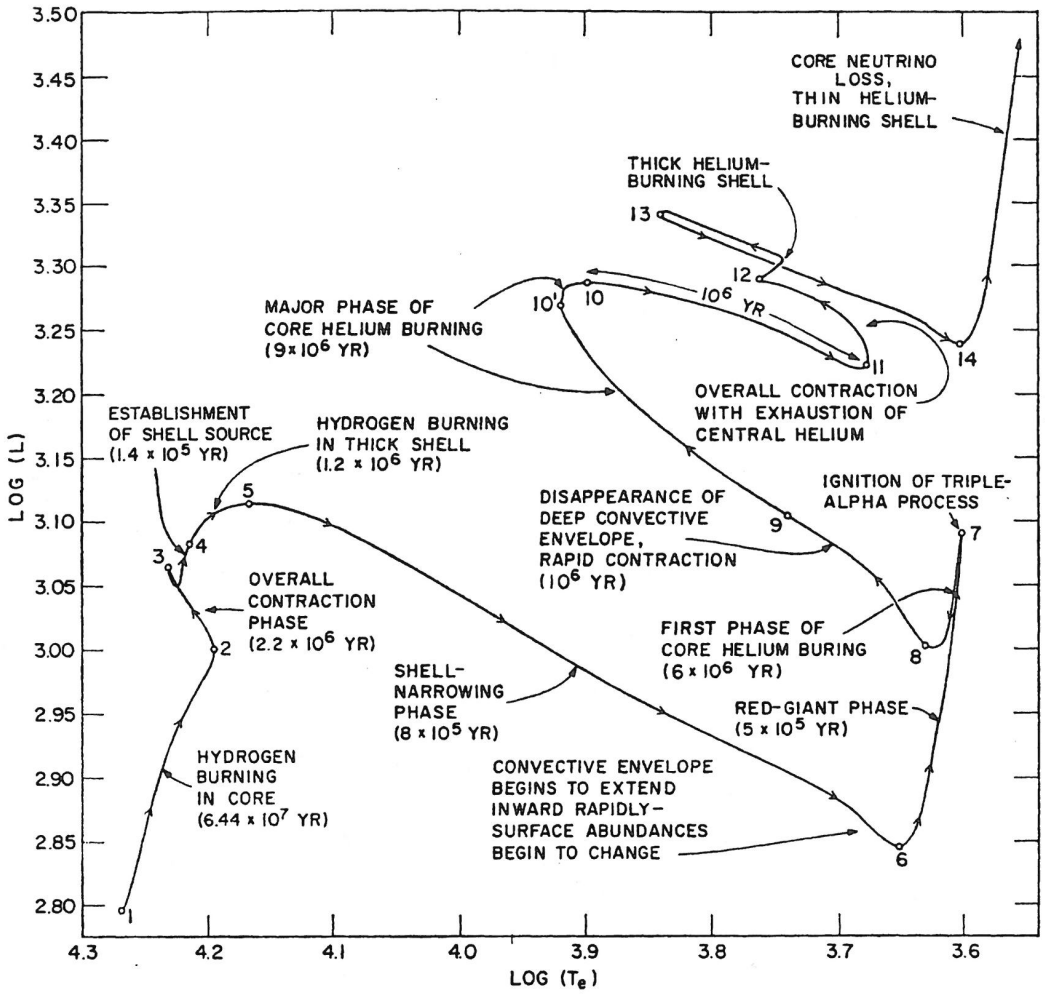

Figure 13.4 The evolution of a 5 $M_\odot$ star from the zero-age main sequence to the asymptotic giant branch. The luminosity is given in solar units. (Figure from Iben, *Annu. Rev. Astron. Astrophys.*, *5*, 571, 1967. Reproduced with permission from the *Annual Review of Astronomy and Astrophysics*, Volume 5, ©1967 by Annual Reviews Inc.)

Fig. 13.4. At a given time, a vertical slice in the diagram shows the structure of the star as a function of interior mass. (The center of the star is at the bottom of the figure.)

The end of the main-sequence phase of evolution at point 2 in Fig. 13.4 (or Fig. 13.1) corresponds to the stage of overall contraction that begins as a result of the near depletion of hydrogen fuel in the nuclear-burning core. By the time the star reaches point 3, the mass fraction of hydrogen has been reduced to $X = 0.01$ in the core (see Fig. 13.6) and hydrogen burning begins in a thick shell immediately surrounding the core. Because the ignition of the shell is quite rapid, the overlying envelope is forced to expand slightly, absorbing some of the energy released by the shell. As a result, the luminosity decreases