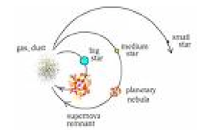
Reading: Life of a Star



Use the following description to guide you through the development of a flow chart of the life of a star.

As they study stars, astronomers try to learn about their life history. Astronomers have been studying stars for over 100 years, but stars may exist for billions of years. Very little change occurs in just 100 years of a star's life. They do, however, change. The nuclear reactions that power them use fuel. In time the fuel runs out. To study stars, astronomers predict how a star might change, and then they look for stars in the predicted stages of their life.

Astronomers think that stars begin as large , spinning clouds of gas and dust called a **nebula**. As the nebula spins, it condenses. Astronomers estimate that a nebula that is large enough to condense must have a mass greater than the mass of 1000 stars. Many pockets of matter within the nebula are the beginnings of stars and are called **protostars**. Stars often seen grouped in clusters because many stars can form within a nebula.

In the beginning, a protostar's diameter may be billions of kilometers. As it condenses, its temperature rises When the temperature in the center reaches 10,000°C, the atoms are colliding with so much force that their electrons and nuclei separate. A protostar is now about 100,000,000 km across. Imagine that in the beginning the star was the size of the Houston Astrodome. It would now have condensed to the size of a baseball.

A protostar continues to condense, and the temperature inside reaches 150,000°C. The surface temperature now is about 3500°C and the protostar produces a red light. It has a diameter of about 50,000,000km. This beginning star is bright enough to earn a place on the **H-R diagram** to the right of the main sequence, just below the red giants. Very few of these young stars can be seen, probably because they are hidden by the nebula in which they are forming.

A protostar continues to condense until the temperature inside reaches 10,000,000°C. At this temperature, nuclear fusion begins. A large amount of energy starts to radiate outward from the core, and this force slows the condensing of the protostar's matter. The life of a new star begins. Stars at this stage are **main sequence** stars.

How long a star lives depends on its mass. The most massive stars may live only 3 million years. A star the size of our sun may live for 10 billion years, while the smallest, least massive stars may have a life span of many billions of years.

When a star begins to run out of its hydrogen, it goes through many changes. The nuclear reactions in the core slow down. Around the hot core, a shell of hydrogen continues to react and to release energy. The heat from the core causes the outer layers of gases from the hydrogen shell to be pushed outward. With these changes, a **red giant** star forms and it moves out of the main sequence. The red giant will grow to tremendous size as helium replaces hydrogen as the fuel.

Although most stars go through these changes, ***the remaining life of a star depends on its mass.***

Small stars begin a series of changes that lead them to the **white dwarf stage**. An expanding shell of gases spreads into space and does not return to the star. The remaining matter condenses and heats up as a result. The star becomes a **white dwarf** This star produces little light but has a high surface temperature. Its gravity may be 500 thousand times the gravity of Earth. A white dwarf slowly cools until all of its heat is gone. It then becomes a cold, lightless piece of matter called a **black dwarf.**

Stars with a mass eight times larger than our sun go through a different series of changes. These stars may expand and contract several times and then explode. This violent explosion is called a **supernova**.

A **supernova** may produce as much light as an entire galaxy. Much of the matter from the supernova is shot into space at tremendous speeds, producing a spreading cloud of gases and dust.

Two strange kinds of stars may result from supernovas. One of these is the **pulsar** (a spinning neutron star). A pulsar produces rapid bursts of radio waves that repeat many times per second. Astronomers are not sure about what causes these emissions. They have estimated that **neutron stars** contain as much matter as our sun, but are only about 15 km in diameter.

If the mass remaining after a supernova is more than 4 times the mass of our sun, it may condense to form a **black hole**. A black hole is an object whose gravity is so strong that even light does not escape it. The matter that makes up a black hole may condense to a very small area. Astronomers estimate that there may be 100,000 black holes in the Milky Way galaxy and they are studying the areas around several suspected black holes.