

## ACTIVITIES for Grades 9-12

### BEFORE YOUR VISIT

#### Online Video: *Journey to the Stars* Trailer and Prelude [amnh.org/stars](http://amnh.org/stars)

To prepare for your Museum visit, watch the trailer and the prelude with your students.

#### Class Discussion: Units of Measure

Pose the following questions to your students to introduce them to the units of measure used by astronomers:

- What types of measurements do astronomers use to quantify distances in space?

*Answers may include: Distances in astronomy are too vast to be measured in kilometers and miles.*

*The following units are used to measure the linear distances between stars, galaxies, and other distant celestial objects: A light-year (ly) is the distance light travels in one year (1 ly =  $\sim 1.0 \times 10^{13}$  km or  $\sim 6.0 \times 10^{12}$  mi).*

*An astronomical unit (AU) is the distance between the Sun and Earth (1 AU =  $\sim 1.5 \times 10^8$  km or  $\sim 9.3 \times 10^7$  mi).*

*A parsec (pc) is a unit of length, equal to just under 31 trillion km or  $\sim 19$  trillion miles, or about 3.26 lys.*

- Where is Earth located in the universe?

*Answers may include: Earth is a planet in our Solar System, moving in orbit around the Sun. Our Sun is one of over a hundred billion stars in our Milky Way Galaxy. And our Milky Way Galaxy is one of several thousand galaxies in the Virgo Supercluster. Finally, this vast supercluster of galaxies is just a tiny part of the Observable Universe.*

#### Reading: *Light: Its Secrets Revealed*

[amnh.org/resources/rfl/pdf/du\\_x01\\_light.pdf](http://amnh.org/resources/rfl/pdf/du_x01_light.pdf)

Have students read this online article to learn how light transmits information about the composition of distant celestial objects. These objects are so distant that even if we could travel at the speed of light, it would take us thousands of years to reach them. Ask students: What types of information does light provide about celestial objects too far for us to ever reach in our lifetime?

*Answers may include: The color of the light that a celestial object emits tells us its temperature. The light given off at a specific frequency by an atom or molecule—spectra—indicates the composition of the object. Every different type of atom or molecule gives off light at its own unique set of frequencies, like a “light fingerprint.”*

#### Online Video: *Interferometry: Sizing Up The Stars*

[amnh.org/sciencebulletins/?sid=b.s.peat\\_fire.20090601](http://amnh.org/sciencebulletins/?sid=b.s.peat_fire.20090601)

Have students view this Science Bulletin video on the Center for High Angular Resolution Astronomy (CHARA), the array of telescopes that uses the technique of interferometry to spot details the size of a nickel seen from 16,000 km away. Hear astronomers discuss how CHARA’s renowned precision gleans valuable data on the properties and life cycles of stars. Engage students in a discussion about the scientific method using this video. Click on “Educator Resources” found in the “More About This Story” tab.

#### NYS Regents Earth Science Curriculum/ The Physical Setting

*Major Understandings*

*Physical Setting 1.2a*

- The Universe is vast and estimated to be over ten billion years old. The current theory is that the Universe was created from an explosion called the Big Bang.

*Physical Setting 1.2b*

- Stars form when gravity causes clouds of molecules to contract until nuclear fusion of light elements into heavier ones occurs. Fusion releases great amounts of energy over millions of years.

**NOTE:** Distribute copies of the **Student Worksheet** before coming to the Museum.

## ACTIVITIES for Grades 9-12 (Continued)

### DURING YOUR VISIT

#### **Journey to the Stars Planetarium Space Show** (30 minutes)

Before the show, prompt students to do the following as they watch the show:

- Several times during the show, the Sun will be shown along with the planets of the Solar System. Note the relative distances and sizes of these objects.
- Identify the types of energy that the Sun emits.

**TIP:** Please plan to arrive at the 1st floor space show boarding area 15 minutes before the show starts.

#### **Big Bang Theater**, Hayden Planetarium (5 minutes)

When you exit the planetarium show (3rd floor), take the escalator down to the 2nd floor. Turn left and proceed towards the Big Bang Theater (bottom half of the Hayden Sphere). After the show, ask students:

- What is the evidence for the Big Bang?  
*Answers may include: The afterglow from the Big Bang that has traveled millions of light years.*
- What can light tell us about objects in the universe?  
*Answers may include: Through the science of spectroscopy, the light emitted by stars may be broken down into its various wavelengths. These wavelengths can be used to identify the various substances, or elements, present in that star's composition.*



#### **Cullman Hall of the Universe: Life Cycle of Stars & the Light They Emit**

(30 minutes)

On the lower level, find the "Stars" wall. Have students explore this area of the exhibition using the Student Worksheet.



### BACK IN THE CLASSROOM

#### **Hands-on Activity: Build a Spectroscope**

[amnh.org/resources/rfl/pdf/du\\_u03\\_spectroscope.pdf](http://amnh.org/resources/rfl/pdf/du_u03_spectroscope.pdf)

Download and print instructions. Have students build a pocket-sized spectroscope from readily available materials. They can use their spectroscopes to examine different light sources in school, home, and around their neighborhood.

#### **Online Activity: Astro Snapshots**

Use the following Astro Bulletin Snapshots to illicit discussions with your students:

*Betelgeuse is Shrinking*

[sciencebulletins.amnh.org/?sid=a.s.betelgeuse.20090629](http://sciencebulletins.amnh.org/?sid=a.s.betelgeuse.20090629)

- What are some of the reasons, in general, for stars appearing larger, smaller, brighter or dimmer?
- What do astronomers know about the relationship between a star's lifetime and its changing size?
- What do you think may be the cause for Betelgeuse's recorded shrinkage?

*Space Telescope Probes Nearby Stars*

[sciencebulletins.amnh.org/?sid=a.s.corot.20081103](http://sciencebulletins.amnh.org/?sid=a.s.corot.20081103)

- What part of the electromagnetic spectrum accounts for the Sun's rays?
- How does COROT's measurement of starlight reveal a star's structure?
- What information does a star's apparent texture and vibration reveal to astronomers?

*Star Formation on a Black Hole's Fringe*

[sciencebulletins.amnh.org/?sid=a.s.black\\_hole.20080908](http://sciencebulletins.amnh.org/?sid=a.s.black_hole.20080908)

- What is the primary force that is responsible for the formation of a black hole?
- If astronomers cannot actually see a black hole, what is some of the evidence of its existence?
- How are models useful and why are they essential in most areas of astronomy?

# STUDENT WORKSHEET for Grades 9-12

## Investigate Life Cycle of Stars & the Light They Emit

1. Find the area of this exhibition labeled "Stars." Find and fill in the information in the table below.

Type of Star	Its mass in relation to the Sun	Life expectancy (birth to death)	Type of remnant	An example this type of star
Low-mass star				
Intermediate-mass star				
High-mass star				
Very high-mass star				

What trends do you observe in the table between mass and life expectancy? \_\_\_\_\_

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Describe how the mass of a star relates to its life span. \_\_\_\_\_

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2. Look for the panel labeled "Organizing the Stars" and find the Hertzsprung-Russell (H-R) **diagram**. This diagram shows luminosity increasing upward and temperature increasing from right to left.

Pick one type of star that is shown on the diagram and describe its luminosity and temperature.

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How does a star's mass change as its luminosity and temperature increase?

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Describe the relationship between this plot of stars and the stages in the life of a star.

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**3. Turn around and find a circular exhibit called "A Spectacular Stellar Finale."** Describe the phenomenon that occurs as a star reaches the end of its life.

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**4. View the black hole video in the Black Hole Theater** located on the opposite corner of where you are standing to discover what happens after the death of a star. Record some questions that come to mind about this mysterious stellar phenomenon. (\*Please note that the Black Hole Theater has an additional screening that alternates with the black hole video. )

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# STUDENT WORKSHEET for Grades 9-12

## Investigate Life Cycle of Stars & the Light They Emit

1. Find the area of this exhibition labeled "Stars." Find and fill in the information in the table below.

Type of Star	Its mass in relation to the Sun	Life expectancy (birth to death)	Type of remnant	An example this type of star
Low-mass star	8-80% of the Sun's mass	0.975 trillion years	white dwarf	Proxima, Centauri, Barnard's star, Gliese 65
Intermediate-mass star	0.8-8 times the Sun's mass	9.75 billion years	white dwarf	Sirius, Polaris (the north star), Sirius B, the Sun, Ring Nebula
High-mass star	8-20 times the Sun's mass	9.5 million years	neutron star	Antares, Cassiopeia A, Spica, Pular J1939+2134
Very high-mass star	20-100 times the Sun's mass	0.925 million years	black hole	Rigel, Eta Carinae, Cygnus X-1

What trends do you observe in the table between mass and life expectancy?

*Answers may include: As mass increases life expectancy decreases.*

## ANSWER KEY

Describe how the mass of a star relates to its life span.

*Answers may include: The mass of a star determines how bright and fast it burns. Examples include, low mass stars are the longest-lived of the energy producing objects in the universe. Some low mass stars will live for trillions of years. The very high mass stars are the rarest and shortest lived.*

2. Look for the panel labeled "Organizing the Stars" and find the Hertzsprung-Russell (H-R) diagram. This diagram shows luminosity increasing upward and temperature increasing from right to left.

Pick one type of star that is shown on the diagram and describe its luminosity and temperature.

*Answers may include: The vertical axis represents the star's luminosity or absolute magnitude. The horizontal axis represents the star's surface temperature. A star in the upper left corner of the diagram is hot and bright. A star in the upper right corner of the diagram is cool and bright. A star in the lower left corner of the diagram is hot and dim. A star in the lower right corner of the diagram is cold and dim. The Sun rests approximately in the middle of the diagram.*

How does a star's mass change as its luminosity and temperature increase?

*Answers may include: As a star's luminosity and temperature increase, its mass also increases. In fact, a star's mass is the determining factor of a star's temperature and luminosity, and how it will live and die.*

Describe the relationship between this plot of stars and the stages in the life of a star.

*Answers may include: Each star is represented by a dot. The position of each dot on the diagram tells us two things: a star's luminosity (or absolute magnitude) and its temperature. These are two of the main characteristics that change throughout the life of a star.*

**3. Turn around and find a circular exhibit called "A Spectacular Stellar Finale."** Describe the phenomenon that occurs as a star reaches the end of its life.

*Answers may include: When a high mass star runs out of fuel, it collapses in on itself, causing it to explode as a supernova and ejecting matter out into space. Its core becomes a neutron star, which takes millions of years to cool down. The most massive stars also explode as a supernova, and form black holes in their centers.*

**4. View the black hole video in the Black Hole Theater** located on the opposite corner of where you are standing to discover what happens after the death of a star. Record some questions that come to mind about this mysterious stellar phenomenon. (\*Please note that the Black Hole Theater has an additional screening that alternates with the black hole video. )

*Some good questions may include: Why do some stars end up as black holes? If nothing travels at the speed of light, except light, how can a black hole also pull light into itself? If we can't see a black hole, how do we know it's there? What is the best evidence of the existence of a black hole? How big or small can a black hole be? How is time changed in a black hole?*

**ANSWER KEY**