

The Life Cycle of a Star

1. Birth of a Star: A NEBULA is a massive cloud of dust and gas where stars are born. GRAVITY causes the densest parts of the nebula to collapse, forming regions called PROTOSTARS (baby stars). Protostars continue contracting and pulling in more and more dust and gas until the core is hot and dense enough to begin nuclear fusion.
2. Main Sequence Stars: When a star is born, it begins fusing HYDROGEN atoms (1 proton) into HELIUM atoms (2 protons). This process releases a lot of energy in the form of heat and light. During the time that stars are fusing hydrogen into helium, they are classified as MAIN SEQUENCE stars. Most of the stars in the observable universe are on the main sequence. A star's MASS determines what happens to it once it leaves the main sequence.
  - a. High mass stars (stars with more than 10 times the mass of our Sun) will follow a different path through their life cycle than our Sun. The heaviest of these stars may one day end up as a black hole!
  - b. Low mass stars such as our Sun will eventually burn out and end their life as a black dwarf.
3. Red Giants: When a star runs out of hydrogen to fuse into helium, it leaves the main sequence and becomes a RED GIANT. Red giant stars contract and expand as heavier ELEMENTS are formed within the core through the fusion process.
  - a. High mass stars eventually become red SUPERGIANTS as heavier elements such as neon (10 protons), oxygen (8 protons), silicon (14 protons), and iron (26 protons) are fused within their core.
  - b. Low mass stars begin fusing helium into CARBON during the red giant stage.
4. Death of a Star: Just as the MASS of a star determines how it lives, its MASS also determines how it will die. Low mass stars eventually fizzle out, while high mass are destined for a more spectacular finish.
  - a. Once a high mass star has fused all of the iron in its core, it can no longer sustain the nuclear fusion process. The force of GRAVITY becomes too great, collapsing the star and causing a massive explosion called a SUPERNOVA. The heat and pressure produced in this explosion is responsible for creating all of the natural elements heavier than iron.
  - b. When a low mass star burns through all of its helium to make carbon, it doesn't have enough mass to continue the fusion process. The gasses on its surface are cast out into space exposing the hot, dense, slowly cooling core. This glowing sphere of carbon is known as a WHITE DWARF. It will continue cooling off until the heat energy stored up during the life of the star is gone.
5. Final Outcome: The final outcome of a star can vary greatly. Some end up as insignificant balls of matter while others can influence the future of the universe.
  - a. High mass stars can affect the future of the universe.
    - 1) The most massive of high mass stars collapse into an extremely dense ball of mass. Their GRAVITY is so great that not even LIGHT can escape. As a result, these objects are called BLACK HOLES.
    - 2) Other high mass stars end up as NEUTRON STARS. These form when the normal spaces within atoms are eliminated during a supernova. What is left is a dense, spinning core of neutrons pulsing light across the universe.
    - 3) Another effect of a supernova is the formation of new nebulae. Dust and gas along with heavy elements are cast out into the universe to form new stellar nurseries. These regions of dust and gas can eventually give birth to new STARS!
  - b. The outcome of a low mass star is much less exciting. White dwarfs continue to get dimmer and dimmer as their heat radiates out into the universe. Eventually, their energy is gone and they remain as cold, dark balls of carbon called black dwarfs.

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3a. Red SUPERGIANT

2a. A HIGH mass star

3. RED GIANTS  
The star runs out of hydrogen to fuel it. The star expands and contracts as heavier ELEMENTS are formed through fusion.

2b. A LOW mass star

3b. Red GIANT

4a. SUPERNOVA  
A huge explosion where all the elements heavier than IRON are formed

5a<sub>2</sub>. The core collapses into a NEUTRON STAR

5a<sub>1</sub>. The most massive stars become a BLACK HOLE

5a<sub>3</sub>. DUST and GAS are flung out into space

1. NEBULA  
Clouds of gas and dust gather due to GRAVITY. Baby stars (PROTOSTARS) form

2. \_\_\_\_\_ stars fuse hydrogen atoms into helium atoms by \_\_\_\_\_ and burn for billions of years

4b. WHITE DWARF  
There are no more light elements to fuse and it collapses

5b. The star will end its life as a BLACK DWARF

