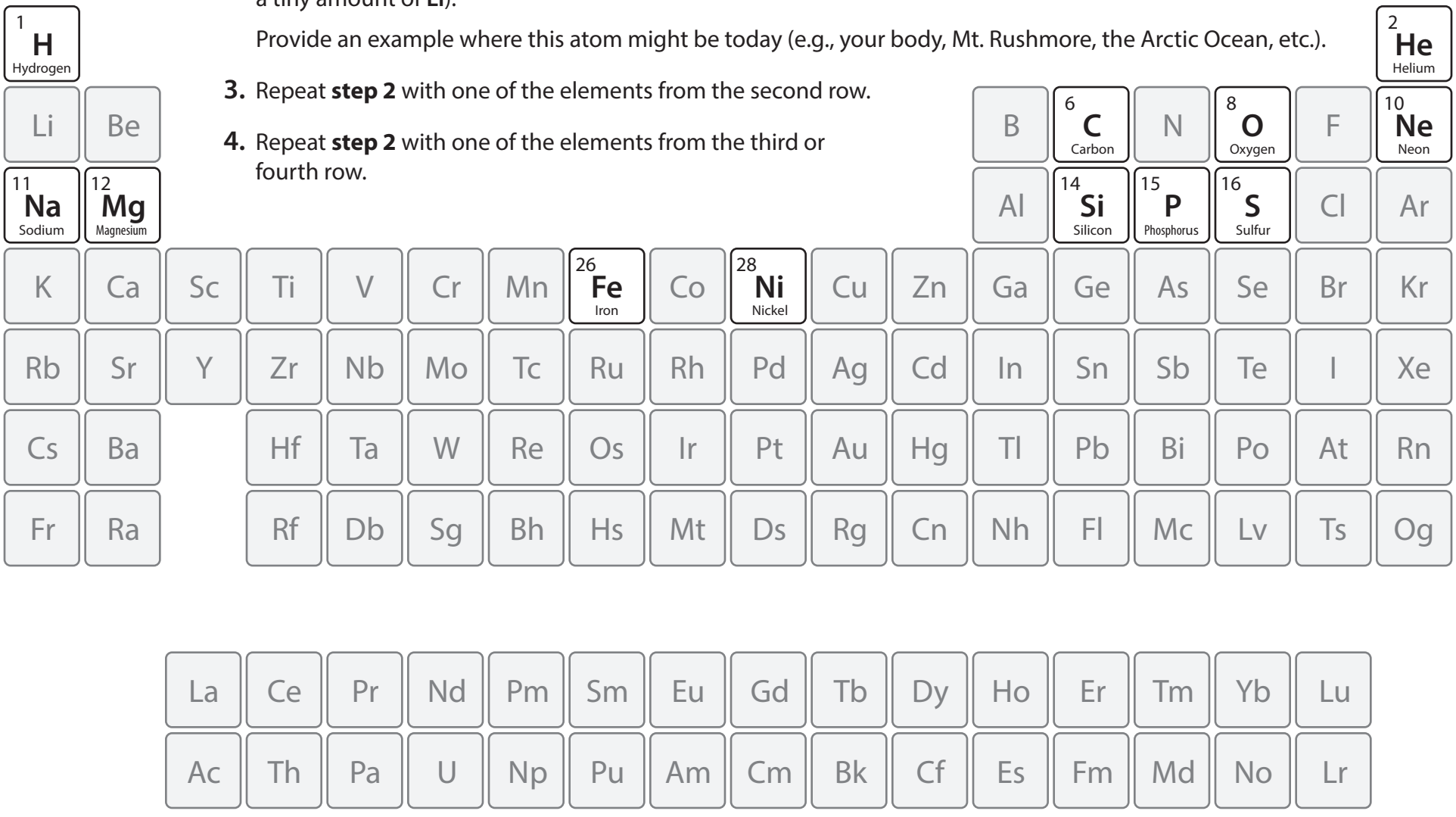
Life Cycle of Stars: Atomic History

projects.wwtambassadors.org/star-life-cycle

What to do:

1. Consider a single atom of helium (**He**).
2. Using information collected from the *Life Cycle of Stars* interactive, explore how this atom might have evolved and migrated over the past 13.8 billion years since the big bang (which produced only **H** and **He** and a tiny amount of **Li**).

   Provide an example where this atom might be today (e.g., your body, Mt. Rushmore, the Arctic Ocean, etc.).
3. Repeat **step 2** with one of the elements from the second row.
4. Repeat **step 2** with one of the elements from the third or fourth row.



Life Cycle of Stars: Element Formation

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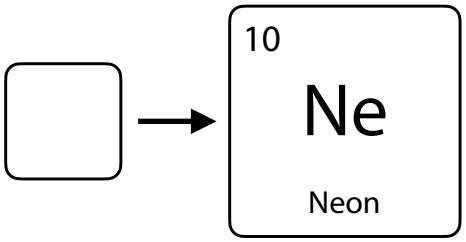
What could it form from?	ELEMENT	This reaction occurs in...	What is happening in the star that makes this reaction possible?
H (Hydrogen) →	2 He Helium	☑ Sun-like main-sequence stars ☑ Massive main-sequence stars ☑ Red giants ☑ Red supergiants	Gas compression raises the core temperature and density until hydrogen atoms start fusing to helium.
☐ →	6 C Carbon	☐ Sun-like main-sequence stars ☐ Massive main-sequence stars ☐ Red giants ☐ Red supergiants	
☐ →	8 O Oxygen	☐ Sun-like main-sequence stars ☐ Massive main-sequence stars ☐ Red giants ☐ Red supergiants	

Forms from? **Reaction occurs in...**



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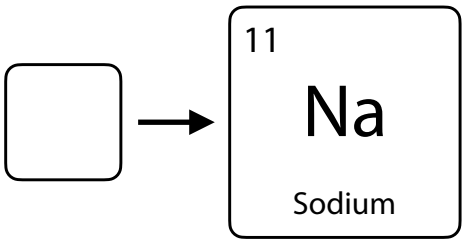
- ☐ Massive main-sequence stars
- ☐ Red giants
- ☐ Red supergiants



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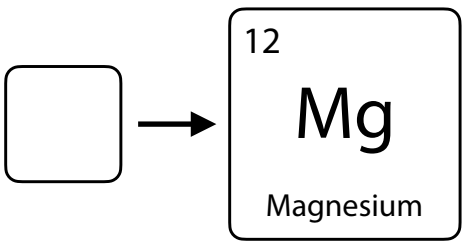

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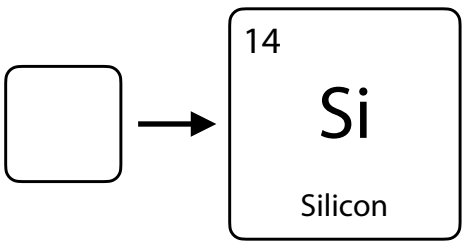

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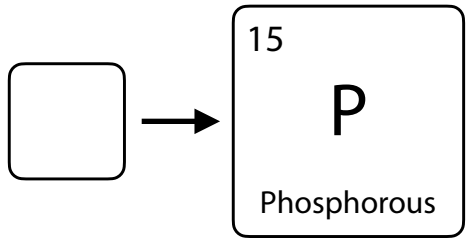
Forms from? **Reaction occurs in...**



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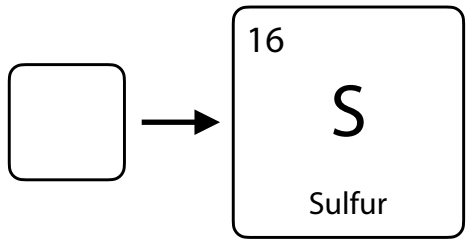

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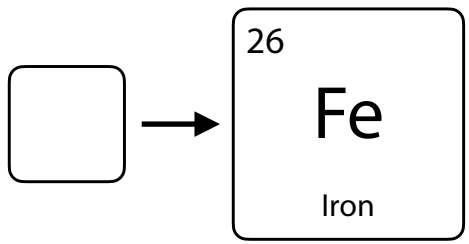

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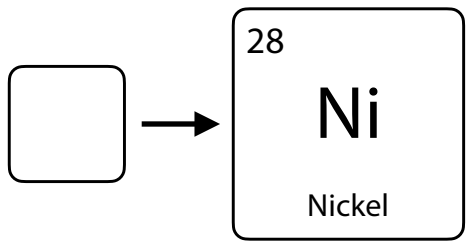

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Life Cycle of Stars: Schematic

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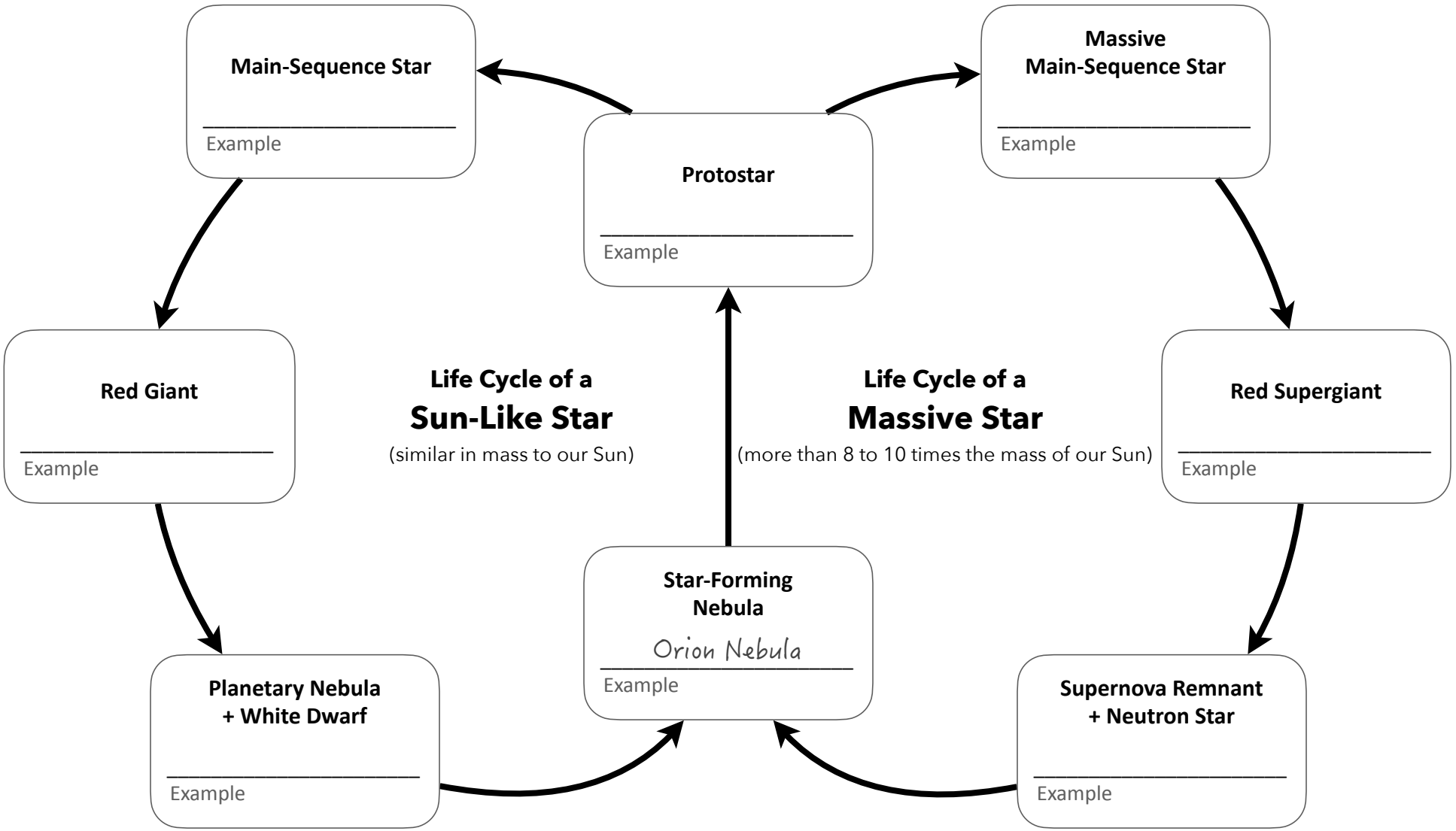

Life Cycle of Stars: Stages and Transitions

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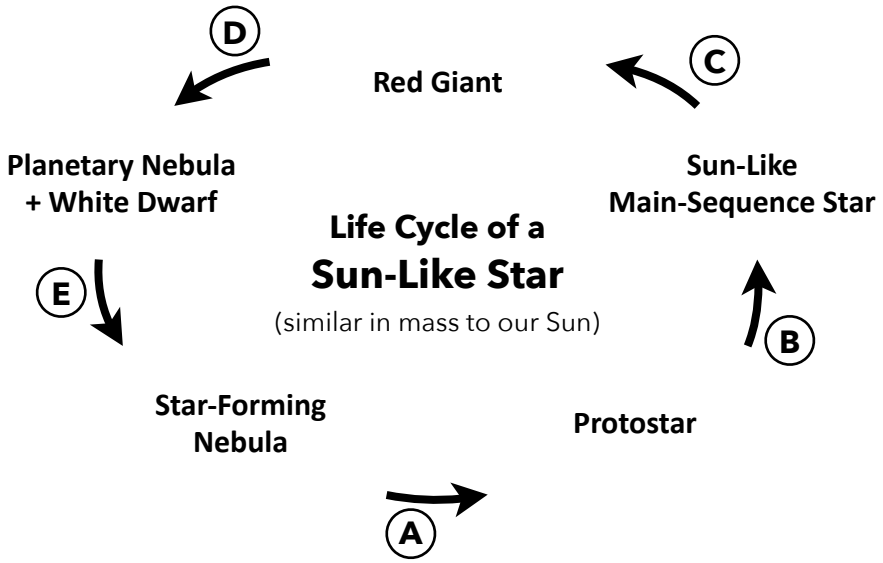


Star-Forming Nebula

Role of gravity: Draws together gas and dust left behind by previous generations of stars into a large cloud. Denser parts of cloud contract due to gravity.

Role of fusion: None during this stage.

Balance of gravity and fusion: No fusion reactions stop gravity from compressing the gas and dust (which increases temperature, pressure, and density in the core).

What causes **transition (A)**?

Gravity's compression eventually increases the temperature and density enough to trigger deuterium fusion in the core of the gas and dust clump, forming a new protostar.

Protostar

Role of gravity: Gravity compresses protostar. When temperature and density of core is high enough, deuterium fusion can start. (Gravity also draws more gas and dust onto outside of protostar. A disk may form around protostar to form planets.)

Role of fusion: Deuterium fusion heats up inside of protostar and increases outward pressure.

Balance of gravity and fusion: Radiation pressure created by deuterium fusion in the core can counteract the inward force of the gravity, and the protostar can remain stable for some time.

What causes **transition (B)**?

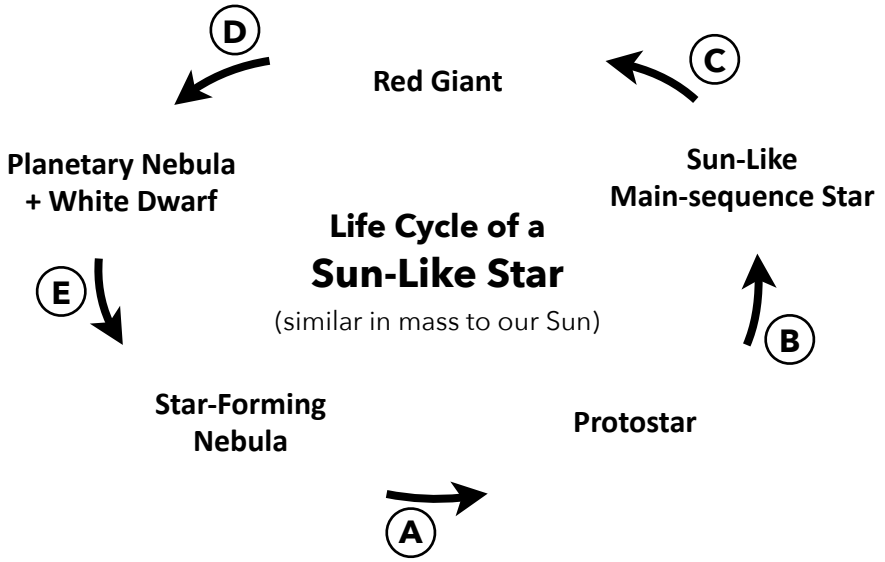
Eventually, gravity compresses the core until the temperature and density are high enough to fuse H to He.

Sun-Like Main-Sequence Star

Role of gravity: _____

Role of fusion: _____

Balance of gravity and fusion: _____



What causes **transition Ⓒ**?

_____

_____

_____

Red Giant

Role of gravity: Compresses star until H->He fusion ignites in shell around core and He->C fusion ignites in core.

Role of fusion: H->He fusion in shell triggers expansion and cooling of star to become a red giant. Energy from fusion in core and shell makes star shine.

Balance of gravity and fusion: Star stays in balance while fusion in core and shell is ongoing.

What causes **transition Ⓓ**?

_____

_____

_____

Planetary Nebula + White Dwarf

Role of gravity: Compresses core until it becomes a white dwarf. (Stellar winds blow the outer layers of the star away to form the nebula.)

Role of fusion: _____

_____

Balance of gravity and fusion: Fusion plays no role here. Another process (quantum physics) stops complete collapse of star under gravity.

What causes **transition Ⓔ**?

_____

_____

_____