**Binding Energy Diagram**

- Fusion generates energy until it reaches the “iron peak”.
- Fission generates energy by destroying nuclei heavier than iron.

**Burn heavier nuclei**

- When protons (or hydrogen nuclei) are exhausted, stars begin to contract.
  - Inert helium core
  - Hydrogen-burning shell
- When temperature in the core increases to ~100 million degrees K, helium begins to burn, generating nuclear energy again. The surface of the star expands.
  - \[ ^4\text{He} + ^4\text{He} + ^4\text{He} + ^4\text{He} \rightarrow ^{12}\text{C} + \text{(binding energy)} \]
  - Inert carbon core
  - Helium-burning shell
  - Hydrogen-burning shell
- When helium nuclei are exhausted, the star wants to burn carbon, but a low-mass star can’t burn it…
  - \[ ^{12}\text{C} + ^4\text{He} \rightarrow ^{16}\text{O} + \text{(binding energy)} \]; this reaction requires ~600 million K! So, a low-mass star becomes a carbon star.

**White Dwarfs and Planetary Nebulae**

- Expanding gas gets ionized by radiation from the central core
- The core
  - White dwarf
  - Supported by “degeneracy pressure”
- The expanding gas
  - Planetary nebula

**Type Ia Supernovae**

- If the W.D. has a companion star, mass from the companion accretes on the W.D., increasing mass.
- At some point (M>1.4M_{\odot}), carbon begins to burn!
  - The “carbon bomb” disrupts the W.D. completely
  - This type of supernova is called the “Type Ia”, and plays a very important role in cosmology