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Life Cycle of Stars

Purpose
This activity enables students to demonstrate the life cycles of different types of stars, thereby illustrating the rarity of black hole-producing stars.

Objectives
- Students will understand how and when black holes form.
- Students will be able to describe the Sun as a star.
- Students will be able to explain that there are different kinds of stars that we categorize by color or mass.
- Students will be able to describe that stars have life cycles.

Related Standards and State Goals
Illinois State Goals:
Middle/Junior High School
- *12.F.3c* Compare and contrast the Sun as a star with other objects in the Milky Way Galaxy.

Early High School:
- *12.F.4b* Describe and compare the chemical and physical characteristics of galaxies and objects within galaxies.

Late High School:
- *12.F.5a* Compare the processes involved in the life cycle of stars.
- *12.F.5b* Describe the size and age of the universe and evaluate the existing evidence.

Audience
- 6th-12th grade

Time Recommended
30 - 40 minutes

Materials and Preparation:
- 18 Red, 8 Yellow, 3 White, and 1 Blue Balloons (1 balloon/student for a class of 30)
- 26 Wooden beads
- 3 Marbles
- 1 Ball bearings
- Pin (to pop balloons)
- Life Cycle of Stars Information Chart (at the end of this lesson)

Place 1 wooden bead inside each red and yellow balloon.
Place one marble inside each white balloon.
Place one ball bearing inside the blue balloon.
Make "cheat sheets" with the age on front of the card and chart of changes on the back of the card (copied from Life Cyle of Stars Information Chart)

Procedure:

1. Begin by asking students if all stars are the same. Make a list of things that might vary between stars: mass, heat, color, life cycle.
2. State that the class will do an activity that illustrates how all of these differences are related.
3. Pass out balloons, distributing different colors, one balloon per student. Explain that the property that causes the main differences between stars is mass. As you pass out balloons, tell students the approximate mass of their star.
4. Ask students which balloons they think represent the hottest stars. Point out that actually red stars are the coolest, and blue stars are the hottest. Ask what color our Sun is (yellow).

5. Ask which color star students believe will live longest, and why. Write prediction on board. Record differing opinions, too.
6. Guide students through the series of steps on the Life Cycle of Stars Information Chart (at the end of the lesson). For each age, tell students what to do for their color of balloon. To help students follow the progression, you might write different ages on a board or overhead as you move on, and note important events. Also, ask students to predict what will happen next.
7. After all the stars are "dead," review the sequence you have just covered. Point out which stars died first, which last. Which stars deflated and which stars exploded? What is the main difference between those stars? What stages did all stars go through? Point out how infrequent black holes form and how uncommon really massive stars are. How will the fate of our Sun affect the fate of the Earth? (About 7 billion years from now, the Sun will turn will turn into a red giant, with its outer surface expanding to about the radius of the Earth's orbit.)

Grade Level Adaptations:
Teachers of younger children may wish to only examine one or two types of stars.

Adler Planetarium Field Trip Connections:
The following experiences* at the Adler can enhance the content covered in this lesson.

Shows:
- *Earth, Moon & Sun* (Grades 3-6)
- *Journey to the Stars* (Grades 8-12)

Guided Gallery Experiences:
- *In Our Solar System* (Grades 2-7)

Exhibitions:
- Learn about our Sun and the other bodies in our Solar System in the *Our Solar System Gallery*.

* *Please note that shows, classroom programs, and guided gallery experiences are available for an additional cost.*

This activity is adapted from the Sun-Earth Connection curriculum. You may download the curriculum in its entirety at http://www.adlerplanetarium.org/educate/resources/curriculum.
This curriculum is also available along with supporting classroom materials for loan in the Sun-Earth Discovery Kit. Information about the Adler Planetarium's Discovery Kit program is available at http://www.adlerplanetarium.org/educate/resources/kits.

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Life Cycle of Star Information Chart

	Red Balloon	Yellow Balloons	White Balloons	Blue Balloons	Additional information
Mass and type of star	.4 Solar Mass (2/5 the mass of our Sun): Red stars	1 Solar Mass (the mass of our Sun): Yellow stars	8 Solar Masses (8 times the mass of our Sun): White stars	16 Solar Masses (16 times the mass of our Sun): Blue stars	
(Start)	Blow up the balloon to about 3" diameter	Blow up the balloon to about 3" diameter	Blow up the balloon to about 3" diameter	Blow up the balloon to about 3" diameter	A new star forms when gas and dust clump together through gravity. Once the pressure inside the clump is high enough, hydrogen nuclei join to form helium nuclei through nuclear fusion, and a star is born. Nuclear fusion is the process by which lighter elements combine to form heavier elements. (For example, Hydrogen fuses to form Helium.) This process releases energy.
10 Million Years	Wait. Do not change the diameter of the balloon.	Wait. Do not change diameter of the balloon.	Wait. Do not change diameter of the balloon.	Blow slightly more air into balloon. This star is becoming a **red giant**.	When hydrogen beings to run low, the star becomes a **red giant.** The outer shell of the star expands (up to 100 times the size of the original star) and cools.
11 Million Years	Wait.	Wait.	Wait.	Quickly blow up balloon until fully inflated. Pop balloon. Catch ball bearing. This star exploded in a **supernova** and became a **black hole.**	A **supernova** is a tremendous explosion that occurs when lighter elements in a star's core have been converted into iron. A **black hole** forms when a star collapses in on itself. The star collapses to a point of zero volume and infinite density. The force of gravity is so strong that not even light can escape.
50 Million Years	Wait.	Wait.	Blow slightly more air into balloon. This star is becoming a **red giant**.	Still black hole.	
55 Million Years	Wait.	Wait.	Quickly blow up balloon until fully inflated. Pop balloon. Catch marble. This star exploded in a **supernova** and became a **neutron star**.	Still black hole.	A **neutron star** is only about 10 miles in diameter, but has a mass about1.4 times that of the Sun and a magnetic field a trillion times stronger than the Earth's.

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10 Billion Years	Wait.	Blow up a little bit. This star is becoming a **red giant**.	Still a neutron star.	Still black hole.	
12 Billion Years	Wait.	Blow up more. This star is a **red giant**.	Still neutron star.	Still black hole.	
12.5 Billion Years	Wait.	Blow up a little more. Then cut up balloon and throw pieces away from you. Catch bead. This star releases its outer layers as a **planetary nebula** and becomes a **white dwarf.**	Still neutron star.	Still black hole.	**Planetary nebulae** are the expanding shells of gas that are ejected by some stars. A **white dwarf** is a slowly cooling core of a star. One unusual property is that the more mass the star has, the smaller it is.
100 Billion years	Deflate balloon. This star has become a **white dwarf**.	Still white dwarf.	Still neutron star.	Still black hole.	