

WHAT IS A STAR?

A star is a massive, glowing ball of **plasma**, which is held together in a round shape by its own **gravity**.

Why do stars shine?

Stars shine because they produce huge amounts of energy in their core through **nuclear fusion**. The energy released takes the form of visible light, heat and other types of **electromagnetic radiation**.

▼ This labelled illustration shows the structure of a Sun-like star. Nuclear fusion takes place in the core.

Our star, the Sun

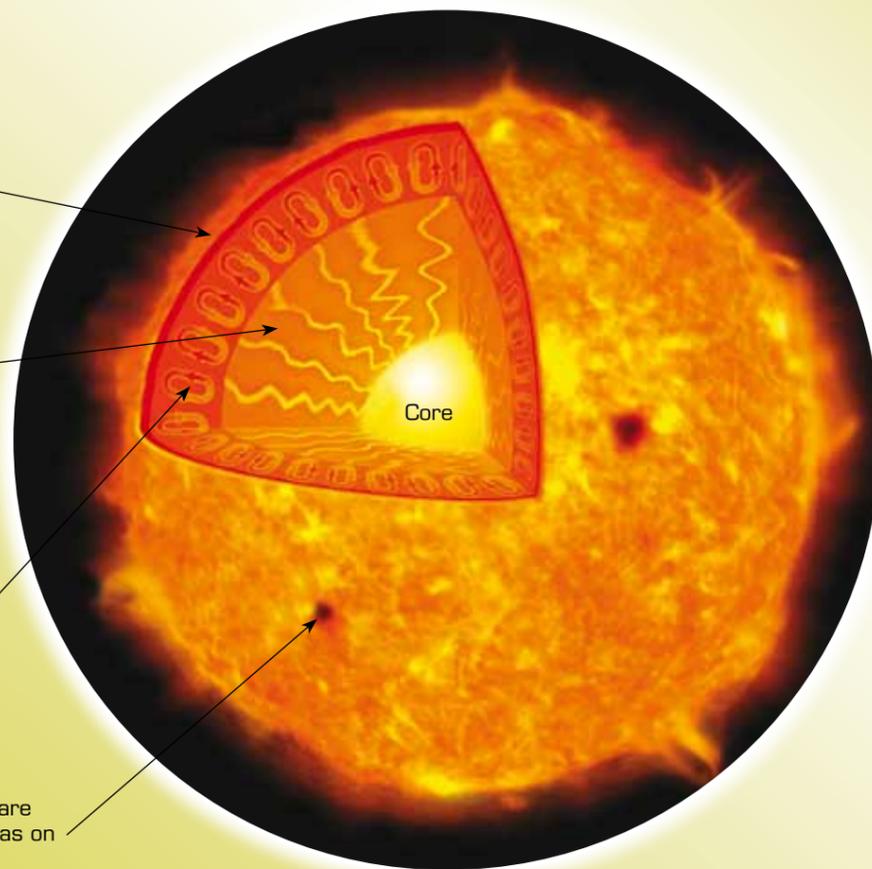
The Sun is a star. It has a diameter of at least 1.39 million km (864 327 mi), which is about 108 times wider than Earth's. The Sun is composed of 92.1 per cent hydrogen and 7.8 per cent helium. Small quantities of other **elements** are also present. The Sun has a surface temperature of about 5500 degrees Celsius (10 000 degrees Fahrenheit) but temperatures at its core reach more than 15 million °C (27 million °F).

Photosphere
This is the visible surface of a star.

Radiation zone Matter is packed together very tightly and heat from the core is transferred outwards by the process of radiation (the direct transfer of energy from one particle to another).

Convection zone Matter is packed less tightly and is able to move around. In this zone, heat from the core is transferred outwards by the process of convection (the transfer of energy through the flow of currents in a liquid, gas or plasma).

Sunspots These are darker, cooler areas on the photosphere.



▲ The universe contains stars of all sizes, colours and magnitudes. This image shows a cluster of stars about 200 000 light-years away, in a galaxy known as the Small Magellanic Cloud.

Classifying stars

Stars can be classified in three main ways. One way astronomers classify, or group, stars is by their size. Stars can also be classified according to colour and magnitude.

Size

The Sun belongs to the category of smallest stars. It is a dwarf star. Giant stars are between 10 and 100 times as big as the Sun, while supergiants can be up to 1000 times as big.

Colour

A star's colour depends on how hot it is. Red stars are the coolest, with surface temperatures of 3500°C (6300°F), while blue stars are the hottest, at 50 000°C (90 000°F).

Did you know?

The Sun is a main sequence star. Main sequence stars are stars in the adult phase of their life cycle, during which time nuclear fusion in their core converts hydrogen into helium.

Magnitude

A star's brightness is measured on a scale known as magnitude. The faintest stars have a high magnitude, while the brightest have a low magnitude. Sirius, the brightest star in the sky, has a negative magnitude of -1.46. Stars with magnitudes of up to six are visible to the naked eye.

THE LIFE CYCLE OF A STAR

Although stars seem unchanging to us, they have a life cycle just like living things do. The only difference is that stars live for billions of years.

The birth of a star

Stars form in a huge cloud of gas and dust called a nebula. As **gravity** pulls matter in the nebula together, clumps are formed, which heat up. Each clump forms a spinning disc called a protostar. Eventually, the centre of the protostar gets so hot that **nuclear fusion** begins. The solar wind, a stream of charged particles ejected from the upper **atmosphere** of the forming star, blows the remaining dust away and a star is born.

▶ **New stars are born all the time. The Carina Nebula, shown here, is about 7500 light-years away. New stars are forming inside the towering clouds of gas and dust.**

Find a star-forming nebula

The Orion Nebula is a region of intense star formation that is visible to the naked eye. It is the brightest object in what is known as Orion's sword, which is a small cluster of three stars below Orion's belt (in the northern hemisphere) or above the belt (in the southern hemisphere). The Orion Nebula is the middle 'star' in the sword.

▶ **This is part of the constellation of Orion. Orion's belt is the group of three stars in the middle. The Orion Nebula is the bright purple area in the section below it, known as Orion's sword.**

The life cycle of dwarf stars

A star's life cycle depends on its mass. Dwarf stars, such as the Sun, are the most common type of star. They shine for a few billion years as main sequence stars. Then they expand to become **red giants**, before shedding their outer layers and becoming **planetary nebulae**. Eventually, they end their days as small, cold, **white dwarfs**.

The life cycle of massive stars

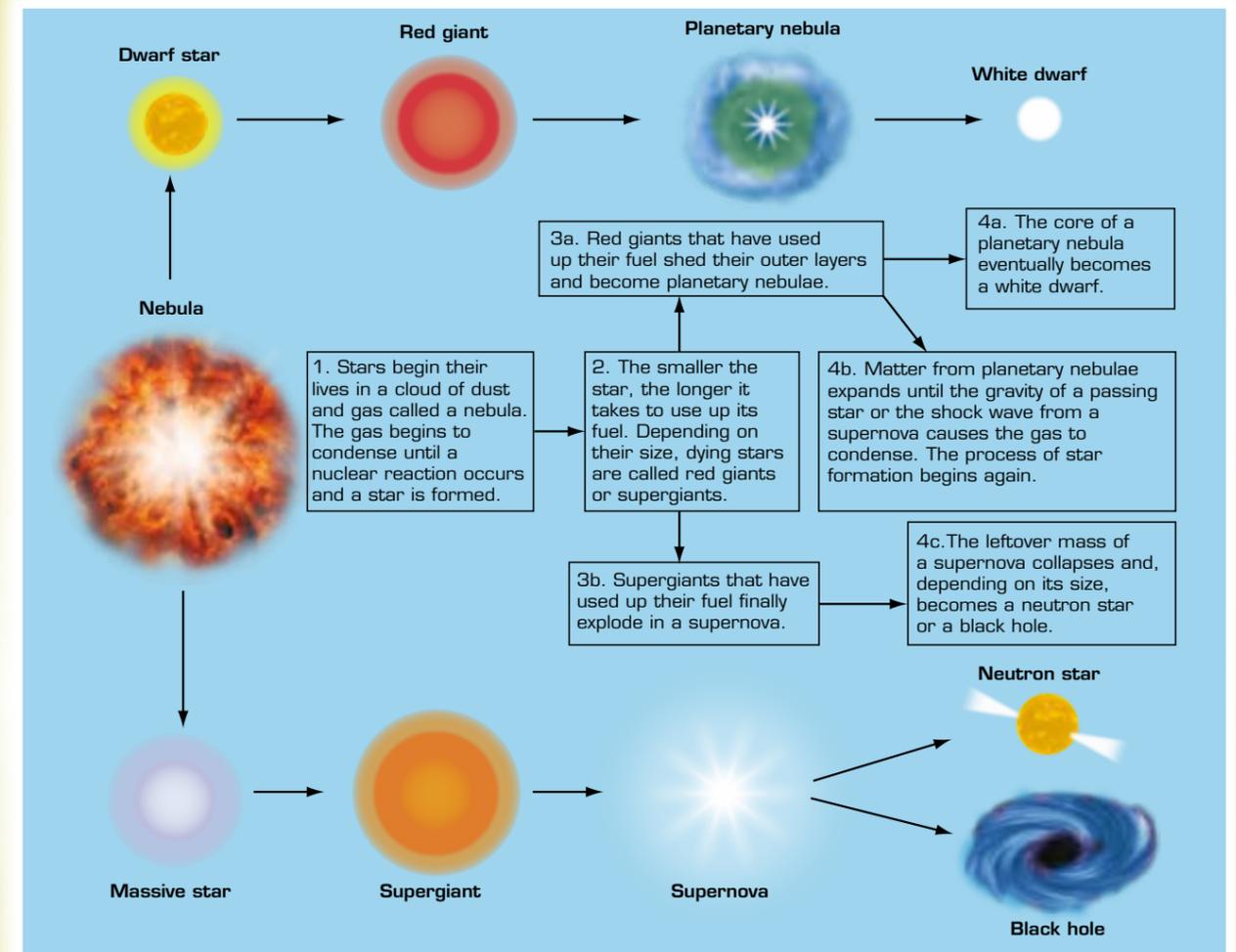
Massive stars have a more dramatic life cycle. When hydrogen in their core runs out, they expand to become supergiants, before tearing

themselves apart in an enormous explosion called a **supernova**. After the supernova, all that is left of the star is an extremely hot and dense **neutron star** or, if the remains are massive enough, a **black hole**.

Did you know?

The last supernova that occurred in the Milky Way was observed in 1604. It was named Kepler's Supernova after Johannes Kepler, the German astronomer who was the first to observe it. The supernova was visible to the naked eye for about 18 months and, at its brightest, was brighter than Jupiter.

▶ **A star's life cycle depends on its mass. Massive stars die dramatically in supernova explosions. Less massive stars fade away gradually.**



VARIABLE STARS

A variable star is one whose brightness varies, or changes. Some stars alternate between bright and dim. Such stars are called *intrinsic variables*. Other stars, called *extrinsic variables*, only appear to change because something else blocks their light.

Intrinsic variables

Intrinsic variables are stars whose brightness varies because of changes in the star itself. Some intrinsic variables have a cycle of growing and shrinking. Others go through periods of violent storms and are much brighter when the storms are raging. Some intrinsic variables have enormous sunspots, which are cool, dark areas. When these sunspots are pointing towards Earth, the star is noticeably dimmer.



20 May 2002

2 September 2002



28 October 2002

17 December 2002



8 February 2004

Did you know?

Most stars have some degree of variability. The Sun has an 11-year cycle, during which its brightness varies.

These images of a variable star were taken over a period of 21 months. They show the central star getting brighter and its light echo (the brown halo) getting bigger.



▲ Sirius, the brightest star in the sky, is actually a binary system. This artist's impression shows Sirius A, which is twice as massive as the Sun and 25 times brighter, and Sirius B, which is a faint white dwarf (the small, blue star on the right).

Extrinsic variables

The most common type of extrinsic variable is a binary star system, which is made up of two stars in **orbit** around each other. Although the two stars in a binary system may be of a similar magnitude, they often vary in brightness. At certain times, the dimmer star may block the brighter star and the system will appear fainter when viewed from Earth.

Multiple star systems

Some extrinsic variable stars are star systems with more than two stars. These are called multiple star systems. Most contain three stars, although systems with up to six stars have been discovered.