8.2 Stellar Evolution

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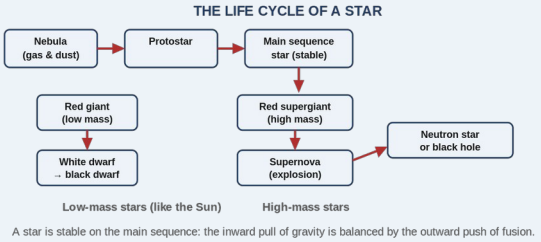
1. KEY VOCABULARY

TERM	MEANING
Nebula	A cloud of gas and dust where stars are born.
Protostar	A star forming as gravity pulls a nebula together.
Main sequence	The long, stable phase of a star's life.
Supernova	The huge explosion of a high-mass star.
Black hole	An object so dense not even light can escape it.

2. THE LIFE CYCLE OF A STAR



A star is stable on the main sequence: the inward pull of gravity is balanced by the outward push of fusion.

3. HOW A STAR FORMS

1. Gravity pulls a nebula of gas and dust together.
2. It heats up and becomes a protostar.
3. When it is hot enough, fusion begins — it becomes a stable main sequence star.

4. LOW-MASS vs HIGH-MASS STARS

Low mass (like the Sun): main sequence → red giant → white dwarf → black dwarf.
High mass: main sequence → red supergiant → supernova → neutron star or black hole.

5. THE BALANCE IN A STABLE STAR

On the main sequence a star is stable because two forces balance: **gravity pulling inwards** = the outward pressure from fusion.
When the fuel runs low, this balance is lost and the star changes.

6. THE WHY

Why a main sequence star is stable for so long: the inward pull of gravity is exactly balanced by the outward push of energy released by fusion.
Why high-mass stars end so violently: their stronger gravity drives faster fusion — when the fuel runs out the core collapses and the star explodes as a supernova.

7. COMMON EXAM MISTAKES

✗ "All stars end as black holes."
✓ Only the most massive do; low-mass stars become white dwarfs.
✗ "The Sun will go supernova."
✓ The Sun is low mass — it will become a red giant, then a white dwarf.
✗ "A star is held together only by gravity."
✓ Gravity is balanced by the outward pressure from fusion.

8. SELF-CHECK · cover & quiz

Can you…

1. Describe how a star forms from a nebula?
2. Give the life cycle of a low-mass star?
3. Give the life cycle of a high-mass star?
4. Explain what keeps a main sequence star stable?
5. Explain why high-mass stars end in a supernova?