

Unit 103

Stellar Evolution: Star's Life Cycle

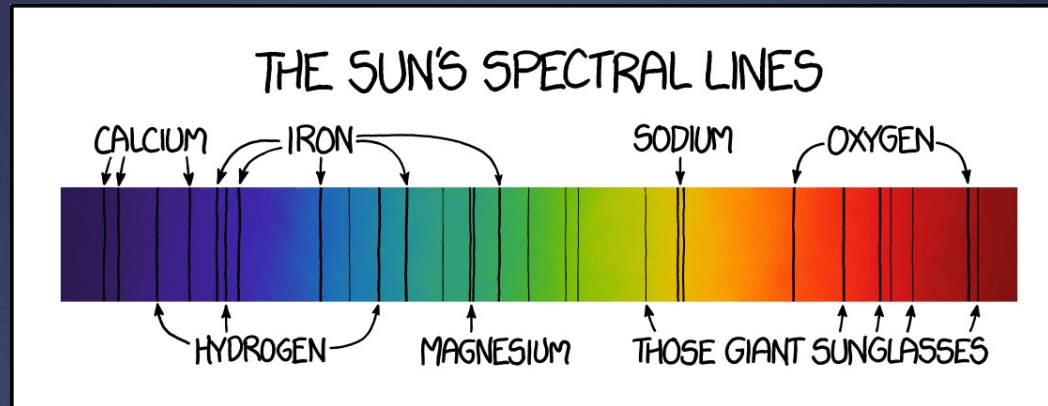
Goal:

- ▶ Create a diagram to help you understand how Stars lives lead to elements we have on Earth.

Brain Starter:

- ▶ How do we know what's in a Star?

How do we know what's in a Star?



Electromagnetic emission and absorption spectra are used to determine:

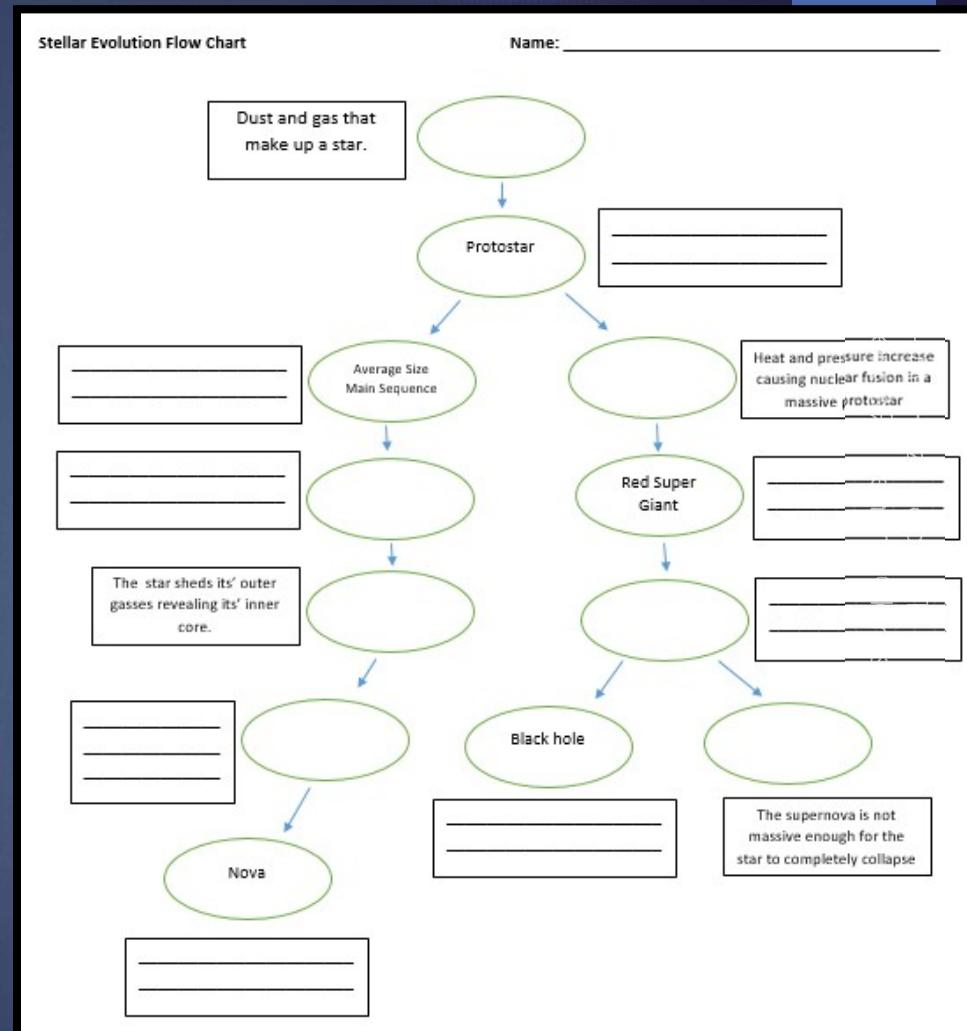
- a star's composition and,
- motion and distance (Doppler & Hubble)

Stellar Evolution Flow Chart

- Fill out digital version

OR

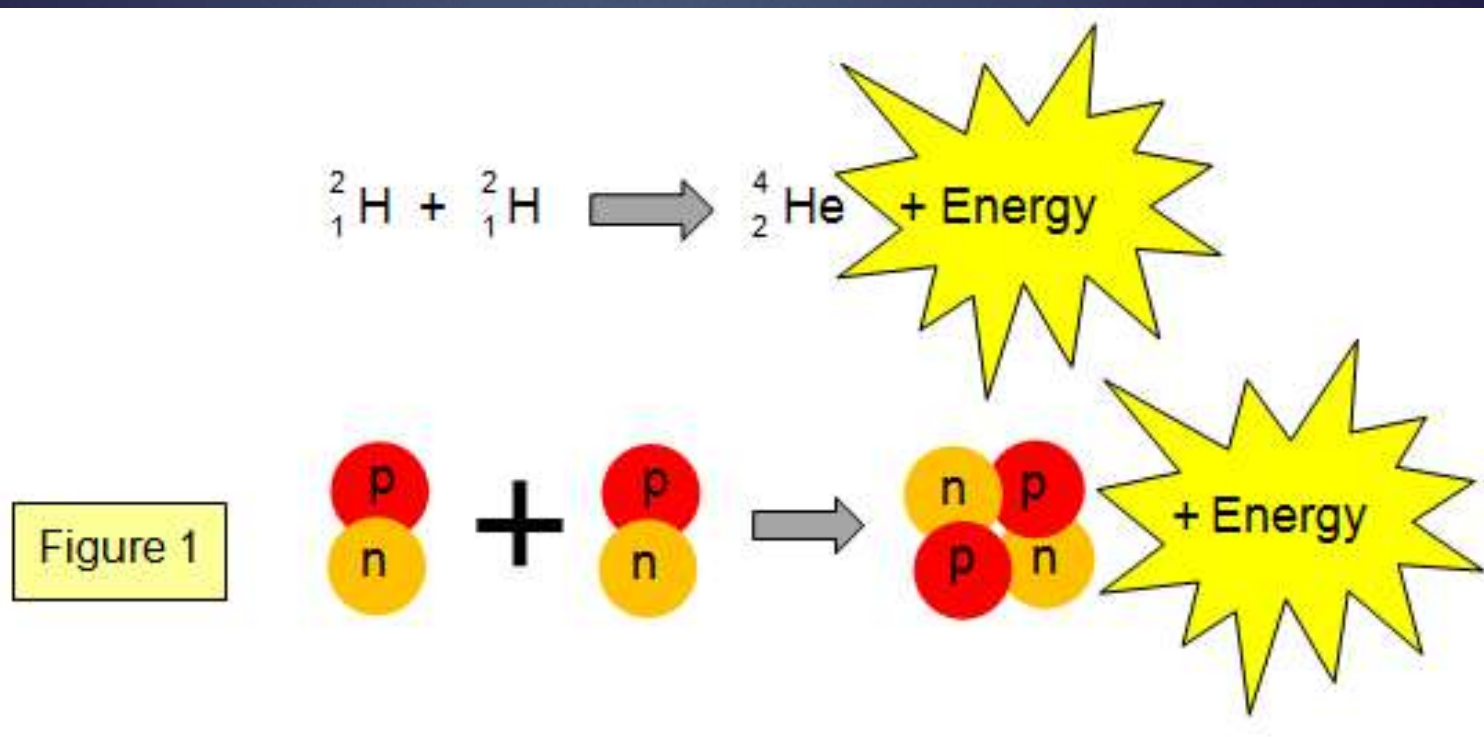
- Create your own to match the slides and your note-taking style



So, what is a star?

- ▶ A hot ball of gas
- ▶ Hydrogen fusing into helium at its core.
- ▶ Hydrogen gone?
 - ▶ Fuse helium
 - ▶ Make carbon, oxygen, iron and nickel.
- ▶ Battle between gravity and gas pressure
 - ▶ Known as equilibrium
 - ▶ Crucial to understand how stars live and die.

Hydrogen fusion





nu·cle·o·syn·the·sis

/ˌn(y)ōōklēōˈsɪnTHəsəs/

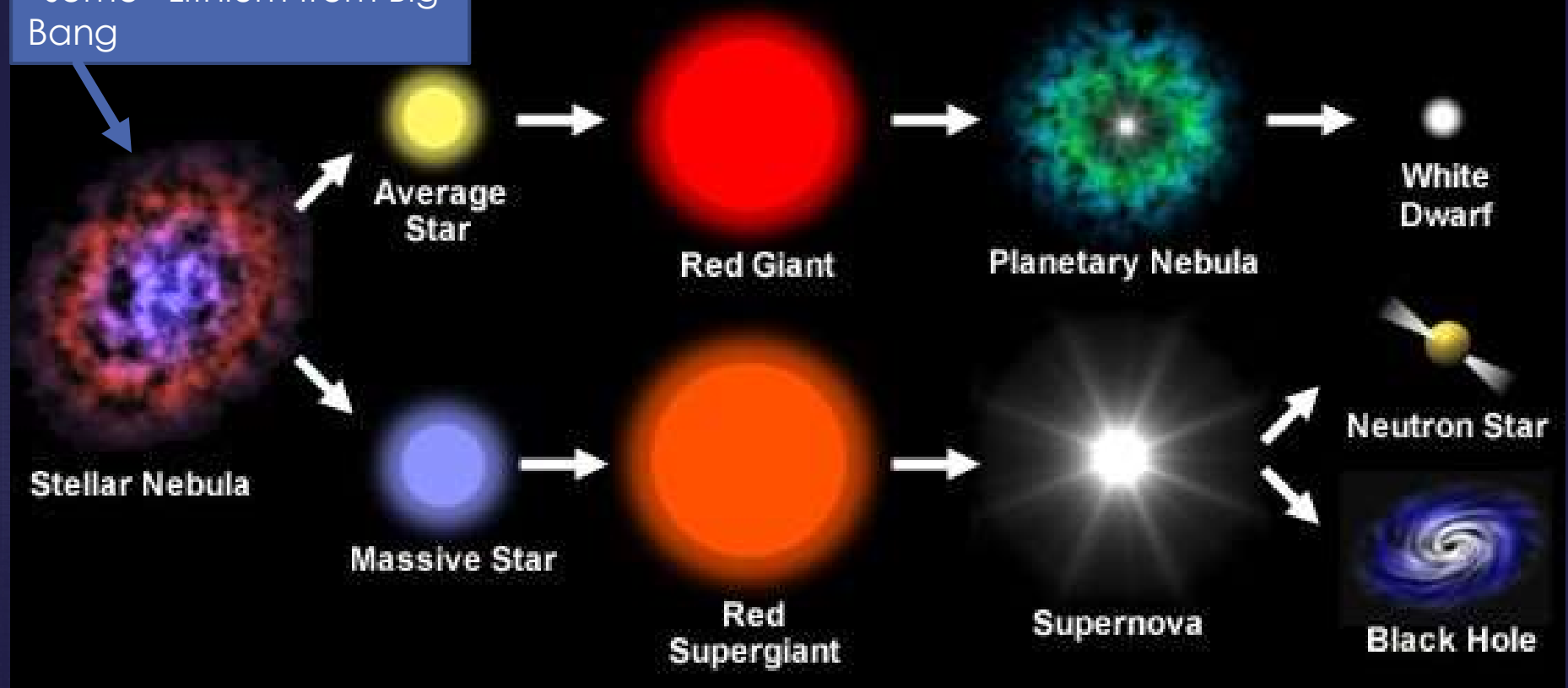
noun **ASTRONOMY**

the cosmic formation of atoms more complex than the hydrogen atom.

<div><div><div><div>Big Bang fusion</div><div>Cosmic ray fission</div></div><div><div>Dying low-mass stars</div><div>Merging neutron stars</div></div><div><div>Exploding massive stars</div><div>Exploding white dwarfs</div></div><div><div>Human synthesis No stable isotopes</div></div></div></div>																<div>He 2</div>					
<div>H 1</div>	<div>Li 3</div>	<div>Be 4</div>														<div>B 5</div>	<div>C 6</div>	<div>N 7</div>	<div>O 8</div>	<div>F 9</div>	<div>Ne 10</div>
<div>Na 11</div>	<div>Mg 12</div>														<div>Al 13</div>	<div>Si 14</div>	<div>P 15</div>	<div>S 16</div>	<div>Cl 17</div>	<div>Ar 18</div>	
<div>K 19</div>	<div>Ca 20</div>	<div>Sc 21</div>	<div>Ti 22</div>	<div>V 23</div>	<div>Cr 24</div>	<div>Mn 25</div>	<div>Fe 26</div>	<div>Co 27</div>	<div>Ni 28</div>	<div>Cu 29</div>	<div>Zn 30</div>	<div>Ga 31</div>	<div>Ge 32</div>	<div>As 33</div>	<div>Se 34</div>	<div>Br 35</div>	<div>Kr 36</div>				
<div>Rb 37</div>	<div>Sr 38</div>	<div>Y 39</div>	<div>Zr 40</div>	<div>Nb 41</div>	<div>Mo 42</div>	<div>Tc 43</div>	<div>Ru 44</div>	<div>Rh 45</div>	<div>Pd 46</div>	<div>Ag 47</div>	<div>Cd 48</div>	<div>In 49</div>	<div>Sn 50</div>	<div>Sb 51</div>	<div>Te 52</div>	<div>I 53</div>	<div>Xe 54</div>				
<div>Cs 55</div>	<div>Ba 56</div>	<div>○</div> <div>○</div>		<div>Hf 72</div>	<div>Ta 73</div>	<div>W 74</div>	<div>Re 75</div>	<div>Os 76</div>	<div>Ir 77</div>	<div>Pt 78</div>	<div>Au 79</div>	<div>Hg 80</div>	<div>Tl 81</div>	<div>Pb 82</div>	<div>Bi 83</div>	<div>Po 84</div>	<div>At 85</div>	<div>Rn 86</div>			
<div>Fr 87</div>	<div>Ra 88</div>			<div>La 57</div>	<div>Ce 58</div>	<div>Pr 59</div>	<div>Nd 60</div>	<div>Pm 61</div>	<div>Sm 62</div>	<div>Eu 63</div>	<div>Gd 64</div>	<div>Tb 65</div>	<div>Dy 66</div>	<div>Ho 67</div>	<div>Er 68</div>	<div>Tm 69</div>	<div>Yb 70</div>	<div>Lu 71</div>			
				<div>Ac 89</div>	<div>Th 90</div>	<div>Pa 91</div>	<div>U 92</div>	<div>Np 93</div>	<div>Pu 94</div>	<div>Am 95</div>	<div>Cm 96</div>	<div>Bk 97</div>	<div>Cf 98</div>	<div>Es 99</div>	<div>Fm 100</div>	<div>Md 101</div>	<div>No 102</div>	<div>Lr 103</div>			

Summary of a Star's "Life Cycle"

Gas and dust; Comes together by gravity
Hydrogen, Helium and
"some" Lithium from Big Bang



Stellar Evolution Flow Chart

Flow Chart

Stellar Evolution Flow Chart

Name: _____

Dust and gas that

Dust and gas that
make up a star.

Stellar Nebula



Protostar

Contracting mass of gas
(gravity);
increasing density



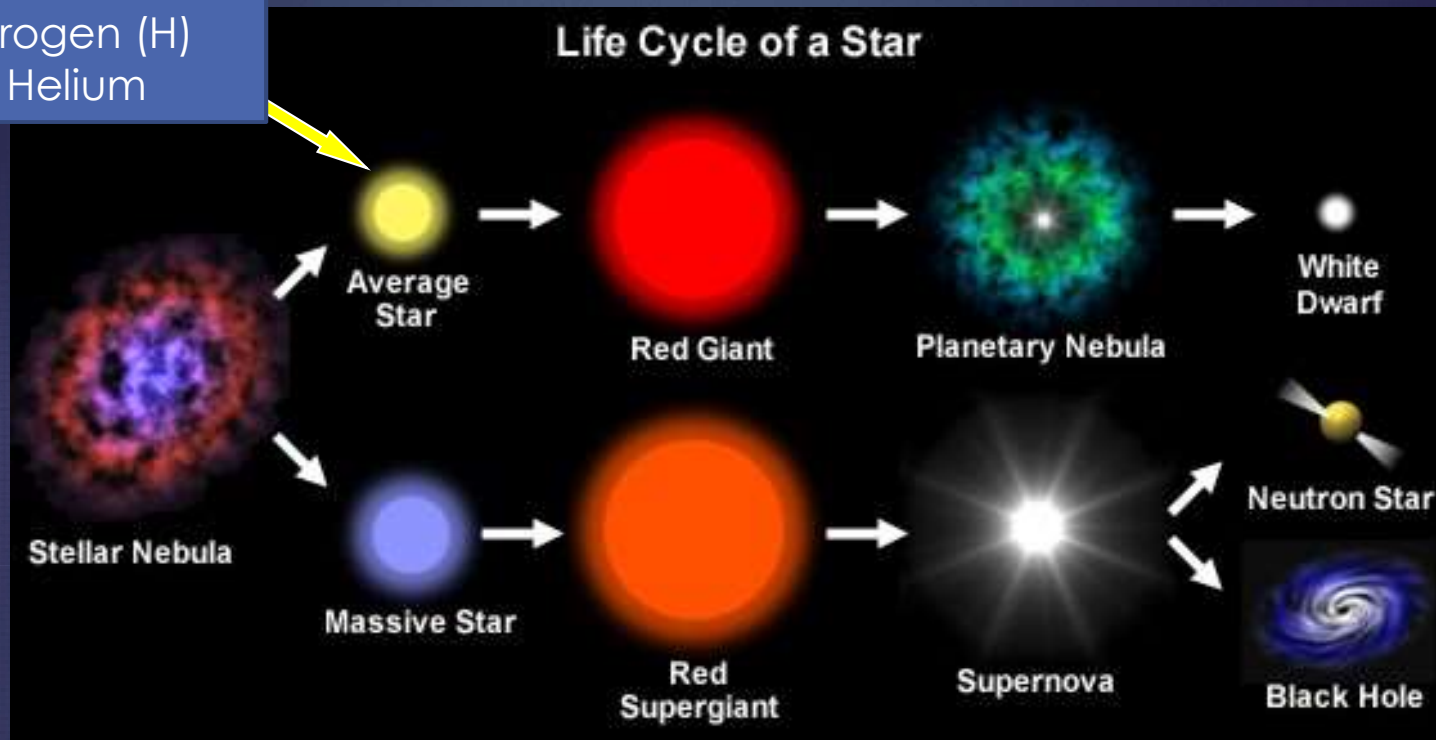
Nova

are increase
fusion in a
protostar

is not
for the
star to completely collapse

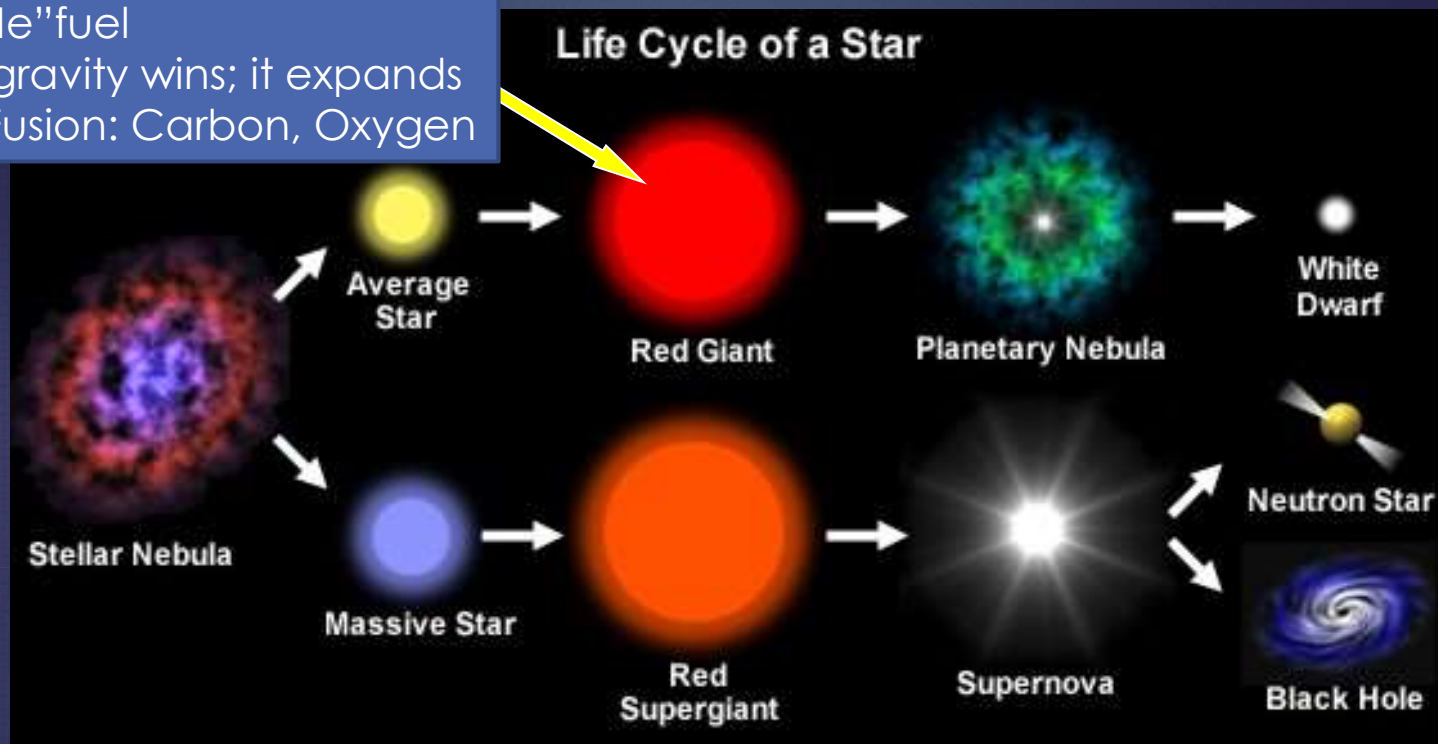
Main sequence
– 98% of stars
– our sun
– Fusion
Hydrogen (H)
into Helium

Life Cycle of a Star



Life Cycle of a Star

- Runs out of "H" and "He" fuel
- gravity wins; it expands
- Fusion: Carbon, Oxygen

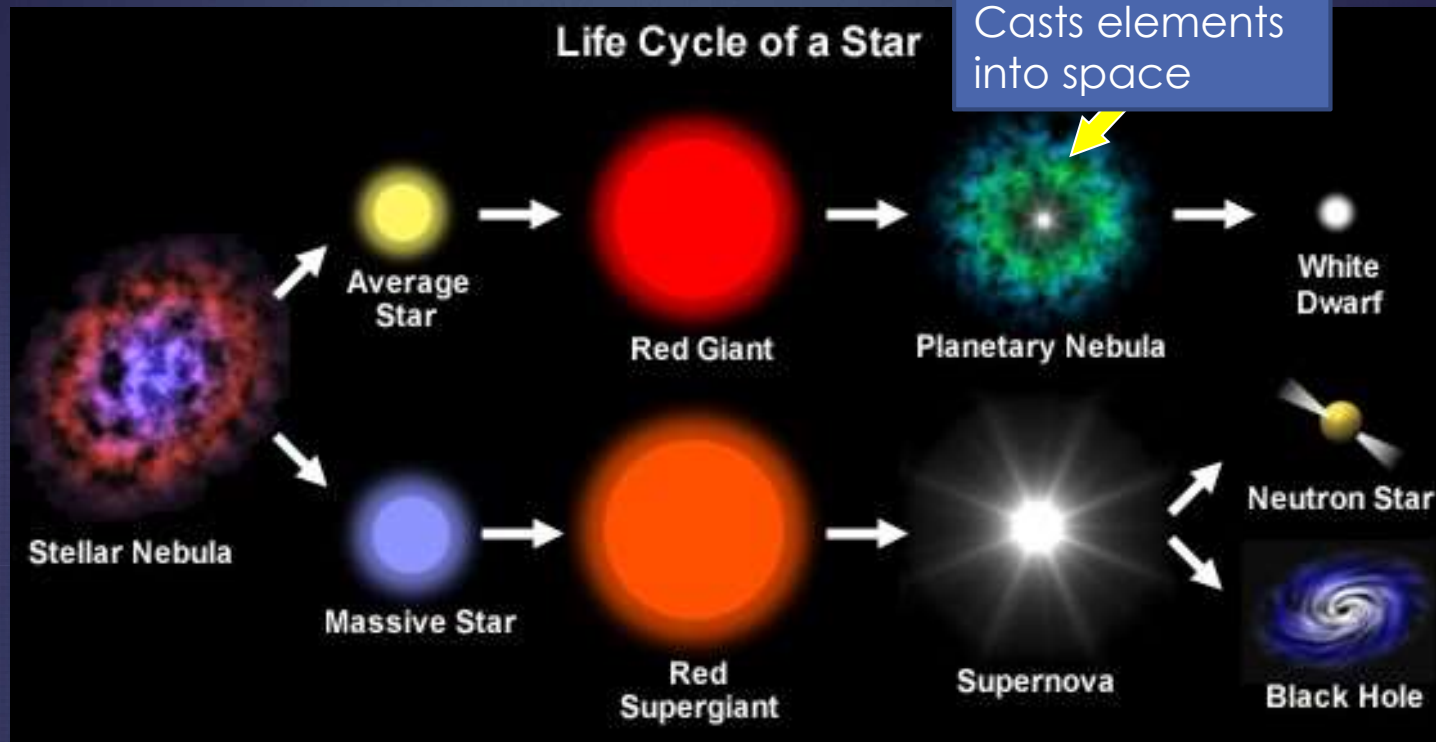


Vocab Review

- ▶ Red Giant – a large reddish star late in it's life that converts helium into **carbon** or **oxygen**

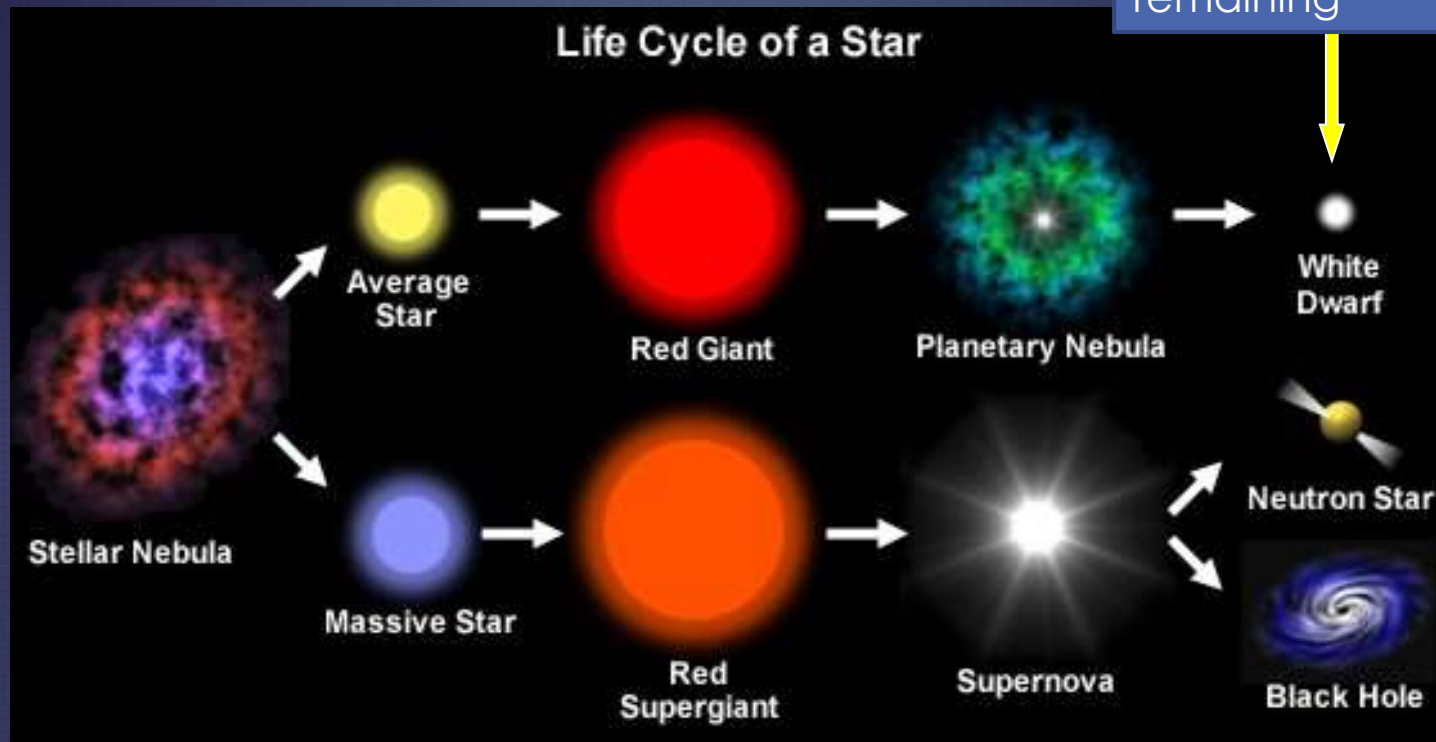


Life Cycle of a Star



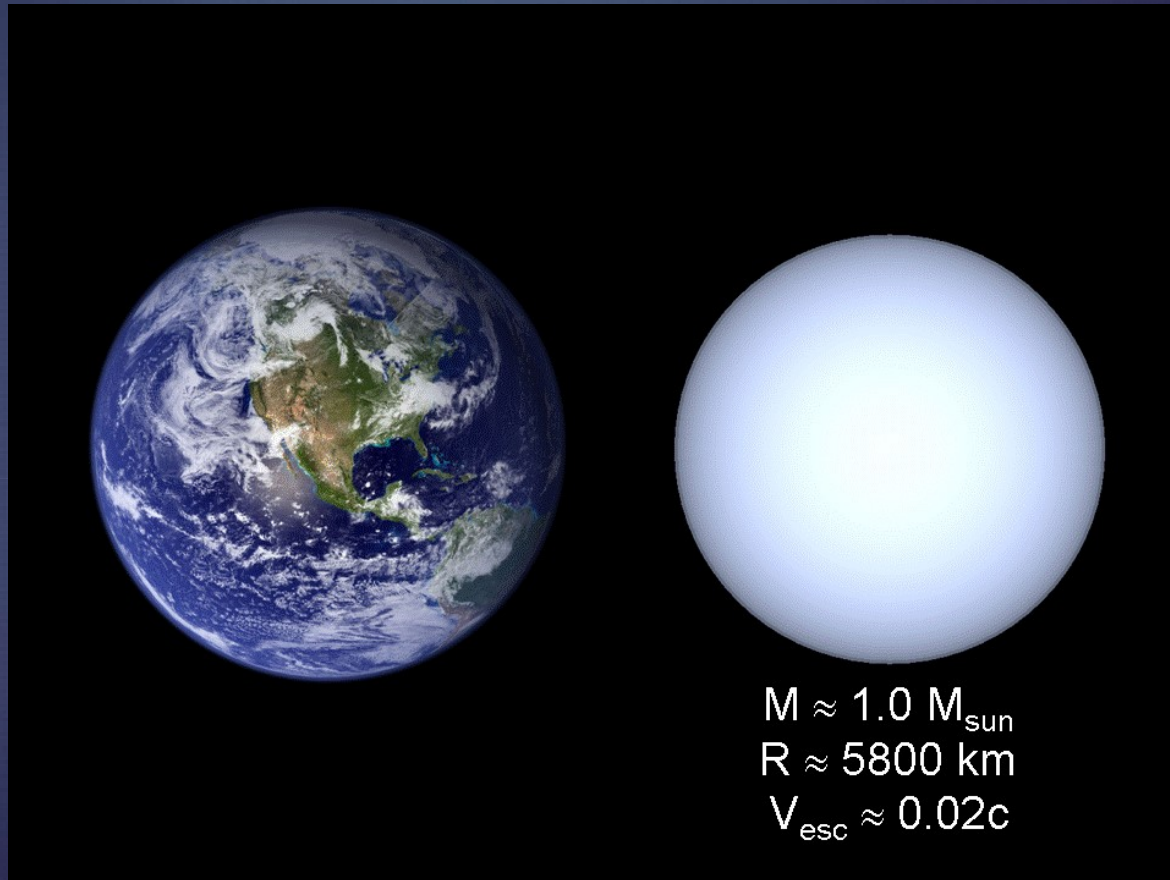
Expands ...like
an explosion
Casts elements
into space

Life Cycle of a Star



Vocabulary Review

- ▶ White Dwarf – a small, dense star that remains after a red giant converts all of its helium into **carbon** or **oxygen**

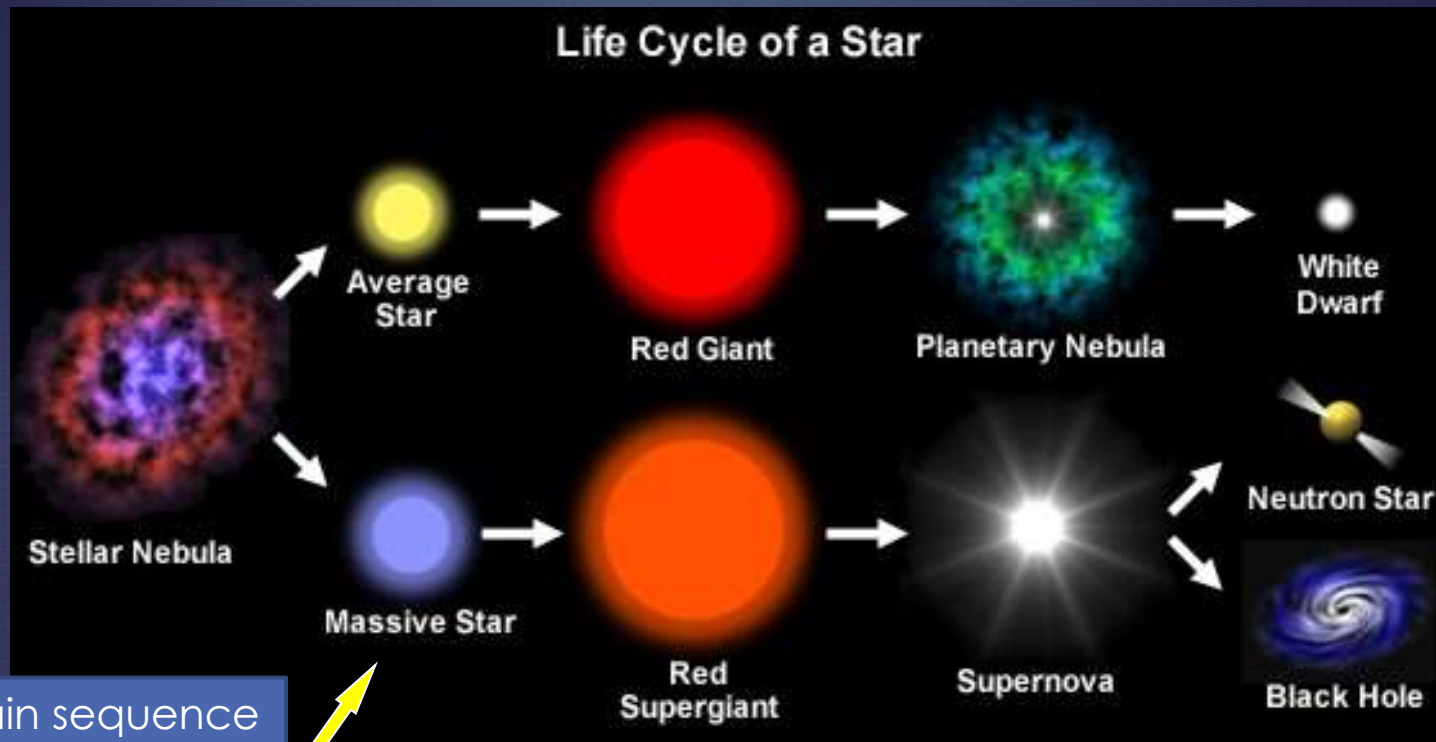


Black Dwarf

- ▶ When a white dwarf cools and no longer emits significant heat or light.
- ▶ Tens to hundreds of billions of years to cool
- ▶ The Universe hasn't been around that long
 - ▶ the oldest stars: 10 - 20 billion years old
- ▶ Therefore there are no black dwarfs yet, but there will be in the future.

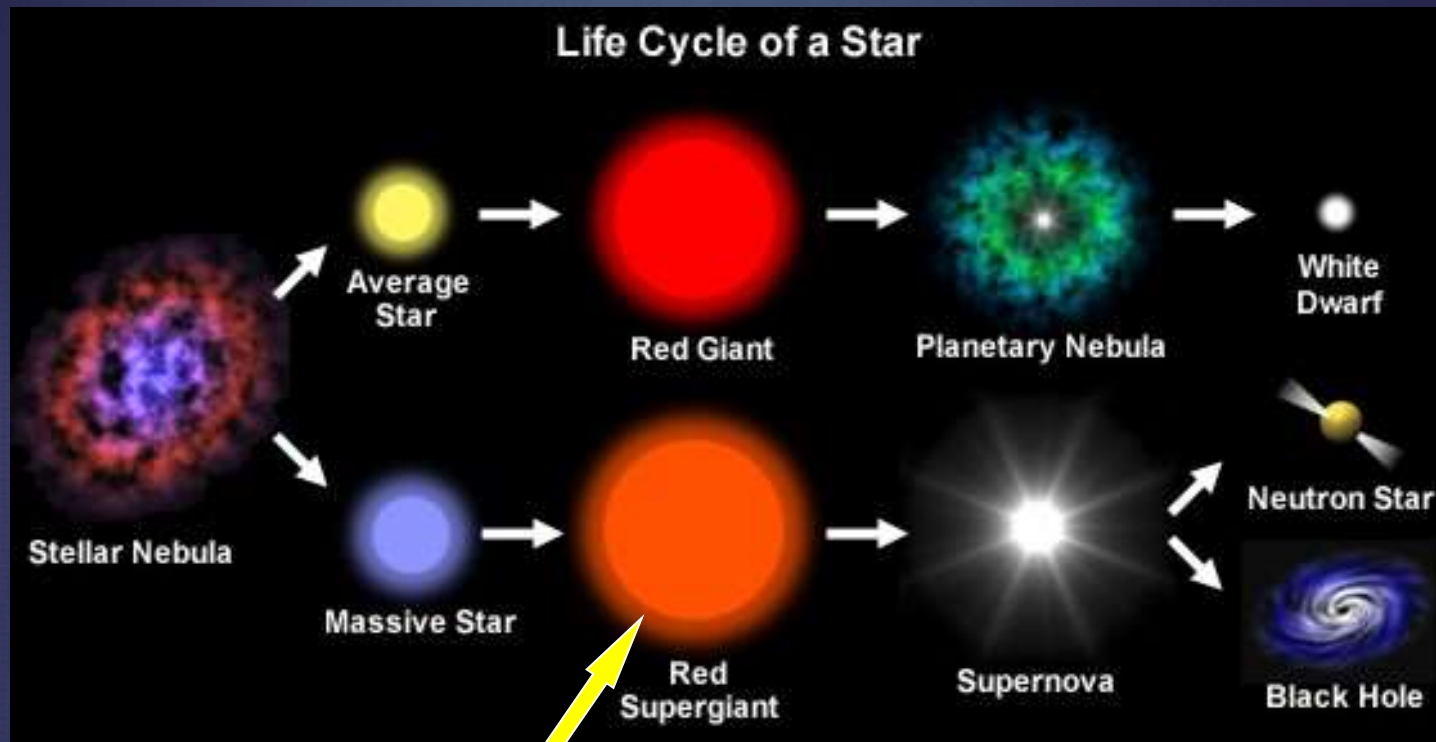


Life Cycle of a Star



Main sequence
– 2% of stars
– Fusion
Hydrogen (H)
into Helium

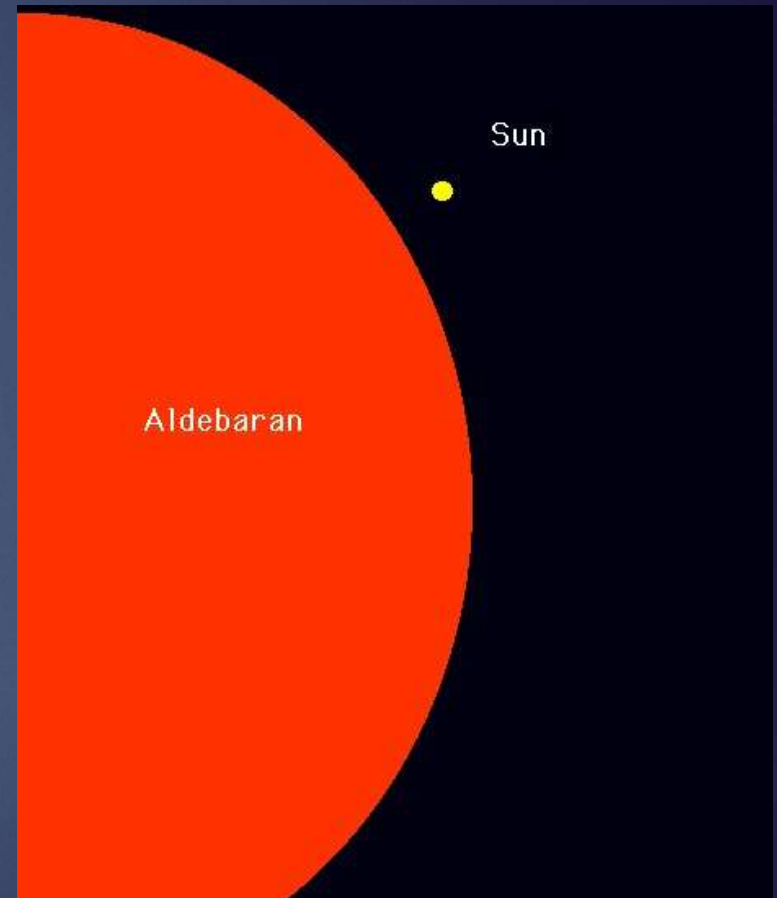
Life Cycle of a Star



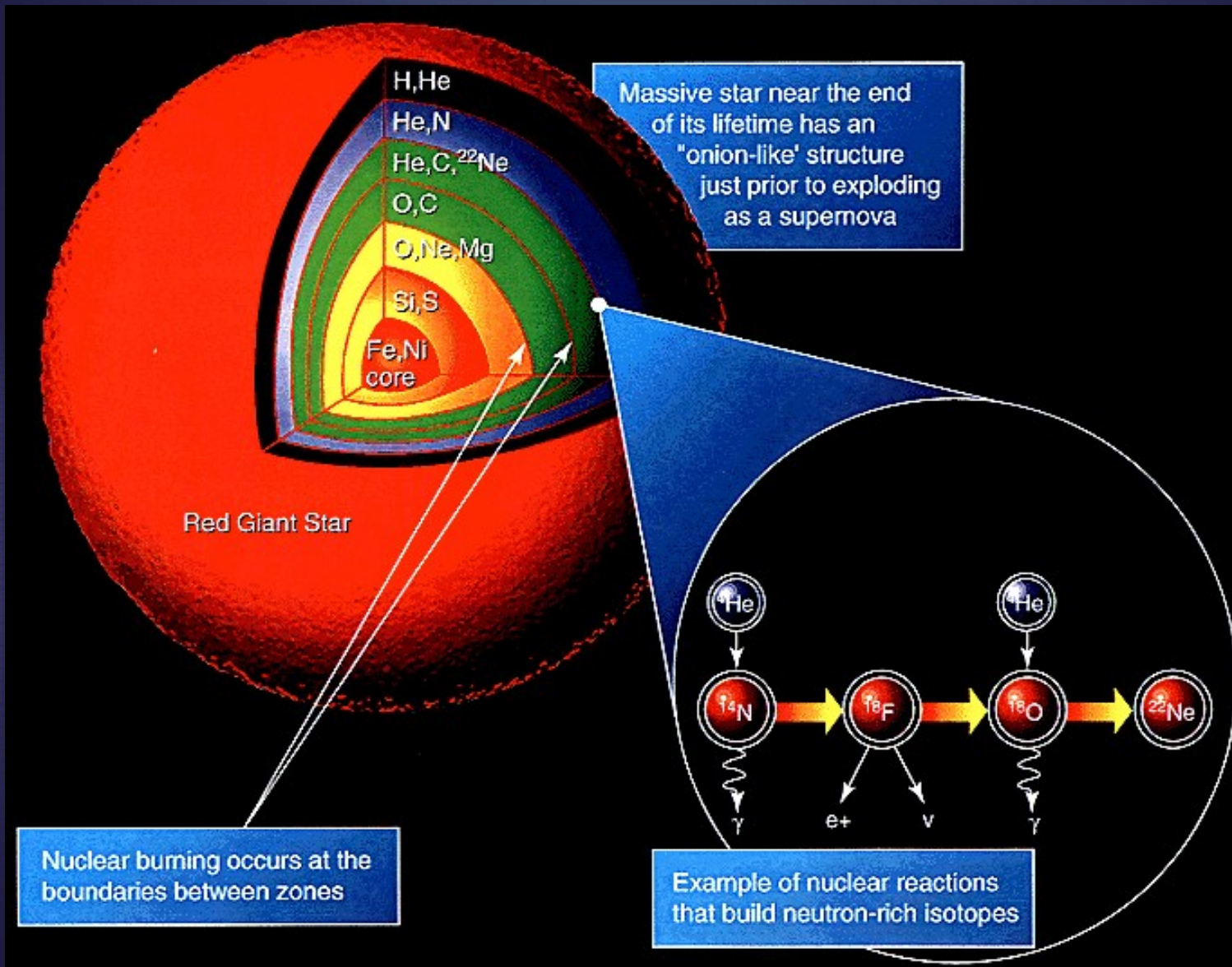
Helium fuses to Iron and Nickel
- Runs out of fuel
- gravity wins

Vocab Review

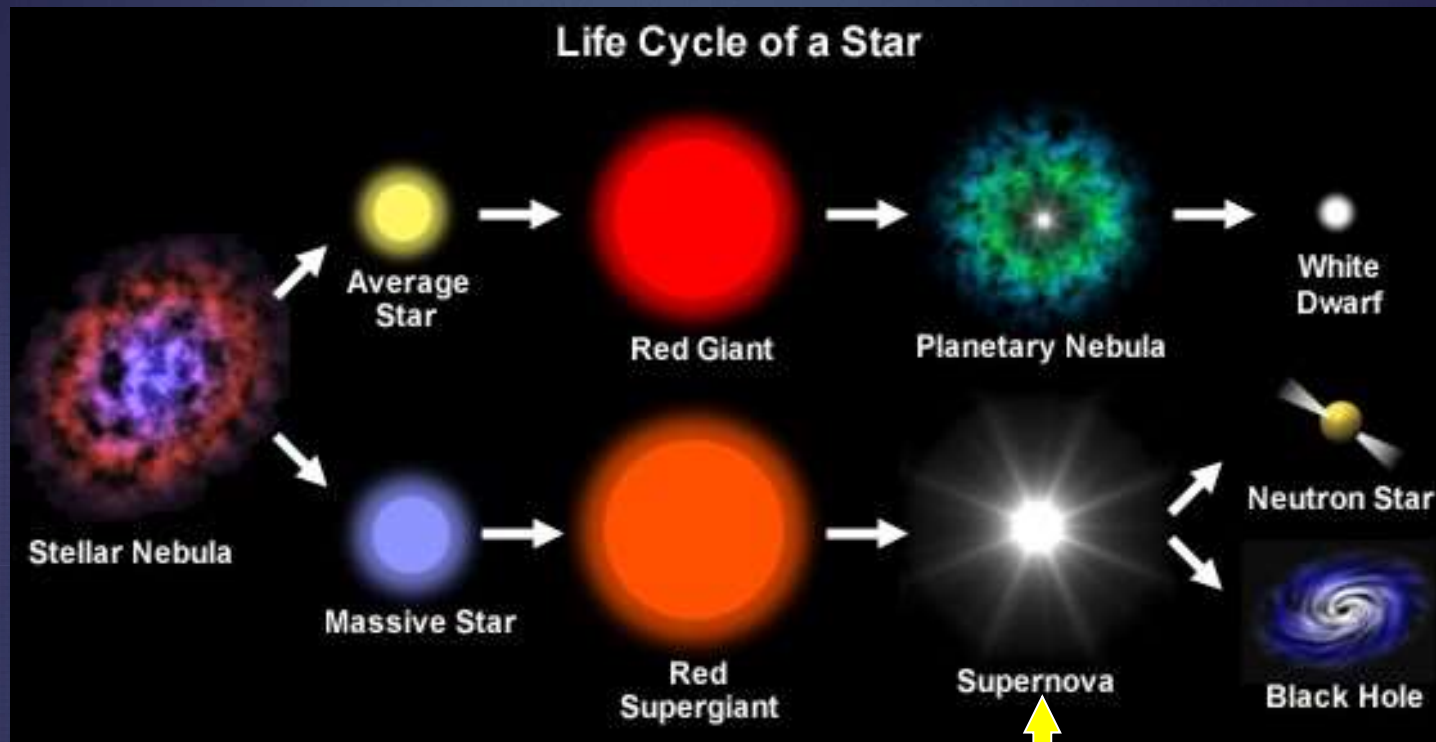
- ▶ Red Supergiant -
- ▶ a large star late in its life cycle
- ▶ converts its helium into iron and nickel



Red Super Giant



Life Cycle of a Star



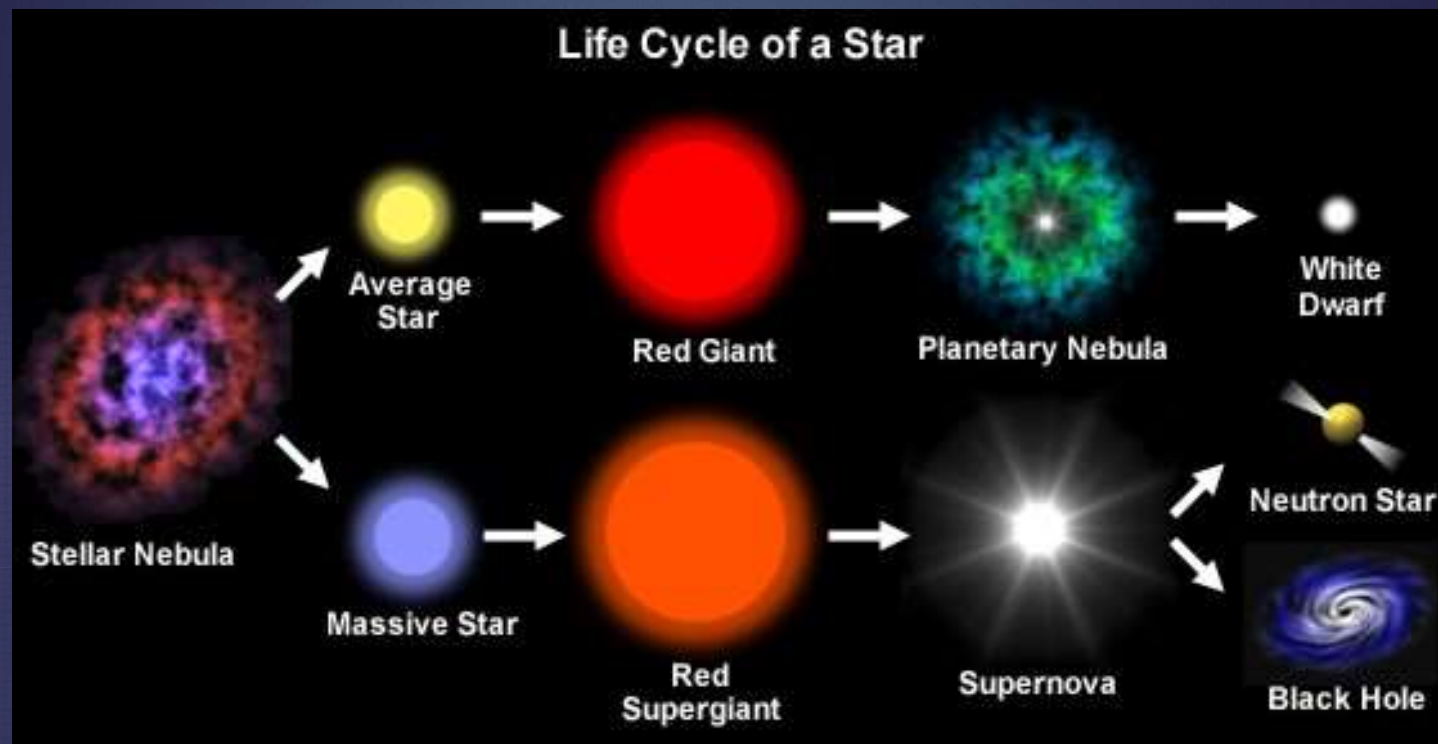
- Implodes under gravity
- Expands ...like an explosion
- Elements Larger than Iron!!!

Supernova

- ▶ These have been observed!
- ▶ Supernova explosions are relatively rare events in our own galaxy, happening once a century or so on average.
- ▶ In 1987, there was a supernova explosion in the Large Magellanic Cloud, a companion galaxy to the Milky Way. Supernova 1987A, which is shown below:



Life Cycle of a Star



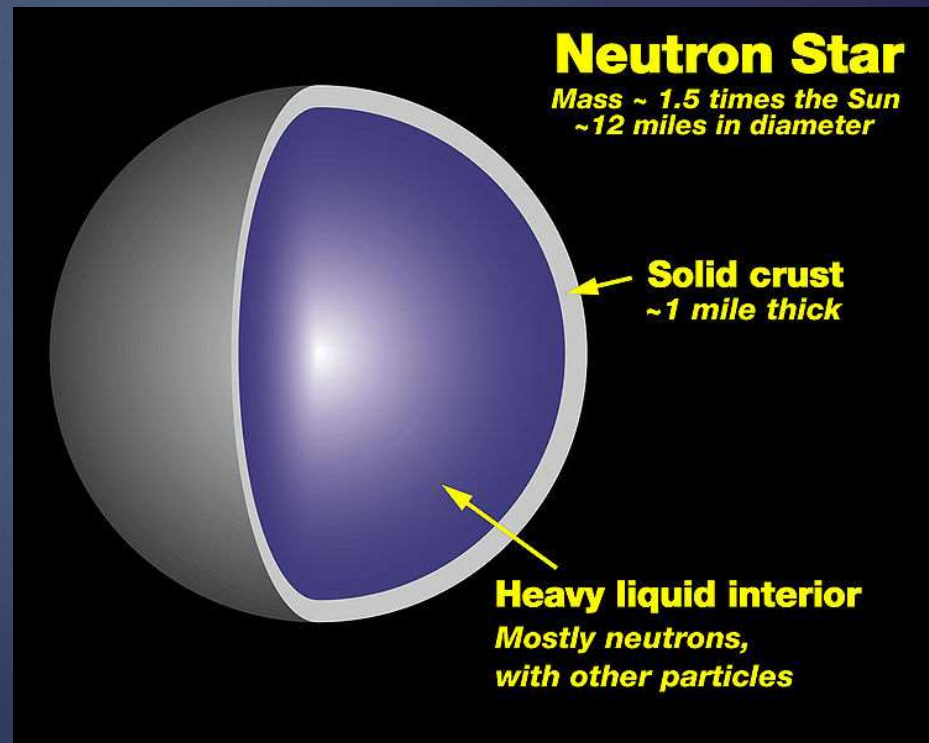
dense core
remaining

Two pathways

- ▶ There are two possible results of the supernovas:
 - ▶ Neutron Star
 - or
 - ▶ Black hole

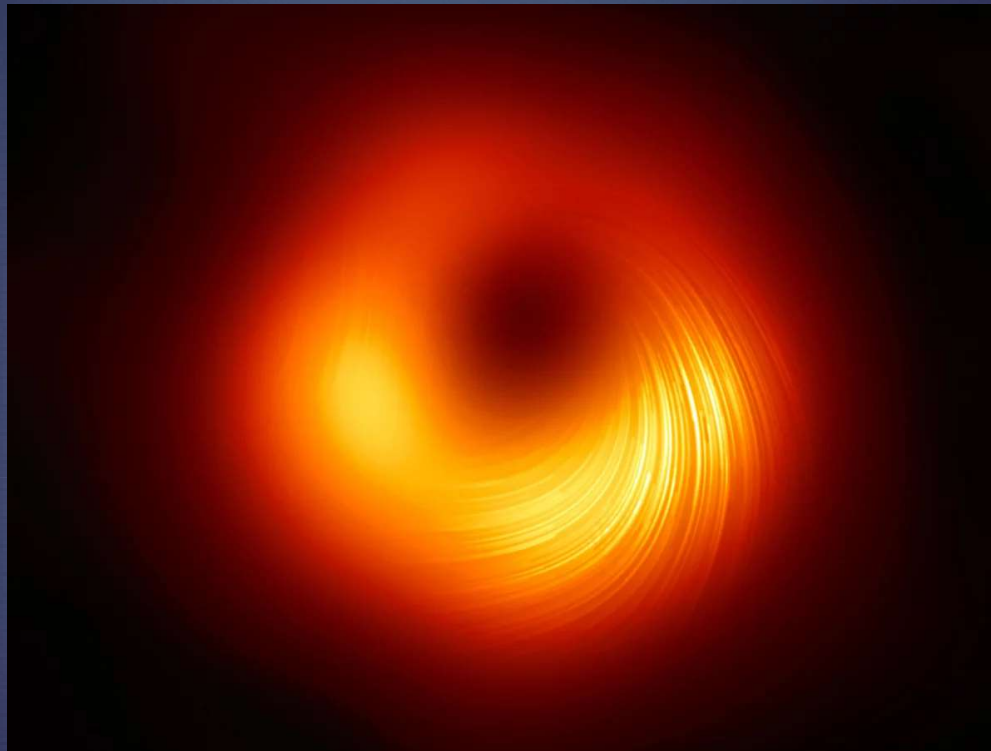
Vocab Review

- ▶ Neutron Star – a small, dense dead star that can remain after a supernova



Vocab Review

- ▶ Black Hole - Extremely massive and dense object; Light cannot escape its gravity



The Event Horizon Telescope collaboration, which released the world's first image of a black hole in 2019, unveiled a new view on Wednesday showing how the object at the center of the M87 galaxy looks in polarized light.

EHT Collaboration

March 2021: Messier 87 Black Hole



Summary of a Star's "Life Cycle"

