Name: _____

A Star is Born

Stars exist for millions or billions of years. As a result, it's impossible for scientists to study one star during its whole life cycle. In a night sky filled with stars, there are millions of examples for astronomers to study. Stars change in a predictable pattern over time, so studying a variety of stars gives astronomers evidence of how our sun will change in the future.

Life cycles of stars can be illustrated on a diagram. The amount of mass a star contains determines its path along the life cycle. Stars are formed in a **nebula** or cloud of stellar dust and gas. If there is enough mass in a nebula, gravity will pull the particles together and fusion will begin. The new star is a called a **protostar** and will likely burn for millions or billions of years.

The "adult life" of a star is called the **main sequence**. The size of the star affects both the color and the life span of a star. The larger the star, the larger it's gravitational pull. Because of a large star's gravitational pull, it burns fuel at a much faster rate. These blue stars give off immense amounts of energy, but they do not live very long - only about 10 million years! A smaller star has a much weaker pull and therefore gives off less energy. Red stars can live up to 10 billion years.

Our Sun is a main sequence star that is average in size and color when compared to other stars. It is about halfway through its 10 billion-year life span. Based on its size and brightness, we believe the Sun is about 4.5 billion years old. Since beginning to burn, it has used up about half of the hydrogen in its core. It will continue to radiate for another 5 billion years.

Young main sequence stars convert hydrogen into helium, but as time passes, the amount of available hydrogen decreases and eventually stars begin to burn more helium. The stars start to contract, which increases the temperature. The heat causes the outer layers of the star to expand reducing the amount of mass in the core. These stars are called red giants or super red giants depending on their initial mass. **Red giants** give off more light than normal but are cooler in temperature because of their immense size. Our sun's expansion as it turns into a red giant will destroy the inner planets.

Eventually the core of a less massive star collapses enough to cause the remaining helium in the core to change into carbon. The energy that is given off causes the outside layers to be blown off and all that is left is the dim core called a **white dwarf**. Even though the energy that is being created is very intense, there is not a lot generated because of its small size. Over time, all the helium in the white dwarf turns into carbon. By this point low mass star does not have the gravitational force necessary to fuse the carbon. The white dwarf will cool and fade and the lumps of remaining carbon are called **black dwarfs**.

Very massive stars end their life cycles in more exciting ways. After becoming a red supergiant, the gravitational pull of massive stars continues to be strong. Unlike a smaller mass star, a red supergiant has a strong enough gravitational pull to bring the outside gasses back to the core. After the helium has all been converted into carbon, there is a strong enough gravitational pull to cause the carbon to bond together to create even larger elements. As these larger elements are created, an immense amount of energy is also created. Eventually, this energy is released in a huge explosion called a **supernova**. The explosion ejects dust and gas into space. Some supernovae are so strong that they light up the sky for weeks. Following a supernova, there is a collapsed stellar core remaining. The core of stars that are about four times more massive than the Sun become **neutron stars or pulsars**, while the core of stars eight times or more massive than the Sun become black holes.

Black holes form when there is no fusion to balance the force of gravity of the matter remaining after the supernova. Without the balance, the matter is "swallowed" by its own gravity. Astronomers cannot see black holes, but they can detect the x-rays given off by the matter.

Answer each of the following questions in a complete sentence.

1. What is a nebula?

2. What force is responsible for pulling together particles of a nebula causing fusion to begin creating a protostar?

3. What type of star is our sun?

4. What is a supernova?

5. How do astronomers know black holes exist?

6. Why don't all stars end their life in the same way?

7. What will happen to the Sun in the future?

8. What is the difference between a white dwarf and a black dwarf?

9. What do you think happens to the dust and gas following a supernova?

10. Explain why the life cycle of a star is considered a "cycle".