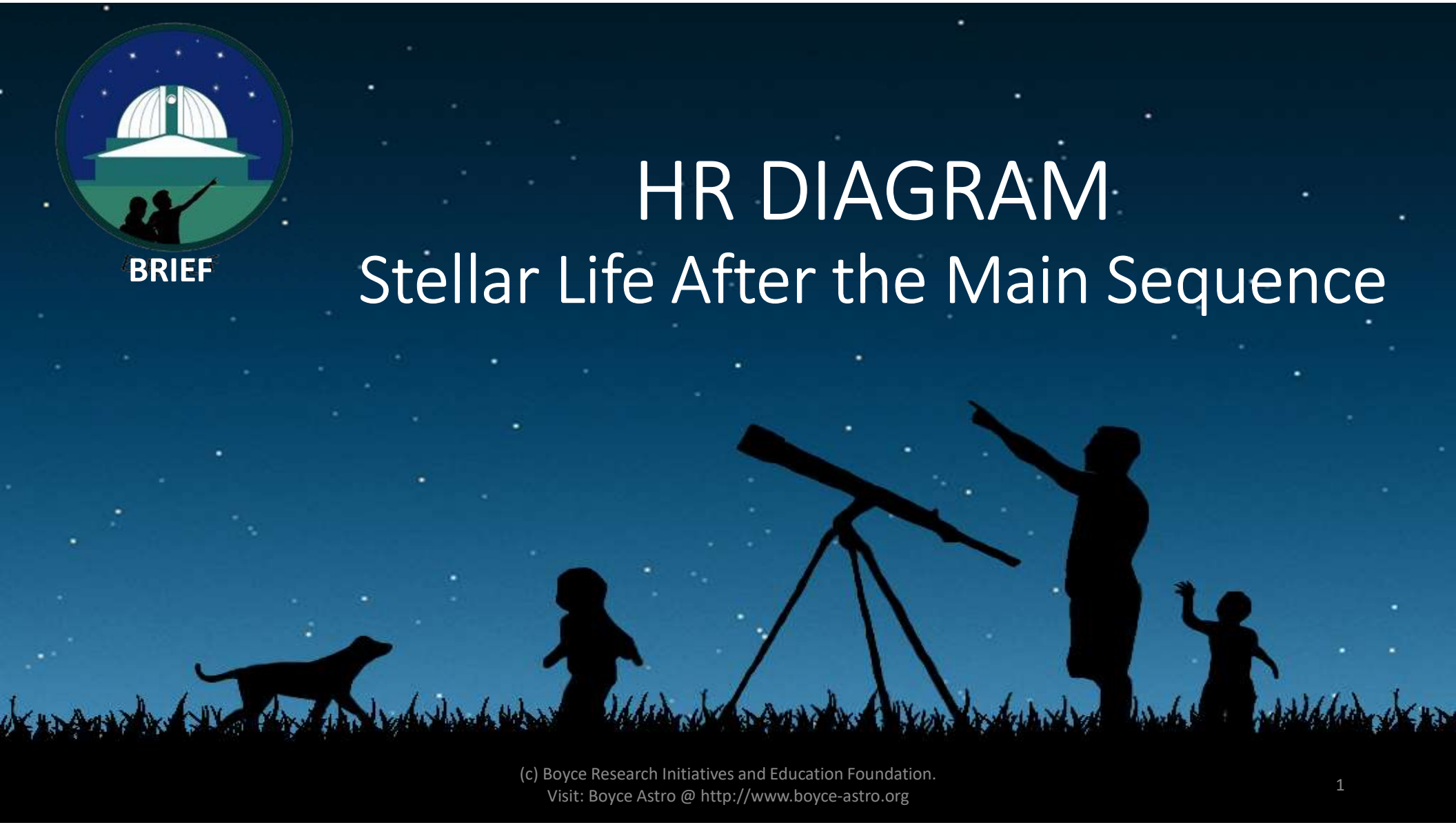
BRIEF

HR DIAGRAM
Stellar Life After the Main Sequence



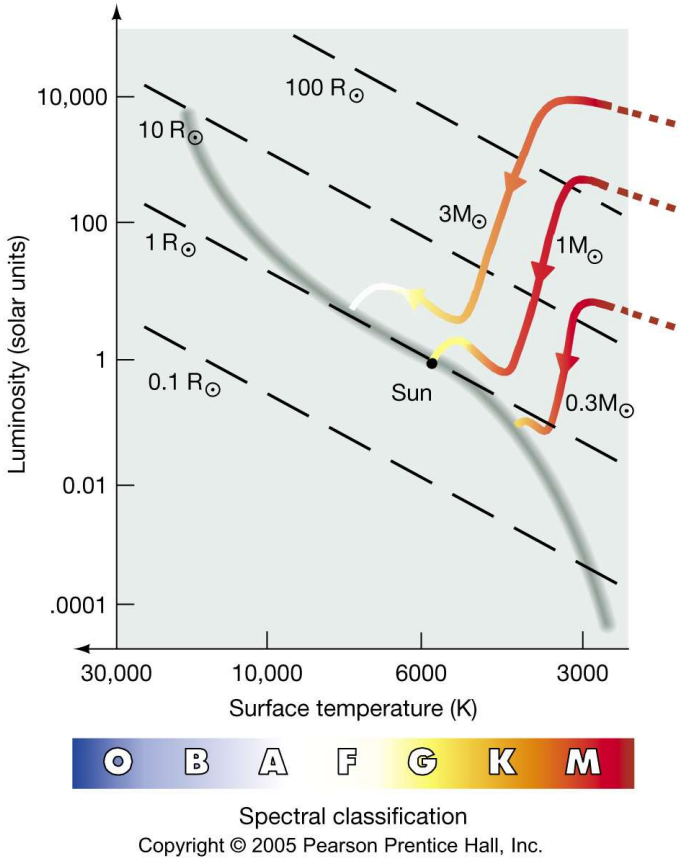
Overview

This lesson will cover an overview of the stellar life cycle after a star has left the Main Sequence. This is important to understand as each type of variable star is particular to a specific point in stellar evolution.

The path a star will take from this point is dependent on its mass.

This presentation will take up to the point where the paths of fate are determined on mass.

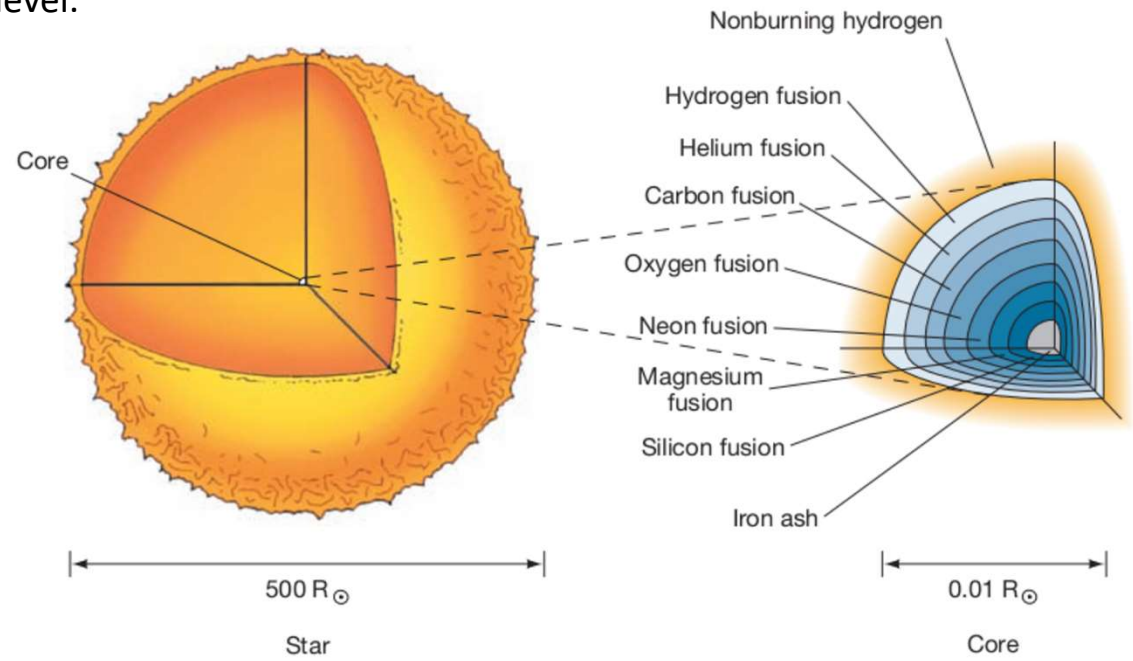
NOTE: Many of today's images will come from the outstanding book *Astronomy Today* by Chaisson and McMillan (Pearson Prentice Hall, Inc).

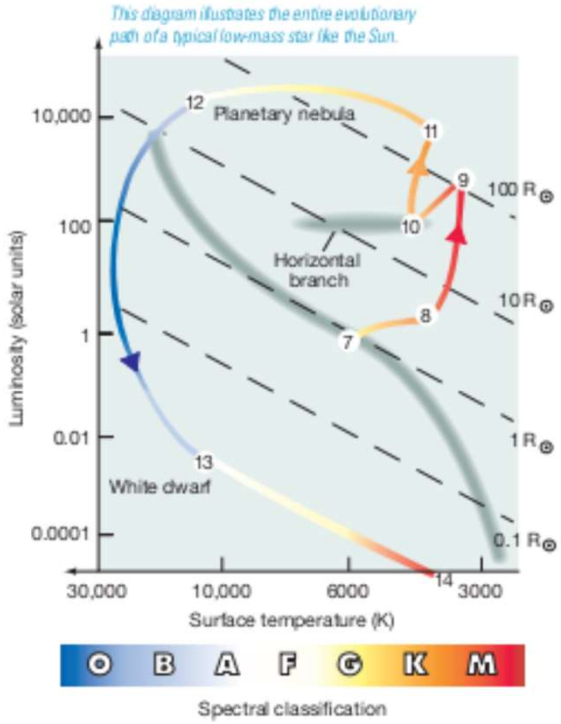


General Concepts

This path will flow up from the Main Sequence through the various luminosity classes (III, II, I, etc) and changes in stellar type based on temperature.

Progression through varying fusion types depends on whether the star has enough mass to begin the next level.



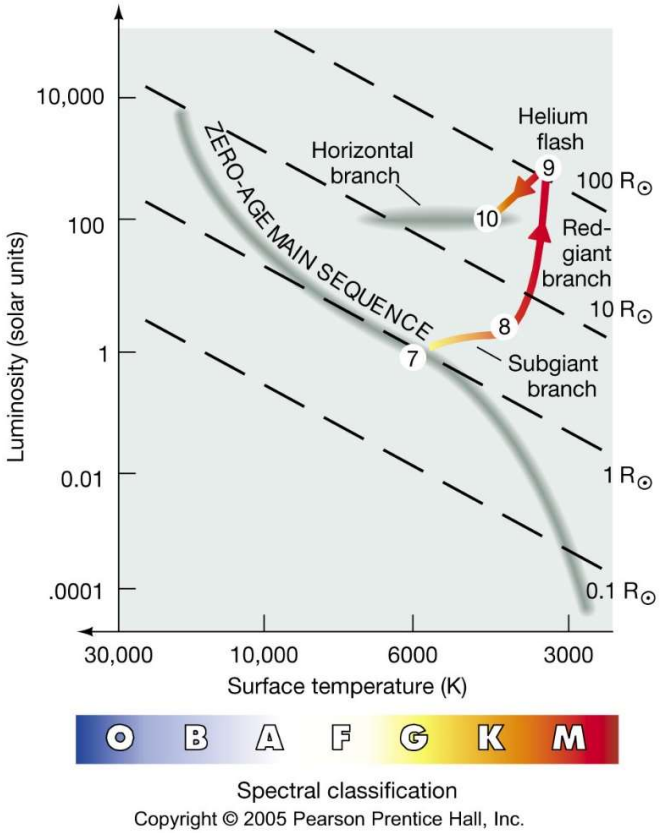


Stage 8: Subgiant Brach

- Gravitational compression causes the core to heat as internal temps cannot defend against gravitational pressures.
  - Core warms towards Helium fusion
  - Accelerates Hydrogen fusing in layers above
- Star gets brighter

Stage 9: Red-Giant Brach

- Core continues to shrink; the outer layers of the star expand and cool.
- Convection keeps star's surface temperature nearly constant
- Hydrogen shell burring speeding up keeps luminosity growing as the star swells
  - Speeding up from heat below as well as current temperature in fusion
- Despite its cooler temperature, its luminosity increases enormously due to its large size.
- It is now a red giant, extending out as far as the orbit of Mercury

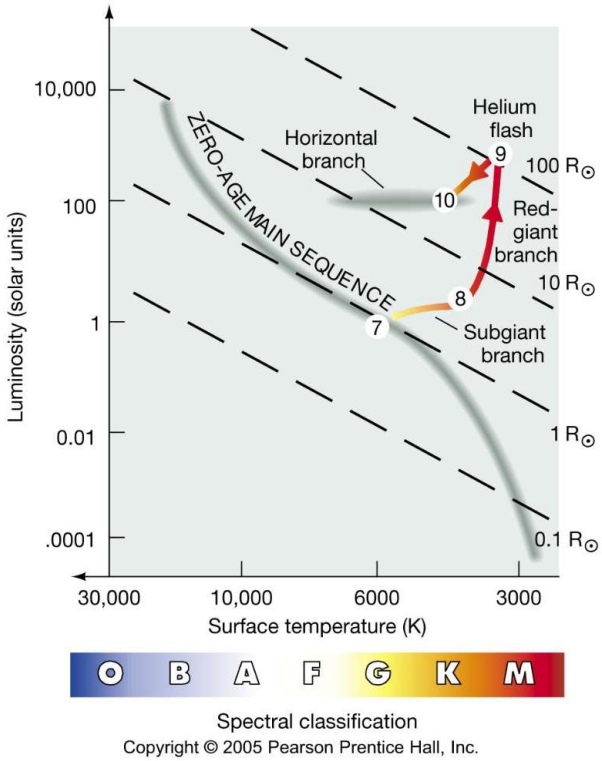


Stage 9: Red-Giant Brach – Helium Flash

- Pressure within the helium core is almost totally due to "electron degeneracy"
  - Sea of floating electrons stripped from their atoms. Pressure here is not from temperature, but floating electrons in contact with each other.
- Thus the pressure cannot adjust.
- Helium begins to fuse extremely rapidly without a means to regulate temp control.
- Helium Flash - Within hours the enormous energy output is over
- Star once again reaches equilibrium as the expansion of core results in reduction of energy output
- Luminosity decreases and it descends on to the Horizontal Branch

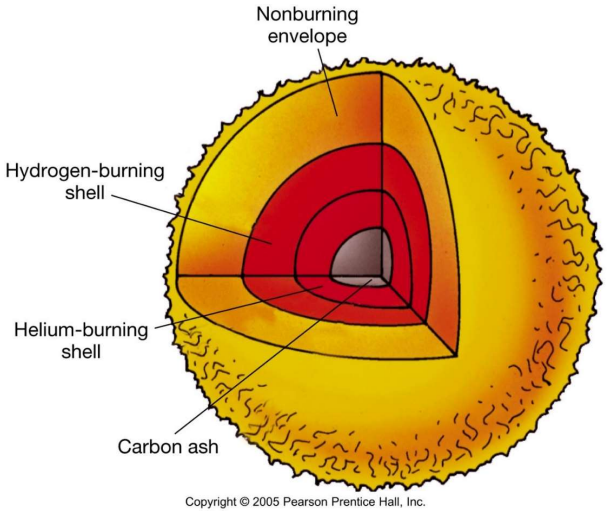
Stage 10: Helium Fusion & Horizontal Branch

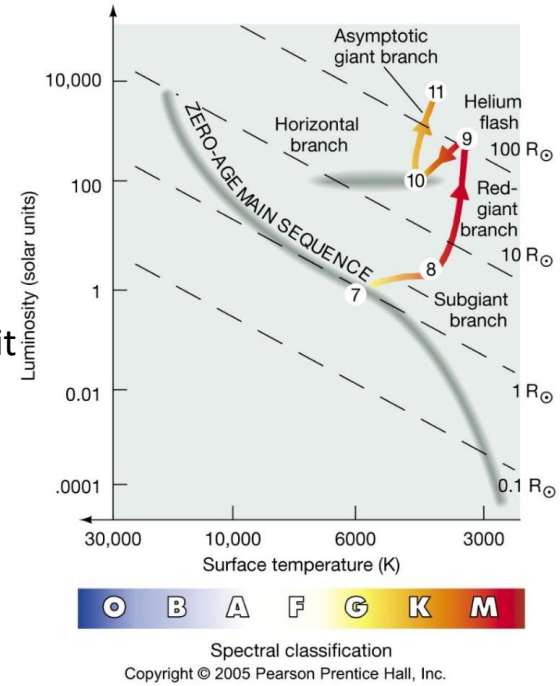
- Helium to Carbon fusion begins
- Temperature of star rapidly increases
- Ideal Gas Law properties resume: Heating=‘s Expansion



Stage 11: Asymptotic Giant Branch

- Helium fusion is rapid
- The familiar cycle starts again:
  - Fusion, Temperature increase, causes stellar expansion
  - Expansion causes luminosity increase due to size increase
  - Outer shell temp drops with expansion causing slight
- Star becomes a Red Giant for the second time
- Star is now similar to its condition just as it left the main sequence, except now wit fusion shells

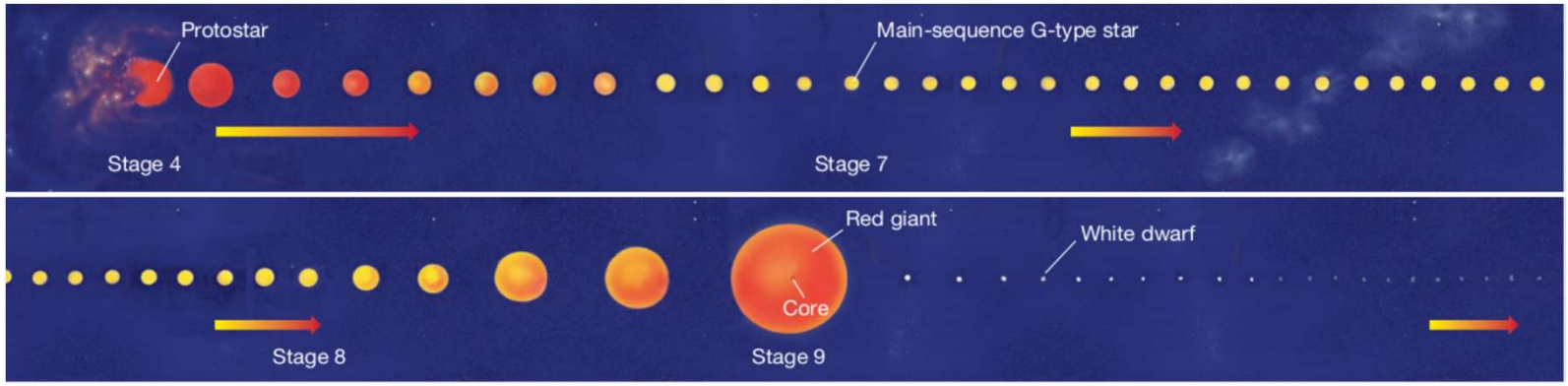


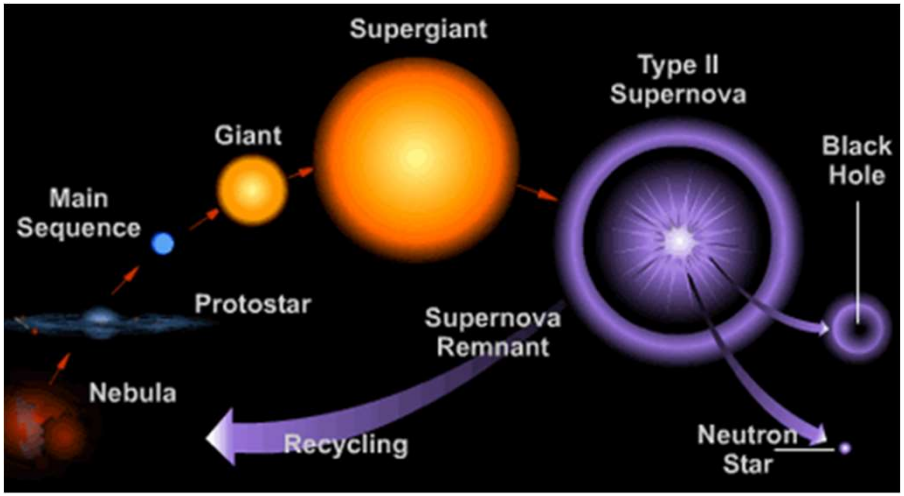


The Stellar Crossroads: It's all about MASS!!!!

HR DIAGRAM - Stellar Life After the Main Sequence

Summary & Process Review





(Image credit: Brooks/Cole Thomson Learning)

Questions?