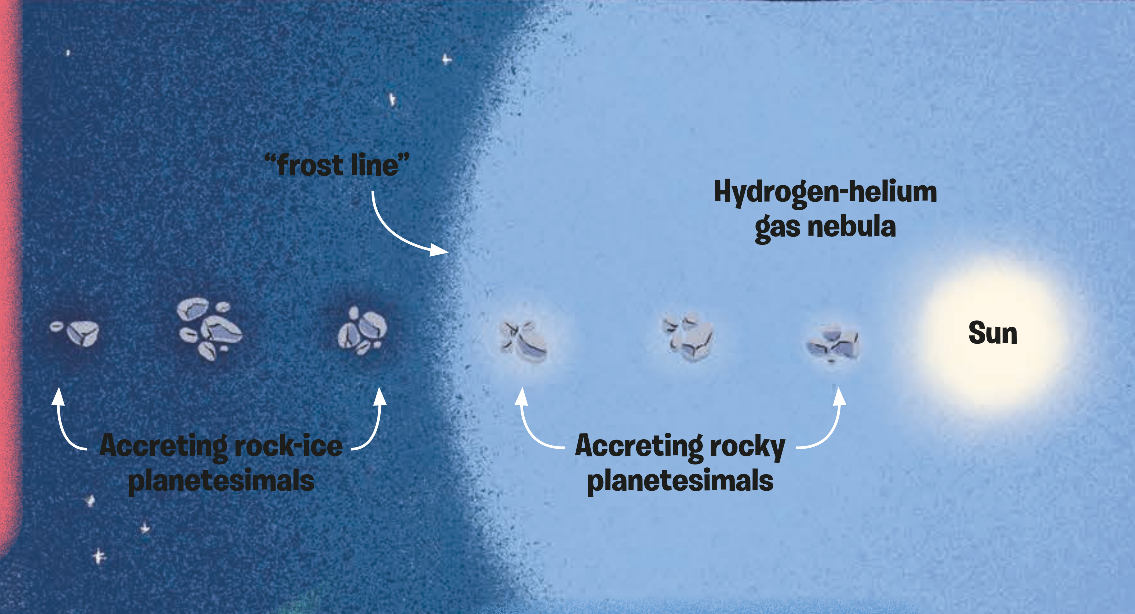
Very close to the Sun it's so hot that substances that are solid on Earth exist as gases. Further from the Sun, space grows cooler and cooler. Materials with a high melting point—such as rock and metal—freeze close to the Sun and form dust in the spinning cloud. Further out, matter that is liquid or even gas on Earth can freeze into solid specks.

Billions of years ago, as particles collided, they formed clumps and lumps. Over time, these grew into larger and larger lumps as they combined in collisions—a process called accretion. Some of these lumps became the first baby protoplanets, and eventually the planets we know today. In just five million years, Earth grew from dust to an early planet. That might sound like a long time, but in the life of stars and planets, it's no time at all.

Rocky planets, gassy planets

Rocky planets like Earth formed closest to the Sun. Matter with a lower freezing point formed lumps further out, making the gas planets like Jupiter. Earth is inside the "frost line"—an imaginary line around the Sun that marks the point at which chemicals such as water and methane freeze. Each substance has its own more precise frost line.





Lumps and chunks continued to crash into and be added to accreting protoplanets.