The planet’s roughly 20,000 butterfly species are amazingly diverse, ranging from New Guinea’s massive Queen Alexandra’s Birdwing (both a wingspan of 28 cm) to North America’s 1.3 cm Pygmy Blue. The Monarch (Danaus plexippus) is one of the most familiar. It’s also known as a milkweed butterfly because females lay their eggs on toxic milkweed leaves. Monarch larvae feeding on the leaves become poisonous to predators.

Wings allow butterflies to fly, of course, and may also play a role in temperature regulation. But their striking colors and patterns are their most noticeable—and beloved—aspects. The hues, shapes, and markings of butterflies’ wings are important for camouflage, courtship, and species recognition. Monarch’s distinctive coloration warns potential predators of their unpalatability.

The wings of most butterflies consist of a membrane overlaid with layers of very delicate scales. (In fact, the name of butterflies’ taxonomic order, Lepidoptera, is derived from the Greek for “scale wing.”) The scale layers usually contain two types of scales in alternating orientations, much like tiles on a roof.

A wing scale’s upper layer consists of longitudinal ridges joined by transverse crossing structures, creating a gridlike appearance of repeating hills and valleys. Within the valleys, open rectangular pores reveal the scale’s hollow interior and flat lower layer. Except for columnar pillars called trabeculae, the area between the upper and lower layers is largely empty.

The ridges on most butterfly wing scales are comprised of a lattice of microribs and ridge-lamellae. The bright orange in a Monarch’s wing is produced by pigments in the scales. However, some species’ microribs and ridge-lamellae (such as those of genus Morpho) create iridescent colors by preferentially reflecting light of certain wavelengths. This property has led to experimentation with paints, cosmetics, and other products in which color is created by the light interference effects of nanoparticles.

Chitin fibrils are composed of molecular chains of oxygen, nitrogen, carbon, and hydrogen atoms. Strong bonds between these give chitin its exceptional toughness. However, this also means that chitin doesn’t stretch with growth—so insects and other arthropods periodically shed their exoskeleton, or molt. Some researchers study chitin’s properties to create strong, lightweight materials; others explore its structure to discover new ways of combating insect pests.

Carbon is one of Earth’s most common elements—and an essential building block of life. Carbon atoms can combine with other elements to form many types of molecules, from simple carbon dioxide (CO₂) to complex, long-chained molecules like chitin. Sheets of carbon atoms can also form carbon nanotubes. The lightness and strength of these fibers have resulted in both practical advances (such as superminiaturized electronics) and fantastical new ideas (like elevators to space).