

01 / LEARNER PAGE

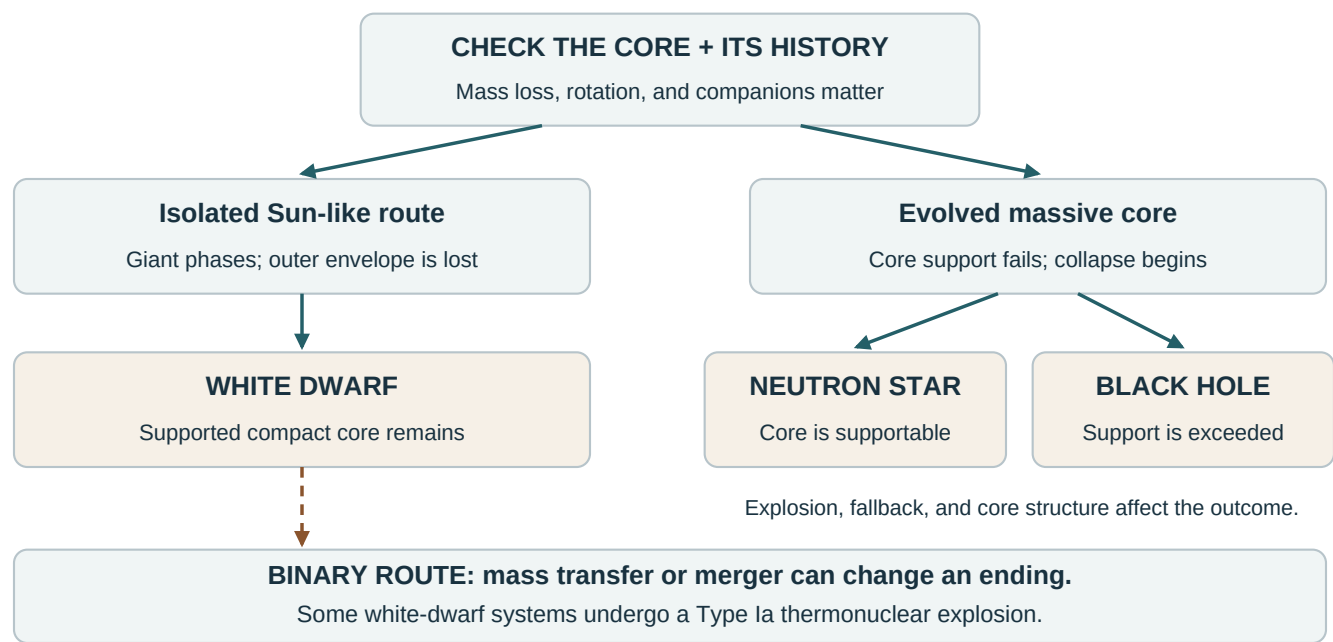
Choose a Star's Fate

Follow the core. Check the companion. Explain the ending.

35-45 minutes | Suggested ages 12+ | Pencil + printed guide

A solar mass means the mass of our Sun, but a star's ending also depends on the retained core and a companion. Use four invented cases to explain a possible fate and the information you still need.

A route map, with room for uncertainty



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Original teaching model, not a mass-threshold calculator. The paths summarize possibilities; they do not predict an individual star from initial mass alone. Sources S1-S4.

Start here / Underline the part of the star that becomes the remnant. Name one way a companion can change the route.

S2 / Find the missing information

A star started with 20 solar masses. Can you name its final remnant with certainty? List two additional facts you would want and explain why.

02 / LEARNER PAGE

Follow the case conditions.

Use the source numbers to check the clues. Write before reading the discussion.

CASE A / SINGLE STAR

An isolated star began with roughly the Sun's mass. It becomes a giant and loses its outer envelope. A carbon-oxygen core remains, supported by electron degeneracy pressure. No companion transfers new material to it.

CASE B / COLLAPSING CORE

An evolved massive star's core collapses. An explosion ejects much of the envelope. For this case, assume the remaining compact core is within the range supportable as a neutron star and later fallback does not push it beyond that limit.

CASE C / COLLAPSING CORE

Another massive core collapses. For this case, assume the retained core and falling-back material exceed the supportable neutron-star limit. A powerful visible explosion is not guaranteed by the information on this card.

CASE D / BINARY SYSTEM

A carbon-oxygen white dwarf gains matter from a close companion or takes part in a merger. For this case, conditions trigger runaway nuclear burning that disrupts the white dwarf. Not every accreting white dwarf follows this path.

S1 / Choose the outcome and defend it

Case	Outcome	Reason from the case
A		
B		
C		
D		

S3 / Separate the explosions

How does core collapse differ from runaway nuclear burning in case D? Does every stellar death produce a bright supernova?

S4 / Test a rule against another system

Rewrite: 'All stars end as black holes, and binary companions only watch.' Use one counterexample and one companion interaction from the activity.

03 / ANSWER DISCUSSION

Discuss the reasoning.

These are defensible explanations, not a demand for identical wording. Return to the measured clue or the stated case assumption whenever a claim becomes too broad.

S1 / The four cases follow their stated assumptions

A: a white dwarf, because envelope loss leaves a supported carbon-oxygen core. B: a neutron star, because the card explicitly assumes a supportable compact core after collapse. C: a black hole, because the assumed retained mass exceeds neutron-star support. D: a Type Ia thermonuclear explosion, because runaway burning disrupts the white dwarf under the stated conditions. Type Ia is an event here, not a surviving neutron-star remnant. These are fictional teaching cases, not classifications of newly observed objects.

S2 / Starting mass is only part of the history

A starting mass does not supply the final core structure. Useful additional facts include the pre-collapse core mass and composition, mass lost in winds, rotation, and whether a companion stripped or added material. The explosion and fallback can also change the retained mass. Published model grids do not produce one clean division between neutron stars and black holes at a single initial mass. Accept two relevant facts with an explanation of why they matter.

S3 / Collapse and thermonuclear burning are different routes

In a massive core-collapse event, gravity drives the core inward after it can no longer maintain support; a successful explosion involves energy transport and shock revival. In a Type Ia event, runaway nuclear burning in a white dwarf releases the disruptive energy. An isolated Sun-like star instead loses its envelope and leaves a white dwarf. Some black holes may form without a powerful visible supernova. Brightness alone does not identify a remnant or an explosion mechanism.

S4 / A good revision keeps a counterexample

One defensible revision is: 'Stars can leave white dwarfs, neutron stars, or black holes, depending on their evolution and retained core. A close companion can exchange mass or merge, and some white-dwarf binaries can undergo a Type Ia explosion.' Case A challenges the claim that every star becomes a black hole; case D shows that a companion can change an ending. A complete answer names both the counterexample and the mechanism, rather than replacing one absolute slogan with another.

A useful answer connects a clue, an interpretation, and a limit. Scientific uncertainty is part of that answer.

04 / SOURCES + FACILITATION

Keep the source trail.

Primary mission explanations and published research. Links are clickable in the PDF; complete addresses remain available on paper.

S1 / NASA: Stars

Fusion, gravity, pressure, and the broad stages of a stellar life.

<https://science.nasa.gov/universe/stars/>

S2 / NASA: Types of stars

Giant stars, white dwarfs, neutron stars, and their physical differences.

<https://science.nasa.gov/universe/stars/types/>

S3 / NASA Roman: Type Ia supernovae

White-dwarf binary progenitors and the distinction from massive core collapse.

<https://science.nasa.gov/mission/roman-space-telescope/type-ia-supernovae/>

S4 / Sukhbold et al.: Core-collapse models (2016)

Model-dependent explosion and remnant outcomes across initial masses; a starting mass is not a unique fate.

<https://arxiv.org/abs/1510.04643>

For teachers and astronomy clubs

Give learners pages 1-2 first. Spend about 10 minutes on the route map, 20 minutes matching and defending the case cards, and 10 minutes comparing explanations. Discuss why the assumed post-collapse core conditions matter more than guessing a mass threshold. Use page 3 after learners have written their own reasoning.

Optional Atlas extension: compare a single star with a binary in Stellar Fates. Identify the interface's teaching assumptions before describing a result. The animation illustrates a model and does not independently establish a real star's future.

Continue the investigation

Read How Stars Die

<https://darksciencedocs.com/guides/how-stars-die/>

Examine the stellar-life-cycle Evidence File

<https://darksciencedocs.com/evidence/how-we-know-the-life-cycle-of-a-star/>

Explore Stellar Fates in the Atlas

<https://darksciencedocs.com/atlas/star-life-cycle/#stellar-stage>

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