**U3a Physics: Cosmology/Astrophysics**

**Lifecycle of Stars**

All stars [form in nebulae](https://www.schoolsobservatory.org/learn/astro/stars/formation), which are huge clouds of gas and dust. The changes that occur in a star over time and the final stage of its life depend on a star's [size](https://www.schoolsobservatory.org/learn/astro/stars/class/starsize).



[Credit: NASA]

A nebula is a cloud of dust and gas (hydrogen). The material in the cloud is unevenly distributed and gradually, the gravity of the denser parts attract more material, clumping together to form an accumulation of material that gradually becomes more and more massive. The temperature such a fledgling star rises and it begins to emit heat and light.

When the temperature and pressure in the centre becomes high enough, nuclear fusion processes begin. Hydrogen nuclei fuse together to form helium nuclei, in the process releasing large amounts of energy. This continues until most of the hydrogen has been used up. This stage is called the '[**main sequence**](https://www.schoolsobservatory.org/learn/astro/stars/cycle/mainsequence)'. The exact lifetime of a star depends on its size. Very massive stars use up their fuel quickly. This means they may only last a few hundred thousand years. Smaller stars use up fuel more slowly so will shine for several billion years.

During this time there is a balance between gravity pulling inwards and radiation pressure pushing out. The star remains stable as long as it has enough fuel (hydrogen) to maintain the balance. In the case of our Sun, this could take about 10,000 million years and it is about half way through this time.

When most of the hydrogen is used up, the star becomes a large, cooler, red giant and helium fusion (or helium burning) begins and heavier elements like carbon are formed.

What happens next depends on how massive the star is. A **smaller star**, like the sun, will collapse into a hot, very dense white dwarf, which will eventually cool into a black dwarf. A more **massive star** is likely to end more dramatically in an explosion called a supernova. The central core collapses to form a very dense neutron star or, in the case of **very massive stars**, a black hole. A neutron star may be only about 20km across but will have a density of about 1018 kg/m3. A cubic centimetre of a neutron star would have a mass of 1000 million kg. A spinning neutron star emits radio signals which appear as pulses. These stars are called pulsars.

**Hertzsprung-Russell diagram**

This diagram shows stars according to their temperature and brightness.



[Credit: BBC Bitesize]

Our Sun would be found roughly in the middle part of the main sequence (having a surface temperature of approximately 6 000 K).

For a lot more detail on the subject of the life-cycle of stars, have a look at <https://imagine.gsfc.nasa.gov/educators/lifecycles/LC_main3.html>