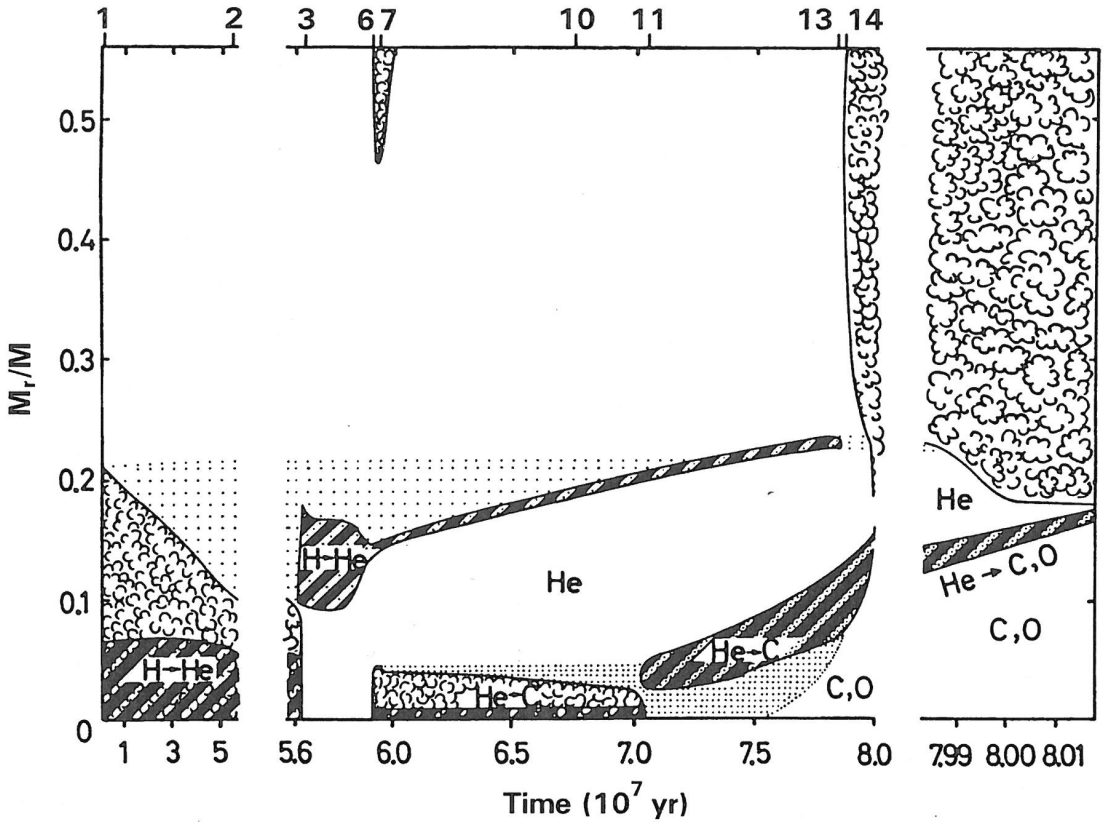

Figure 13.5 The structure of a 5 $M_\odot$ star as a function of time. Note that the time axis is not linear. Cloudy regions represent convection zones, dots show regions of changing composition, and stripes designate regions where a significant amount of energy is being generated by nuclear reactions. Although the numbers on the top of the diagram correspond to those in Fig. 13.4, this evolutionary model is based on calculations carried out by another research group. (Figure adapted from Kippenhahn, Thomas, and Weigert, *Z. Astrophys.*, *61*, 241, 1965.)

momentarily, as can be seen in Fig. 13.4. A sketch of the star's structure at this point is given in Fig. 13.7.

As the shell continues to consume the hydrogen that is available at the base of the envelope, the size of the helium core steadily increases and, as with the 1 $M_\odot$ star, it becomes nearly isothermal. At point 5 in Fig. 13.4, the Schönberg–Chandrasekhar limit is reached and the core begins to collapse, causing the evolution to proceed on the much faster Kelvin–Helmholtz time scale.

As the core collapses, a nonzero temperature gradient is reestablished because of the release of gravitational potential energy. At the same time, the temperature and density of the hydrogen-burning shell increase, and, although the shell begins to narrow significantly, the rate at which energy is generated