Name:______________________________________ Block:__________ Partner:___________________

The Life Cycle of a Star

Objective: To create an illustrated life cycle flow chart using NASA images that accurately depicts the life cycle of both average-low mass and high-supermassive stars, including information on elements being fused at each stage, and the physical relationships between fusion and gravity at each stage.

Procedure:

1.) **Read** the background information below. After you have read the background information, **answer** the pre-lab questions in the lab (15-20 minutes of lab)
2.) **Cut out** the satellite images of different celestial objects and assemble them in the correct order on to the life cycle of a star diagram. Remember that stars take different paths based upon initial mass. **The images may be trimmed to remove extra space (BLACK) to make more room on your diagram- DO NOT remove the titles.** Have Mrs. Cohn check your flow chart before you physically glue them down!
3.) Using the space around the images listed below, label one of the following three relationships between fusion and gravity, depending upon which stage the star is in:
    - **a.** Ff>Fg (Force of fusion is greater than the force of gravity)
    - **b.** Ff <Fg (force of fusion is less than the force of gravity)
    - **c.** Ff=Fg (Force of fusion is roughly equal to the force of gravity/equilibrium)

Main sequence stars, Red Giants, SuperGiants, White Dwarfs, Supernova (think of what **causes** the supernova)

4.) Include what elements are fusing for all stages listed in step 3, except for white dwarfs. Choices are below
    - **a.** H→He **b.** He→C **c**. C→NE→O→Si→Fe **d**. All elements heavier than Fe
5.) Finally, use the data portrayed on page two of this lab to label the ranges of temperatures and brightness compared to the sun for each of the following stars: **Main Sequence, Red Giant, SuperGiant (Red), White Dwarf, Black Dwarf**
    Example of how you would label this on the main sequence star: **T**: 5,000-15,000 C **B**: 1-1000x

Background Information: Stars are different than other celestial objects such as planets, asteroids, comets, etc. in that they are self -luminous, meaning they actually produce light. In order to produce light, a process known as nuclear fusion must take place, where lighter elements are continuously converted into heavier elements, generating energy that will be radiated from the star throughout its life. All stars will fuse Hydrogen into helium, but depending upon their initial mass, they can generate enough pressure and temperature to fuse heavier elements at other stages of their life outside of the main sequence stage. Depending upon where a star is in its life cycle, it will create different elements, and thus have different temperatures and sizes, directly related to the balance of fusion and gravity within the star. To summarize the life cycle, a brief summary is given below for each type of star (low-ave mass and high-supermassive stars)

Average to low mass stars

Stage 1- stars are born in clouds of gas and dust called Nebulas

Stage 2- The gas and dust spiral together and contract under their own gravity. Gas begins to heat up and forms a protostar

Stage 3- If a protostar contains enough matter, the pressure will generate a temperature of 15 million degrees celcius and nuclear fusion will begin, where hydrogen→helium. It is now considered a **main sequence star**. Electromagnetic energy is released, and the star will continue to remain in equilibrium until all of the hydrogen is converted into helium

Stage 4- eventually the hydrogen runs out and the helium core contracts. Reactions begin to occur in a shell surrounding the core of the star as temperatures soar from this increased pressure generated from the contraction. The core is now hot enough for helium to fuse into carbon. The pressure generated from these new fusion reactions causes the star to expand, and cool, forming a **red giant**.

Stage 5- the helium core runs out, just as hydrogen did in stage 4, and the outer layers are ejected from the star, called the **planetary nebula**.

Stage 6- all that is left is the remaining core of the star (80% of the original stars mass). It is now known as a **white dwarf**, so small, but hot, still with nothing left to fuse. When all the electromagnetic energy has radiated away, it will be known as a **black dwarf.**

Massive-Super-Massive Stars

The first 3 stages are the same as a low-average mass star

Stage 4- The hydrogen runs out and the helium core contracts generating high enough pressures and temperatures to fuse carbon. The star expands, forming a **red supergiant,** but will expand and contract several times over the span of this stage, generating enough pressure and temperature to form other elements such as oxygen, magnesium, neon and so forth all the way to Iron.

Stage 5- When all the remaining elements have fused into Iron, fusion reactions will no longer generate enough pressure to hold up the star, and gravity wins, causing an internal collapse or implosion. This happens in less than a second, generating a violent explosion called a **supernova.**

Stage 6- if the core survives the explosion, it will contract to form a very tiny, very dense, **neutron star.** If the core is greater than 20 solar masses, the core will continually collapse (never ending) known for creating a **black hole**.

DATA TABLE

Star Type	Temperature (C)	Brightness (compared to the Sun)
Black Dwarf	2,500	.0001x
White Dwarf	8,000-15,000	.01-0.5x
Red Giant	3,000-6,000	100-4,000x
Red Supergiant	4,000	100,000-1,000,000x
Main Sequence	5,000-15,000	1-1,000x

Pre-Lab Questions

1.) Our own star, the Sun, is in which current stage of life? _________________________ This must mean that it is composed of which gases? ____
]Is the sun considered young, middle aged, or old? ________________

2.) What is the name of the process responsible for creating electromagnetic energy in stars?

3.) Will all protostars become stars? Why or Why not?

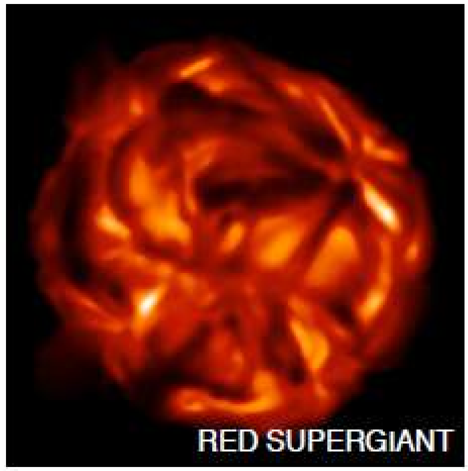
4.) How is a massive stars stage 4, different than an average stars stage 4 in terms of the fusion reactions taking place? Why do they differ?

5.) Which two forces are responsible for keeping a star in equilibrium, or causing it to expand or contact?

6.) Why do some massive stars become neturon stars, while others become black holes?

7.) Why do you think a supergiant star is listed as the brightest star, despite its temperature being cooler than both a main sequence star, and a white dwarf?

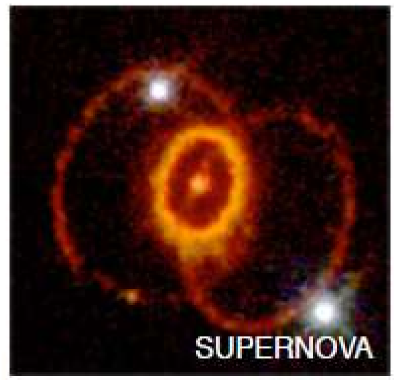

RED GIANT

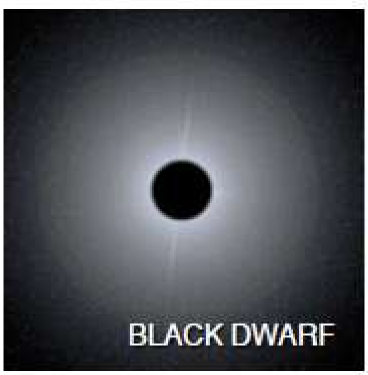

RED SUPERGIANT


PLANETARY NEBULA


WHITE DWARF

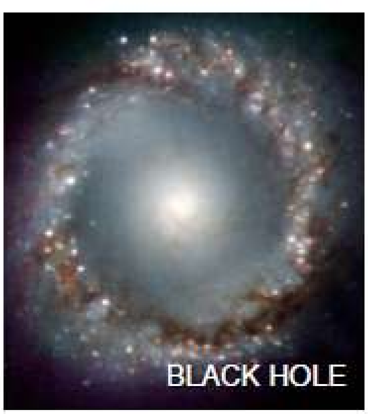

PROTOSTAR

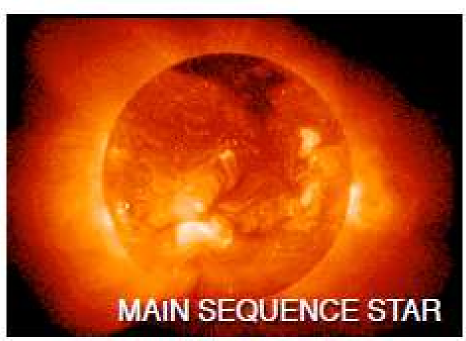

SUPERNOVA


BLACK DWARF


NEBULA


NEUTRON STAR


BLACK HOLE


MAIN SEQUENCE STAR

The ... of a Star