



Activity: Stellar Evolution Scavenger Hunt

BACKGROUND:

The Milky Way galaxy contains several hundred billion stars of various ages, sizes and masses. Many factors affect the rate at which a star evolves, and the evolutionary path it takes. The most important of these factors is its mass.

Protostars form in a large cloud of gas and dust called a nebula. When nuclear reactions begin in a star, it is called a young stellar object (YSO). Stars become main sequence stars when the process of thermonuclear fusion of hydrogen to helium stabilizes. As the core of a main sequence star begins to run out of hydrogen, various processes cause the star's outer atmospheric layers to expand. The star becomes cooler and redder—a red giant or a red super giant depending on its mass.

A mid-sized star eventually becomes a white dwarf, the remains of its core after its outer layers have been ejected. Initially, these outer layers form a beautiful structure called a planetary nebula which, over time, becomes too thin to see. A massive star will explode as a type II supernova, leaving behind a neutron star or a black hole. If a white dwarf has a nearby companion, it could accrete enough mass to explode as a type Ia supernova. The “Stellar Evolution” chart enclosed in this packet illustrates, in a general way, how stars of different masses evolve.



*Janus Brink
Milky Way Southern
Hemisphere*

WHAT TO DO:

- ✓ Find each of the images on the next page in the exhibit, on the “From Earth to the Universe” website at http://www.fromearthtotheuniverse.org/tour_images.php, or on given flash cards.



Lola Chaisson, Artist

- ✓ Read the caption for the image (on the website, click the image to go to the caption). Record a few key words or phrases to describe the images.
- ✓ Using the information you read in the image caption and the “Stellar Evolution” chart, number the images in each set in order from the earliest (1) to the latest (4) stage of stellar evolution and determine if your evolutionary sequence is for a massive star or a mid-sized star.



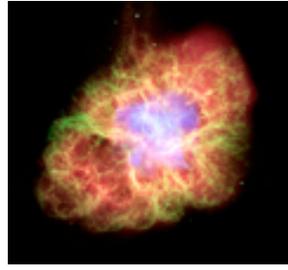
SET A: MASSIVE OR MID-SIZED STAR? (CIRCLE ONE)



NUMBER: ____
DESCRIPTION:



NUMBER: ____
DESCRIPTION:

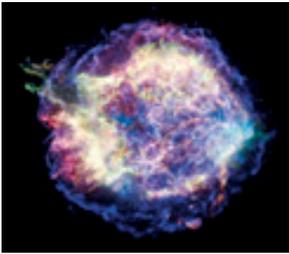


NUMBER: ____
DESCRIPTION:



NUMBER: ____
DESCRIPTION:

SET B: MASSIVE OR MID-SIZED STAR? (CIRCLE ONE)



NUMBER: ____
DESCRIPTION:



NUMBER: ____
DESCRIPTION:



NUMBER: ____
DESCRIPTION:

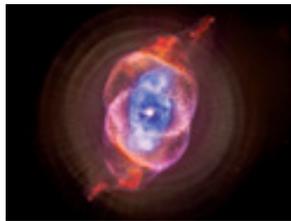


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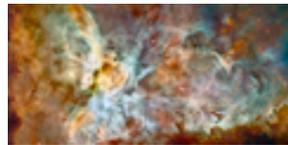
SET C: MASSIVE OR MID-SIZED STAR? (CIRCLE ONE)



NUMBER: ____
DESCRIPTION:



NUMBER: ____
DESCRIPTION:



NUMBER: ____
DESCRIPTION:



NUMBER: ____
DESCRIPTION:

STELLAR EVOLUTION FLASH CARDS - PAGE 1



CARINA NEBULA (7500 light years)

The Carina Nebula, an immense landscape of dark dust columns silhouetted against glowing gas clouds, which lies about 7500 light years away in the southern sky. The nebula, almost 500 trillion kilometers wide, is both lit and sculpted by the intense radiation of its brilliant young stars.

Credit: Image made in visible light by N. Smith (UC Berkeley) and the NASA / ESA Hubble Heritage Team.



OMEGA CENTAURI (17,300 light years)

A million lights fill this view across the core of Omega Centauri, a huge spherical mass of stars known as a globular cluster, picked out in amazing detail by the Hubble Space Telescope. There are about 200 of these clusters in our galaxy, each containing millions of very old stars clumped together into a ball by gravity.

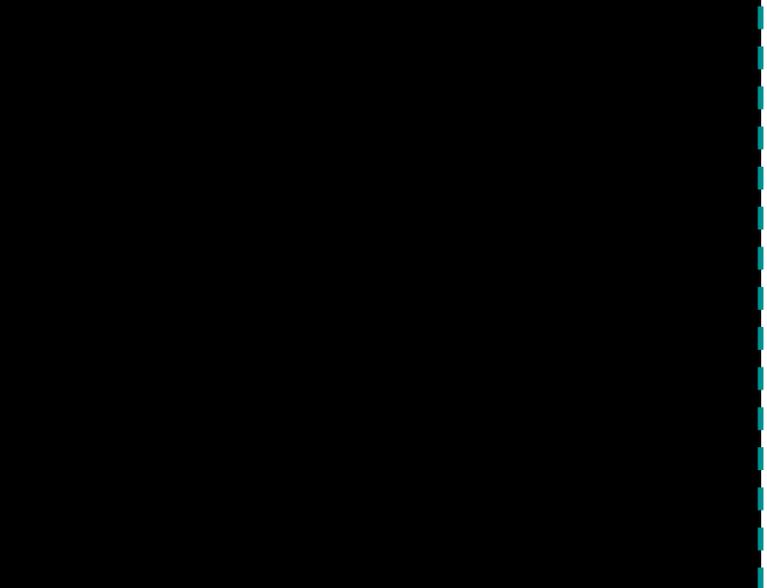
Credit: Image made in visible light by the NASA / ESA Hubble Team.



DOUBLE CLUSTER (7500 light years)

These clusters are among the brightest, densest, and closest of those containing moderately massive stars. Intervening dust from the Milky Way's disk slightly obscures our view, dimming the pair's overall brightness by about a factor of five. The two clusters (known as NGC 884 and NGC 869) are strikingly similar in many ways and are believed to have originated from a single ancestral gas cloud some 12.8 million years ago.

Credit: Robert Gendler.



CRAB NEBULA (6000 light years)

The Crab Nebula is the remnant of a supernova explosion recorded by Chinese and Arab astronomers in 1054. In its wake the explosion left us the ever expanding nebula, and a rapidly spinning neutron star called a pulsar at its centre. This image was made by a trio of space based instruments - the Spitzer Space Telescope (red), the Hubble Space Telescope (green and dark blue) and the Chandra X ray Observatory (light blue).

Credit: J. Hester for NASA / CXC / STScI / ASU, R. Gehrz for NASA / JPL Caltech / U. Minnesota.

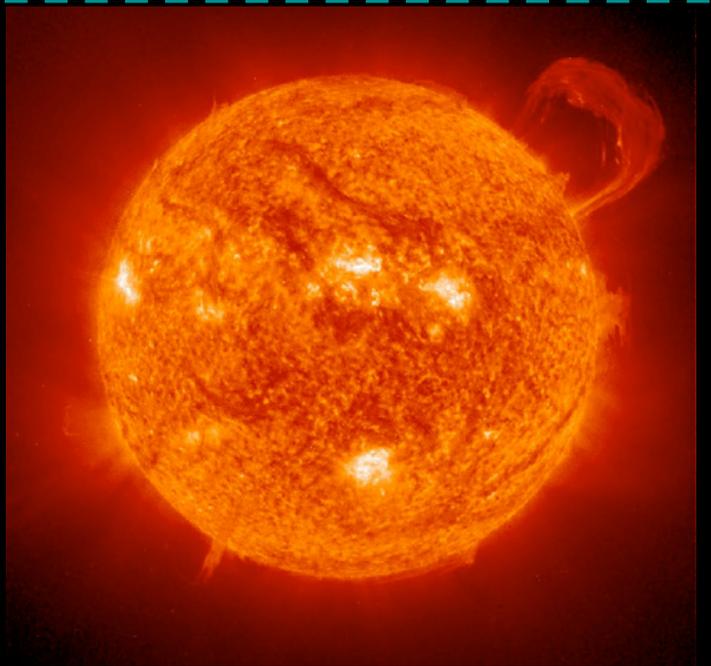
STELLAR EVOLUTION FLASH CARDS - PAGE 2



CAT'S EYE (3,000 light years)

This stunning image (formally known as NGC 6543) is a composite of X-ray data from NASA's Chandra X-ray Observatory (blue) and optical light from the Hubble Space Telescope (red and purple). This famous object represents a phase of evolution that our Sun will experience several billion years from now. When a Sun-like star begins to run out of fuel, it sheds some of its outer layers while leaving behind a hot core. A fast wind from this hot core rams into the ejected atmosphere and pushes it outward, creating the graceful filamentary structures seen here.

Credit: X-ray: NASA / CXC / SAO; Optical: NASA / STScI.



SUN IN ULTRAVIOLET (8.3 light minutes)

This image was recorded from space by the Solar and Heliospheric Observatory (SOHO) in ultraviolet light. This highlights the upper chromosphere, a thin layer just above the Sun's surface which is a scorching 60,000 degrees Kelvin. The hotter areas appear white, while darker red indicates cooler temperatures. The image features a large eruption from the solar surface that escaped the Sun's atmosphere.

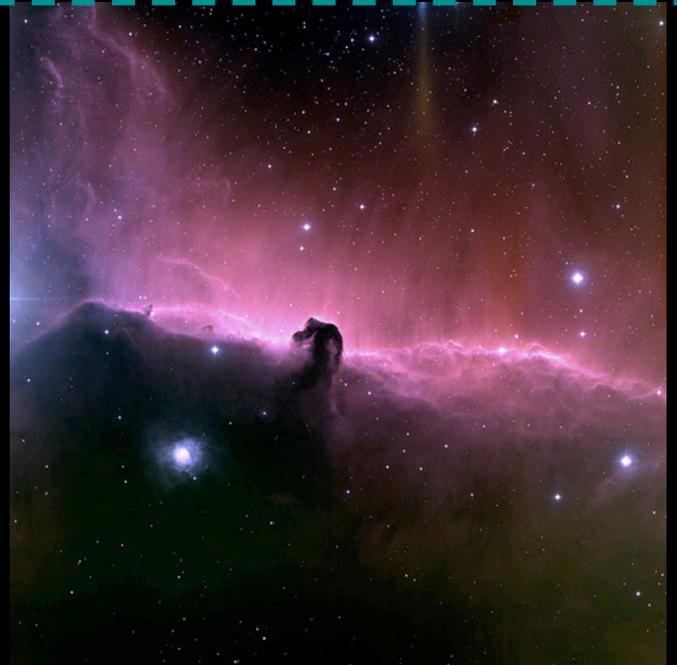
Credit: SOHO (ESA & NASA).



ETA CARINAE (7500 light years)

One of the brightest parts of the Milky Way is located in the constellation Carina (the keel). The Carina Nebula is composed mostly of hydrogen gas which is seen as pink and purple in this image. The brightest star in the nebula, known as Eta Carinae, is one of the most massive and luminous stars in the Milky Way and may explode within the next couple of centuries.

Credit: Stephane Guisard & Robert Gendler.

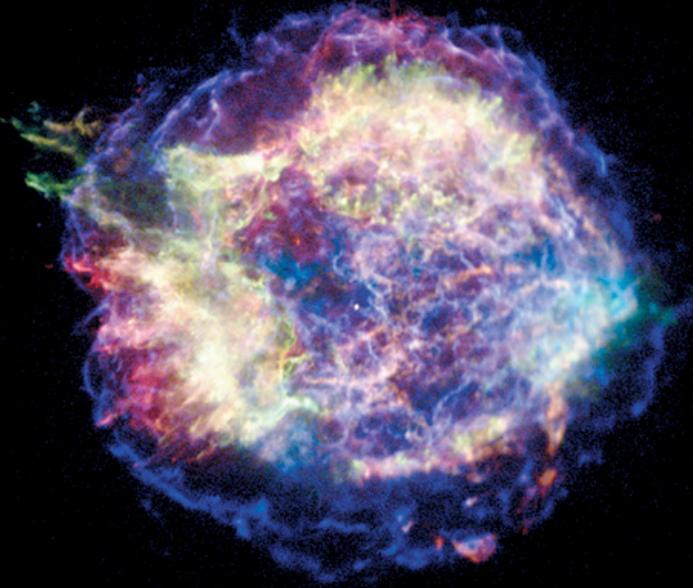


HORSEHEAD NEBULA (1500 light years)

Located in the constellation of Orion (the hunter), the Horsehead is part of a dense cloud of gas in front of an active star-forming nebula. The Horsehead is illuminated by the bright star Sigma Orionis, which is located above the top of the image. This exceptional picture was taken using the National Science Foundation's 0.9 meter telescope on Kitt Peak in Arizona.

Credit: T.A. Rector (NOAO/AURA/NSF) and Hubble Heritage Team (STScI/AURA/NASA).

STELLAR EVOLUTION FLASH CARDS - PAGE 3



CASSIOPEIA A (11,000 light years)

Cassiopeia A is the youngest supernova remnant in our Milky Way Galaxy, believed to be the leftovers of a massive star that exploded over 300 years ago. The material ejected during the supernova smashed into the surrounding gas and dust at about 16 million kilometres per hour. This collision superheated the debris field to millions of degrees, causing it to glow brightly in X rays as seen here by the Chandra X ray Observatory.

Credit: Chandra, NASA / CXC / MIT / UMass Amherst / M.D.Stage et al.



ANTARES (600 light years)

One of the most colourful vistas in the night sky is the region around the red supergiant star called Antares. This huge star is about 700 times the diameter of our Sun. If we had a star of this size in our Solar System it would completely engulf all the planets out as far as Mars including Earth. Behind Antares there are colourful areas of hydrogen gas (pink) and dust (yellow). To the right is the triplet star Rho Ophiuchi, sitting in its own glowing blue mantle of gas. This image also includes the globular star clusters M4 and NGC 6144.

Credit: Jay Ballauer / Adam Block / NOAO / AURA / NSF



NGC 3603 (20 000 light years)

The star forming region NGC 3603 seen here in a Hubble Space Telescope image contains one of the most impressive massive young star clusters in the Milky Way. Bathed in gas and dust, the cluster formed in a huge rush of star formation thought to have occurred around a million years ago. The hot blue stars in the core are responsible for carving out a huge cavity in the gas seen to the right of the star cluster in NGC 3603's centre.

Credit: NASA, ESA and the Hubble Heritage (STScI/AURA) ESA/Hubble Collaboration.



PLEIADES (400 light years)

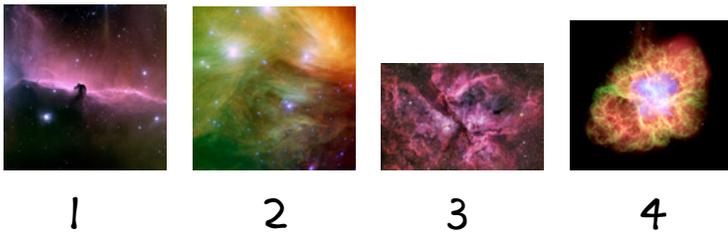
The Seven Sisters, also known as the Pleiades star cluster, seem to float on a bed of feathers in this infrared image from the Spitzer Space Telescope. Clouds of dust sweep around the stars, wrapping them in a cushiony veil. The Pleiades, located in the Taurus constellation (the bull), are the subject of many legends and writings in cultures around the globe.

Credit: NASA/JPL Caltech/J. Stauffer (SSC/Caltech).



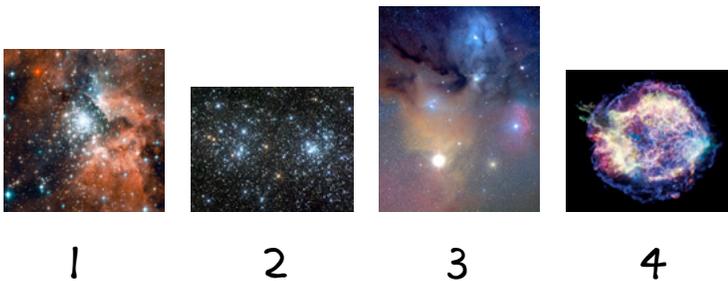
Activity: Stellar Evolution, possible sequences

SET A: MASSIVE STAR



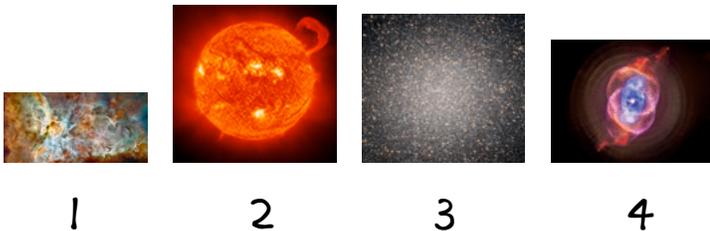
1. HORSEHEAD NEBULA—active star-forming nebula
2. PLEIADES—massive, blue main sequence stars (infrared image)
3. ETA CARINAE—a massive star that may explode within the next couple of centuries
4. CRAB NEBULA—supernova remnant with a rapidly spinning neutron star at its center

SET B: MASSIVE STAR



1. NGC 3603 — star-forming region, massive young star cluster
2. DOUBLE CLUSTER—contains moderately massive stars
3. ANTARES—red supergiant star.
4. CASSIOPEIA A—remnant from the type II supernova of a massive star

SET C: MID-SIZED STAR



1. CARINA NEBULA—lit by brilliant young stars
2. SUN IN ULTRAVIOLET—mid-sized main sequence star
3. OMEGA CENTAURI — millions of very old stars (red giants) clumped together by gravity
4. CAT'S EYE—planetary nebula, core of mid-sized star in center

FOR MORE INFORMATION ON STELLAR EVOLUTION, VISIT:

Stellar Evolution - Cycles of Formation and Destruction
http://chandra.harvard.edu/edu/formal/stellar_ev/story/

Interactive Guide to Stellar Evolution
http://chandra.harvard.edu/edu/formal/stellar_ev/stellar_ev_flash.html

