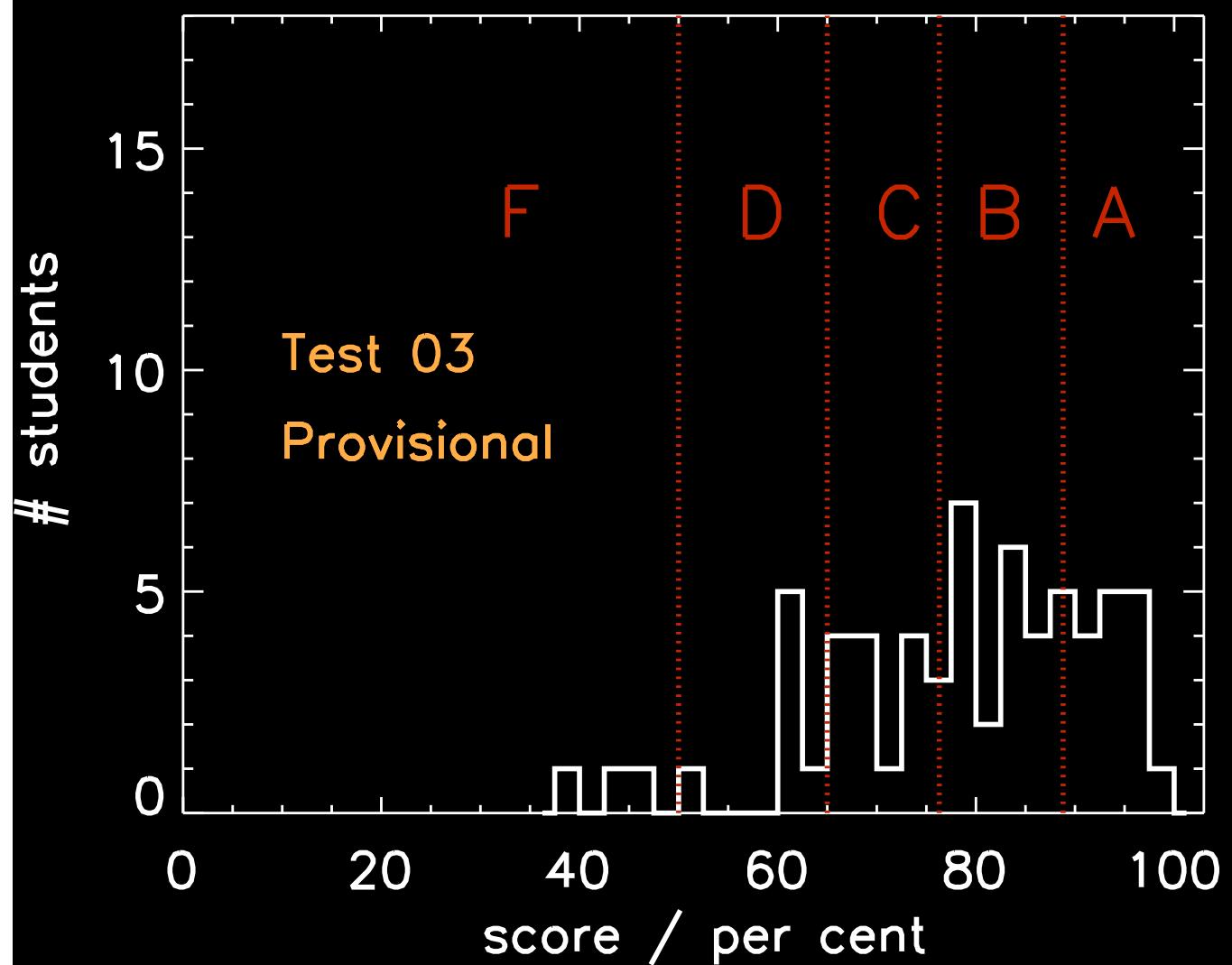


Lecture 20 – 14 April 2009



- **SCIENCE TOPICS:**
Stellar Evolution (cont.)
- **READING**
Ch 12, sec 12.1 – 12.5
Ch 13, sec 13.1, 13.5 – 13.8
Beware of excessive detail
- **PRACTICE: Ch 12**
Review: 1-3, 7-9, 11
Self-test: 2, 3, 6, 9, 10, 12, 13
Problems: none

HOMEWORK 8:
Out now, due next
Tuesday, 21st April
2009, 11:59pm

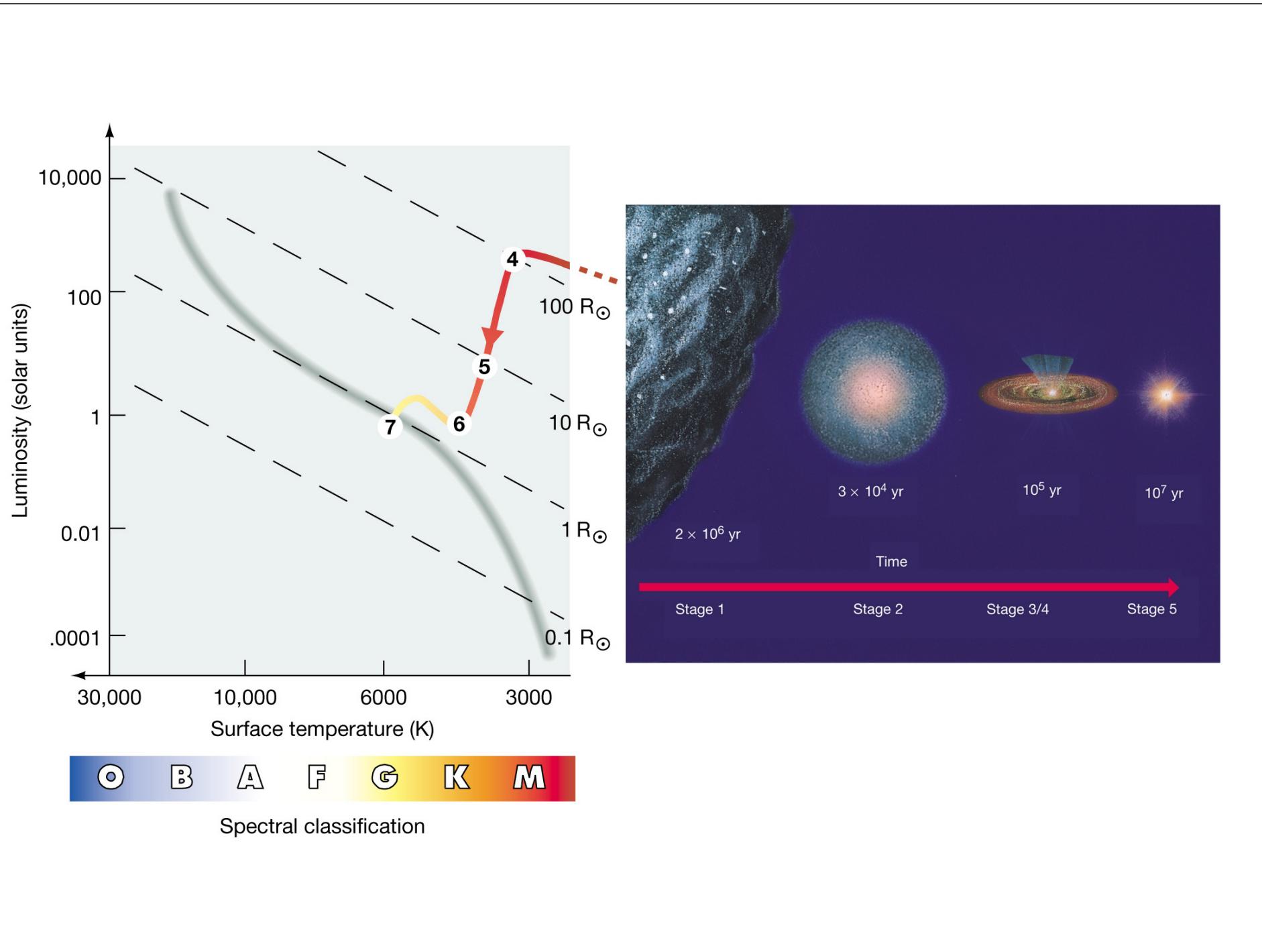


mean = 77.3% Std. Dev= 13.8%

Finals

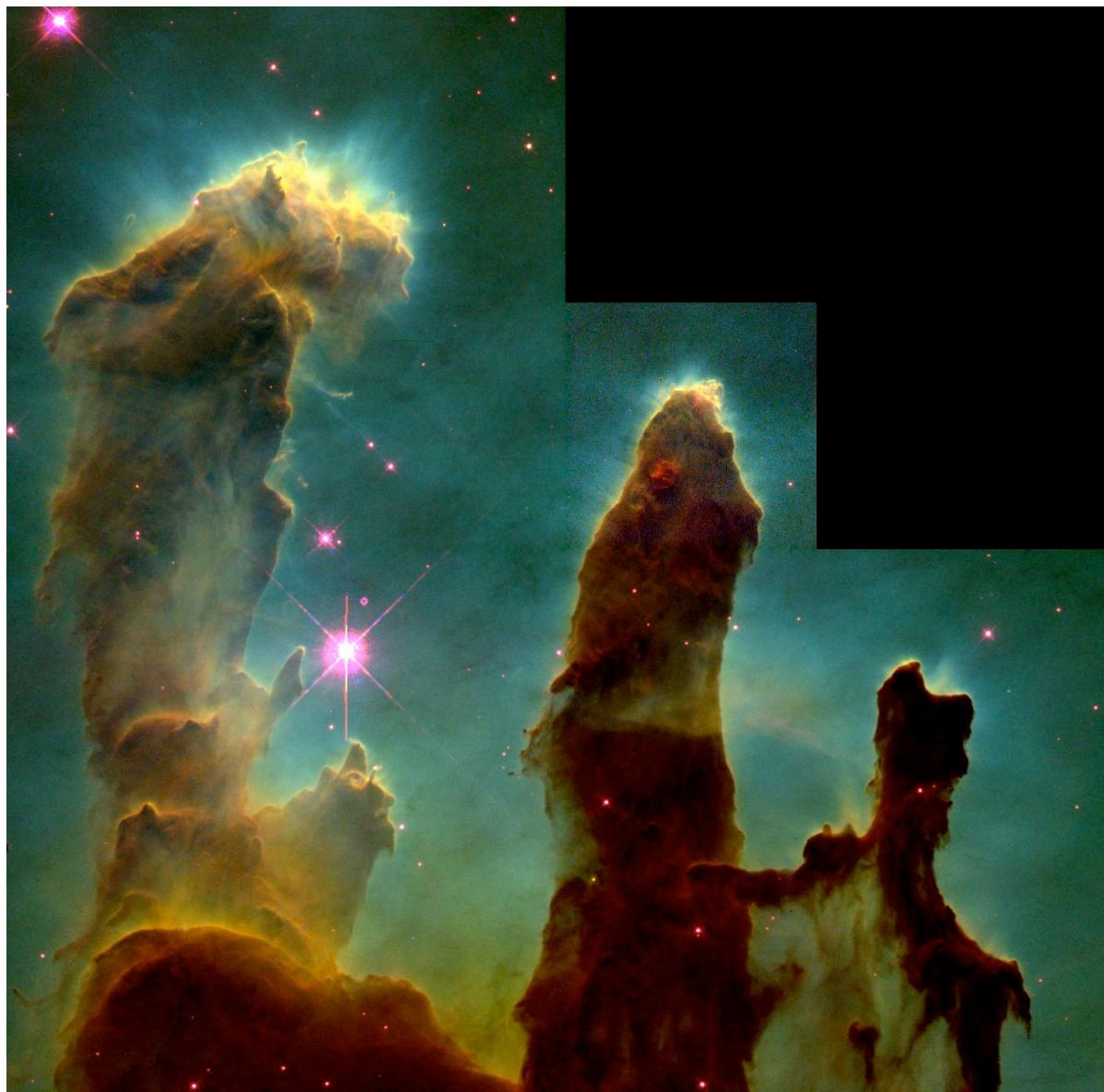
- Test 04 and Comprehension 03
- ***Friday, 8th May 2009, (NO make-up)***
 - 08:00-09:50am, this room
- Lecture 19 (2nd half) to end of course
 - Topics:
 - Stellar Evolution
 - Black Holes
 - Galaxies
 - Dark Matter and Dark Energy
 - The Fate of the Universe

Stellar Evolution I: Evolution of a Solar-Type Star

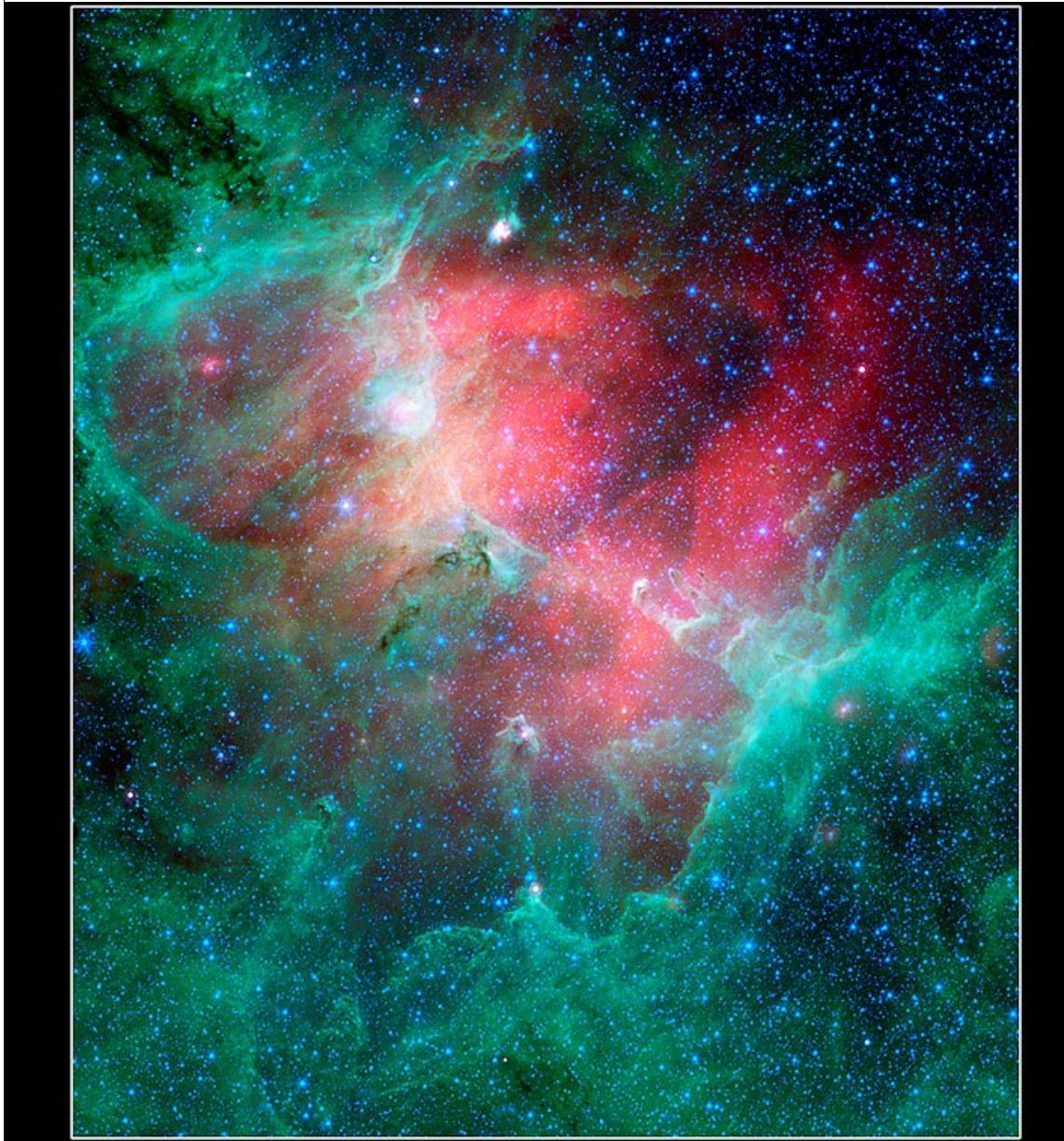


Eagle Nebula

- 7,000 ly away
- ~50 ly in size
- Active star forming region
- “Pillars of Creation”
- Image from *HST*

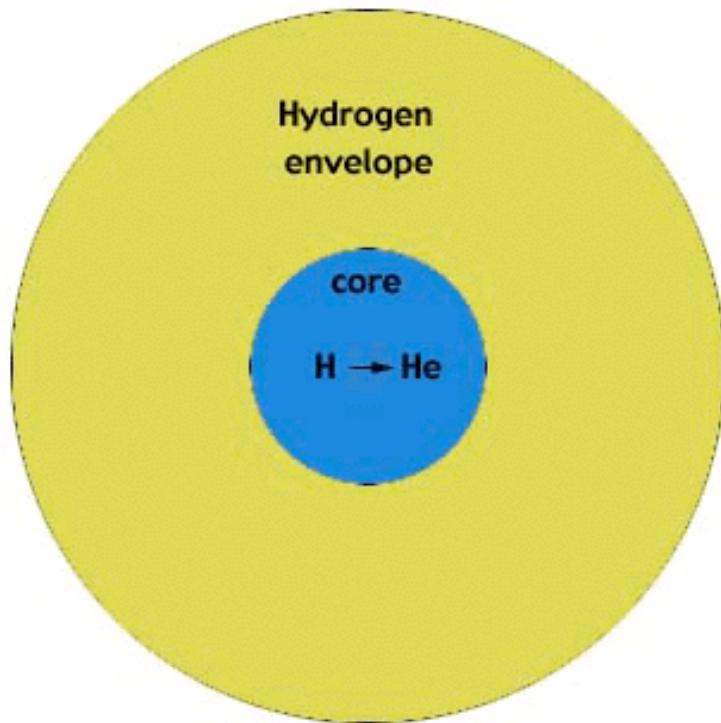


Eagle Nebula, *HST* and *Spitzer*



- New star formation, good chance of a SUPERNOVA...
- Gas and dust of pillars blown away
- Universe is a violent place...

Main Sequence phase (equilibrium)

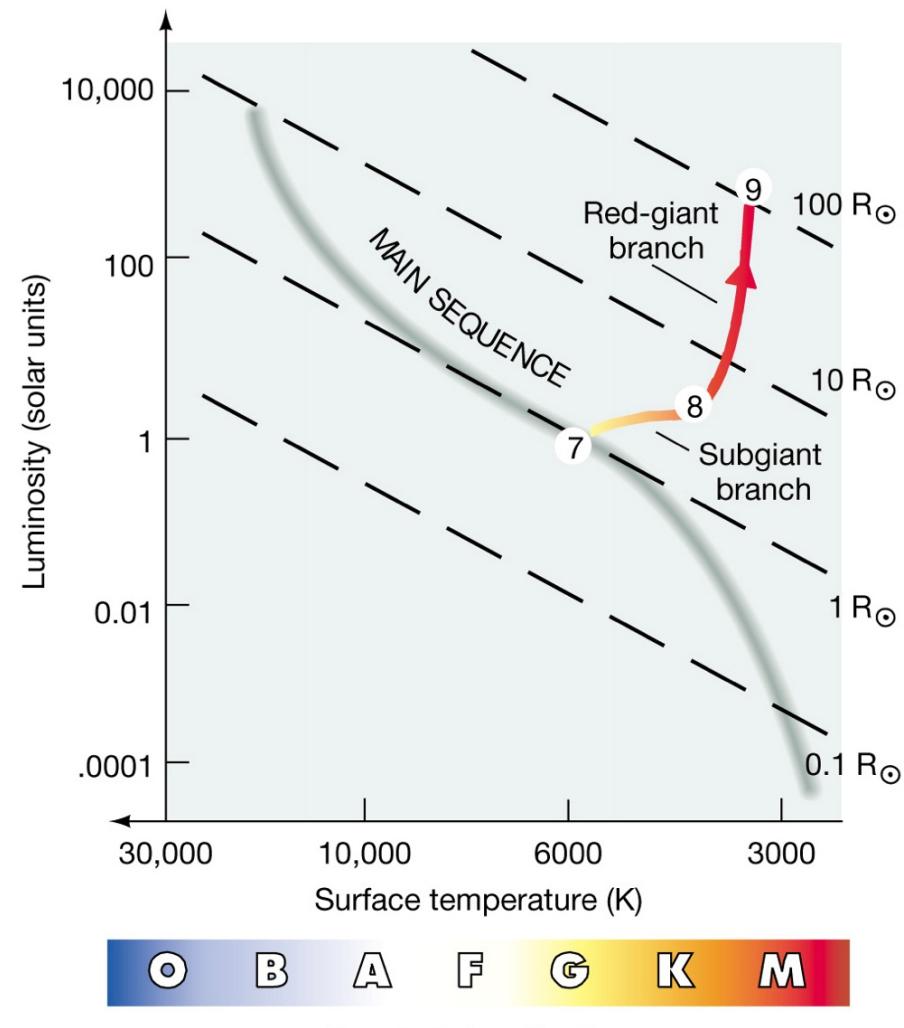
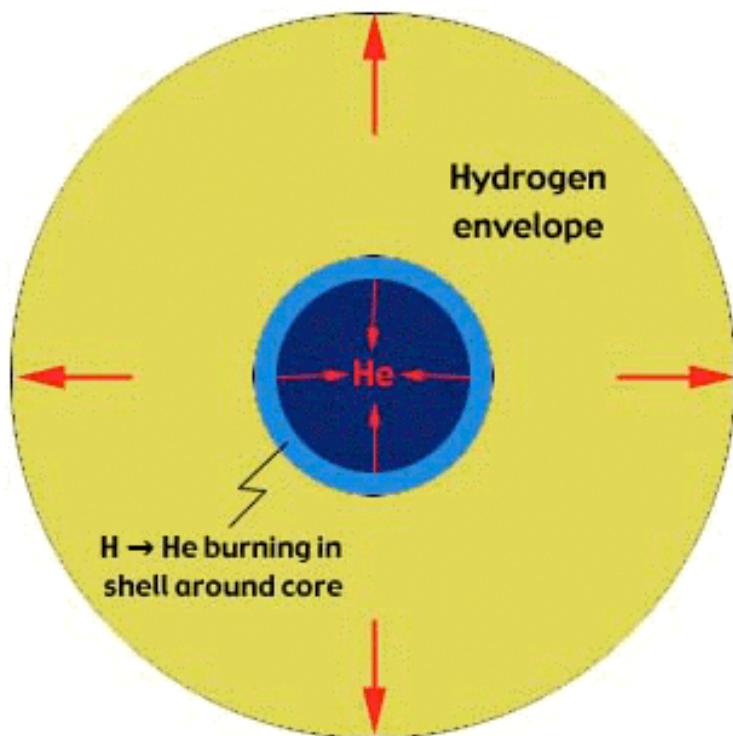


Dependence of luminosity
and main-sequence life time
on the **mass** of a star

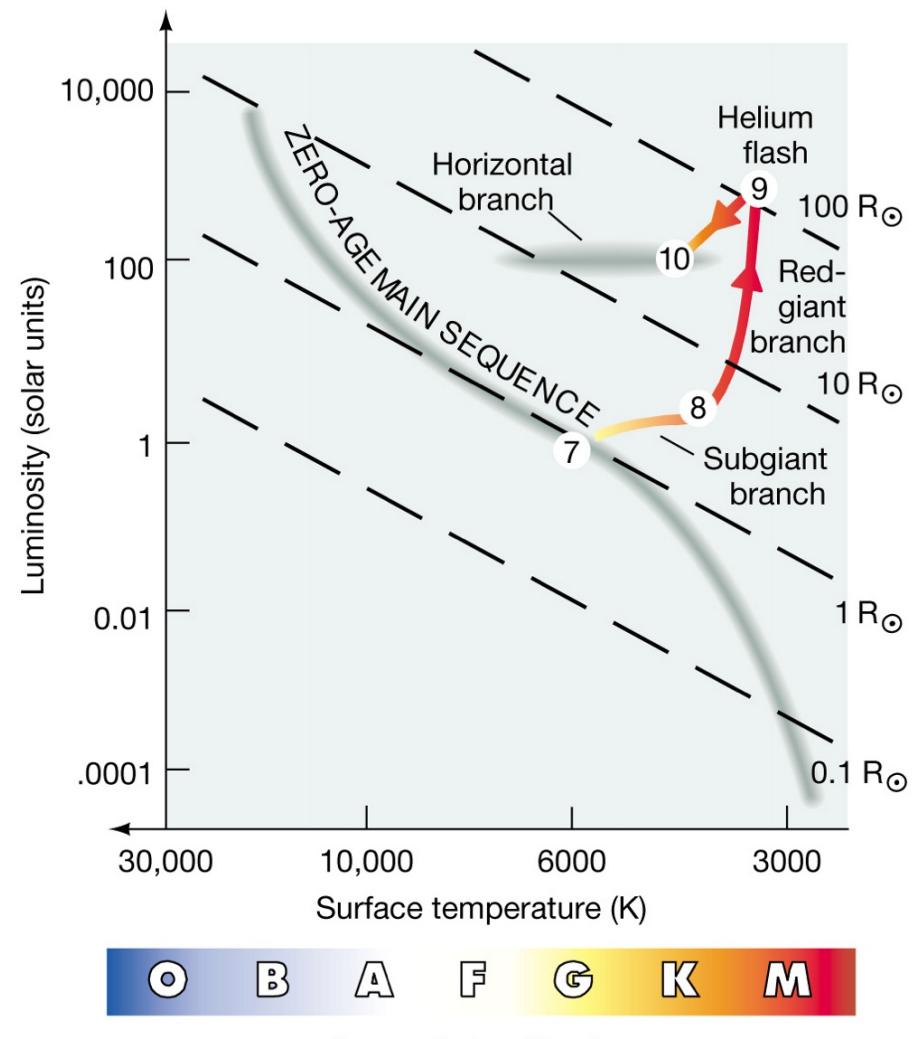
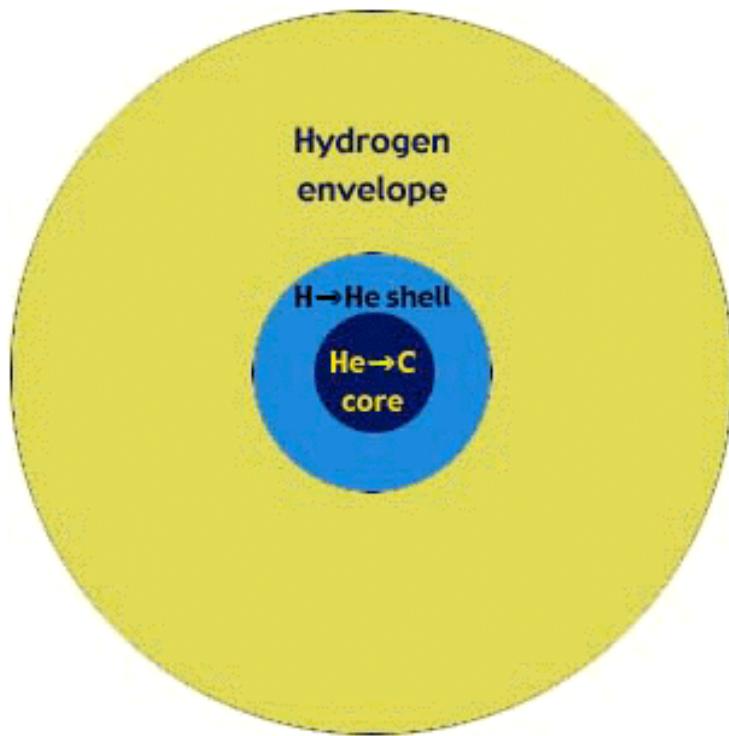
$$L \propto M^3 \quad \text{or} \quad \frac{L}{L_\odot} = \left(\frac{M}{M_\odot} \right)^3$$

$$t \propto \frac{1}{M^2} \quad \text{or} \quad \frac{t}{t_\odot} = \left(\frac{M_\odot}{M} \right)^2$$

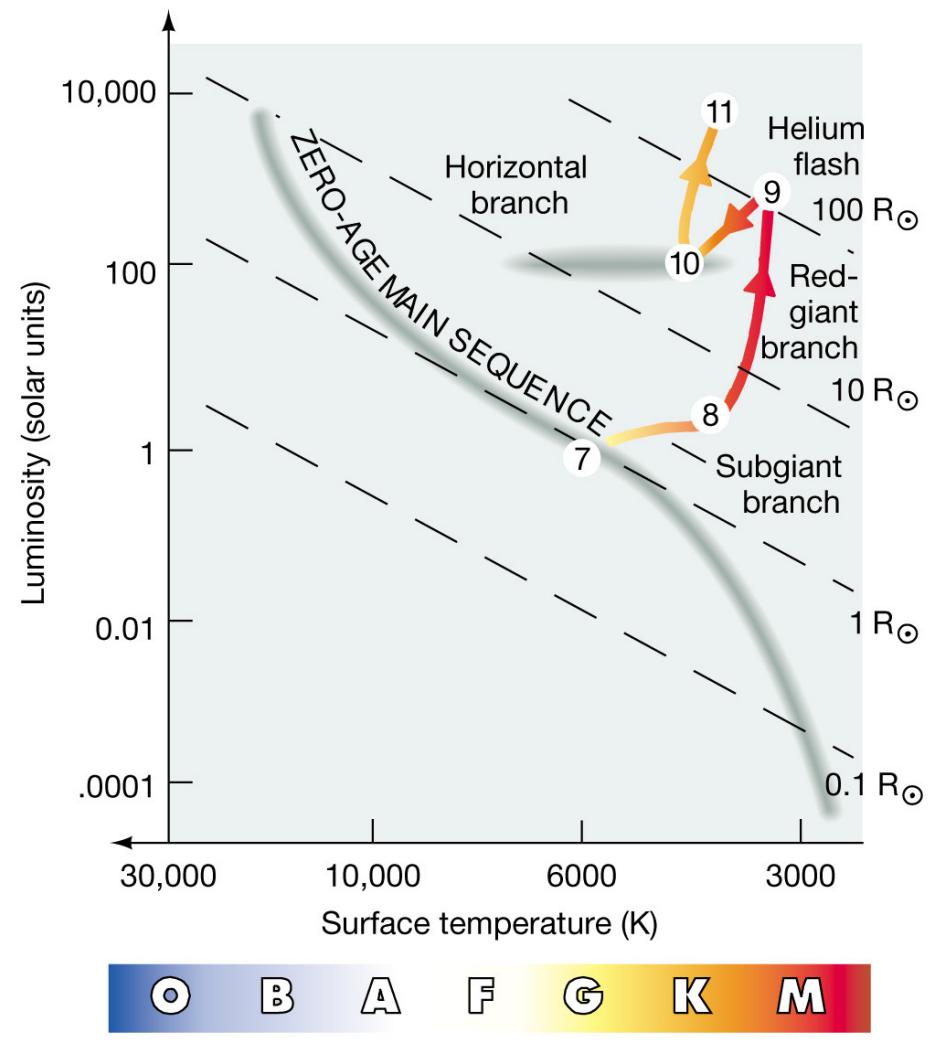
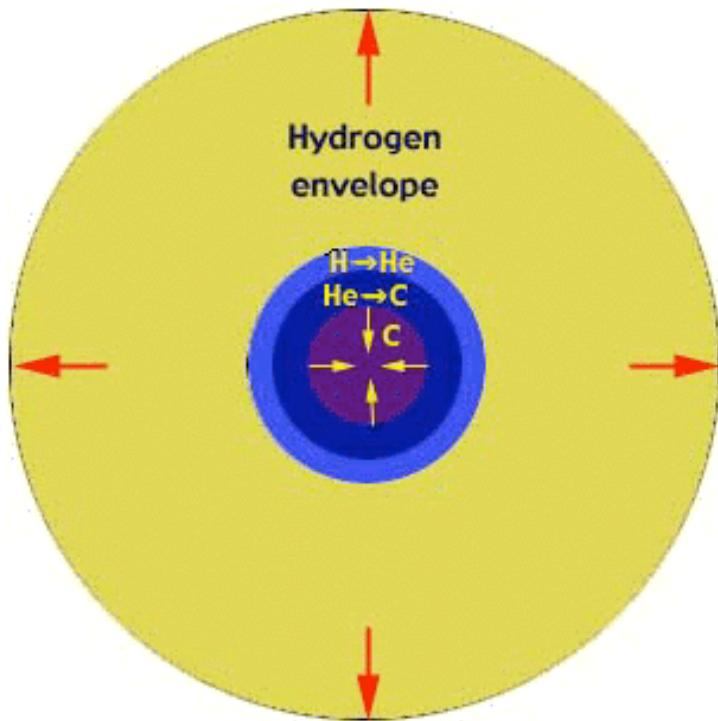
Subgiant/Red Giant phase (non-equilibrium)

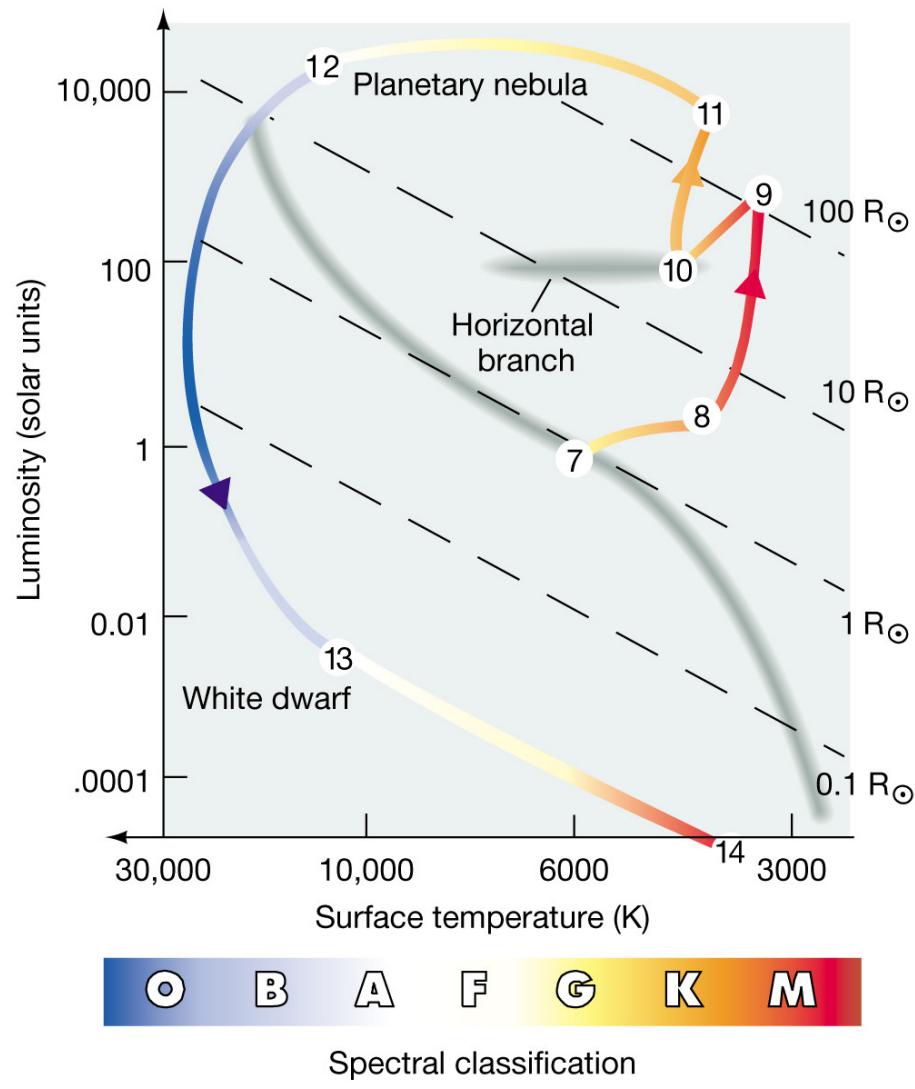
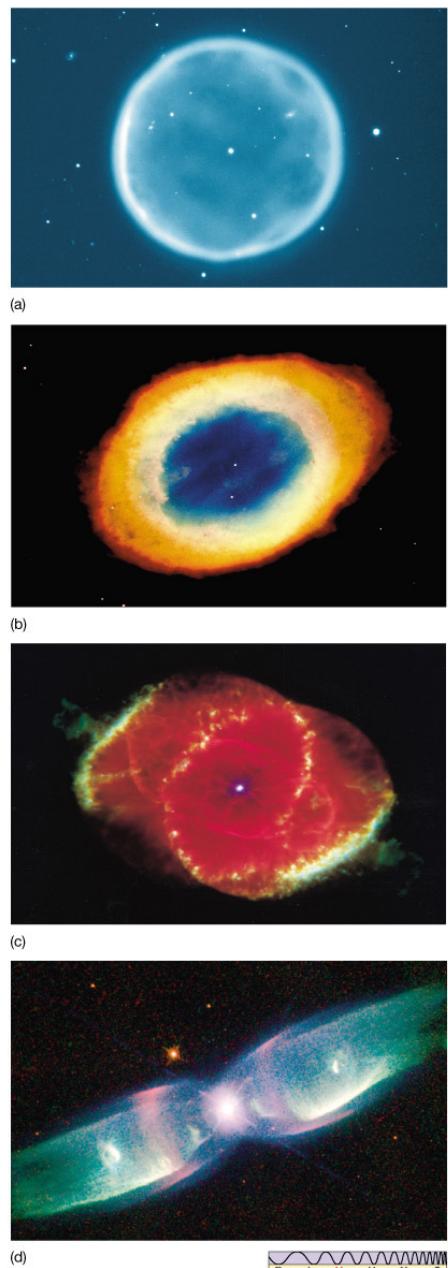


Horizontal Branch (equilibrium) a.k.a. Helium main sequence



Red supergiant and beyond (non-equilibrium)



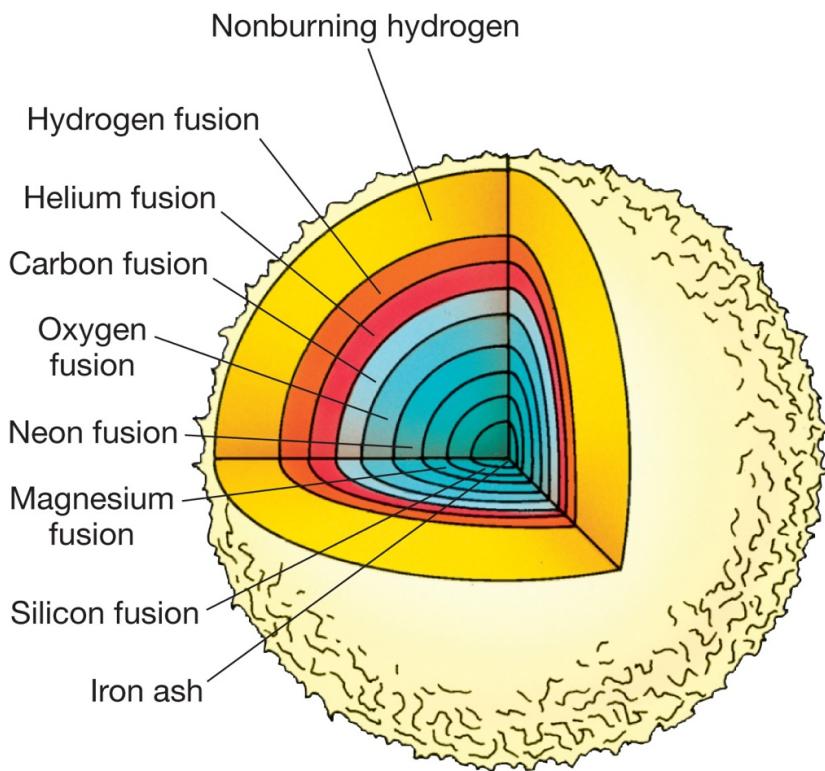


Stellar Evolution II: Evolution of a Massive Star

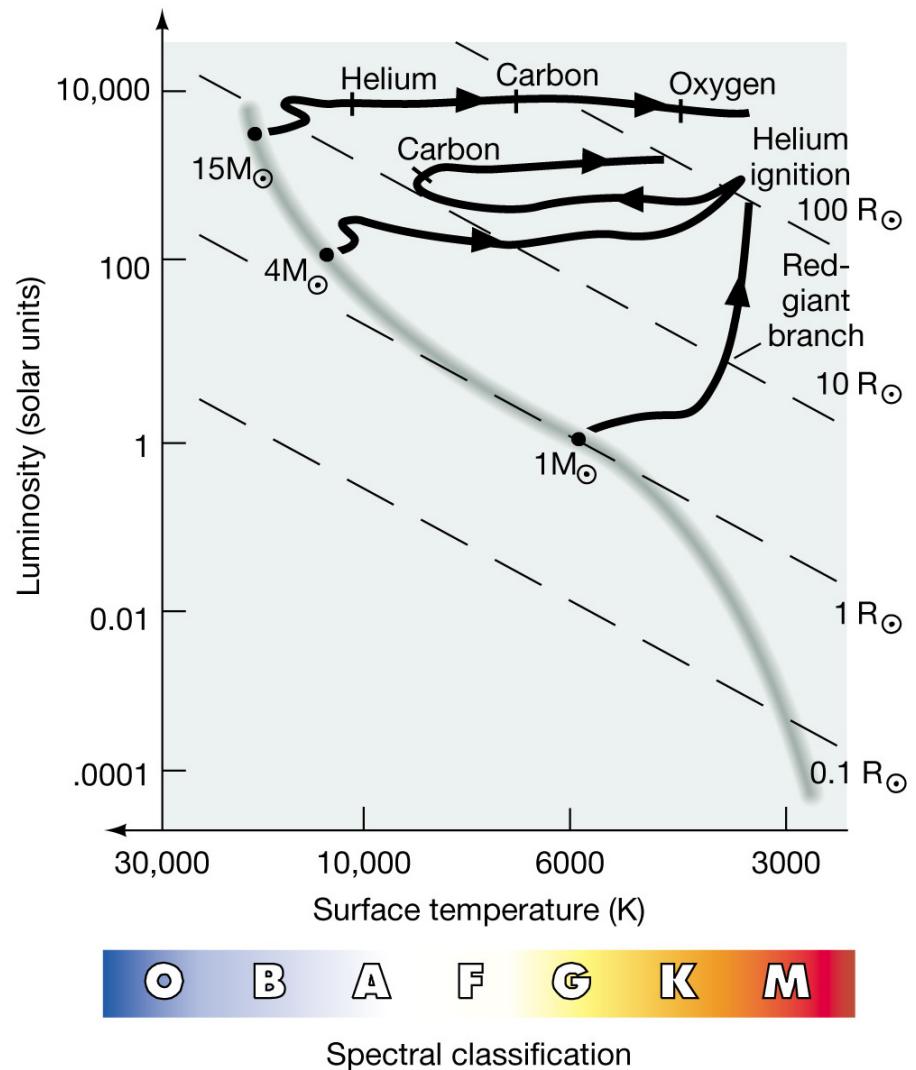
Fates of Stars (depends on mass)

Evolution of a Massive Star

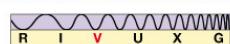
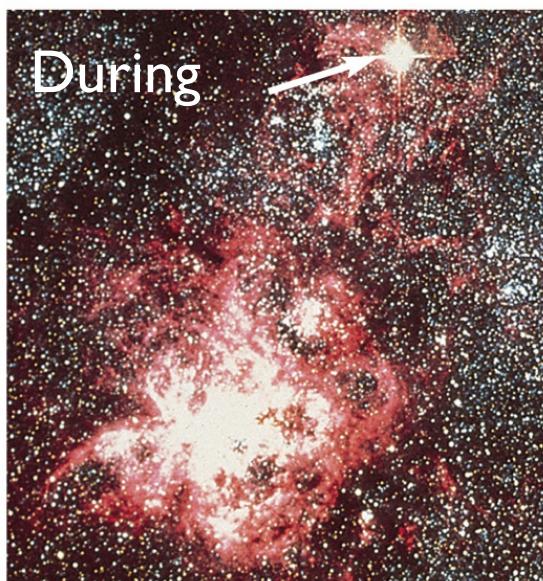
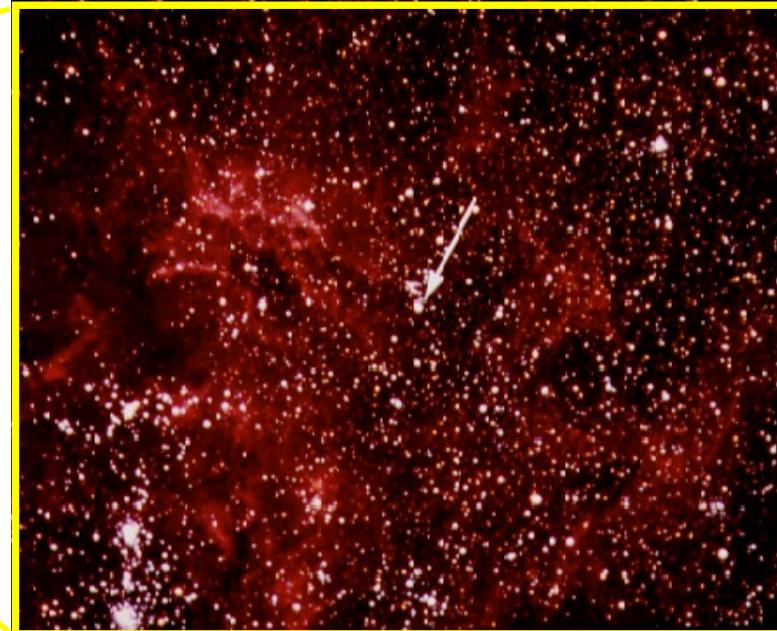
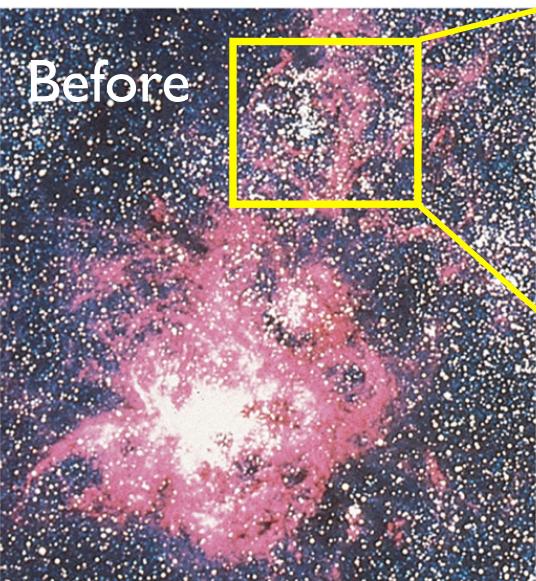
$M > 8 M_{\odot}$



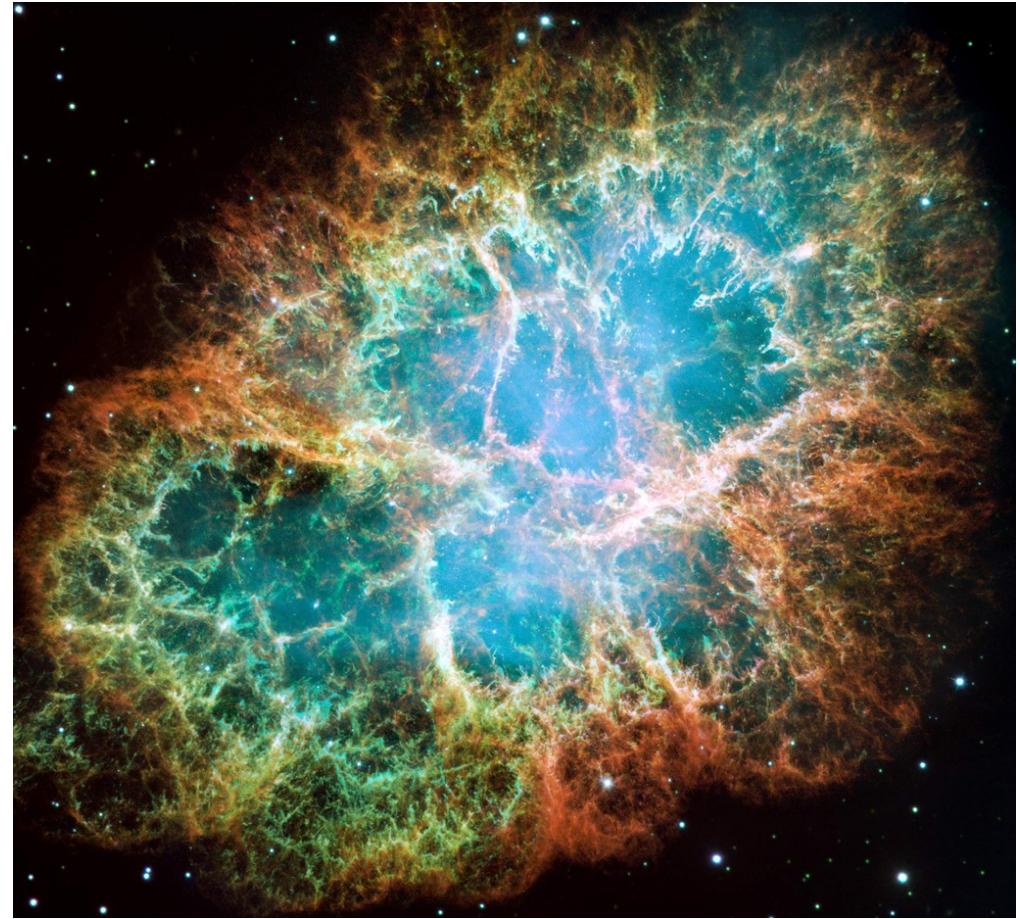
Copyright © 2007 Pearson Prentice Hall, Inc.



SN 1987A



Supernova Remnants



Copyright © 2007 Pearson Prentice Hall, Inc.

Cassiopia A

Crab Nebula
(SN 1054 AD)

Two types of Supernovae...

- **Type I**
 - Binary stars, exploding White Dwarf!
(good for cosmology...)
- **Type II**
 - Exploding massive star

Neutron Star vs. State College

