DK

THE NEW Children's Encyclopedia

Packed with thousands of facts, stats, and illustrations

FULLY REVISED
NEW EDITION
AND UPDATED

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THIRD EDITION

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A WORLD OF IDEAS:
SEE ALL THERE IS TO KNOW

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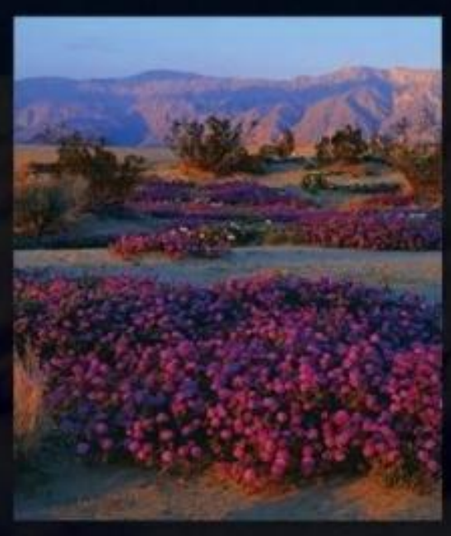
Contents

Introduction





Every child needs a book that answers his or her questions about the world: how it was made, what makes plants grow, why the Sun shines, how the human body works, what happened in the past, and why other countries are different to their own. Properly stimulated, this early thirst for knowledge can become a lifelong process of discovery and understanding. This encyclopedia aims to encourage young readers to make these discoveries for themselves by presenting clear and concise information in an exciting visual manner that draws them in and entices them to read on.

This brand new *Children's Encyclopedia* is divided into thematic chapters. All the major topics are represented: space, earth science, the environment, animals and plants, countries of the world, culture, history, science and technology, and the human body. Stunning photographs and illustrations accompany the text, which is packed with fascinating facts, timelines, and special features. Cross references lead the reader to related topics that help cover the subject in more depth and from new angles. Unique features focus on items of special interest, such as an orchestra or time zones, or collections of bugs or minerals. With so much to look at and find out about, this book will prove to be a valuable reference that young readers will treasure for years to come.

(p110–111) When you see this symbol in the book, turn to the pages listed to find out more about a subject.

▲ COLLECTIONS *look at a particular group of things such as beetles and bugs (p116–117), flags, and mammals.*

▲ DETAILED MAPS *accompany features about countries and continents (p128–153). These are packed with facts and figures about the geography, people, and cultures of the region.*

▲ GENERAL ARTICLES *focus on particular topics of interest (p196–197). Many have timelines that chronicle key stages in development, fact boxes, and picture features.*

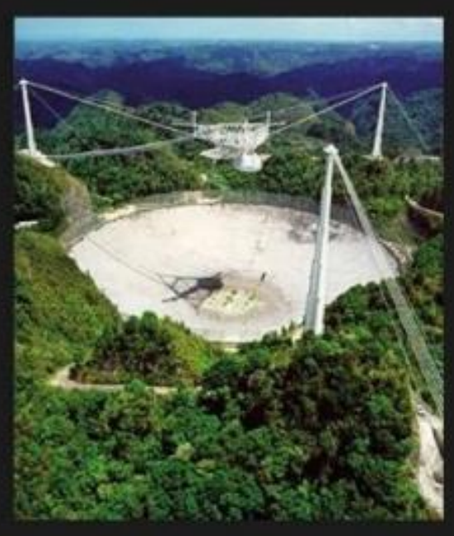
▲ FACT FILES *take an in-depth look at one topic, such as electric cars (p258–259). They detail all you need to know about the subject.*

SPACE

- Many scientists think the Universe began in a Big Bang about 13.7 billion years ago.
- Space begins where the atmosphere disappears 100 km (62 miles) above Earth.
- Our solar system has 8 planets, 5 dwarf planets, and more than 180 known moons.
- The Sun is orbited by billions of space rocks, such as asteroids and comets.
- The first artificial satellite, Sputnik, was launched by the Soviet Union in 1957.

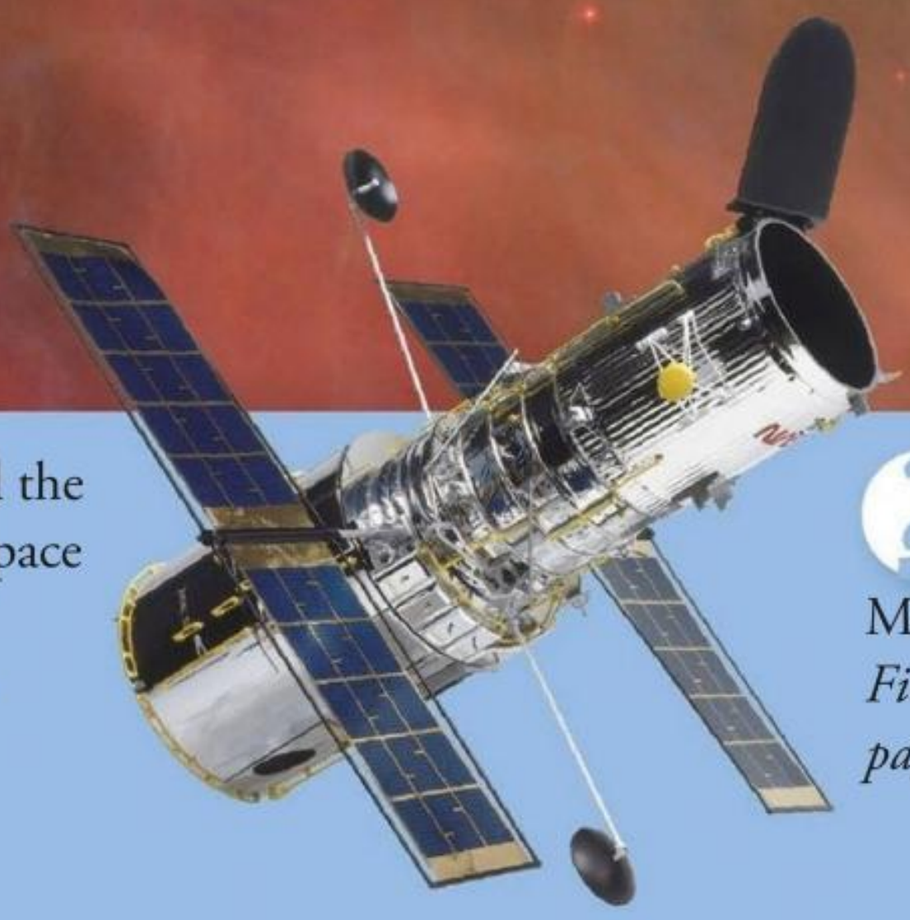
Which star is our nearest star? *Find out on pages 12-13*

Which planet is the king of the planets? *Find out on pages 16-17*



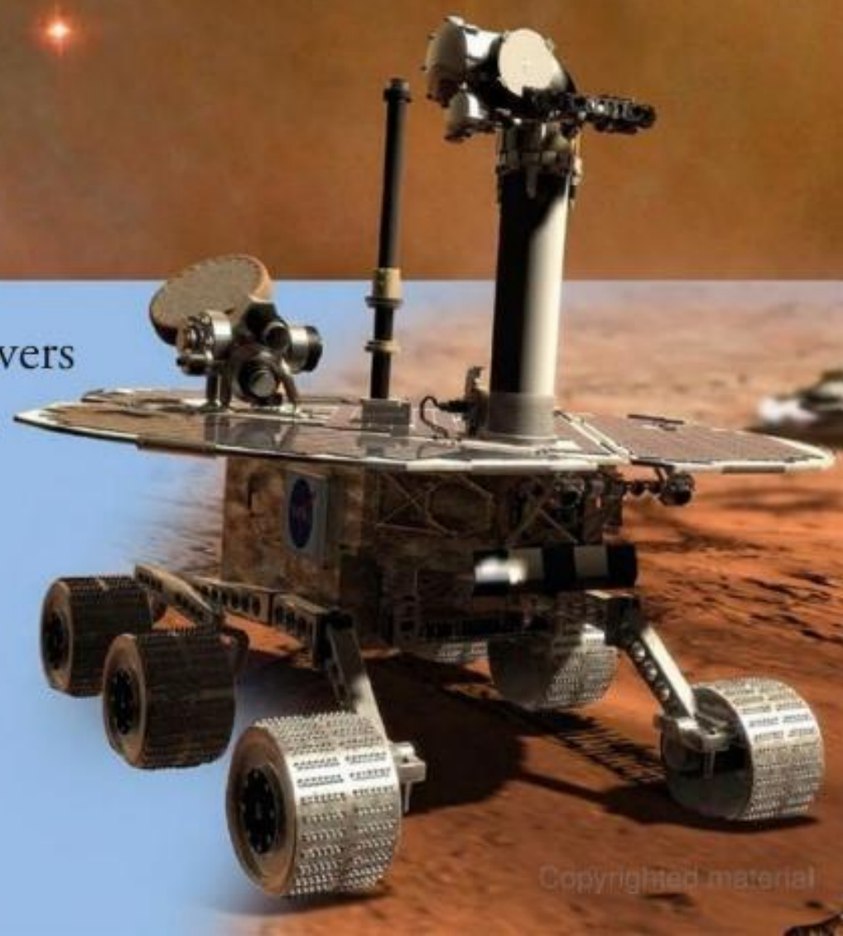
Definition: **Space** includes the Universe beyond Earth's atmosphere – planets, moons, stars, and galaxies. Since its beginning, space has been expanding outwards continuously.

- More than 550 people have flown in space since the first person did it, in 1961.
- A teaspoonful of material from a neutron star would weigh 5 billion tonnes on Earth.
- A black hole is a region of space where gravity is so strong that nothing can escape.
- The temperature at the centre of the Sun is 15,000,000°C (27,000,000°F).
- When a dying star explodes, it releases about as much energy as it emits in its lifetime.



When did the Hubble Space Telescope go into orbit? *Find out on pages 20-21*

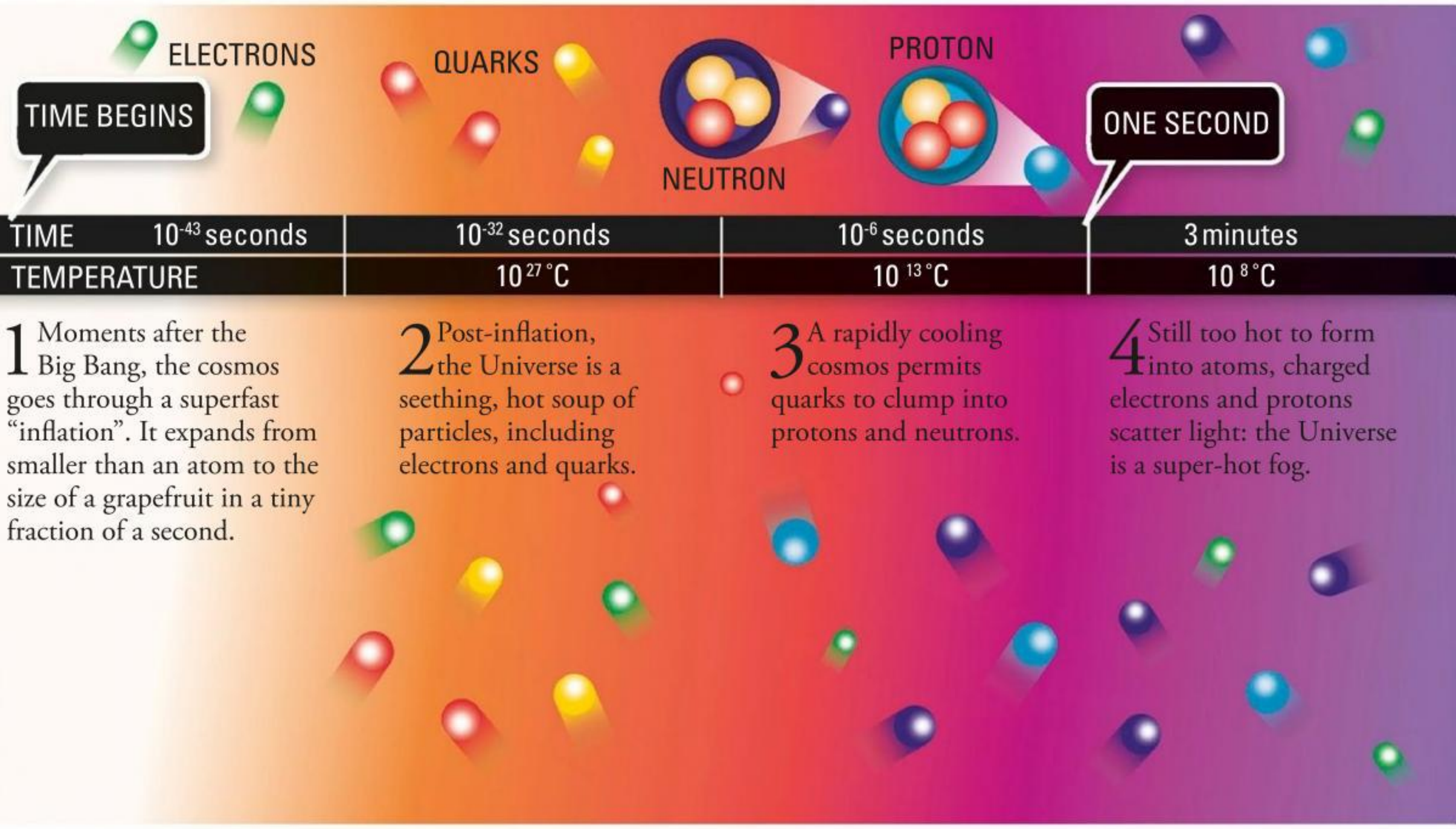
Which rovers landed on Mars in 2004? *Find out on pages 26-27*



The Universe

The Universe is unbelievably huge. It is everything we can touch, feel, sense, measure, or detect, and much that we cannot. It includes people, plants, stars, galaxies, dust clouds, light, and even time. Scientists believe our Universe has existed for almost 14 billion years.

EXPANDING UNIVERSE
Across the visible Universe, galaxies are found to be moving away from each other – rather like spots on an inflating balloon. However, it is actually space that is expanding. The further away from us galaxies are, the faster they seem to be moving.



SPACE FACTFILE

- Light from distant galaxies has taken more than 12 billion years to arrive – so we see them as they were before Earth formed.
- There are more stars in the Universe than there are grains of sand on all of Earth's beaches.
- In its first second, the Universe grew from smaller than an atom to about 1,000 times the size of our solar system today.

Astronomers measure distance in light years. One light year is the distance light travels in one year. Visible light travels at 300,000 km/second (186,282 miles/second) in space. It takes a long time for light to reach us from distant stars and planets. Telescopes are like time machines, allowing us to see what things looked like in the past.

HYDROGEN ATOM

HELIUM ATOM

PROTOGALAXY (DEVELOPING GALAXY)

SPACE

PRESENT DAY

300,000 years	1 billion years	13 billion years	
10,000 °C	-200 °C	-270 °C	

5 Electrons combine with protons and neutrons to form atoms, mostly hydrogen and helium. Light can finally travel long distances across the Universe.

6 Gravity makes hydrogen and helium gas come together to form clouds where the first stars form. Larger clouds and groups of young stars form the first galaxies.

7 As galaxies cluster together under gravity, the first stars cease to exist and spew heavy elements, such as iron, into space: these will eventually form into new stars and planets.

◀ *In 1974, a coded radio message (right) was sent towards the M13 star cluster from the huge Arecibo radio telescope (left). The message will take about 25,000 years to get there, so we may get a reply 50,000 years from now!*

▶ *From the top, the symbols represent the numbers from one to ten, some atoms, molecules, DNA, a human, the basics of our solar system, and information about the sending telescope.*

WOW!

Does **ET** really exist? The only place known to support life is Earth. But scientists believe that life could exist on other worlds if they possess liquid water and the right temperature. As telescopes become more powerful, scientists expect to find huge numbers of Earth-like planets. Some may support life.

Galaxies

Scattered across the Universe are billions of galaxies, each containing millions or even billions of stars. They come in many different shapes and sizes. Modern telescopes can now see very old galaxies that formed not long after the Universe began.

SHAPES AND SIZES

Some galaxies are "elliptical" or almost round, like huge eggs. Some are spirals, with long, curved arms. Many small galaxies are "irregular", with no special shape. Small galaxies may contain a few million stars and measure less than 3,000 light years across. The galactic supergiants contain billions of stars and are more than 150,000 light years across.

GALAXY SHAPES

■ **Spiral galaxy** Spinning spiral galaxies have long, curved arms. Young stars, pink nebulas, and dust are found in the arms.

■ **Barred spiral** Barred spirals have long, trailing arms and a central bar. The most recent stars form at the ends of the bar.

■ **Elliptical galaxy** These galaxies are oval and made up of older stars. Many are found in galaxy clusters. Most are thought to hold supermassive black holes.

■ **Irregular galaxy** Galaxies with no recognizable shape are irregular. They are small with lots of young stars and bright nebulas.

◂ THE WHIRLPOOL GALAXY
This is a huge, well-defined spiral galaxy, 31 million light years away. Its smaller satellite galaxy can be seen to the right. Scientists think there are supermassive black holes at the centre of most spiral galaxies.

ANTENNAE GALAXIES *A well-known collision involves the two Antennae galaxies. They are 45 million light years from Earth and were lit up by bursts of star formation as they collided.*

Colliding galaxies

Most galaxies are separated by vast distances, but sometimes galaxies collide. In fact, the very common elliptical galaxies are thought to have grown through collisions with other galaxies long ago. During collisions, the clouds of gas between the stars are forced together, triggering the formation of new stars. One of the best-known examples is the Antennae galaxies.

GALAXY FACTFILE

▲ SATELLITE GALAXIES *Most large galaxies have smaller satellite galaxies orbiting them. The Andromeda galaxy has many satellite galaxies – two appear as bright spots in this photo. Our own galaxy, the Milky Way, has several dozen.*

▲ GALAXY CLUSTER *Galaxies form clusters because of their huge gravitational pull. They often pull each other out of shape and may collide.*

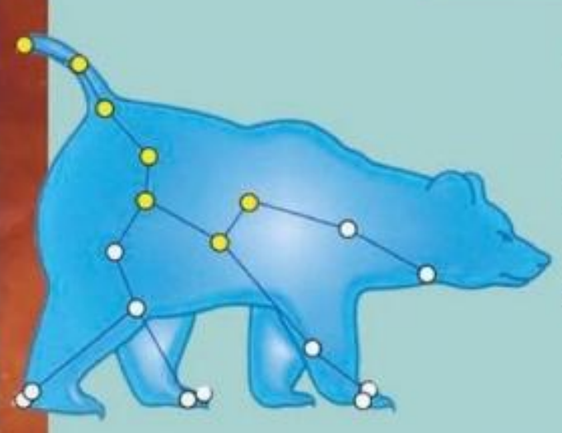
▲ BLACK HOLE *Most galaxies have supermassive black holes at their centre. Their gravity is so strong that not even light can escape. We can see only the hot gas, dust, and stars being pulled in.*

Balls of gas

A star is a huge, glowing ball of hydrogen gas that shines because of nuclear reactions in its core that turn this fuel (hydrogen) into helium, releasing a lot of energy. The hottest stars last up to few million years. Red dwarf stars are the coolest and last the longest.

TAKE A LOOK

Constellations Only a few thousand stars can be seen without a telescope. All of these are in our own galaxy. Ancient people saw patterns and shapes (constellations) in them and named them after mythological creatures or people. The most famous are the 12 zodiac constellations. They form a belt across the sky.



▼ URSA MAJOR
The seven brightest stars, located in the Bear's hindquarters and tail, form the well-known Plough, or Big Dipper.

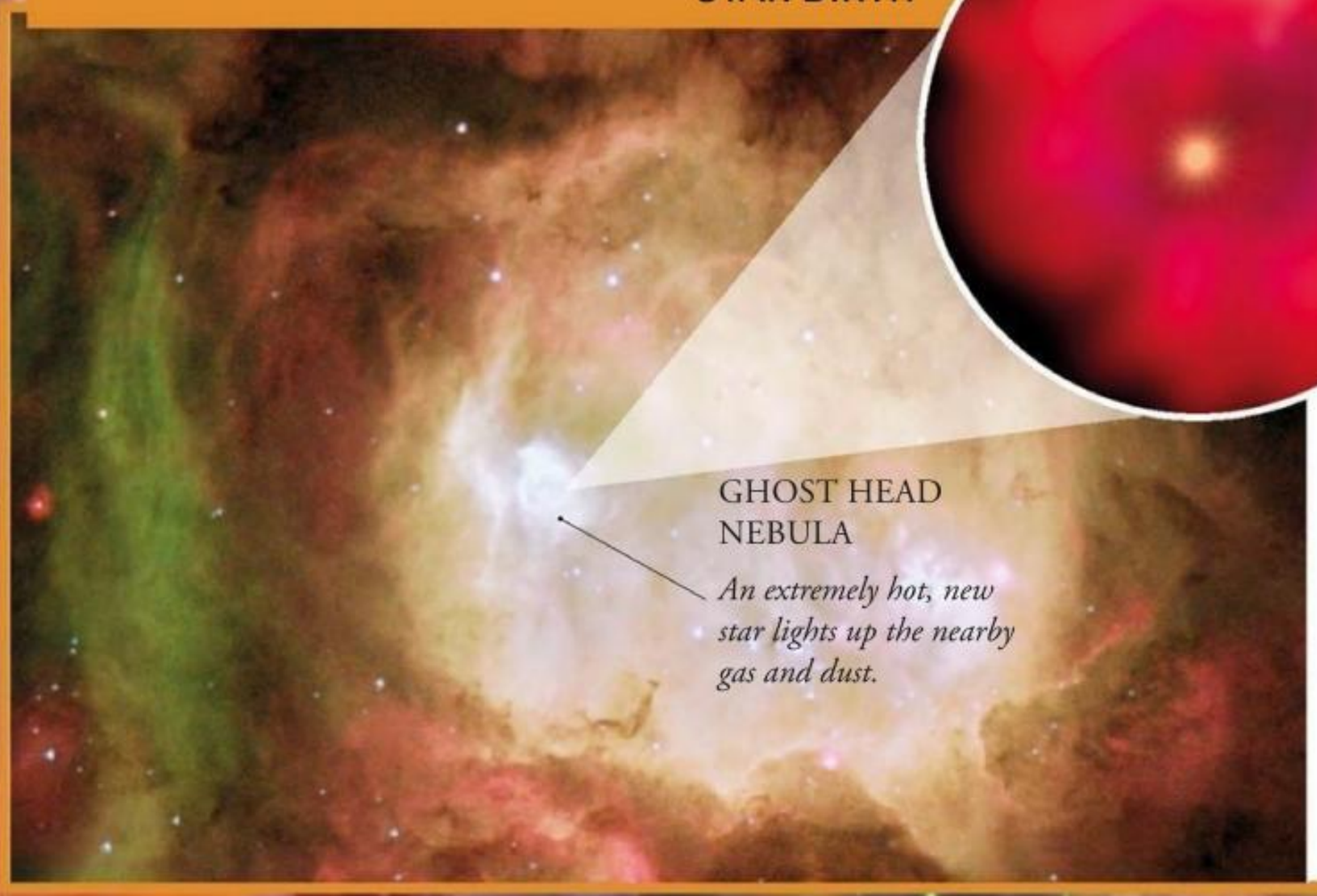
The small orange dots are stars that are still forming.

The clouds are many different colours because they are made up of different gases and dust particles.

There are four young, massive stars at the centre of the Orion Nebula.

Orion Nebula
This galaxy is 15,000 light years away from Earth.

STAR BIRTH



GHOST HEAD NEBULA

An extremely hot, new star lights up the nearby gas and dust.

■ **Most stars are born** inside giant dust clouds called nebulas. Parts of these clouds collapse and as they shrink, the gas and dust get hotter and form a star. When nuclear reactions begin in its core, radiation makes the surrounding material glow. Eventually this disappears and the star appears.

◀ *The Ghost Head Nebula is a star-forming region in the Large Magellanic Cloud, a satellite galaxy of the Milky Way (our own galaxy). The "eyes of the ghost" are two very hot, glowing blobs of gas that are heated by nearby, massive stars.*

The Sun

- **Diameter** 1,390,000 km (864,000 miles)
- **Mass (Earth=1)** 330,000
- **Core temperature** 15,000,000 °C (27,000,000 °F)
- **Average Distance from Earth** 150,000,000 km (93,000,000 miles)

The Sun is our nearest star. Without the Sun, Earth would be frozen and lifeless. The Sun formed in a cloud of gas and dust about 4.6 billion years ago and has another 5 billion years to go.

WOW!

The colour of a star is a guide to its surface temperature. The hottest stars are blue or white, stars like the Sun are yellow, and cool stars are orange or red.

Huge plumes of hot gas sometimes stream away from the Sun. They are called prominences.

FACTFILE

- Betelgeuse, a red supergiant, is about 700 times the size of the Sun.
- Light from the next nearest star after the Sun takes just over four years to reach us.
- Brown dwarfs are stars that weren't hot enough for nuclear reactions to begin.

Brown dwarf (right) with a nearby orbiting object (red).

THE SUN

The Sun is a yellow dwarf, a fairly ordinary star made mainly of hydrogen. Hydrogen is changed to helium at its centre (the core). When this happens, huge amounts of radiation are released.

STAR DEATH

- **Planetary nebulas** Small stars expand to become red giants. When they run out of fuel, they collapse. Their outer layers are puffed out in rings called planetary nebulas. Each star creates a different shape, such as a cat's eye (below), a butterfly, or a ring. The central star shrinks to a tiny, hot white dwarf.

▲ *The Cat's Eye Nebula is made up of many gas clouds ejected by a dying star.*

Before

After

- **Supernovas** Larger stars collapse in a different way when they run out of fuel. Their outer layers explode into space in a supernova (right). These can briefly outshine an entire galaxy, but are rare events. The photograph on the left shows the same star 10 days before a supernova. Medium-sized stars become neutron stars. Massive stars create black holes.

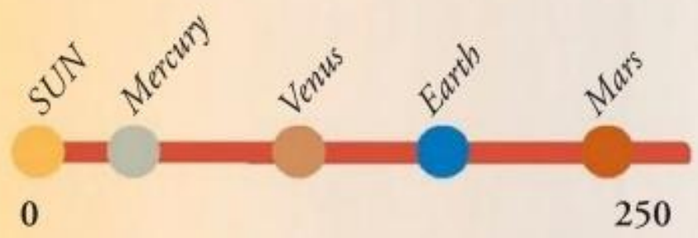
The solar system

The solar system is our local area of space. At its centre is the Sun, our nearest star, which accounts for almost all (99.9 per cent) of the solar system's mass. The Sun's gravity keeps the planets in their orbits.

DISTANCE FROM THE SUN

The red line to the right shows the distance of each planet from the Sun in millions of kilometres. Mercury is closest and Neptune is furthest away. Earth is about 150 million kilometres from the Sun.

All of the planets and asteroids go around the Sun in near-circular orbits in the same direction (west to east).



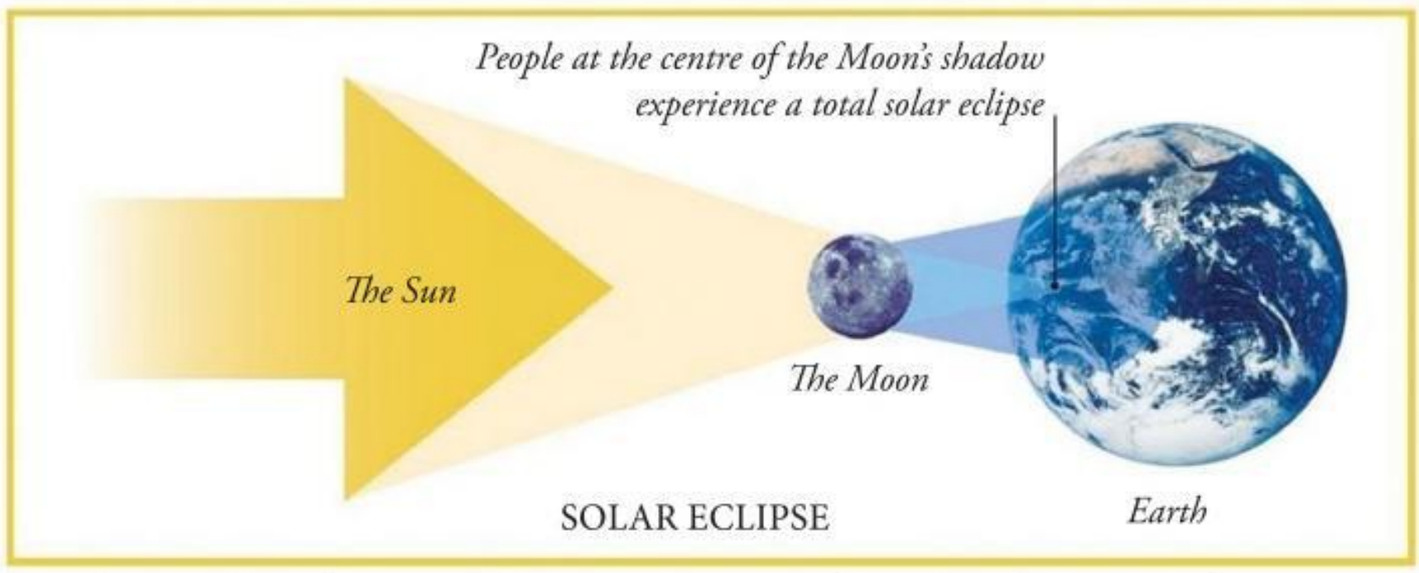
INNER PLANETS

The four planets nearest the Sun are called the inner planets. They are also known as the rocky planets because they are balls of rock and metal. They are dense and have central cores made of iron.

LUNAR AND SOLAR ECLIPSES

In any year there can be up to seven solar or lunar eclipses, when Earth, the Moon, and the Sun line up. Solar eclipses are more common, but are seen only in a narrow area. Lunar eclipses can be seen anywhere on Earth where the Moon is shining in the sky.

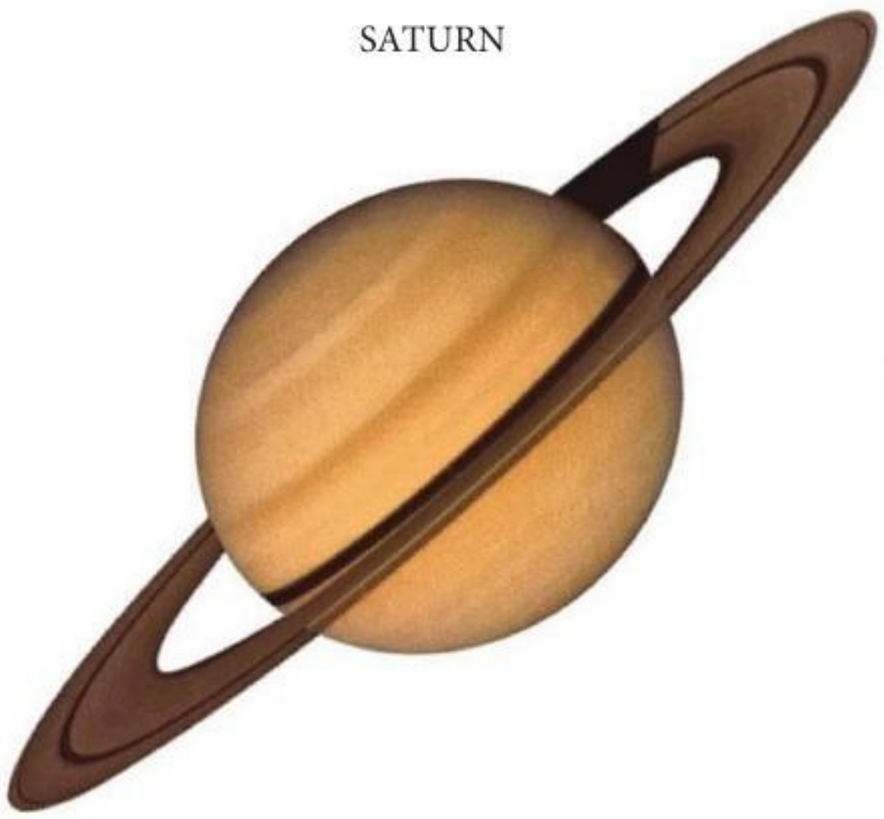
A "diamond ring effect" appears just before or just after an eclipse of the Sun. Then the Sun's corona (atmosphere) can be seen around the Moon.



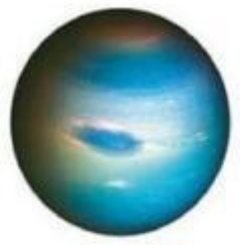
- A lunar eclipse happens when Earth passes between the Sun and the Moon, so that Earth casts a shadow on the Moon.
- A solar eclipse happens when the Moon passes between Earth and the Sun, casting a shadow on Earth. A total eclipse lasts for up to eight minutes.

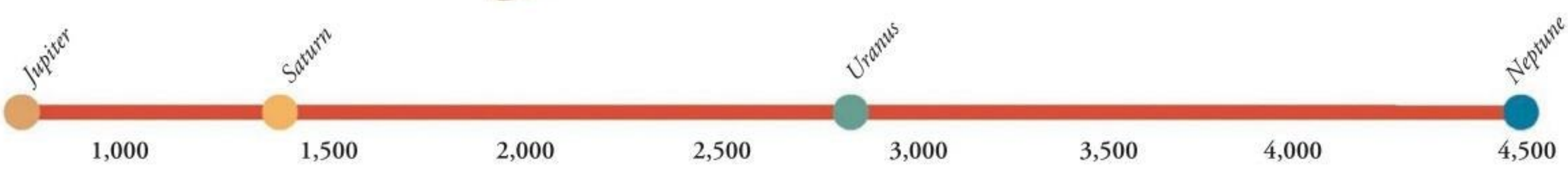
▼ SCALE OF THE PLANETS
The Sun is the most massive object in the solar system. It is so massive that you could fit a million Earths inside it. Jupiter is by far the most massive planet. All the other planets could fit inside it.


JUPITER


SATURN

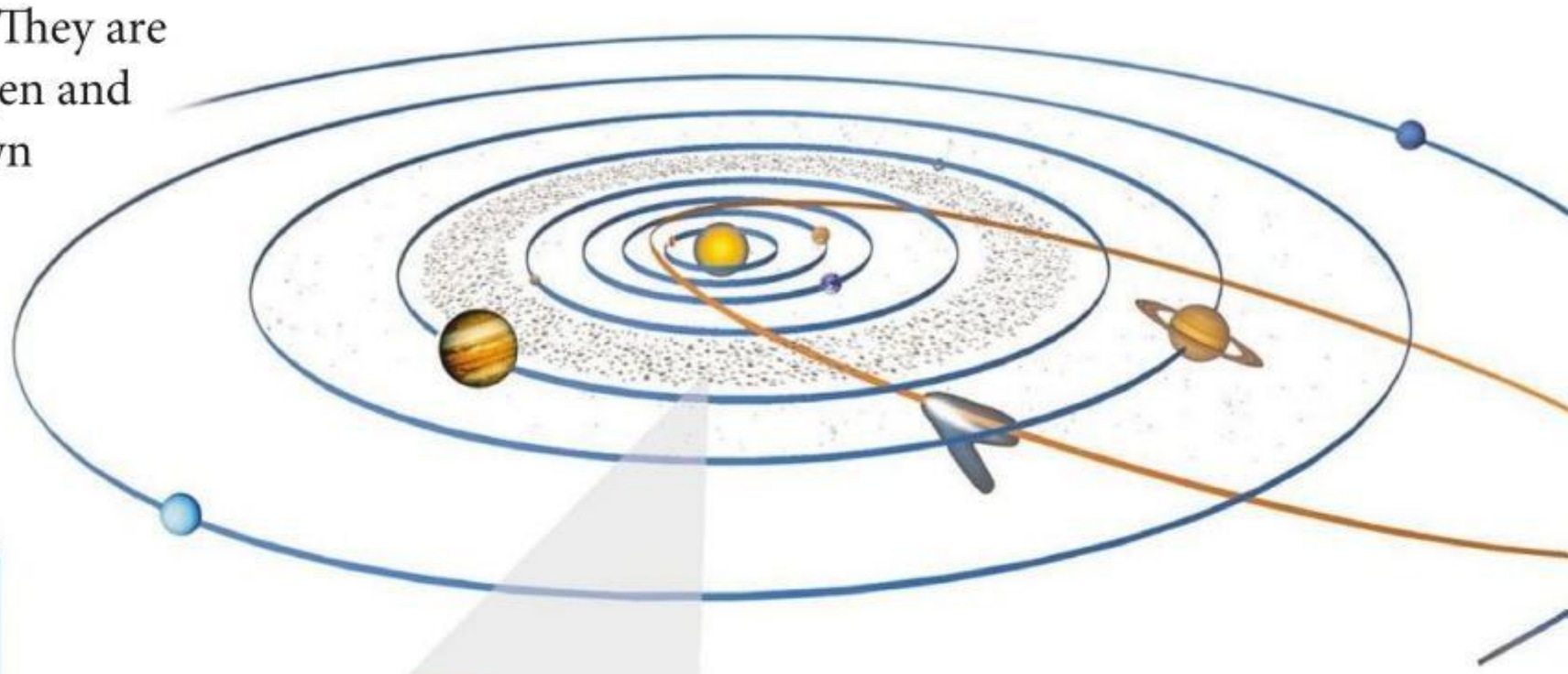

URANUS


NEPTUNE



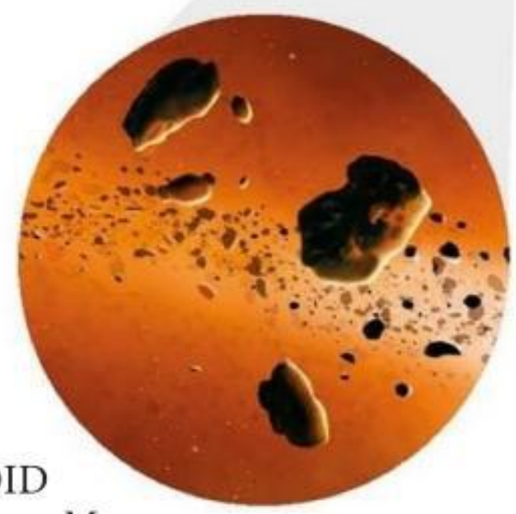
OUTER PLANETS

The four planets furthest away from the Sun are called the outer planets. They are huge balls of gas (mainly hydrogen and helium) and liquid and are known as the gas giants. Uranus and Neptune are also known as the ice giants.



FAST FACTS

- Only six planets are visible to the naked eye. The first planet to be discovered using a telescope was Uranus, in 1781.
- The planets formed in a huge cloud of gas and dust about 4.5 billion years ago.
- About 4 billion years ago the Sun was 25 per cent dimmer than it is today.
- Halley's comet doesn't orbit the Sun in the normal clockwise direction. It travels from beyond Neptune to inside the orbit of Venus as it circles the Sun.
- Excluding the Sun, Jupiter and Saturn contain 90 per cent of the solar system's mass.



▶ ASTEROID BELT *Between Mars and Jupiter is the asteroid belt. It separates the inner planets from the outer planets. About 15,000 asteroids have been found and named. They are thought to be rocks that never clumped together to form planets.*

ORBITING THE SUN

The solar system includes eight planets, at least five dwarf planets, more than 180 moons, and millions more comets and asteroids. These bodies are all orbiting the Sun.

Mercury

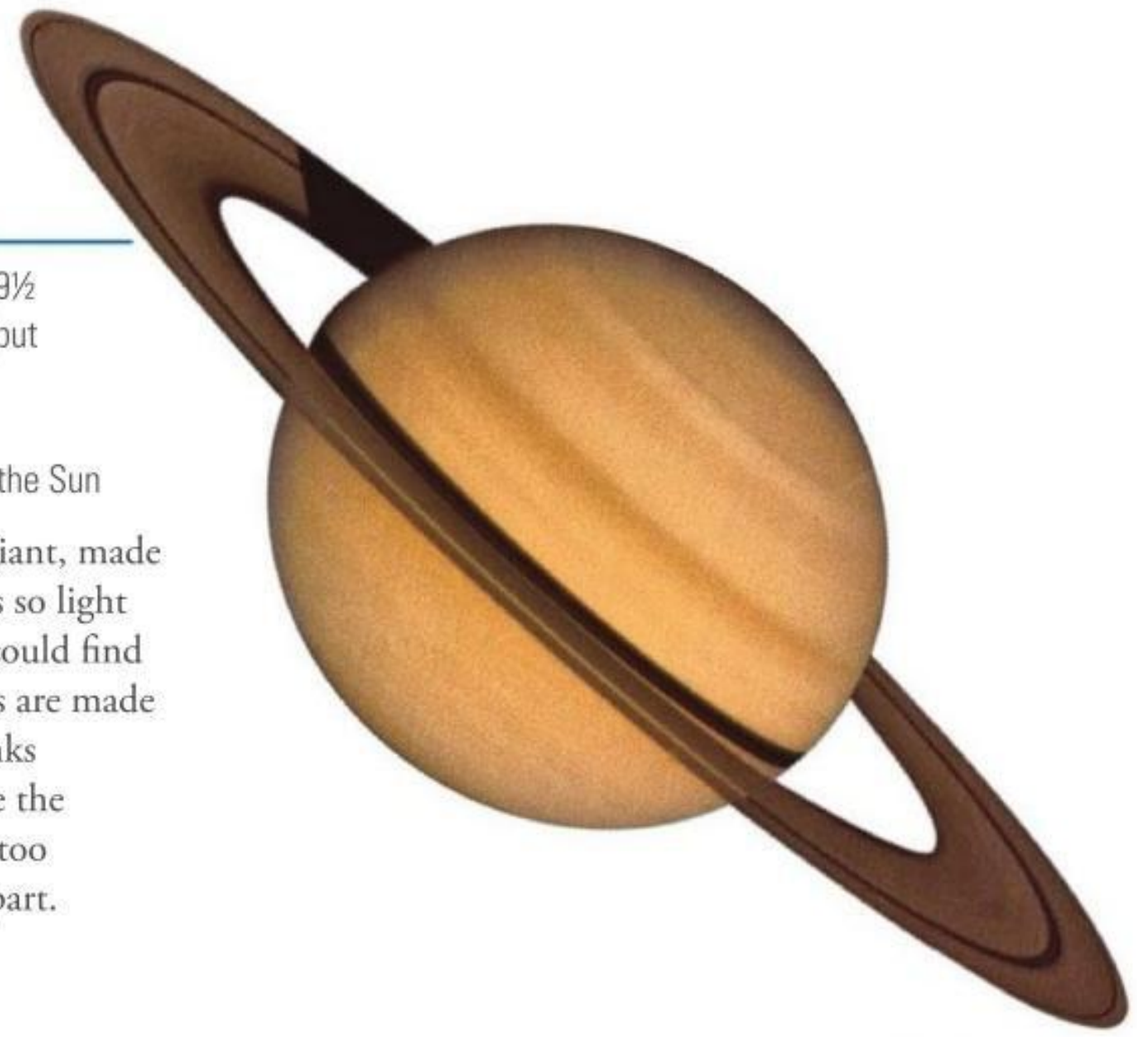
Messenger of the Roman gods

- **Earth days to orbit Sun** 88
- **Discovery date** Unknown (but known since ancient times)
- **Number of moons** 0
- **Location** First planet from the Sun

The solar system's smallest planet, and the densest, temperatures on Mercury range from a freezing -173°C (279°F) to a blistering 427°C (801°F). Unlike Earth, Mercury has no atmosphere, so the planet cannot retain heat.

Saturn

Roman god of agriculture



- **Earth years to orbit Sun** 29½
- **Discovery date** Unknown (but known since ancient times)
- **Number of moons** 62
- **Location** Sixth planet from the Sun

Saturn is an enormous gas giant, made mainly of hydrogen gas. It is so light that it would float – if you could find a big enough ocean! Its rings are made of billions of small, icy chunks orbiting the planet. They are the remains of a moon that got too close to Saturn and broke apart.

Venus

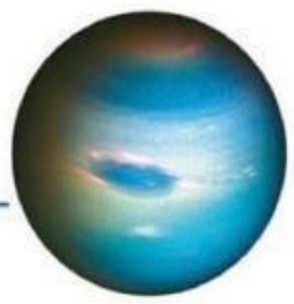
Roman goddess of love

- **Earth days to orbit Sun** 224.7
- **Discovery date** Unknown (but known since ancient times)
- **Number of moons** 0
- **Location** Second planet from the Sun

Venus is almost the same size as Earth, but you wouldn't want to visit Venus. Its atmosphere is incredibly dense and the temperature is so high you would be fried to a crisp. The planet is covered in acid clouds that trap heat.

Neptune

Roman god of the sea



- **Earth years to orbit Sun** 165
- **Discovery date** 1846
- **Number of moons** 14
- **Location** Eighth planet from the Sun

This is an icy planet. That's because it is 30 times further away from the Sun than Earth. A day on Neptune lasts 16 hours and 7 minutes. Neptune has huge storms and very strong winds. It also has five dark, thin rings.

Jupiter

King of the Roman gods

- **Earth years to orbit Sun** 12
- **Discovery date** Unknown (but known since ancient times)
- **Number of moons** 69
- **Location** Fifth planet from the Sun

The solar system's largest planet, Jupiter is a gas giant made mainly of hydrogen. It has many storms in its deep, cloudy atmosphere. The largest of these, which has been blowing for at least 300 years, is called the Great Red Spot. Jupiter has more moons than any other planet.

Uranus

Greek god of the sky

- **Earth years to orbit Sun** just over 84
- **Discovery date** 1781
- **Number of moons** 27
- **Location** Seventh planet from the Sun

Uranus was discovered in 1781 by astronomer William Herschel. Much of the planet is thought to be made of water and ice. It has 13 thin, dark rings. The planet spins on its side, like a top that has fallen over. This is probably the result of a huge impact long ago.

Mars

Roman god of war

- **Earth days to orbit Sun** 687
- **Discovery date** Unknown (but known since ancient times)
- **Number of moons** 2
- **Location** Fourth planet from the Sun

Mars is one of the closest planets to us in space. It is barren and mainly covered with dust and rocks. Two ice caps cover the poles. It is about half the size of Earth, but has no flowing water, and, as yet, no signs of life.

Earth

Terra

- **Earth days to orbit Sun** 365.2
- **Number of moons** 1
- **Location** Third planet from the Sun

Earth is the only planet known to support life. It has the right temperature for life because it's neither too close to the Sun, nor too far from it. Earth is the only planet with oceans on its surface. It is also the only planet with lots of oxygen – the gas that keeps us alive.

Moon

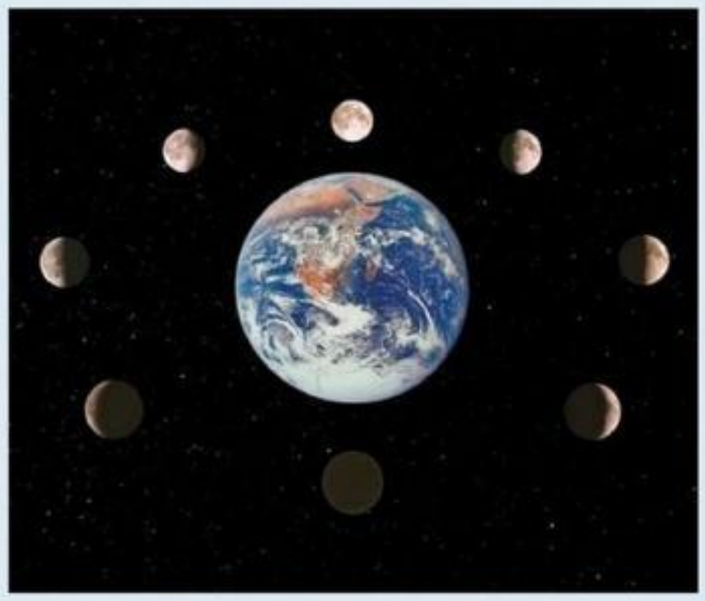
Luna

- **Days to orbit Earth** 27.3
- **Discovery date** Unknown (but known since ancient times)
- **Location** Only moon of Earth

The Moon orbits Earth at an average distance of 384,400 km (238,855 miles) – a journey of three days by spacecraft. It formed when a huge Mars-sized object crashed into the young Earth. The dark patches on its surface that make up the face of "the man in the Moon" are old seas of lava. The Moon has no atmosphere.

TAKE A LOOK: PHASES OF THE MOON

As the Moon orbits Earth, it seems to change shape night after night. We say it goes through phases. This is because we see different amounts of the Moon's sunlit side. At new moon it is dark and cannot be seen (except during a solar eclipse). At full moon the entire Earth-facing side is lit up by the Sun. (p31)



▸ MOONS *The period from full moon to full moon lasts 29½ days.*

◂ HIDDEN FAR SIDE
The Moon always keeps the same side pointing towards Earth. We never see the "far side".

WOW!

Earth and Mars have had many ice ages in the past. When they get colder, ice sheets spread out from the poles and cover large areas. Most of Earth may have been covered in ice 600 million years ago. Ice ages happen because of changes in the orbits and tilt of the planets.

THE OCEAN PLANET

Earth is the only planet with oceans of water on its surface. This water turns to gas, then forms clouds and rain (or snow). It is also the only planet we know with lots of oxygen – the gas that keeps us alive. Its powerful magnetic field shields Earth from harmful particles and radiation from the Sun.

▸ LIFE ON EARTH *Life is thought to have existed on Earth for almost four billion years.*

FAST FACTS

- The planets of our solar system orbit the Sun in nearly perfect circles.
- Our nearest neighbour, Venus, is only 38 million km (23½ million miles) away during close approaches.
- Use this simple sentence to remember the order of the planets: **M**y **V**ery **E**ducated **M**other **J**ust **S**erved **U**s **N**oodles (My = Mercury, Mother = Mars).
- Even today, comets and small asteroids crash into the planets (including Earth). One impact 65 million years ago may have wiped out the dinosaurs.

Flying rocks

There are billions of rocks in the Milky Way that never became big enough to be planets. They orbit the Sun and sometimes crash into each other and the planets. They create spectacular light shows in the sky and could devastate whole planets.

ASTEROIDS

Asteroids are small, rocky bodies that orbit the Sun. Most of them are found between the orbits of Mars and Jupiter. They are left-overs from the formation of the planets 4.5 billion years ago. The main asteroid belt contains tens of thousands of asteroids. The first asteroid to be discovered was Ceres, in 1801.

PLUTO

The Roman god of the underworld

- **Diameter** 2,320 km (1,441 miles)
- **Mass (Earth=1)** 0.002
- **Earth years to orbit Sun** 248
- **Number of moons** 5

Pluto was discovered in 1930. In 2006, astronomers decided it should be classed as a dwarf planet. It is smaller and lighter than the Moon and its egg-shaped orbit means that it sometimes comes closer to the Sun than Neptune. Pluto is very cold because it is so far away from the Sun.

DWARF PLANETS

Pluto, Haumea, Eris, Makemake, and Ceres are the only confirmed dwarf planets. Ceres is the only asteroid big enough to be classed as a dwarf planet. The other dwarf planets are much like Pluto and are found in the outer solar system beyond the orbit of Neptune.

WOW!

Most meteorites are too small to cause much damage. However, 65 million years ago, a 10-km (6-mile) wide asteroid hit Earth, causing massive earthquakes and tidal waves. A cloud of dust from the impact entered the atmosphere and blocked sunlight, causing plants and animals to die. This impact may have ended the age of the dinosaurs.

▸ COMETS *orbit the Sun in the outer solar system and sometimes appear in our skies. They have two tails – of gas and dust – and a solid nucleus made of ice. The Hale-Bopp comet passed near our Earth in 1997. It was one of the brightest comets of the 20th century.*

Meteor showers occur at the same time each year, when Earth passes through trails of dust left by passing comets. Very rarely, a shower may produce thousands of shooting stars that light up the sky.

TAKE A LOOK: METEORS

Look up at the sky on a cloudless night and you will eventually see a meteor, or "shooting star". Meteors are particles of dust and rock that burn up as they enter Earth's atmosphere.

It's strange to think that the Willamette meteorite (above), now found in a museum, was once a brilliant fireball shooting towards Earth. It's made of iron and nickel.

METEORITES

Meteorites are small chunks of rock that have come from space and landed on Earth's surface. Most of them are pieces that have broken off asteroids. A few have come from the Moon and Mars.

▸ METEOR CRATER *One of the youngest and best-preserved craters on Earth is in Arizona, USA. It is 50,000 years old and 180 m (600 ft) deep.*

The crater is 1,200 m (4,000 ft) wide

Eye spy space

People have been staring at the heavens since prehistoric times. They watched the movement of the Sun, Moon, and planets across the sky and measured the positions of the stars. But there was a limit to what could be learned with the naked eye.

LICK TELESCOPE *The James Lick Telescope is an antique refracting telescope built in 1888. It is the third largest example of this type of telescope in the world. It is in California and is 4,209 ft (1,283 m) above sea level.*

WOW!

In order to avoid becoming ill with altitude sickness, people visiting mountain-top observatories, such as Keck I and II in Hawaii, have to stop and wait halfway up the mountain. This allows their bodies to adapt to the decrease in oxygen in the air.

TAKE A LOOK

Optical telescopes can obtain images of far-away planets and stars. Other telescopes study the Universe by capturing radio waves, X-rays, and other types of radiation.

▲ MARS FROM HUBBLE *This picture of Mars was taken with the Hubble Space Telescope. It shows the southern polar cap, the orange deserts, and sheets of ice cloud.*

Gran Telescopio Canarias

Largest optical telescope

- **Diameter of main mirror** 10.4 m (34.1 ft)
- **Weight of main mirror** 17 tonnes (19 tons)
- **Altitude** 2,270 m (7,440 ft) above sea level
- **Location** La Palma, Canary Islands, Spain

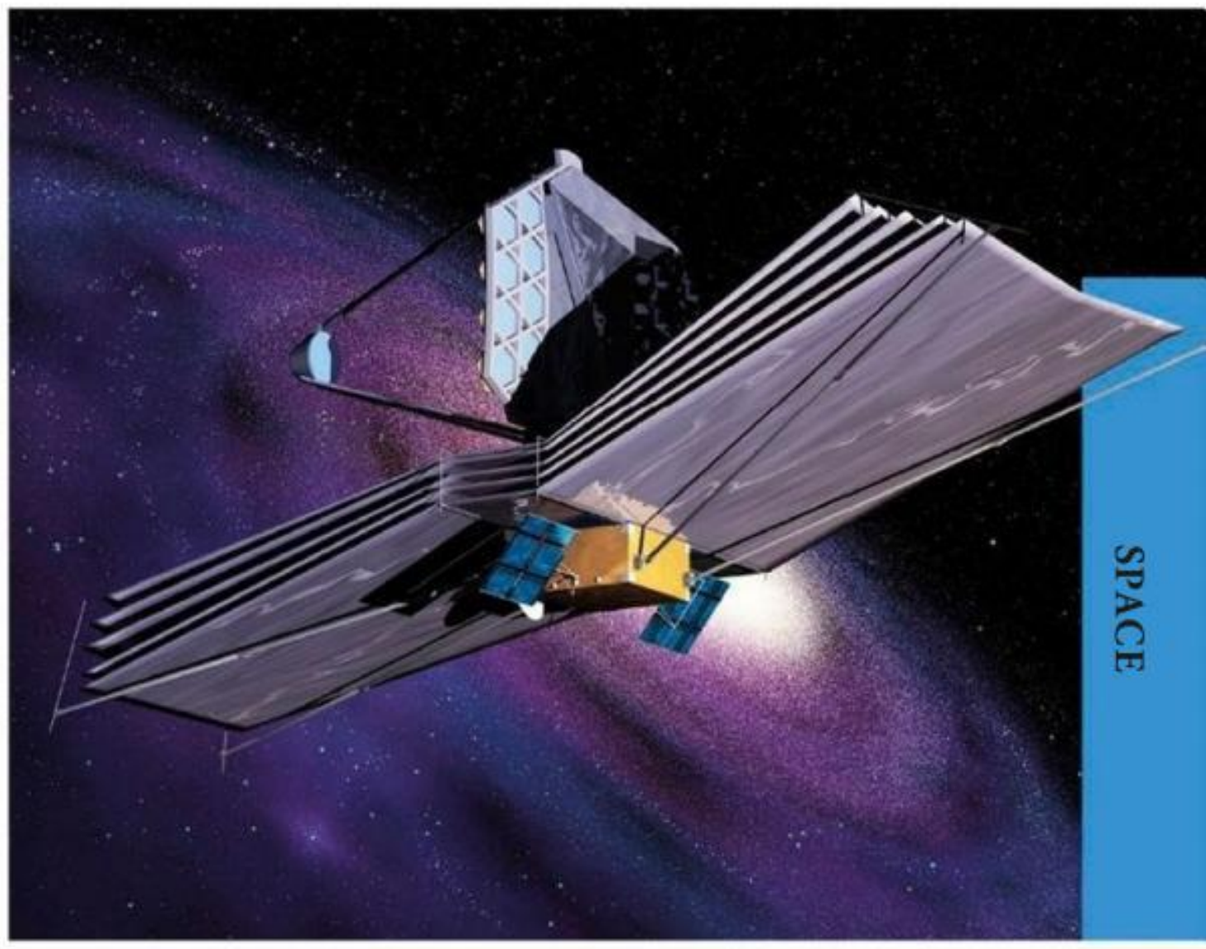
The world's largest single-mirror reflecting telescope is the Gran Telescopio Canarias, built on the peak of an extinct volcano on La Palma. The main mirror is made up of 36 hexagonal segments each 1.9 m (6¼ ft) across. The metal segments are coated with aluminium, which is a very good reflector of light. Observations began in 2009.

James Webb

Largest space telescope

- **Length** 22 m (72 ft)
- **Weight** 6,500 kg (14,300 lb)
- **Mission length** 5–10 years
- **Location** 1.5 million km (1 million miles) from Earth

In 2021 or later, the James Webb Space Telescope will be launched into space. It will have a 6.5 m (21 ft) mirror (nearly three times bigger than Hubble's).



NuStar

Most powerful X-ray observatory

- **Length** 10.9 m (35.8 ft)
- **Weight** 171 kg (377 lb)
- **Launched** 2012
- **Location** Earth orbit

From its observation point above our atmosphere, NuSTAR (Nuclear Spectroscopic Telescope Array) gathers X-rays produced by high-energy objects such as collapsing stars and massive black holes.

Hubble Space Telescope

Famous NASA-ESA observatory

- **Height** 13.3 m (43⅗ ft)
- **Weight** 10,843 kg (23,855 lb)
- **Mission length** 31 years
- **Location** Earth orbit

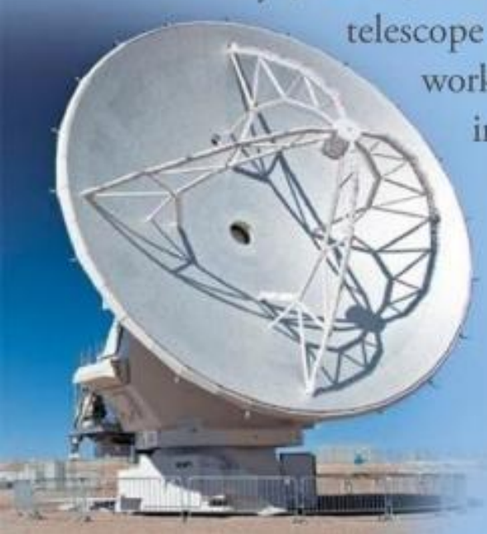
Launched in 1990, the world's most famous space observatory has a 2.4 m (7½ ft) mirror. It is named after American astronomer, Edwin Hubble, who showed that the Universe is expanding.

ALMA

66-dish radio telescope

- **Size** 66 dishes; 54 with a 12-m (39-ft) diameter, 12 with a 7-m (23-ft) diameter
- **Altitude** 5 km (3 miles) above sea level
- **Location** Atacama Desert, northern Chile

The Atacama Large Millimeter/submillimeter Array (ALMA) is the world's largest radio telescope array. Its 66 dishes work together to gather information about newly forming stars and planets.



Allen Telescope Array

42-dish radio telescope

- **Size** 42 dishes, each 6.1 m (20 ft) across
- **Location** Hat Creek, California, USA

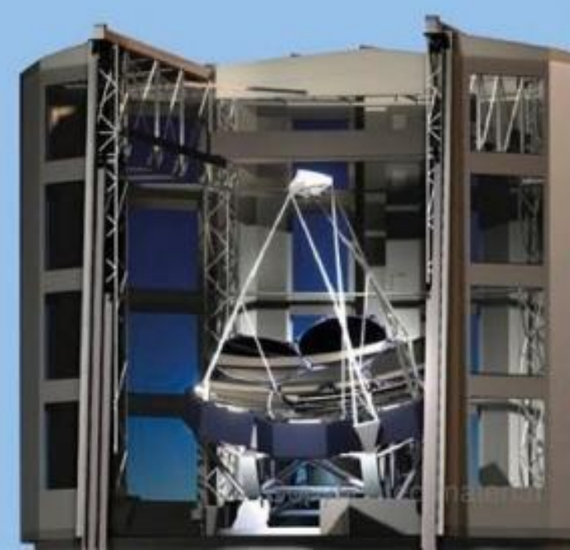
Under construction, this array is planned to contain 350 dishes inside a 1 km- (⅗ mile-) wide circle. They will be linked and act as a single dish to study the distant Universe and search for alien life.

Giant Magellan Telescope

7-mirror optical giant

- **Height** Seven 8.4 m (28 ft) mirrors
- **Total moving weight** more than 1,000 tonnes (more than 1,000 tons)
- **Location** Cerro Las Campanas, Chile

Due to be operational in 2023, the Giant Magellan Telescope will produce images ten times sharper than the Hubble Space Telescope.



The Apollo programme

In the early 1960s, Russia was ahead in the space race, so President John F Kennedy announced that American astronauts would land on the Moon before 1970. In July 1969, after spending 25 billion dollars on the *Apollo* programme, they did.

GETTING THERE

■ The astronauts' journey to the Moon would not have been possible without the *Saturn V*, the most powerful rocket ever built. The huge, three-stage rocket towered 110 m (361 ft) above the Florida launch pad. After the first two stages ran out of fuel, they were released and the third stage was used to boost the *Apollo* spacecraft and its crew towards the Moon.

First man on the Moon *Apollo 11* was the first manned mission to land on the Moon. On 20 July 1969, Neil Armstrong made the first lunar footprint. He was joined on the Moon's surface by Buzz Aldrin.

APOLLO TIMELINE

1966

26 February
First unmanned test flight of *Saturn* 1B rocket. It eventually carried the first manned *Apollo* test flight to orbit Earth.

1967

27 January
Gus Grissom, Edward White, and Roger Chaffee were killed on the launch pad by a fire in their *Apollo* spacecraft during a launch test.

1968

11 October
First manned *Apollo* flight tests the Command Module in Earth's orbit.

21 December
Apollo 8 is the first manned spacecraft to leave Earth orbit and orbit the Moon.

1969

20 July
Apollo 11 makes the first manned landing on the Moon.

Space shuttle In 1981, a new space age began when the first reusable spacecraft lifted off from Cape Canaveral, Florida. Five US space shuttle orbiters were built and flew a total of 135 missions. The final flight was in 2011.

▼ SPACE SHUTTLE LANDING
The shuttle came back to Earth like a giant glider. It landed on a runway at a speed of 345 km/h (215 mph). A tail parachute helped it to slow down.

REUSABLE LAUNCHERS

Only part of the Space Shuttle was reusable – and other rockets are simply lost forever once they launch a payload into space. But the Falcon Heavy, built by SpaceX, is a system that can launch satellites and other objects into space then land its rockets back on Earth to be reused.

▲ THE FALCON HEAVY *has three "cores" that return to the launch pad after launching the payload.*

Space tourism Almost all of the astronaut and cosmonaut flights have been funded by governments. However, space tourism is becoming increasingly popular. The first real space tourist was millionaire businessman Dennis Tito, who paid 20 million US dollars for a week on board the ISS.

Dennis Tito

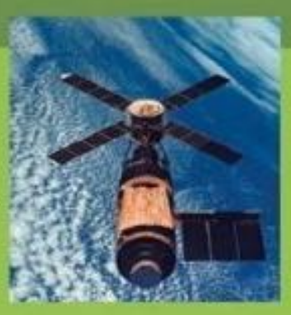
WOW!

Just 12 astronauts have walked on the Moon. They are the only people ever to have set foot on another world. More than 550 people have flown in space since Gagarin's historic flight. Most have come from the Soviet Union/Russia or the United States.

▼ SPACESHIPTWO
Virgin Galactic's sub-orbital spacecraft SpaceShipTwo is carried into space by the WhiteKnightTwo, a four-engine jet aircraft. This spacecraft can carry eight people on a sub-orbital flight.

1970s

1973 *Skylab* launch – the first US space station.



1977 *Voyager* 2, then 1 are launched to Jupiter, Saturn, and beyond.

1980s

1986 First section of *Mir* space station launched.

1990s

1998 First part of the ISS launched.

2000s

2004 *Cassini-Huygens* arrives at Saturn.

2015 *New Horizons* reaches Pluto and sends back images of its surface.

WHERE IS THE WATER?

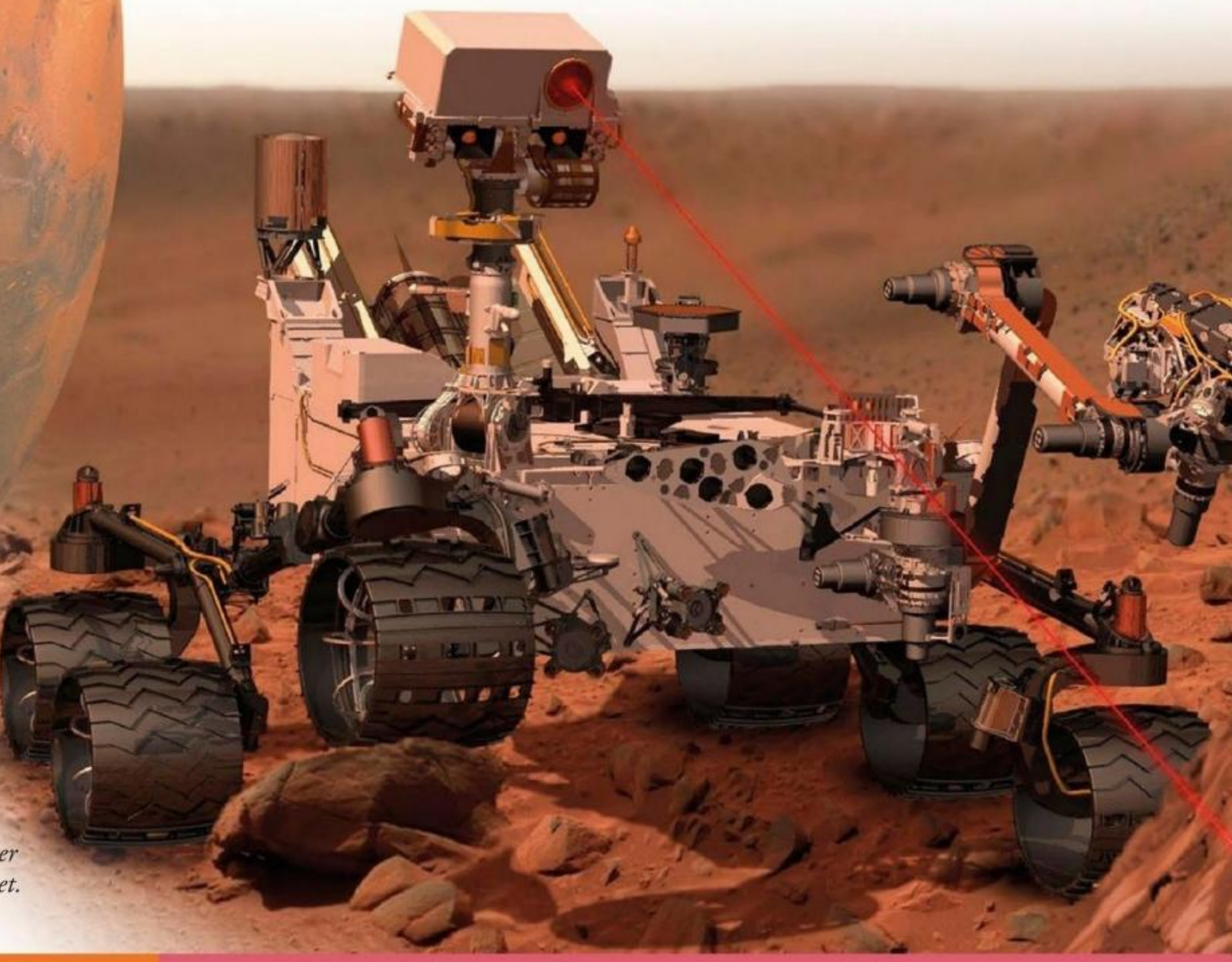
Today, Mars is very cold and the air is too thin for liquid water to exist on the surface. However, huge, winding channels suggest that large rivers flowed over the surface long ago. The water was probably released in sudden floods, possibly when underground ice melted. These river channels have been dry for billions of years.

WOW!

Mars has two small moons, Phobos and Deimos. They are thought to be asteroids that were captured by Mars long ago. Phobos is no more than 27 km (17 miles) across with large craters on its surface. Deimos is just 12 km (7 miles) across and has a smoother surface.

Phobos

Mars Explorers Many robotic spacecraft have been sent to Mars but failed. The successful *Viking* missions in the 1970s included two orbiters and two landers. The first rover was part of the *Mars Pathfinder* mission of 1997. Today there are two large rovers on Mars (*Opportunity* and *Curiosity*) that are still returning images and data to Earth. Missions carrying humans to Mars are planned for the 2020s.



▸ CURIOSITY ROVER *In 2012,* Curiosity *detected water vapour on the red planet.*

1990s

1997
Mars Pathfinder (US) delivers first successful rover to Mars.

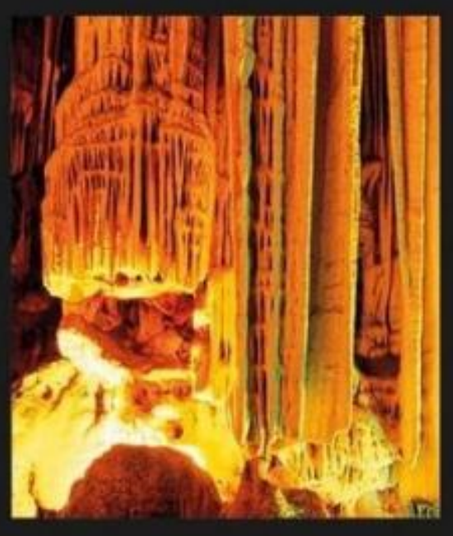
2000s

2003
Europe's *Mars Express* orbiter began taking detailed pictures of Mars.

2008
Phoenix (US) landed in Martian Arctic and operated for over 5 months (before its batteries went flat).

2012
Mars Science Laboratory landed on Mars in 2012, with the *Curiosity* rover (p266).

2016
ExoMars Trace Gas Orbiter (Europe and Russia) launched to examine gases in the Martian atmosphere.



Definition: **Earth** is the planet on which we live. Unlike other planets in our solar system, it is covered with liquid water, which makes it look blue.

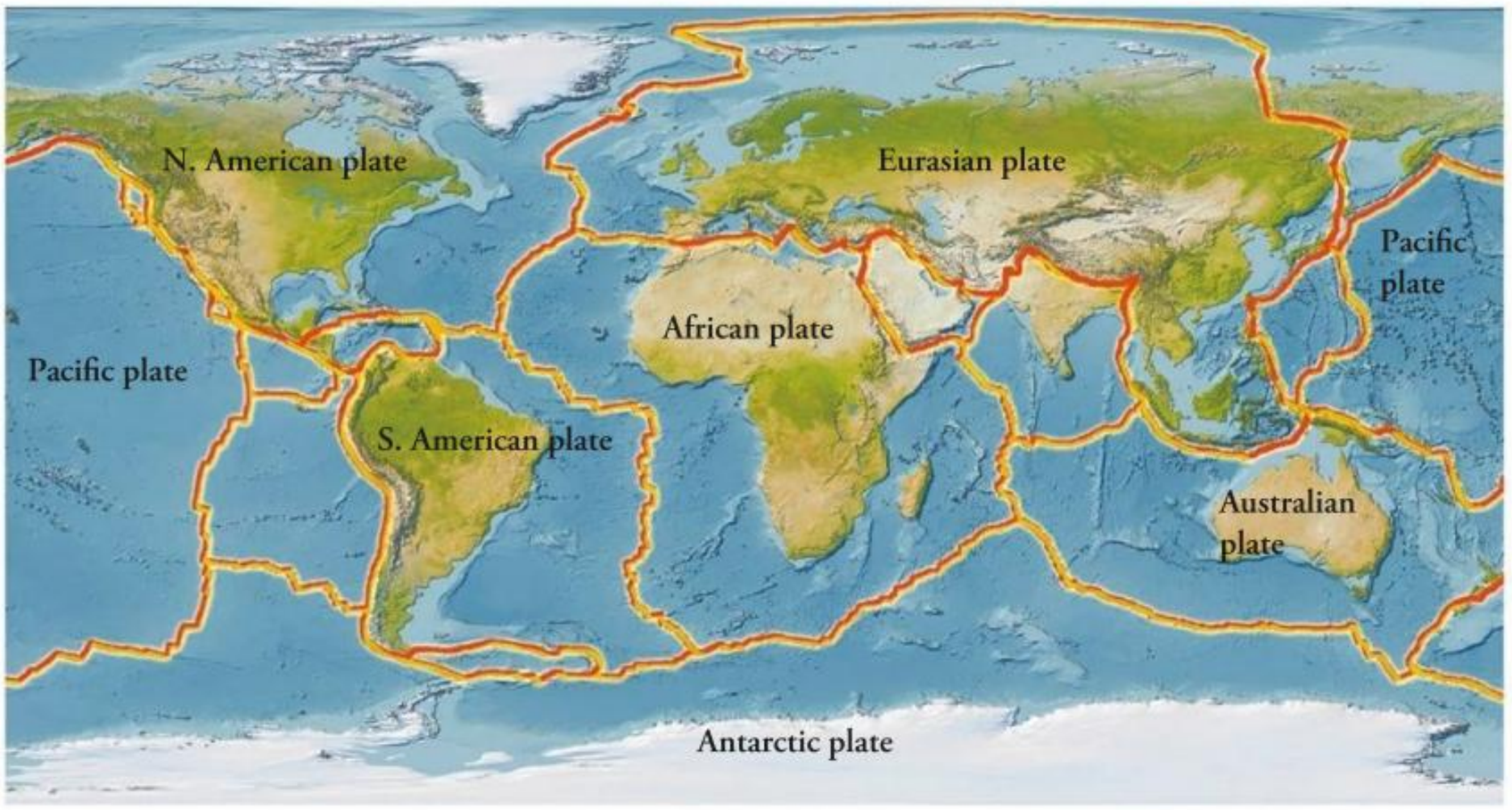
- Winds travelling around the Earth can be faster than 320 k/ph (200 mph).
- The highest tsunami on record was 525 m (1,720 ft) tall.
- A manned submersible has reached an ocean depth of about 11 km (7 miles).
- Stromboli volcano (off the coast of Sicily) has erupted continuously for 2,000 years.
- Earth is surrounded by a thick atmosphere, largely composed of the gas nitrogen.

How can wind, water, and ice shape rock?
Find out on page 44

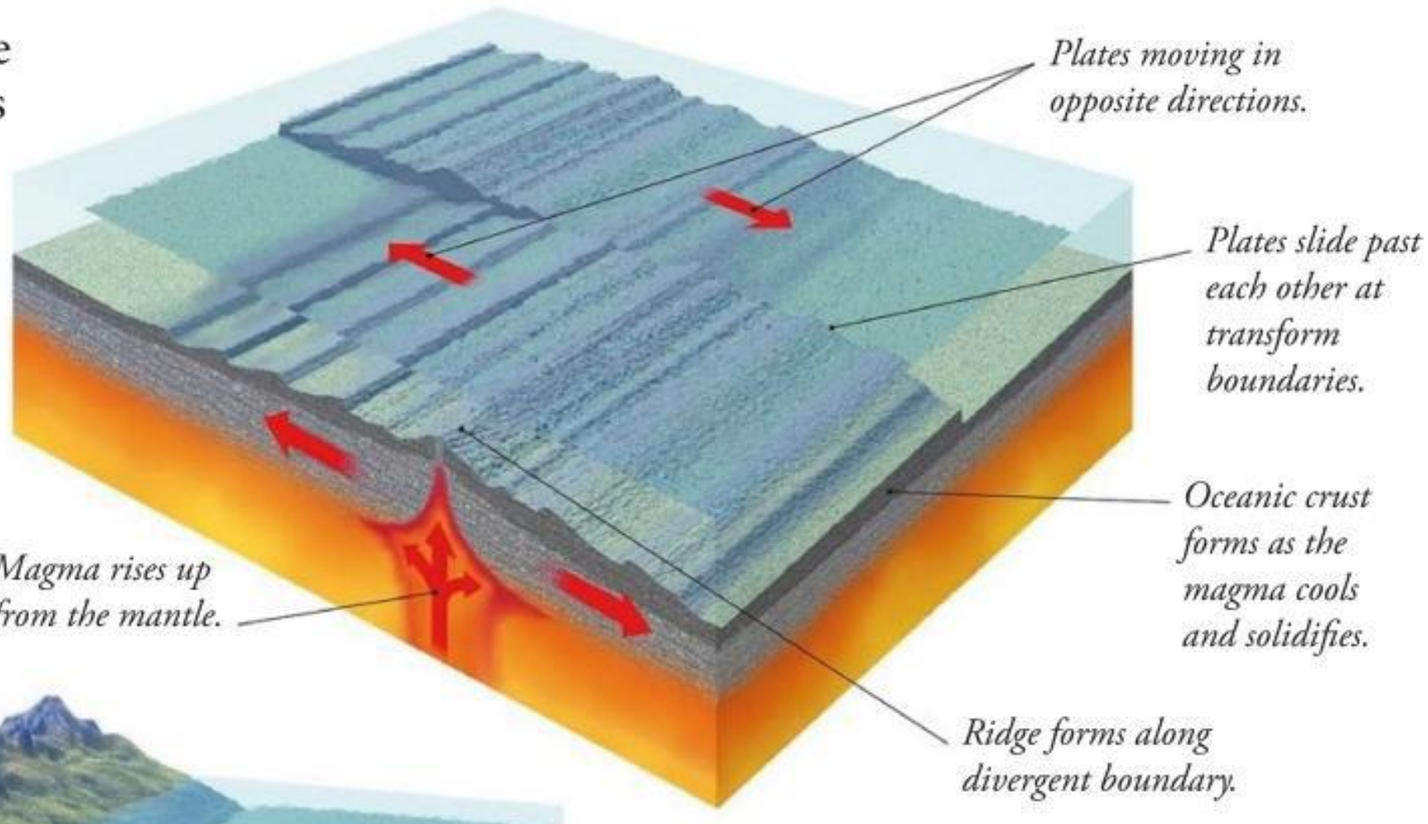
What causes Earth's seasons to change?
Find out on page 53

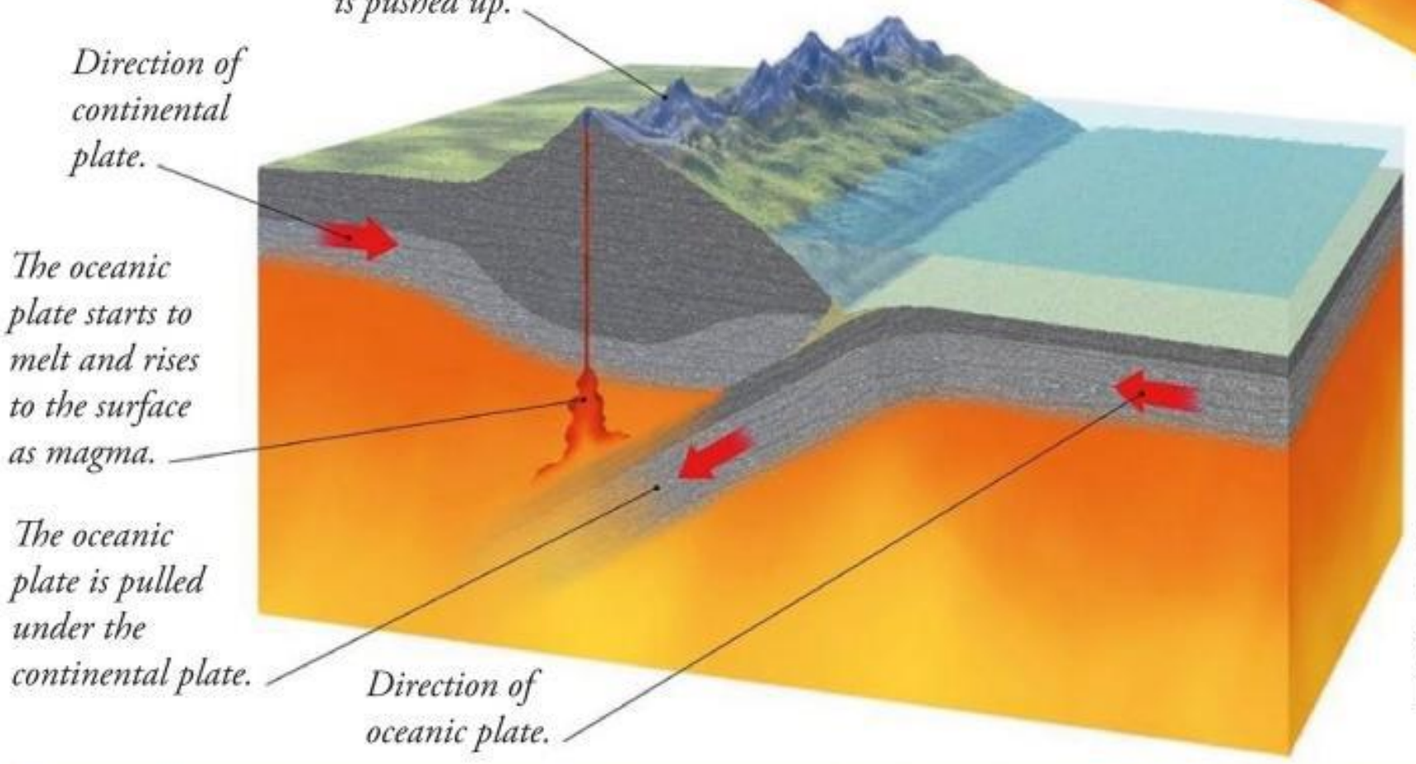
EARTH'S CRUST

The uppermost surface of Earth is called the crust. It has two layers: a light top layer and a slightly thinner but denser bottom layer. The crust is broken into pieces that fit together like a jigsaw. These plates float on the mantle. As the mantle moves, the plates go with it.



Divergent boundaries At the points where the mantle currents rise upwards, the plates above them get pulled apart (diverge). Some of the mantle melts to form magma and fills the gap between the plates. Each time this happens the plates move apart. Sometimes the plates simply slide past each other without any volcanic activity. These are called transform boundaries.





Convergent boundaries When two plates meet (converge), one of the plates is pulled under the other. If a continental plate meets an oceanic plate, the denser oceanic plate gives way. If two oceanic plates meet, the cooler, older plate is dragged under. Should two continental plates collide, the rocks on both sides bend and fold to form mountains.

TAKE A LOOK: PLATE MOVEMENTS

The continents have not always been in the positions they are today. Since Earth's crust cooled they have split, collided, rotated, and reformed. They are still moving about 15 cm (6 in) a year.

▲ *About 225 million years ago all the continents were joined together.*

▲ *Over time, the plates beneath began to pull the continents apart.*

▲ *Today, the continents look like this, but they are still on the move.*

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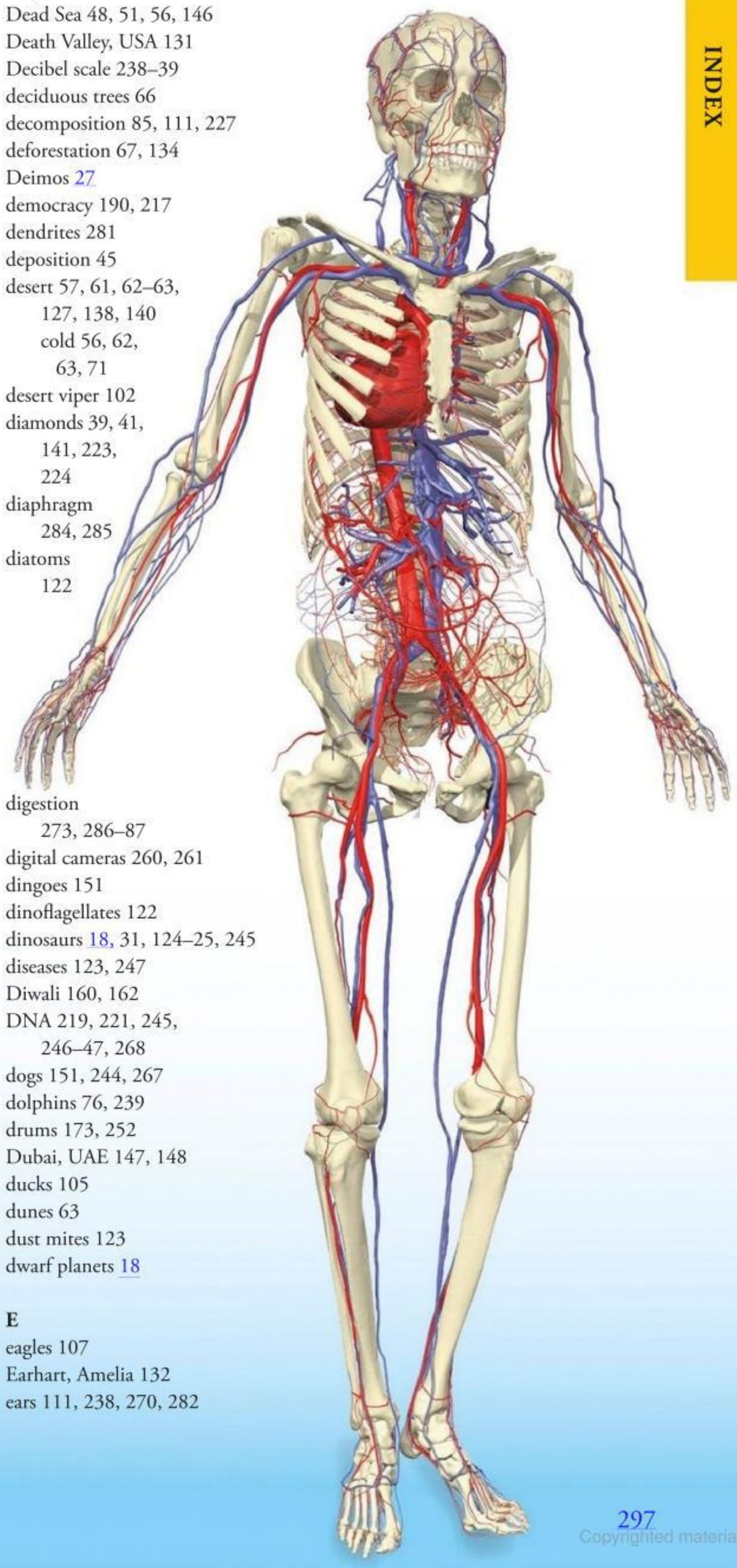

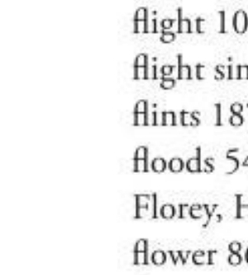

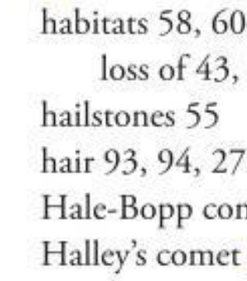

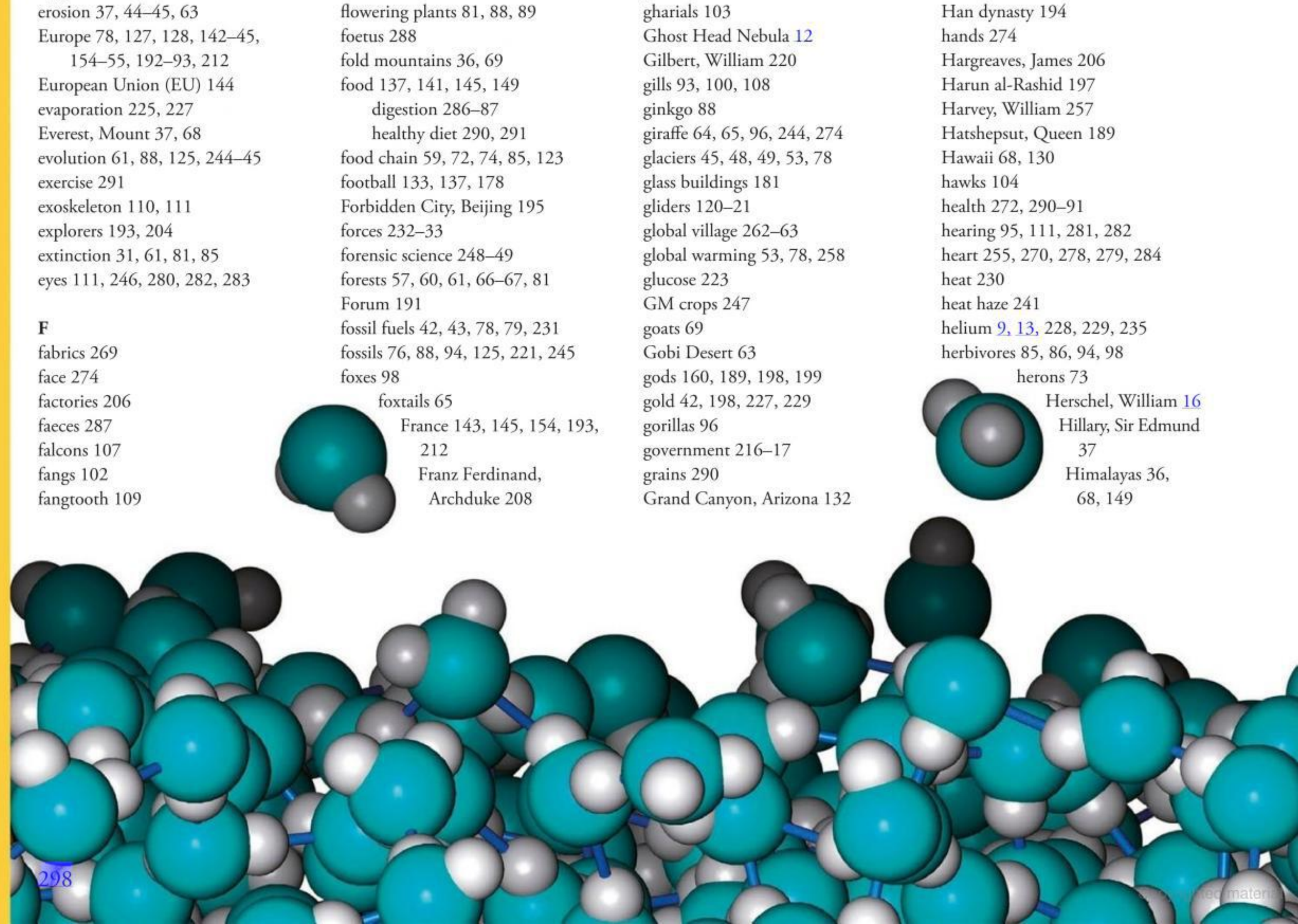

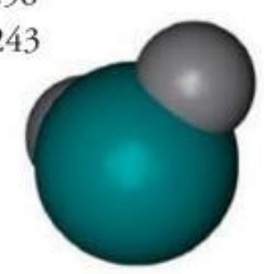

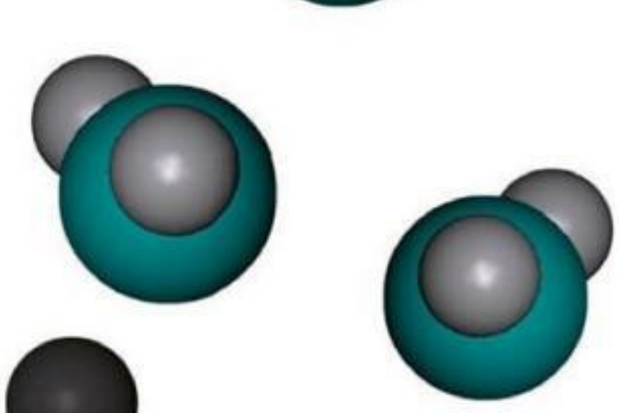

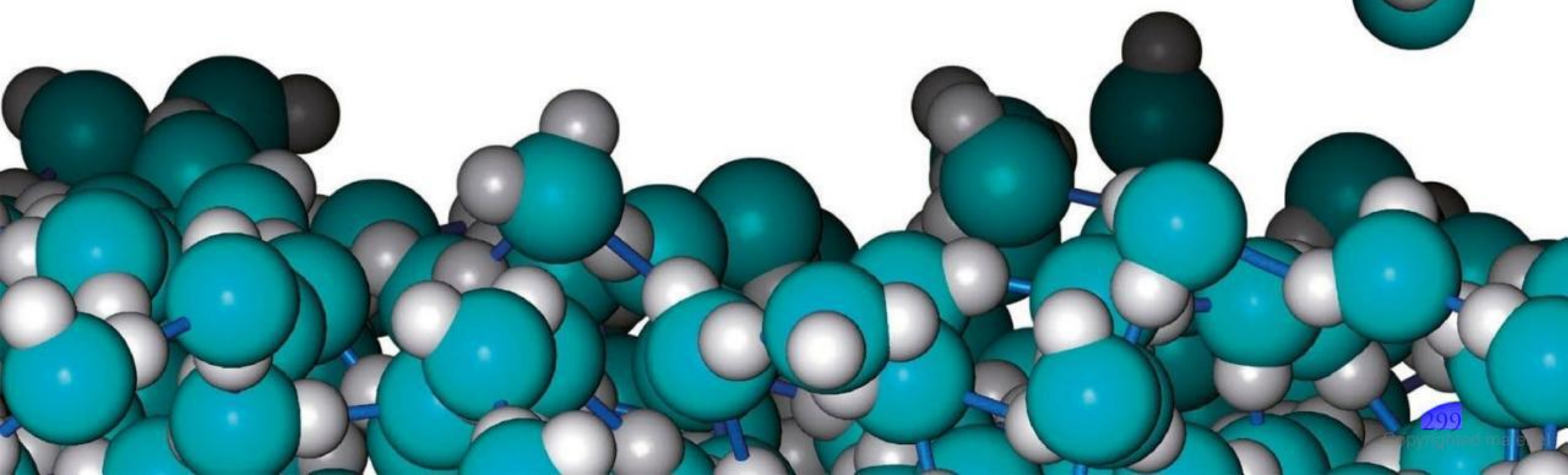

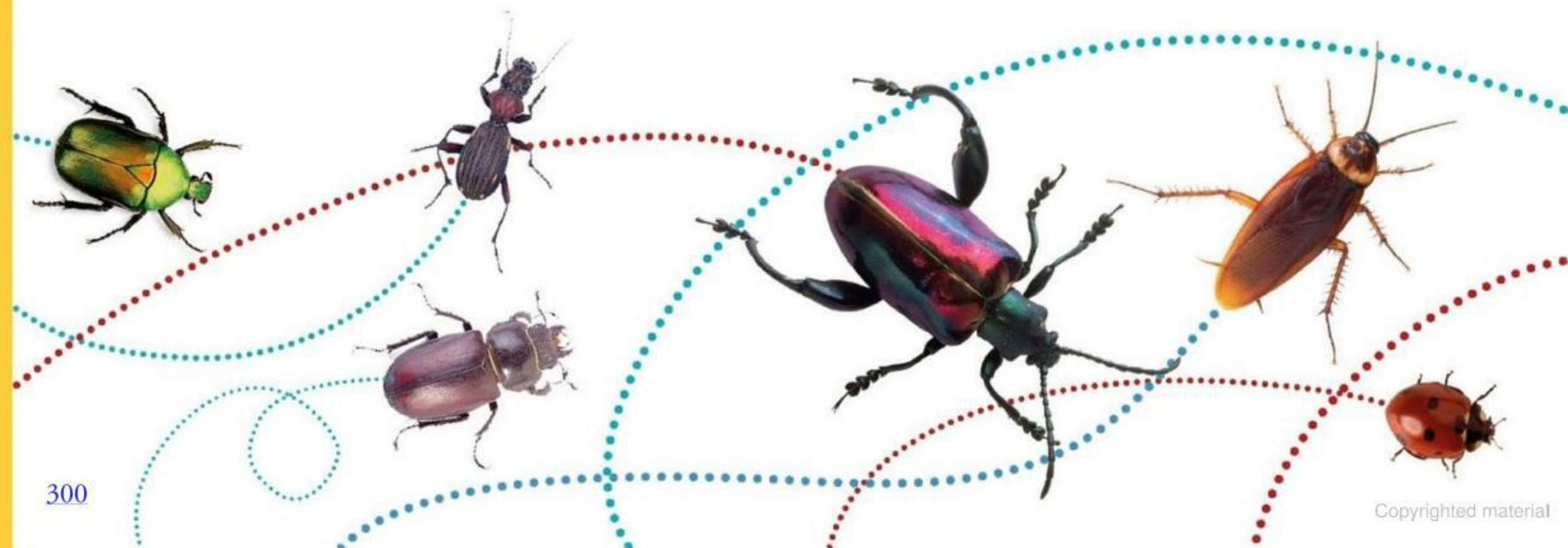

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