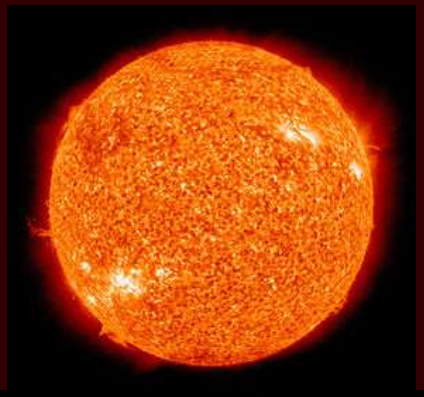
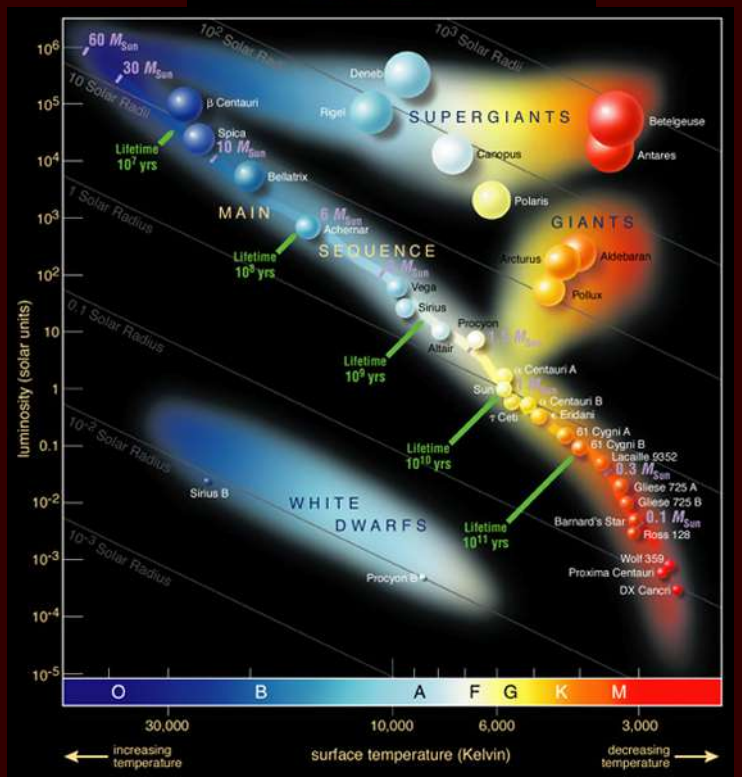
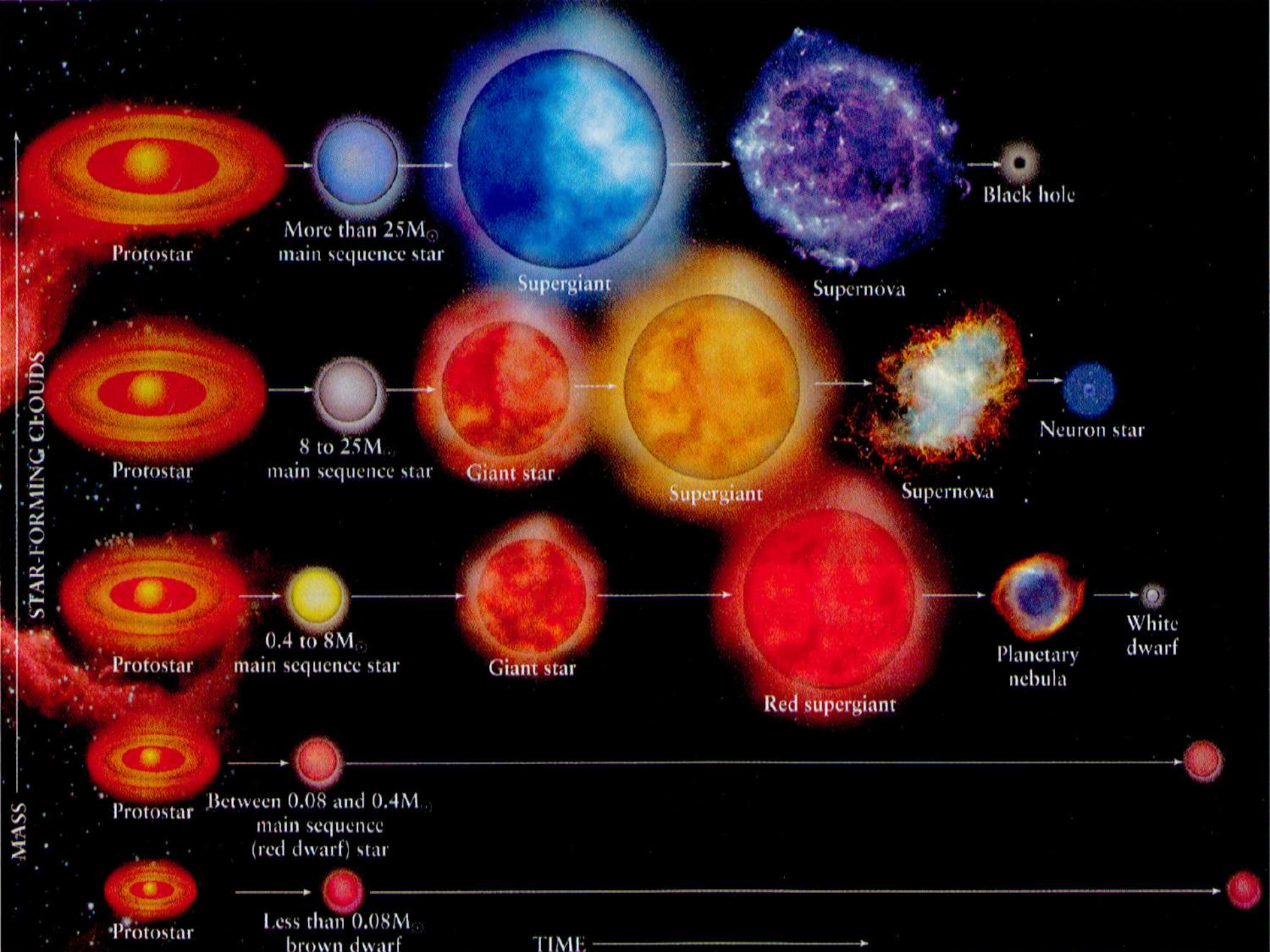
Space – The Life and Death of Stars

- A Star's beginning
  - Nebulas and Protostars
- Fusion
- Low-Mass Stars
- Intermediate-Mass Stars
  - Red Giants
- High-Mass Stars
  - Supernovas
  - Black Holes
- HR Diagram
  - Main Sequence Stars
- Inquiry Activities






STAR-FORMING CLOUDS
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More than 25M⊙ main sequence star
Supergiant
Supernova
Black hole
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White dwarf
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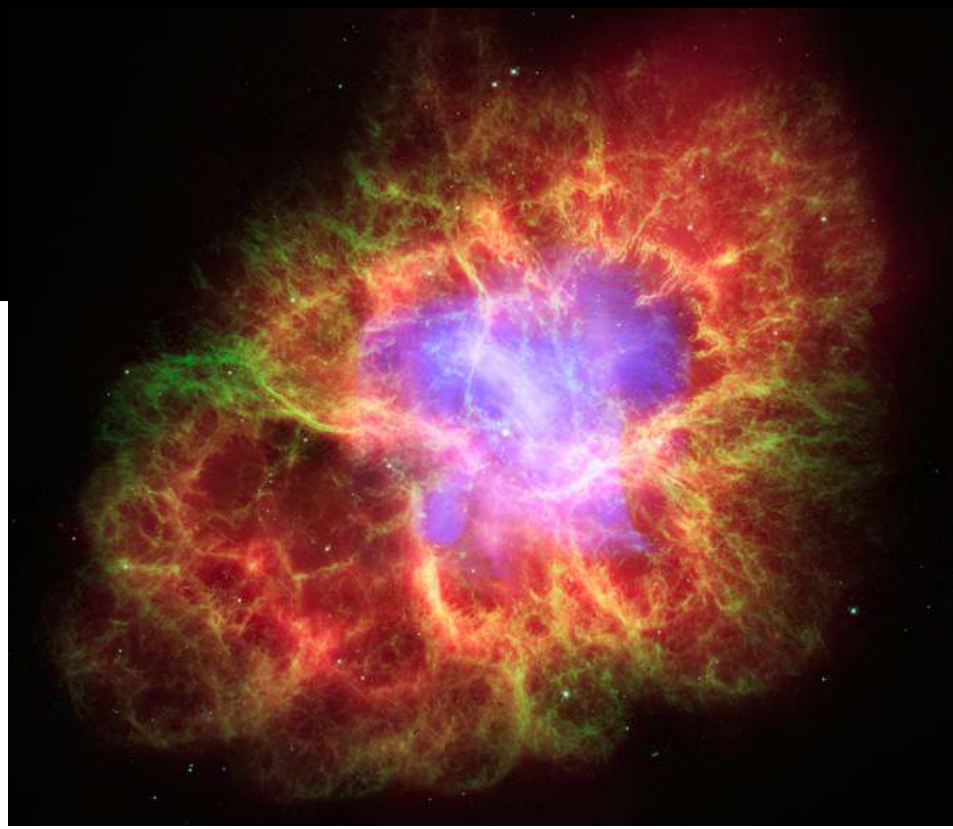
Between 0.08 and 0.4M⊙ main sequence (red dwarf) star
Protostar
Less than 0.08M⊙ brown dwarf
TIME

Stars

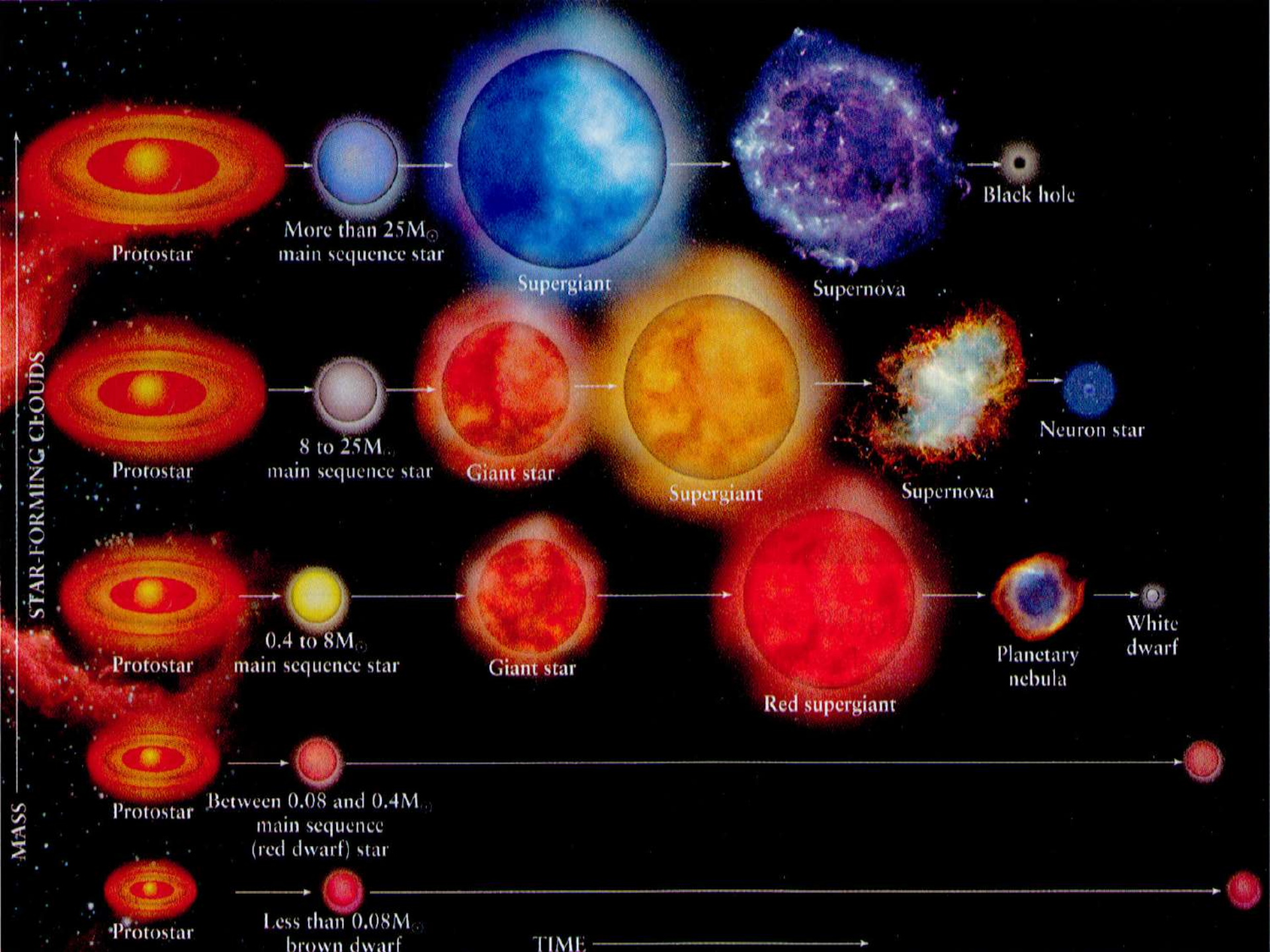
All stars begin their lives as a nebula, which are huge clouds of dust and gases, **mainly hydrogen and helium.**



- These dust clouds bump into each other and combine.
- As the clouds get bigger, their gravitational pull gets stronger and they attract more particles.
- **Once enough particles are together a protostar forms**
- **Protostars become stars and fusion begins**

Star – Life Cycle

- Fusion - combing two hydrogen atoms to form a helium atom and huge amounts of energy
- Eventually that fuel runs out and the star becomes either a Brown, Red or White Dwarf, A Neutron Star or a Black hole
- **What the Star becomes depends on its initial mass**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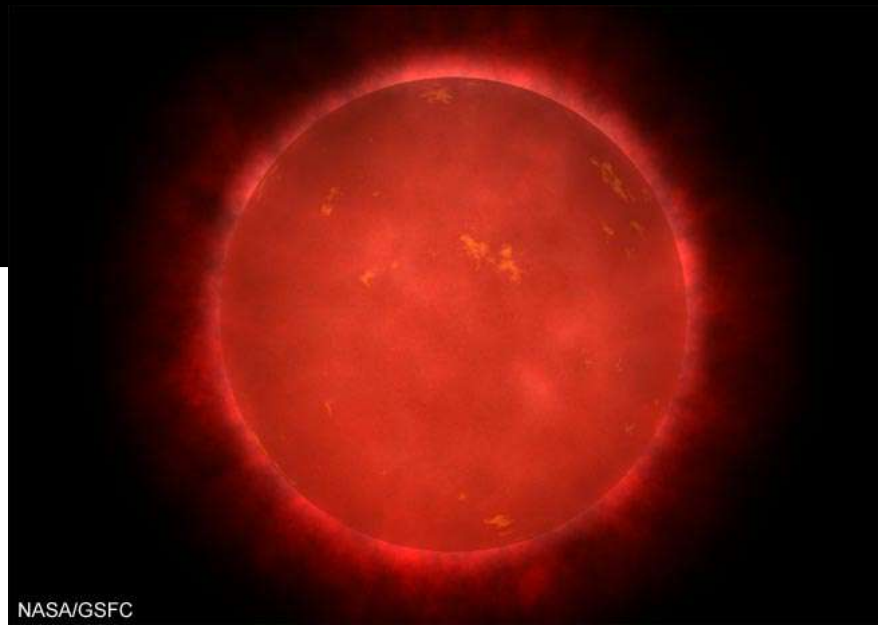
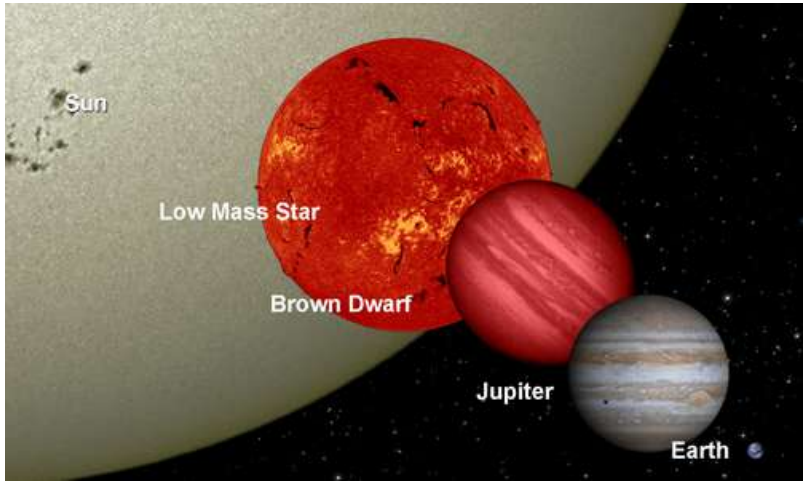
Low-Mass Stars

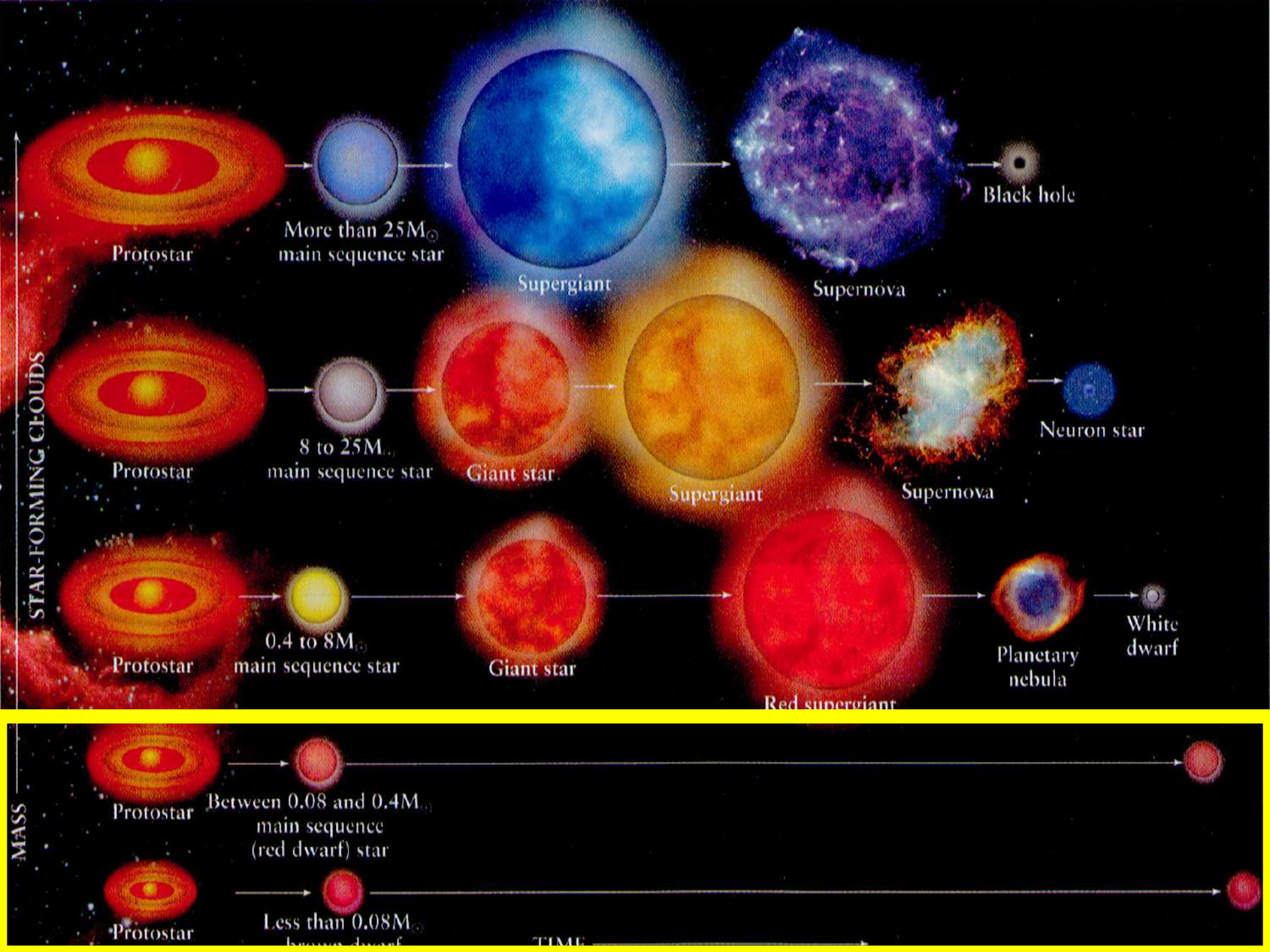


- Brown and Red Dwarfs – **less mass than our Sun (between 8-40% our Sun's mass)**

- Use fuel slowly - Last for 100 billion years

- Nothing spectacular about these guys!

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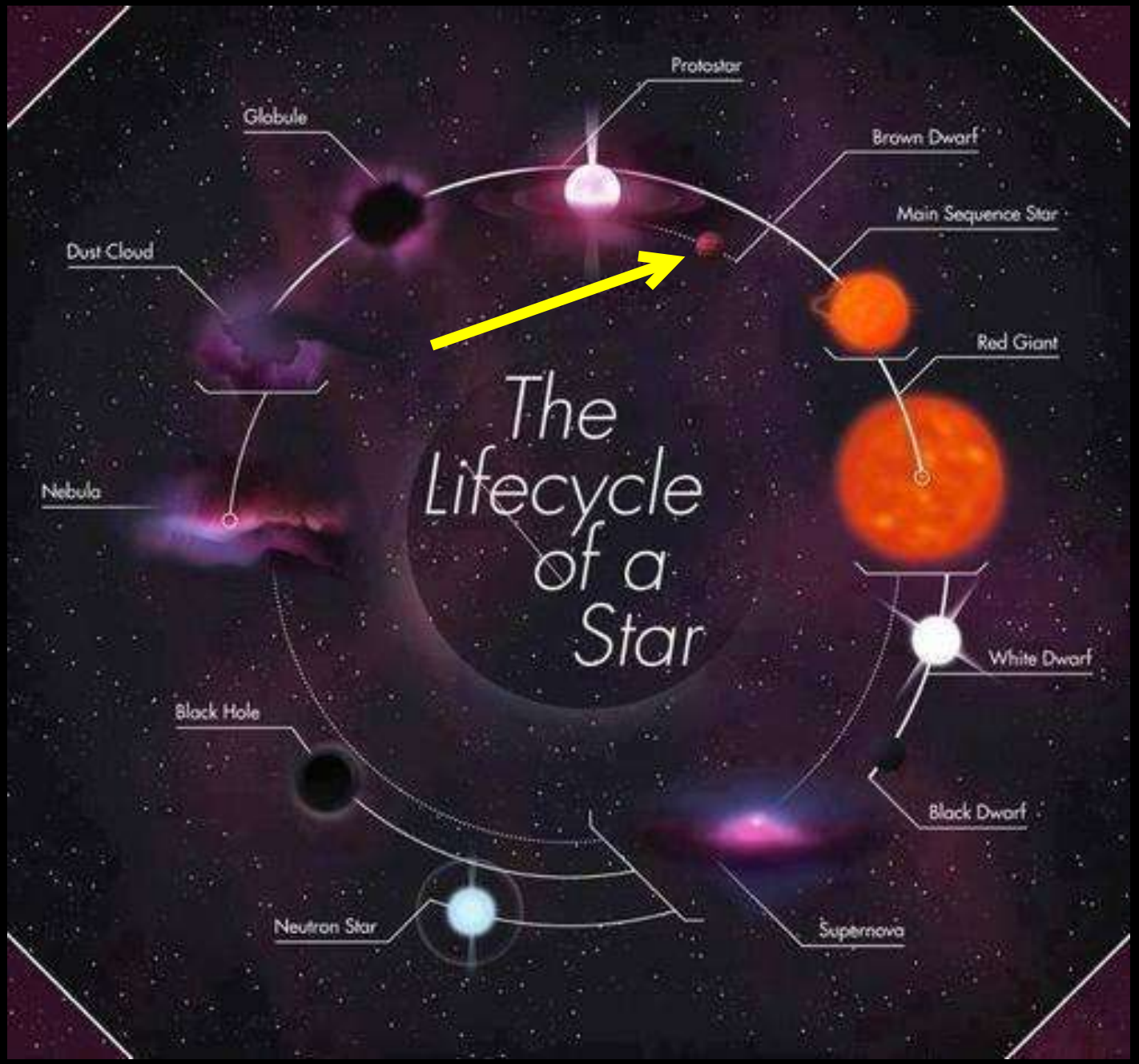
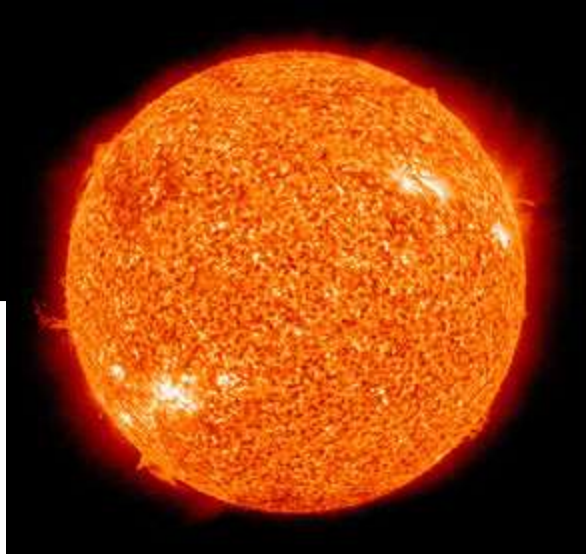
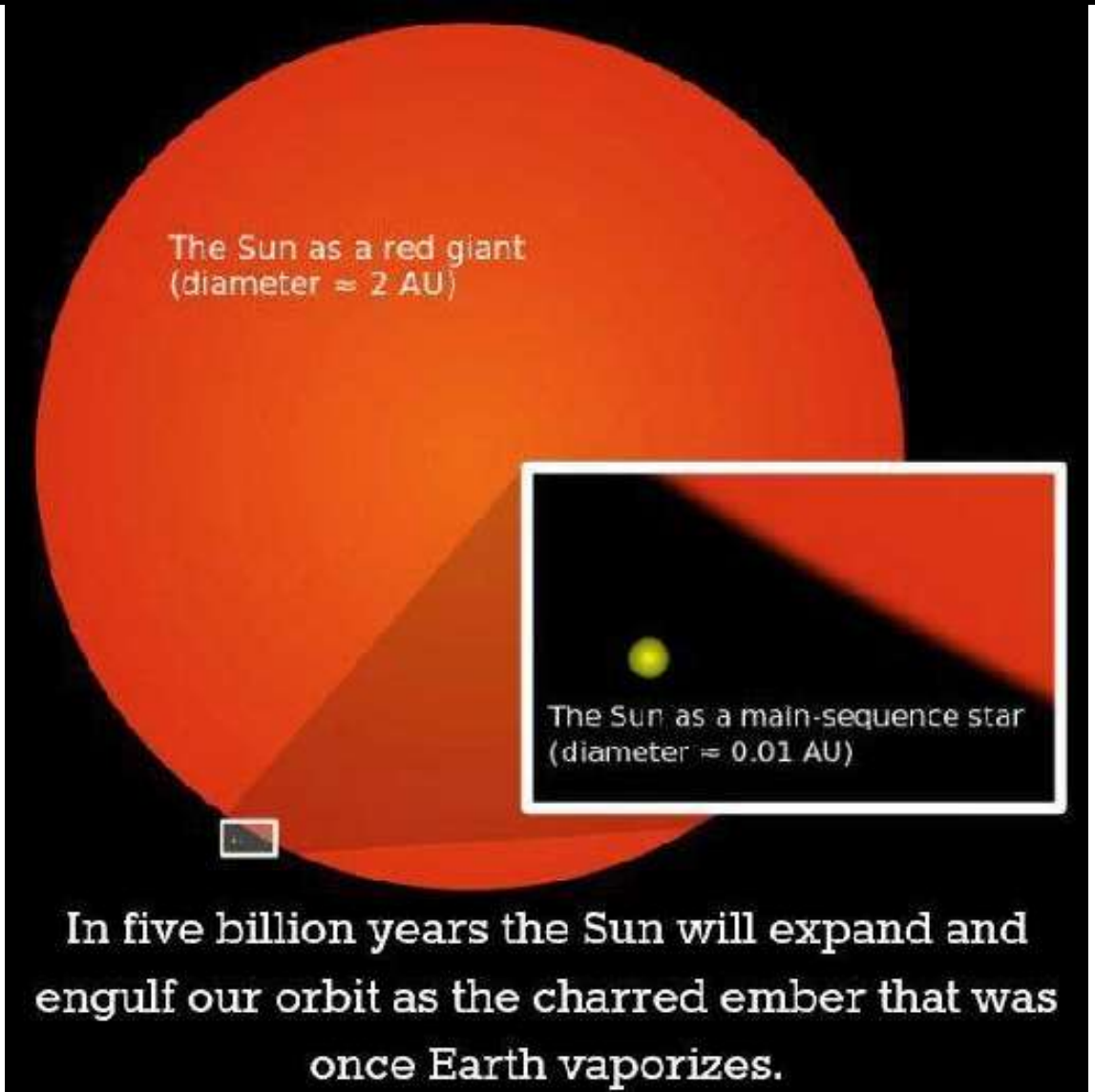

Protostar
Globule
Brown Dwarf
Main Sequence Star
Dust Cloud
Red Giant
The Lifecycle of a Star
Nebula
White Dwarf
Black Hole
Black Dwarf
Neutron Star
Supernova

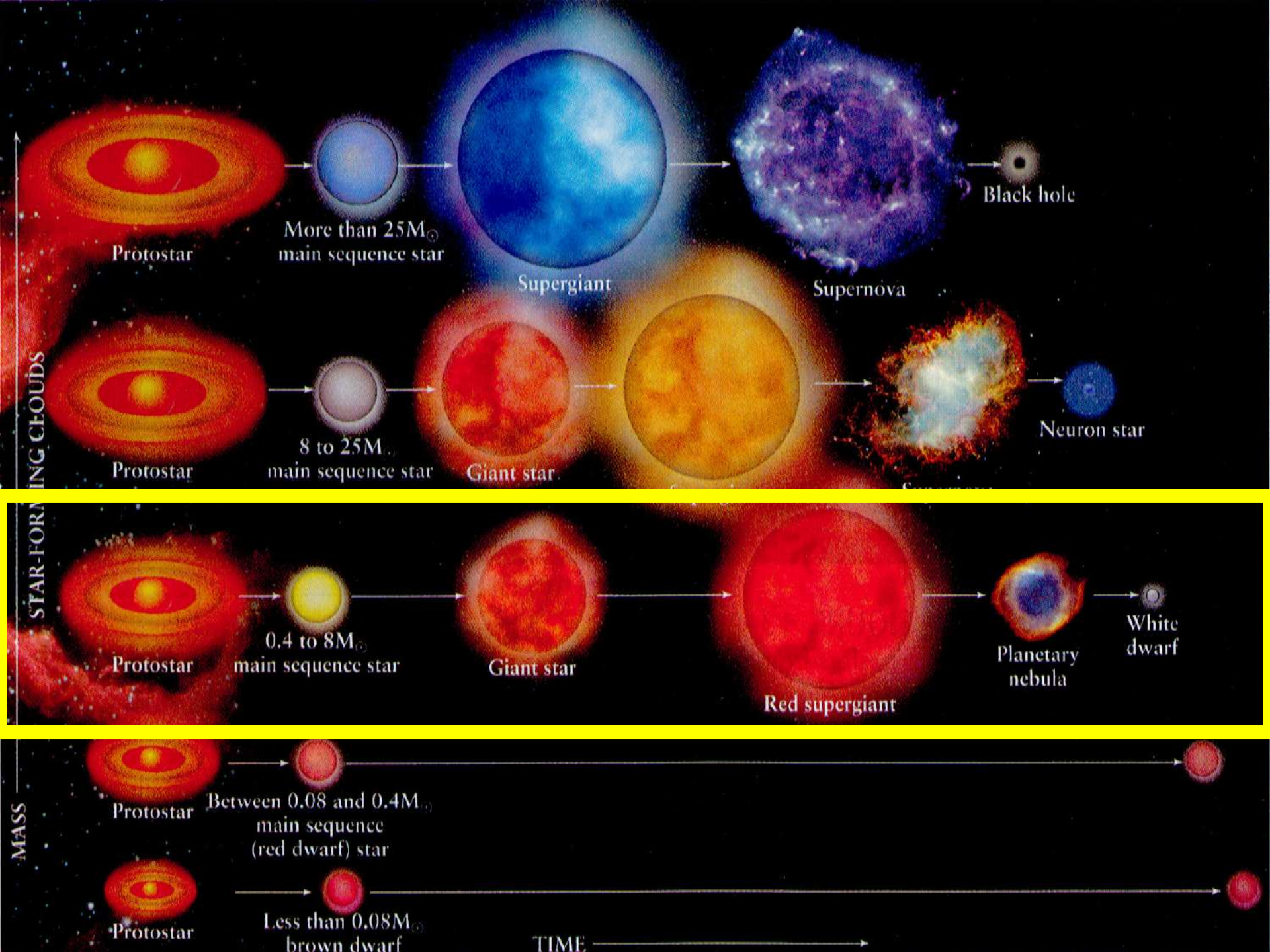
Intermediate-Mass Stars



- Like our Sun (40-800% it's mass)
- **Last about 10 billion years**
- Core collapses when hydrogen is used up which causes their outer layer to expand
  - Called a Red Giant or Red Supergiant
- Our Sun will become one in about 5 billion years and its outer diameter will extend to Mars
- Eventually outer layers disappear and it becomes a White Dwarf

A Red Giant


The Sun as a red giant
(diameter ≈ 2 AU)
The Sun as a main-sequence star
(diameter ≈ 0.01 AU)
In five billion years the Sun will expand and engulf our orbit as the charred ember that was once Earth vaporizes.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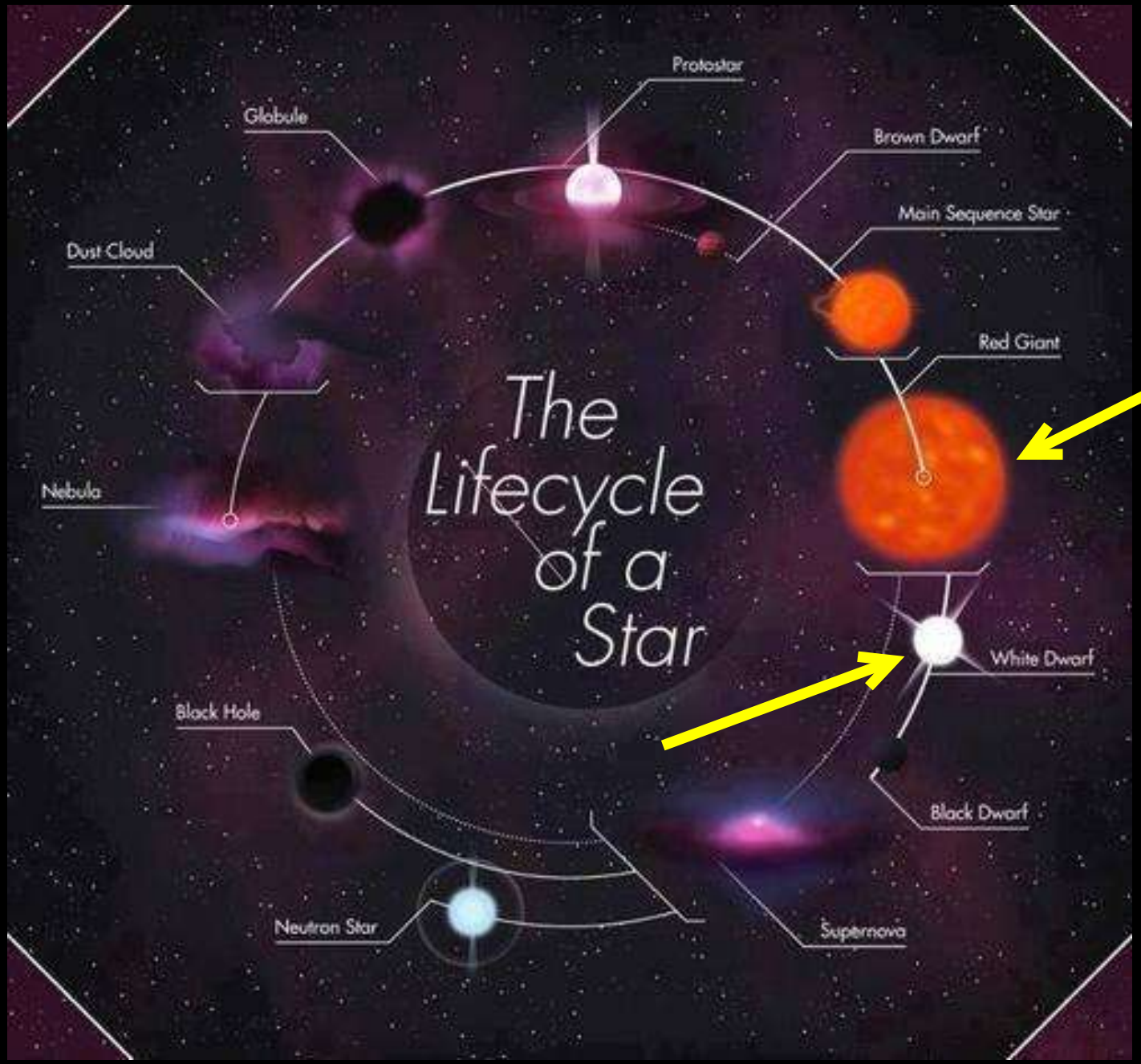
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High-Mass Stars

Play Video

When Stars Go Boom!

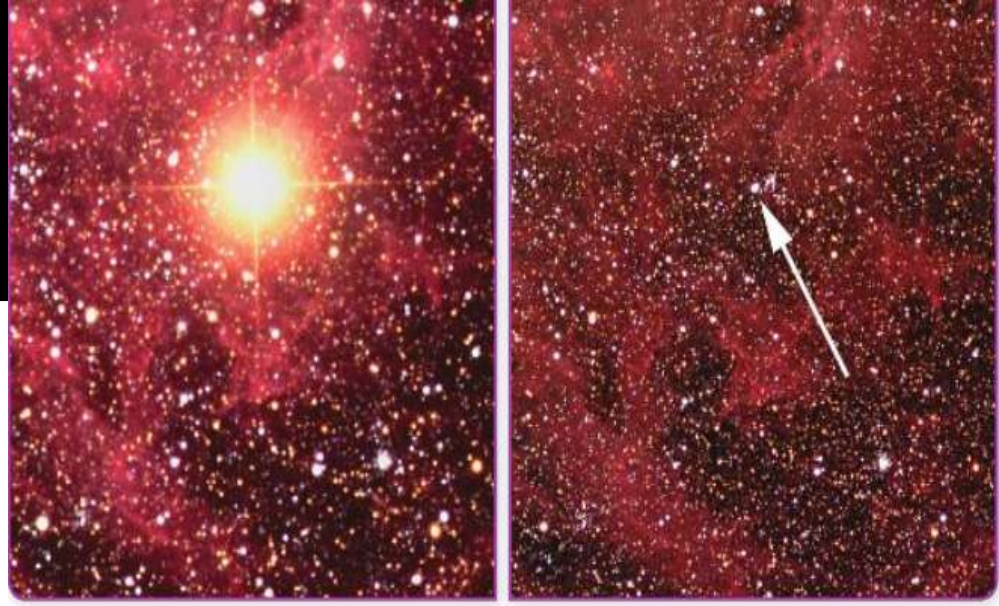
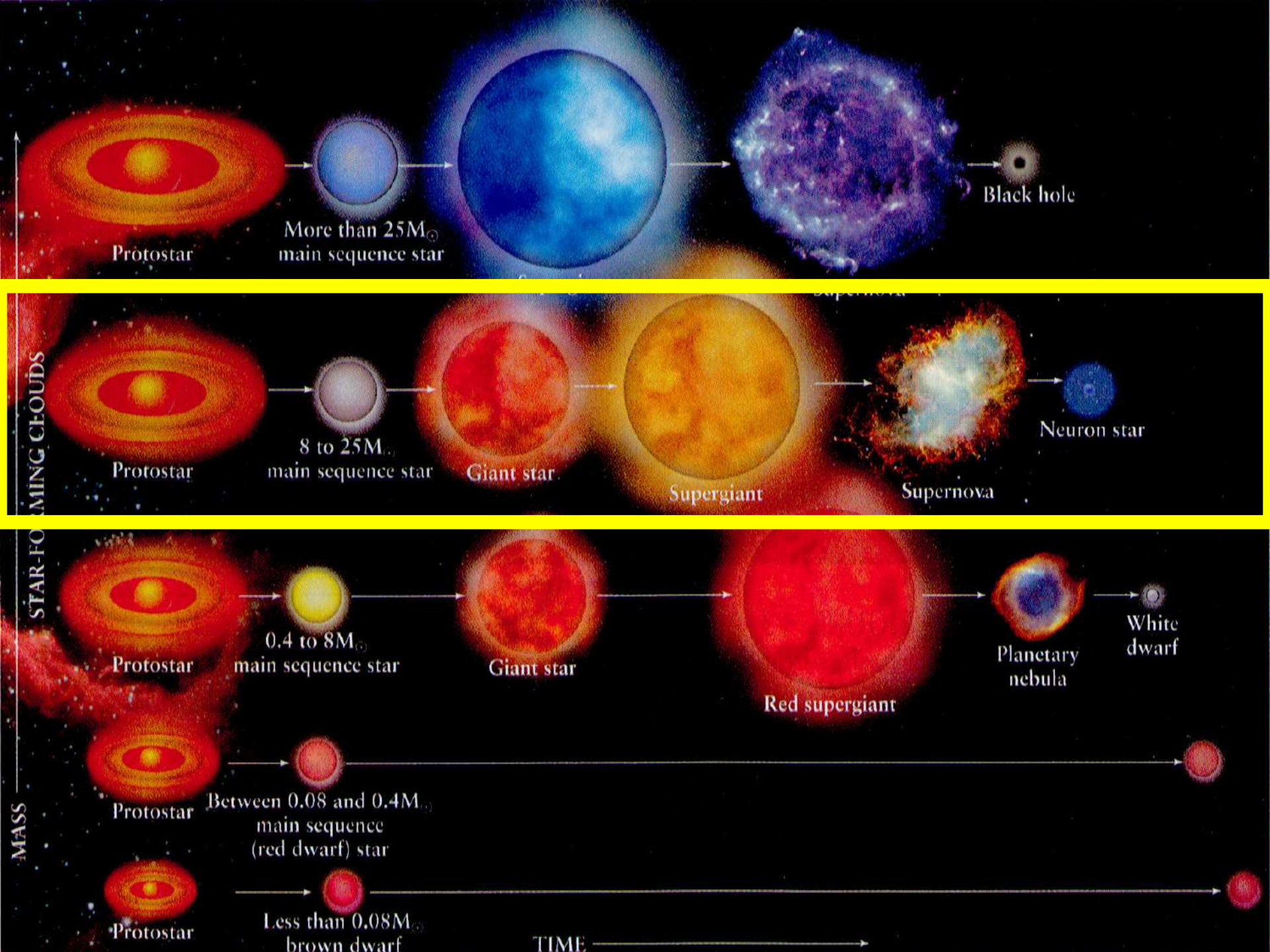


Figure 8.30 The image on the left shows the supernova discovered by Ian Shelton. The image on the right shows the same area before the supernova.

- 8-25X larger than our Sun
- Consume their fuel very fast – die more quickly and more violently
- **Star explodes creating a Supernova followed by a Neutron Star**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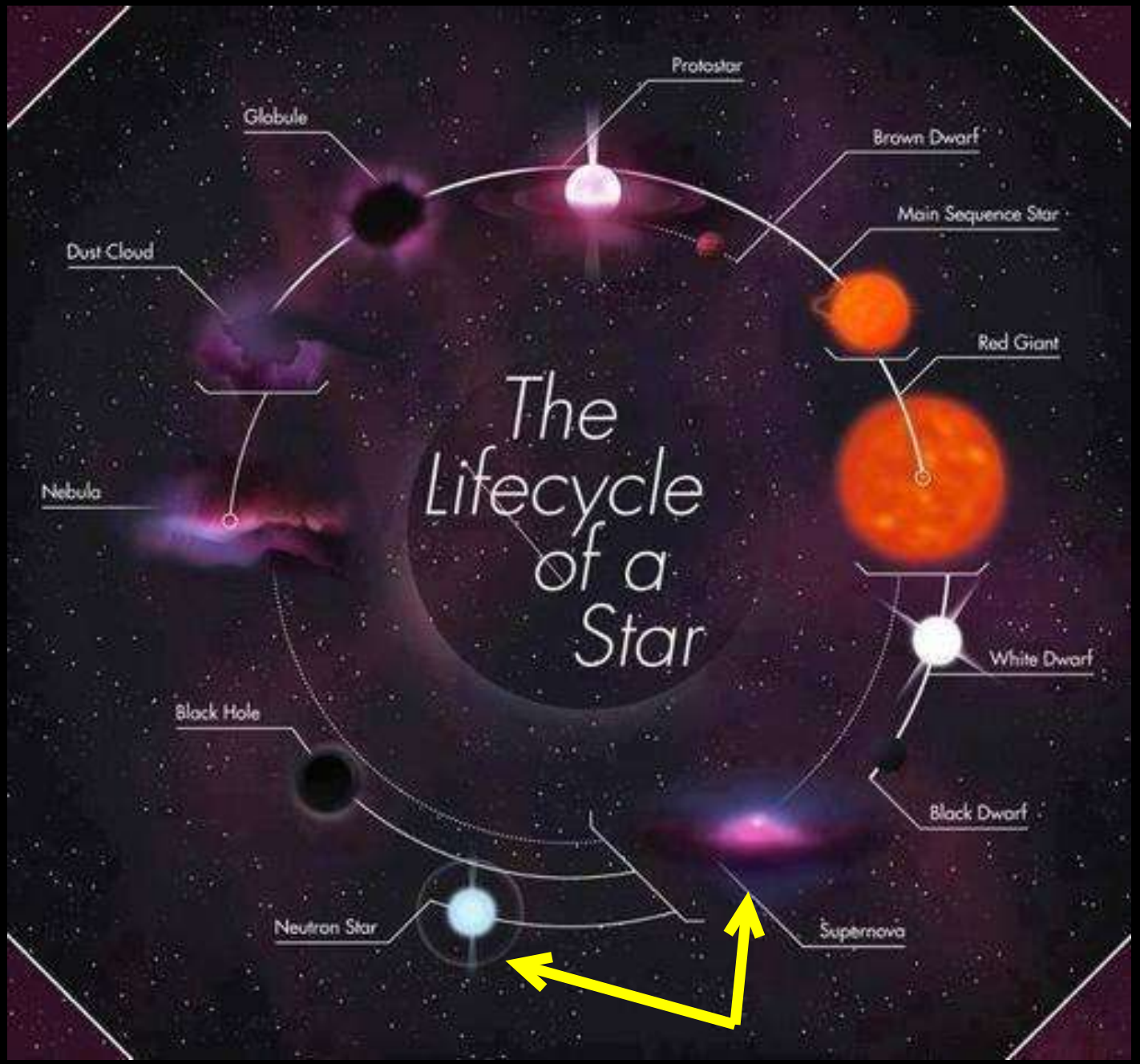
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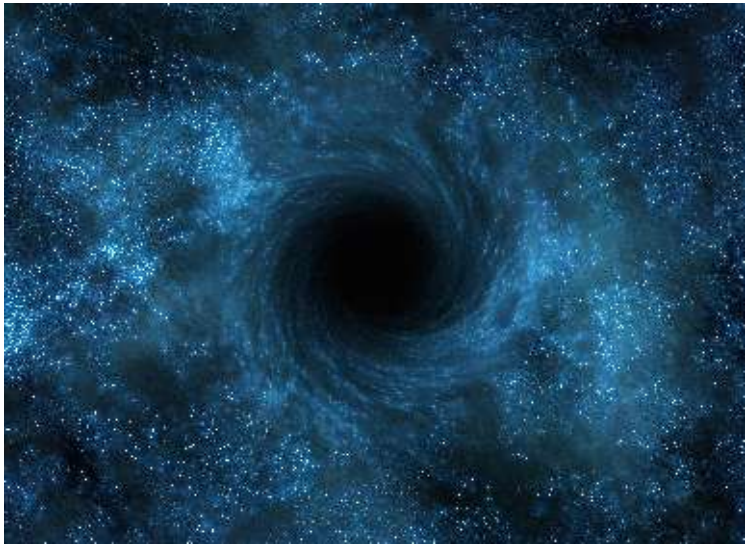
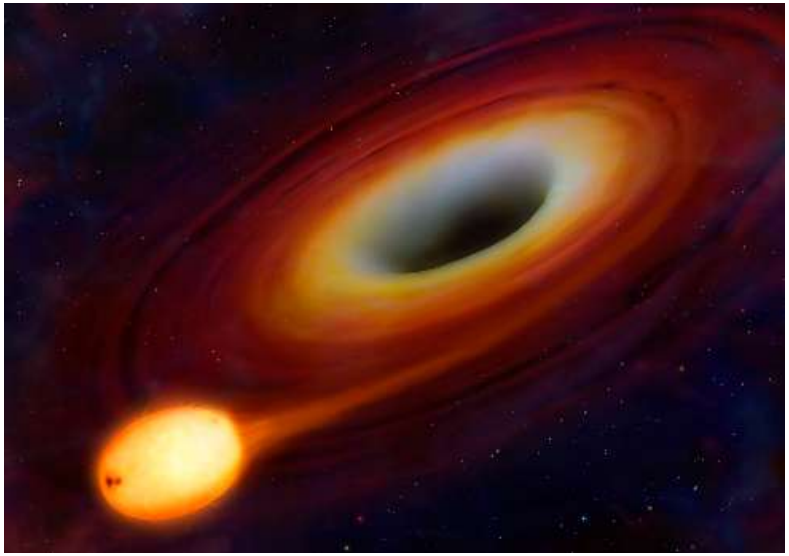
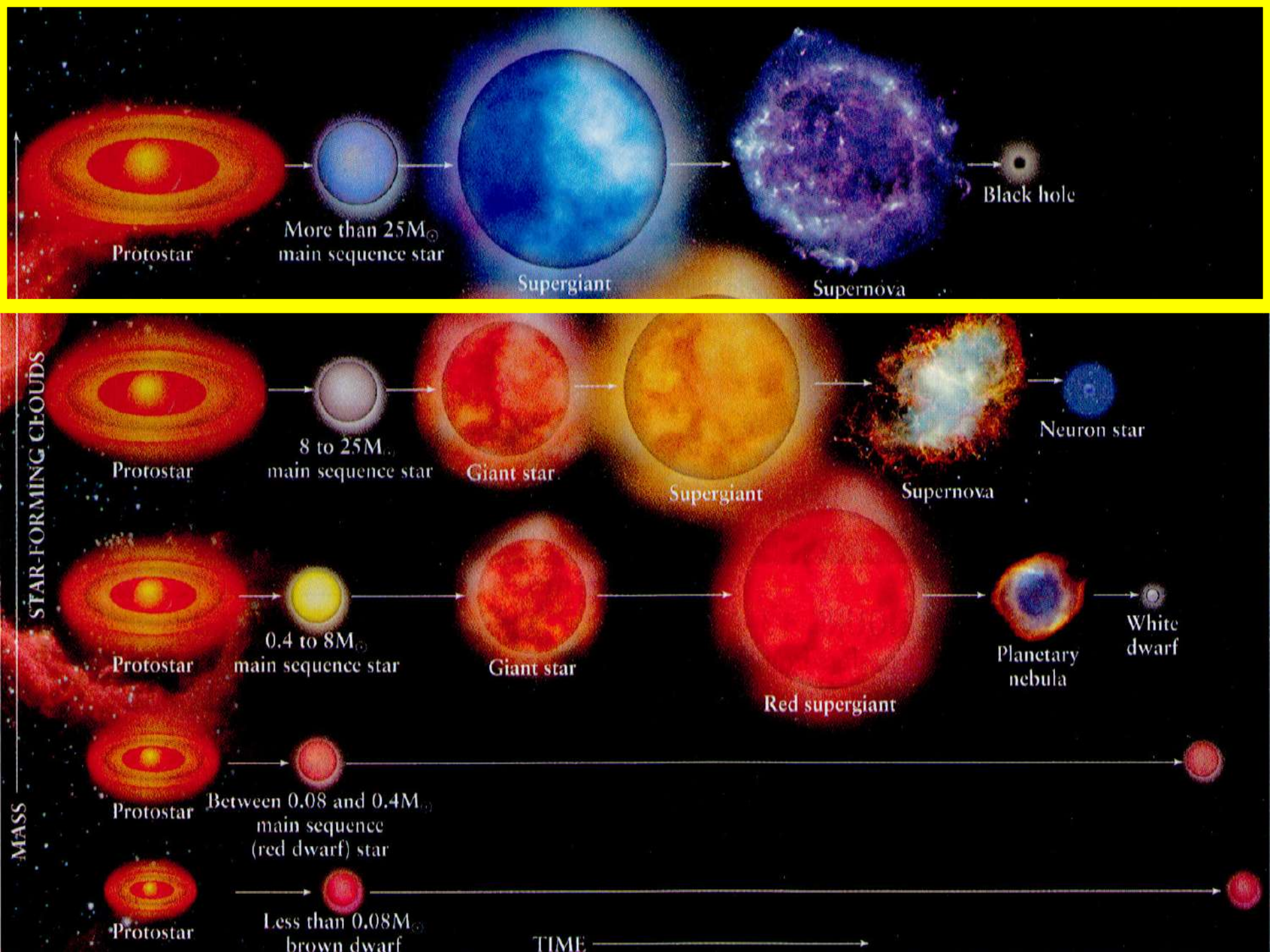
Black Holes

- **<u>Can occur with stars whose masses are more than 25X of our Sun</u>**
- The remains of the supernova explosion is so large that nothing can escape due to its immense gravitational force (even light)



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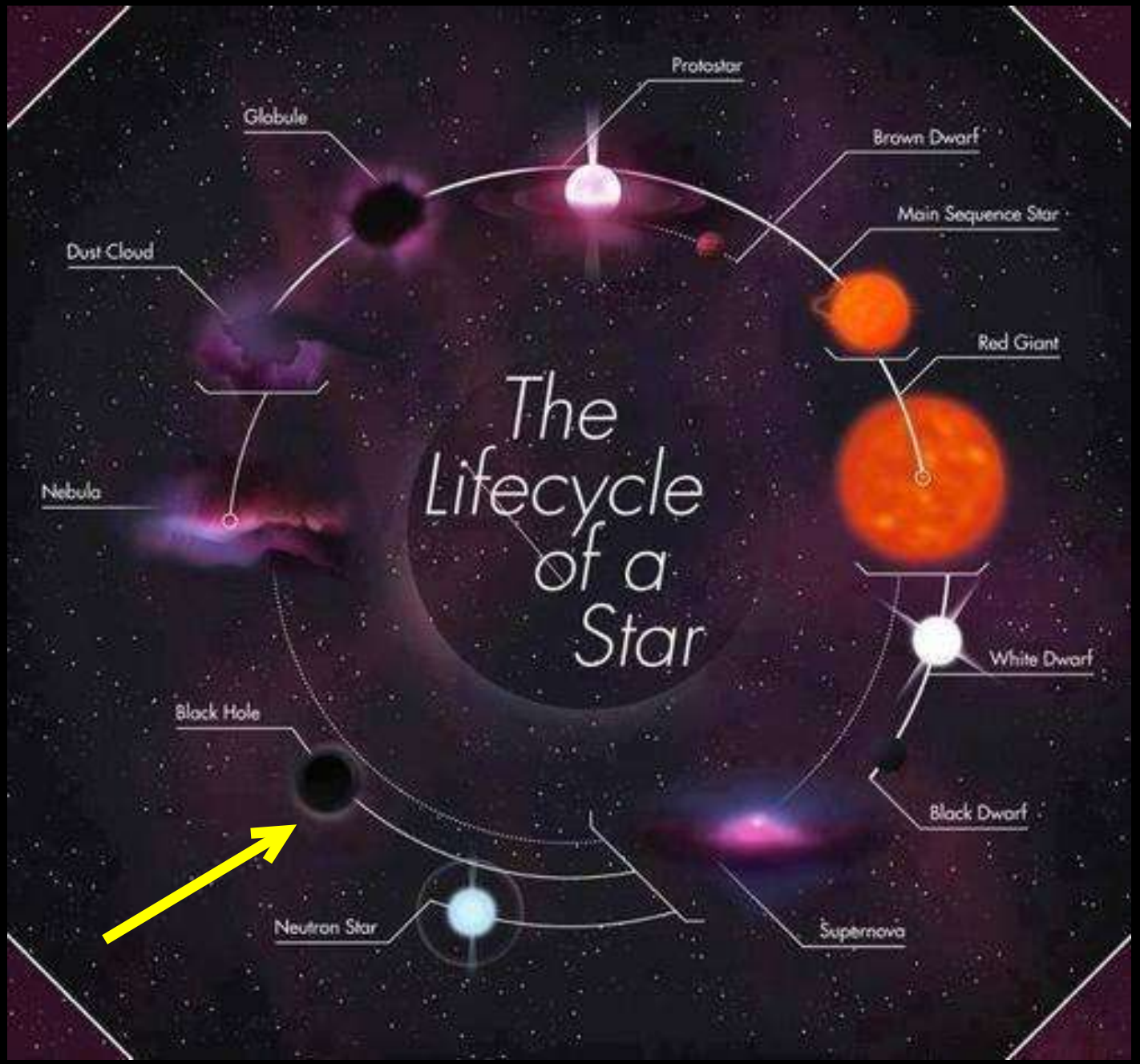
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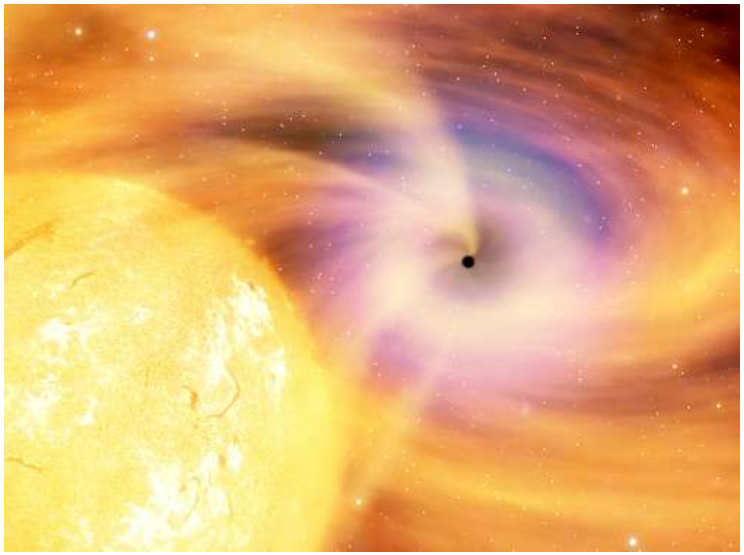
Black Holes

- We cannot "see" a Black Hole, we can only detect the gravitational effects created by one
- **Their gravity is so strong that they can swallow up surrounding planets, stars and light**

Black Holes

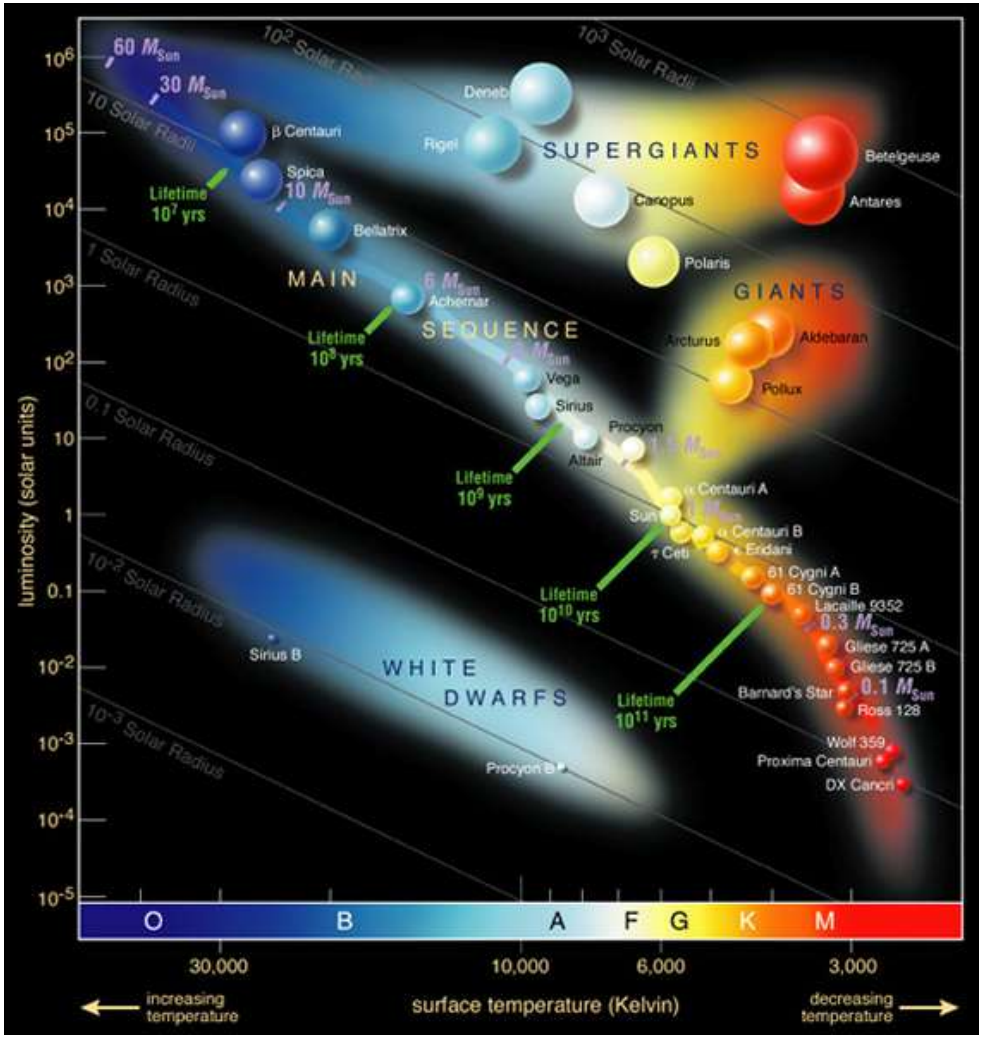


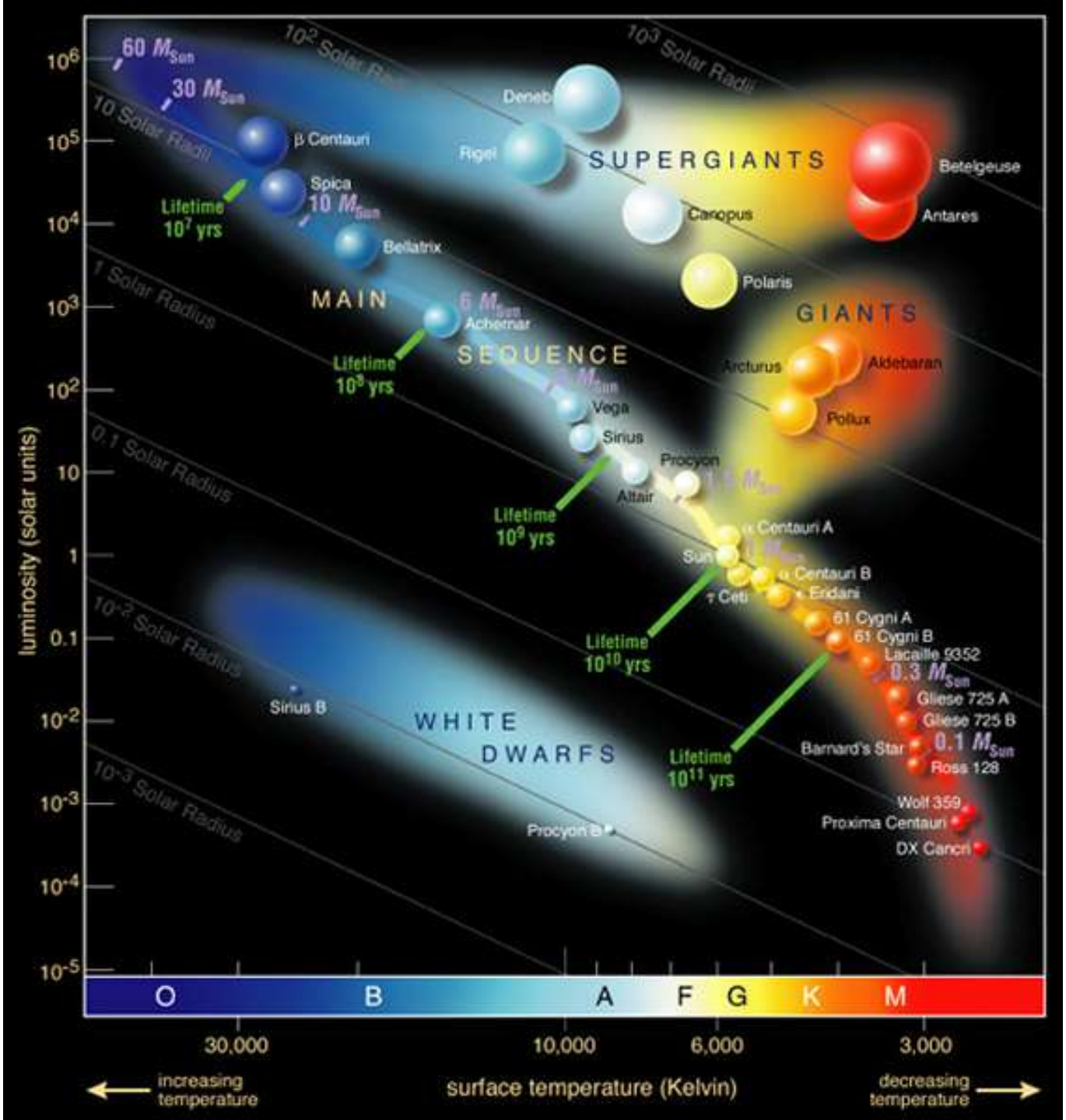
Life Cycle of Stars

Play Video

H-R Diagrams

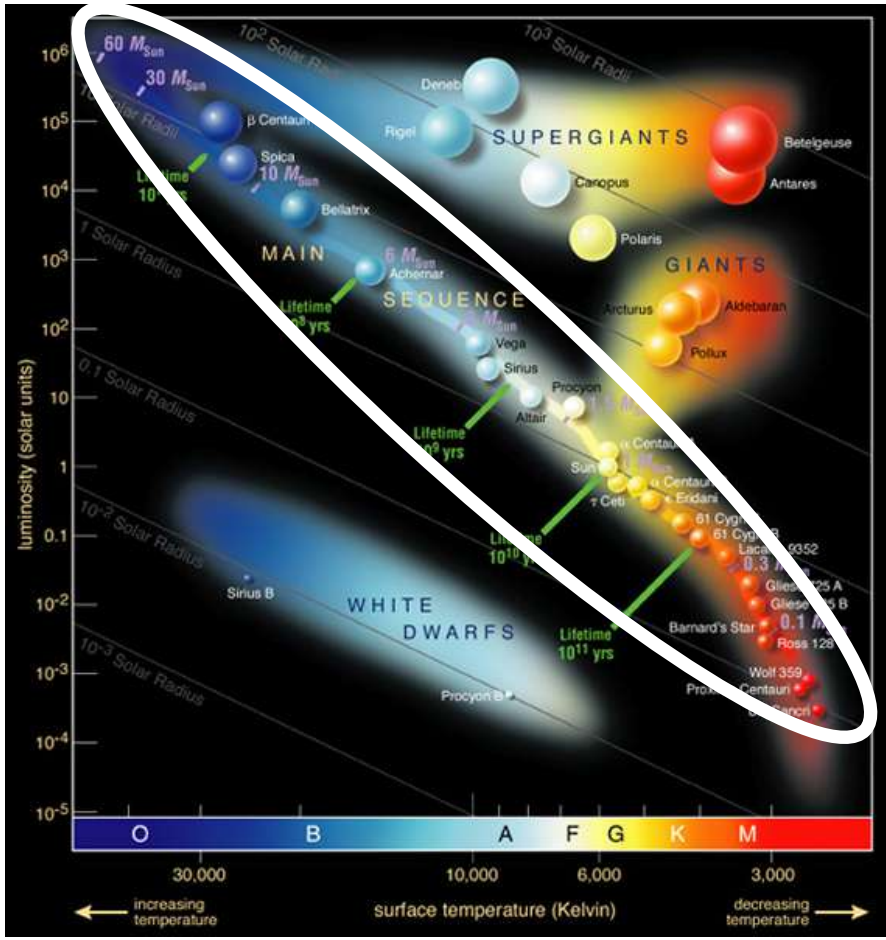
- Stars can be arranged on a chart based on their **luminosity and temperature using a Hertzsprung-Russell (H-R) diagram**




luminosity (solar units)
10^6
10^5
10^4
10^3
10^2
10
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
60 M_{Sun}
30 M_{Sun}
10^2 Solar Radii
10^3 Solar Radii
10 Solar Radii
1 Solar Radius
0.1 Solar Radius
10^{-2} Solar Radius
10^{-3} Solar Radius
Deneb
Rigel
SUPERGIANTS
Betelgeuse
Antares
Canopus
Polaris
β Centauri
Spica
10 M_{Sun}
Bellatrix
Lifetime 10^7 yrs
MAIN
6 M_{Sun}
Achernar
SEQUENCE
Lifetime 10^8 yrs
GIANTS
Arcturus
Aldebaran
Pollux
Vega
Sirius
Procyon
Altair
Lifetime 10^9 yrs
α Centauri A
Sun
α Centauri B
τ Ceti
ε Eridani
61 Cygni A
61 Cygni B
Lacaille 9352
Lifetime 10^{10} yrs
0.3 M_{Sun}
Gliese 725 A
Gliese 725 B
Barnard's Star
0.1 M_{Sun}
Ross 128
Lifetime 10^{11} yrs
Wolf 359
Proxima Centauri
DX Cancri
Sirius B
WHITE
DWARFS
Procyon B
O
B
A
F
G
K
M
30,000
10,000
6,000
3,000
increasing temperature
surface temperature (Kelvin)
decreasing temperature

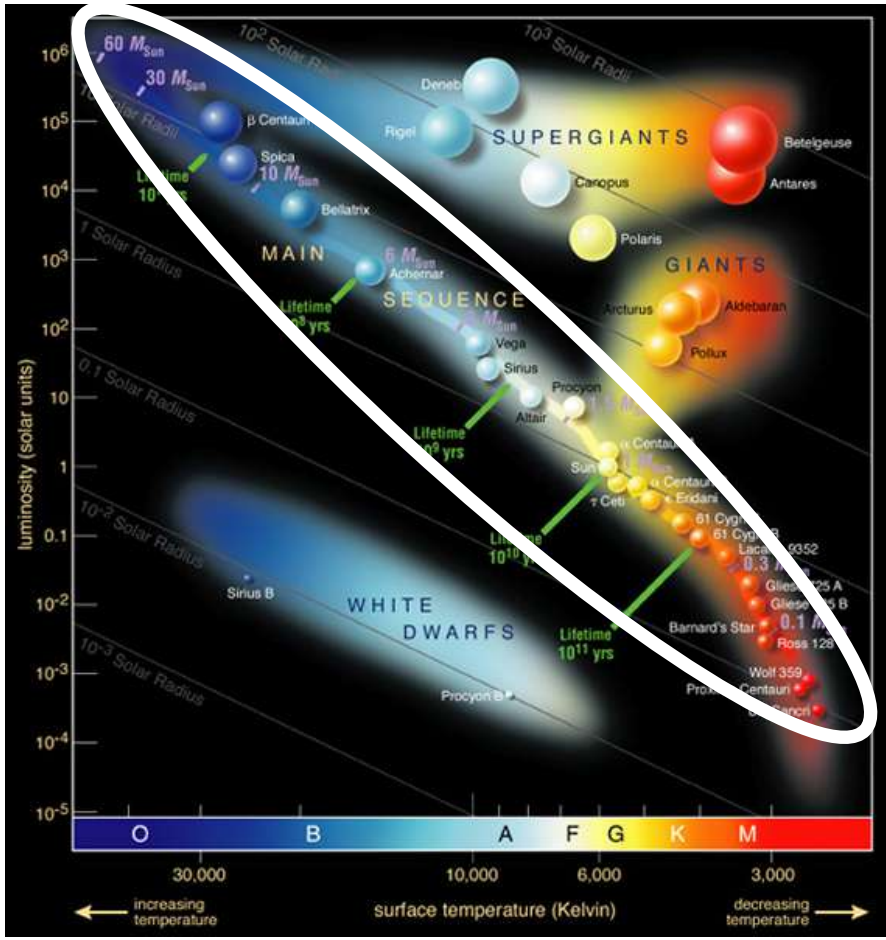
H-R Diagrams

- About 90% of stars are located on the Main Sequence
- Main Sequence stars form helium from hydrogen atoms in their cores

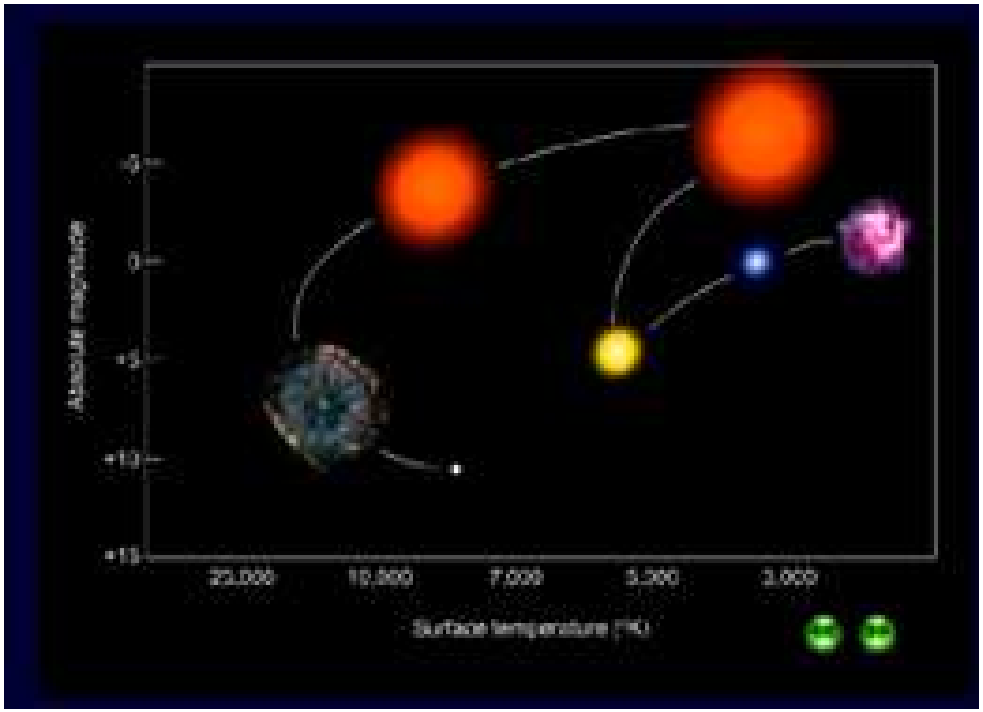


H-R Diagrams

- Main Sequence Lifetime depends on size - Larger stars burn their fuel faster and therefore, **spend less time on the Main Sequence compared with lower mass stars**

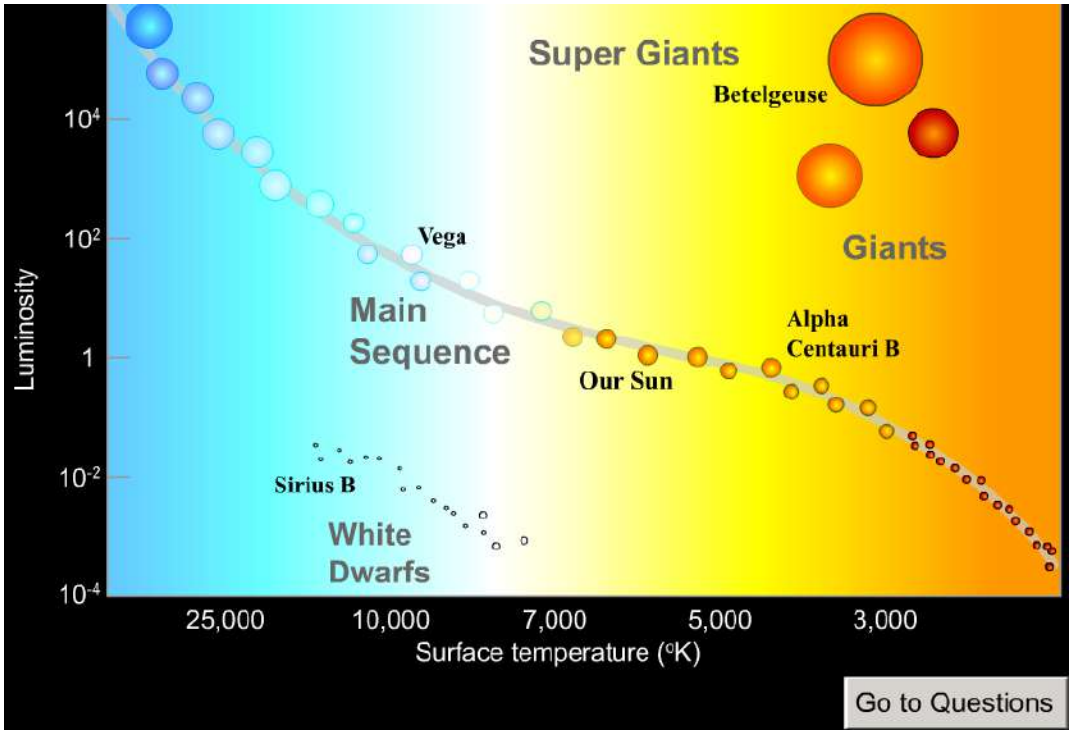


Tracking the life of a star - Animation



- Click the picture to access

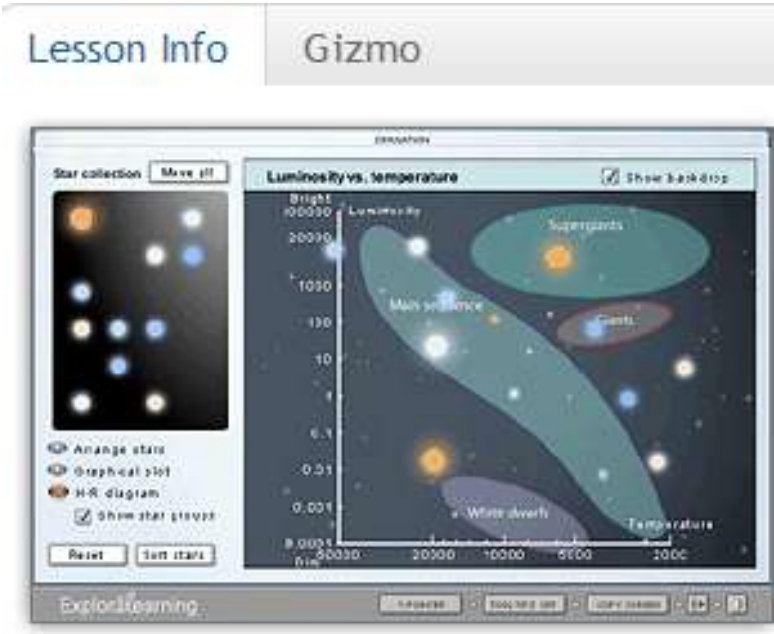
The Life and Death of Star – Review Challenge



Click the image – take the challenge

Inquiry Activities

- Please complete the following Explore Learning Gizmo. The guided worksheet can be found on the simulation access page



- Click here for an engaging HR Diagram Lab