Life Cycle Of A Star

How are stars formed?

A star is a very large cloud of bright glowing hot matter, which is mostly hydrogen and helium in space.

These stars are held together by gravity.

They give out a lot of heat and light because they are very hot. Nuclear fusion makes light and heat while forming bigger and bigger chemical elements.

Quick Check

Answer: B

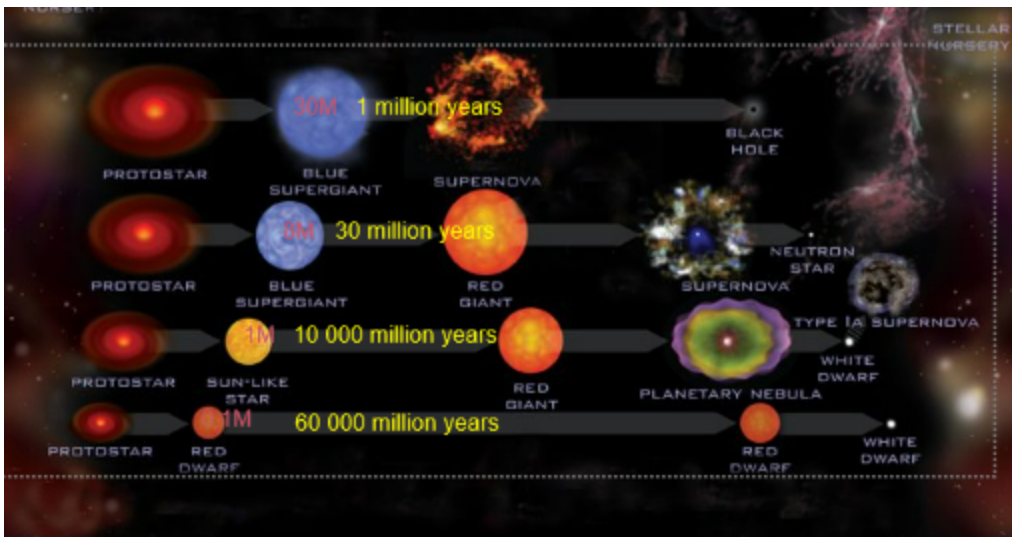
Life Cycle of stars

A star’s life cycle is determined by its mass. Very large, massive stars burn their fuel much faster than smaller stars and may only last a few hundred thousand years. On the other hand, smaller stars live for around a few several billion years.

Quick Check

Answer: A

Image



Different Types of Stars and their classification

Star Type	Solar Mass	Temperature (K)	Color
Red Giant	10 - 15	2,500 - 3,500	orange - red
Red Dwarf	0.1 - 0.5	2,500 – 3,500	red
Blue Giant	10 - 15	~30,000	blue - white
Brown Dwarf	0.013 - 0.084	~1,000	red
Yellow Dwarf	0.8 -1	5,300 - 6,000	white - yellow
White Dwarf	< 1.4	4,000 - 150,000	white
Neutron Star	1.4 - 3	~1,000,000	blue

Nebula

They are defined as thinly spread cloud of gas and dust. Some of these are caused byu the remains of a supernova explosion. A supernova explosion is the death and collapse of a massive star. Most nebulae are gravity induced condensation of gases where protostars are born.

Protostars

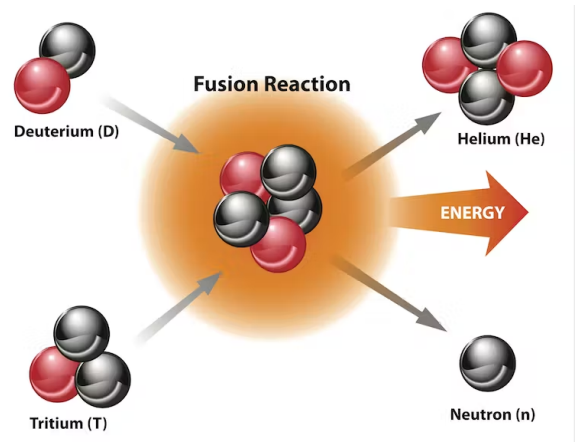
Inside a nebula, there are areas where gravity causes dust and gas to clump together. As these clumps gain in mass, their gravitational pull increases, forcing more atoms.

This process is known as accretion, and the result is a protostar.

The main sequence

A star is in short, a huge ball of gas undergoing nuclear fusion.

The main sequence phase is where the star begins to release energy, stopping it from contracting even more and causing it shine and fusing hydrogen into helium by nuclear fusion.



An example of nuclear fusion

Red Giant

The core becomes unstable and contracts whereas the outer shell of the star is still hydrogen which starts to expand. As it expands, it cools down and glows red. In the core, helium fuses into carbon.

Planetary Nebula

It is a ring-shaped nebula formed by an expanding shell of gas around an ageing star.

White Dwarf

When all the nuclear reactions are over, a small star like the sun may begin to contract under the pull of gravity. What this means is that it grows smaller.

White Dwarfs form from the core of a dead red giant that were too small to fuse carbon.

IN this instance, the star becomes a white dwarf which fades and changes colour as it cools.

Supernova

A larger star with more mass will go on making nuclear reactions, getting hotter and expanding until it explodes as a supernova.

An exploding supernova throws hot gas into space. The large explosion at the end of a large star’s life, which distributes much of the element formed in the star across space.

Neutron Star

Sometimes the core survives the explosion. If the surviving core is between 1.5 - 3 solar masses, it contracts to become a tiny and extremely dense thing known as a Neutron Star.

Some people view neutron stars as very big atoms.

If the core is much greater than 3 solar masses, it becomes a black hole.

Summary (Remember this!)

- Stars are born from giant clouds of hot, glowing matter, mostly made of hydrogen and helium in space. Gravity holds these clouds together, and they shine because they're incredibly hot. They create heat and light through a process called nuclear fusion, where they form bigger elements.
- A star's life depends on its size. Large stars burn their fuel quickly and may only last hundreds of thousands of years, while smaller ones can shine for billions of years.
- Nebulas are thin clouds of gas and dust, sometimes from supernova explosions, the explosive end of massive stars. Most nebulae are where new stars, called protostars, are born. These protostars form through the clumping of dust and gas due to gravity.
- The main sequence is when a star releases energy through nuclear fusion, stopping it from collapsing further and causing it to shine by turning hydrogen into helium.
- Red giants occur when a star's core becomes unstable, while the outer shell expands and cools, glowing red. Helium fuses into carbon in the core.
- Planetary nebulae are ring-shaped clouds of gas around aging stars.
- White dwarfs form from the core of dead stars too small to fuse carbon. They shrink and change colour as they cool.
- Larger stars explode as supernovas, distributing elements into space.
- Sometimes, the core of a large star survives as a neutron star, a tiny and extremely dense object.
- If the core is even more massive, it becomes a black hole.

Questions to reassess your understanding.

1. What is the primary composition of a star, and how are stars held together?

2. How does nuclear fusion contribute to the heat and light emitted by stars?
3. How does the mass of a star influence its lifespan?
4. What is a nebula, and what role does it play in star formation?
5. What is a protostar, and how does it form within a nebula?
6. Describe the main sequence phase in a star's life cycle. What happens during this phase?
7. What occurs in a star to transform it into a red giant, and what elements are involved?
8. Explain what a planetary nebula is and how it forms around aging stars.
9. How do white dwarfs come into existence, and what happens as they cool?
10. What is a supernova, and why is it significant in the life cycle of massive stars?