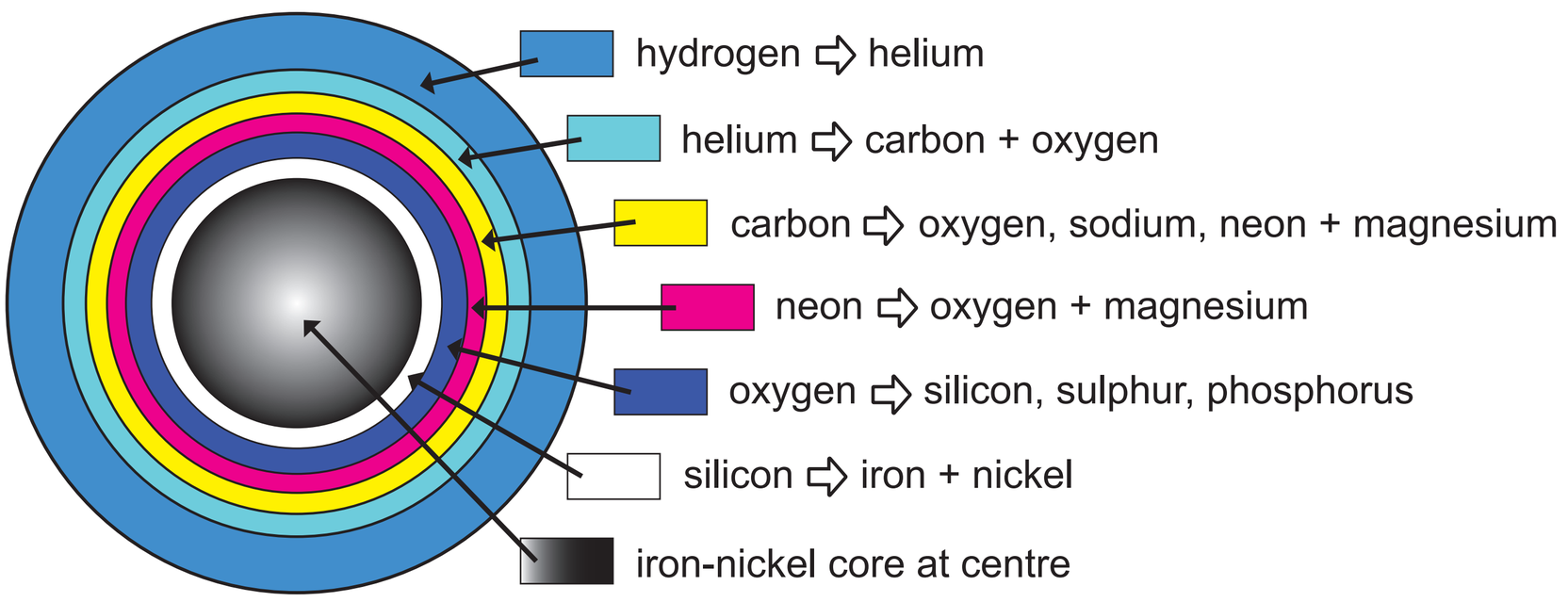
ORIGIN OF THE ELEMENTS

All the chemical elements were formed either in the Big Bang or in high energy stellar processes.

- ☼ Hydrogen (H), Helium (He) and traces of Lithium (Li) and Beryllium (Be) were formed in Big Bang nucleosynthesis 10 seconds – 20 minutes after the Big Bang when the universe was cool enough for ^{1}H (having a single proton as nucleus) and ^{2}H (having a proton and neutron as nucleus) to survive, but hot enough for the thermonuclear fusion of ^{1}H and ^{2}H into Helium to take place.
- ☼ The light elements Beryllium (Be), Boron (B) and some Li are formed when high-energy charged cosmic ray particles (electrons, protons and the nuclei of heavier elements) strike matter in the upper layers of Earth's atmosphere in the process of cosmic ray fission.
- ☼ The first stars after 400 million years were massive enough (mass ≈> 8MΘ, MΘ being the mass of the Sun) to start the thermonuclear fusion of H into He, then He into Carbon (C) and Oxygen (O), and even into heavier elements up to the most stable element Iron (Fe), in concentric shells of the increasingly heavy fusion processes.

The Fusion "Onion"



The "onion layers" of an evolved core of a high-mass star at the end of its red giant stage. Each shell of material is fusing to make the material in the shell inside it, from hydrogen in the outermost shell to iron at the very centre.

- ☼ Low mass stars (< 8MΘ) exploding as Supernovae at the end of their lifetimes form Li, C, Nitrogen (N) and a range of heavier elements up to Lead (Pb).
- ☼ High mass stars (> 8MΘ) exploding as Supernovae at the end of their lifetimes form a range of elements from C to Zirconium (Zr).
- ☼ When White Dwarf stars gather enough mass from binary companions to exceed the limit of 1.4MΘ, they explode as Type 1 Supernovae to form the elements from Silicon (Si) to Zinc (Zn).
- ☼ The first observation of merging neutron stars through the gravitational waves generated during their merger was as recent as August 2017. Analysis of this event – dubbed GW170817 – allowed astronomers to pin down the origin of the 64 naturally occurring elements heavier than Fe.
- ⇨ This implies that all matter that we know that is heavier than H or He, and has not been synthesized by humans, was formed inside stars, a remarkable finding.

The Periodic Table below indicates the processes involved in, as well their relative contributions to, the formation of each element.