

Main sequence stars that can no longer support nuclear fusion of hydrogen in their cores will become red giant stars. Although most main sequence stars become red giants, their specific evolutionary paths after this red giant phase vary greatly, depending on mass.

A low-mass star, less than about eight times the mass of our Sun ($<8m_{\odot}$), eventually ejects its outer layers to produce a planetary nebula. The stellar core remaining in the middle of this planetary nebula is called a white dwarf.

In contrast, a high-mass star, more than eight times the mass of the Sun ($>8m_{\odot}$), will eventually explode as a Type II supernova. Depending on the original mass of the star, the Type II supernova will leave behind either a neutron star or, if the original star was extremely massive, a black hole.

- 1) Use the information above and the word list below to fill in the ovals in the diagram on the next page. Be sure to look at the arrows and words between the ovals to make sure these links between ovals make sense. Check your work with another group.

Word list:

neutron star
black hole
planetary nebula
white dwarf
nova
Type II supernova

The diagram does not give us all the information known about the death of stars. Since it is incomplete, we can always add to this diagram as we learn more information.

- 2) In Parts a and b below, you are given some additional information about the end states of stars. Your task is to change or add to the diagram to incorporate this additional information. (Note: There are several ways to accomplish this.)
 - a) If a white dwarf has a nearby binary companion star, it can gravitationally attract material from its companion in a process known as accretion. When the white dwarf accretes enough material from the companion, the white dwarf will either (1) blow off the outer layers of accreted material in a controlled fusion reaction known as a nova, leaving behind the white dwarf unchanged, or (2) experience a violent, uncontrolled fusion reaction that causes the white dwarf and accreted material to explode as a Type Ia supernova, destroying the white dwarf and leaving nothing behind.
 - b) Completely by itself in space, a black hole can be nearly impossible to detect. However, if a black hole has a nearby binary companion star, the strong gravitational pull of the black hole can gravitationally attract material from its companion in a process known as accretion. This material then spirals around the black hole and increases in temperature. This process causes the rapidly moving material to emit large amounts of X-ray radiation, which we can detect with X-ray telescopes. Thus, one way to look for black holes is to look for strong X-ray sources.

