The life cycle of the Sun – H-R Diagram

**PMS STAR** - contracts while accreting matter onto its core, temperature rises, eventually heats up to $10^7$K, thermonuclear reactions begin. When star no longer contracts to provide energy, is in thermal equilibrium and obtains energy from H burning → **Zero-Age Main Sequence Star**

**RED GIANT BRANCH** - As core contracts, core temp reaches $10^8$K → He burning ignited in the core via triple alpha process. Red Giant has dense core containing most of its mass at ~ $50 \times 10^6$K, core is so dense electrons become degenerate electron gas (no longer obey perfect gas law and pressure does not increase with temperature). High thermal conductivity of degenerate electron gas allows burning to spread quickly through the core. The increase in temperature does not cause an increase in pressure, and so the heat energy increases the rate of the triple alpha process generating more energy, further increasing the temperature → **HELIUM FLASH**

**ASYMPTOTIC GIANT BRANCH** - Triple-Alpha process converts helium core to carbon. He exhausted in core, but He burning continues in surrounding layer. C core contracts, burning outer layer, causing the envelope to expand → 2nd Red Giant Phase. (AGB Star)

**PLANETARY NEBULA** - The electrons in the core become degenerate again. Triple-alpha process is very sensitive to temp changes. He burning shell causes the star to become unstable. The star pulsates (thermal pulses) and ejects outer layers via its super wind.

**WHITE DWARF** → **BLACK DWARF**

**TRIPLE-ALPHA PROCESS**

When temp reaches $350 \times 10^6$K the electrons become non-degenerate, the core expands and cools, stable HE core with H shell burning.

Since core is degenerate it cannot contract and never reaches temperature for C burning → **WHITE DWARF** → **BLACK DWARF**