Monarch Butterfly
(wingspan 8-12 centimeters)
The planet’s roughly 20,000 butterfly species are
amazingly diverse, ranging from New Guinea’s
massive Queen Alexandra’s Birdwing (with a wingspan
of 28 cm) to North America’s 1.3cm 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.

Monarch Butterfly Hindwing
(4 centimeters)
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 already-attractiveness aspects. The hues, shapes,
and markings of butterflies’ wings are important for camouflage, courtship, and species recognition.
Monarchs’ distinctive coloration warns potential predators of their unpalatability.

Wing Scale
(width 60 micrometers, or millionths of a meter)
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.

Scale Ridge
(width 600 nanometers, or billionths of a meter)
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.

Chitin Fibril
(diameter 3 nanometers)
Like other insects, the butterfly’s soft interior is
supported by a hard exoskeleton made of the
carbohydrate chitin and a matrix of fats and proteins.
Chitin is one of nature’s most common organic
molecules, found in insect and crustacean exoskeletons
as well as the beaks of squid and octopi and the cell
walls of fungi. The chitin in a butterfly’s wing scale
takes the form of long strands or fibrils.

Chitin Molecule
(width 1 nanometer)
Chitin fibrils are composed of molecular chains of
oxygen, nitrogen, carbon, and hydrogen atoms.
Strong bonds between chains give chitin its exceptional
toughness. However, this also means that chitin doesn’t
stretch with growth—so insects and other arthropods
periodically shed their exoskeletons, 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 Atom
(.15 nanometers)
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 tiny tubes have inspired both
practical advances (such as super-miniaturized electronics)
and fantastic new ideas (like elevators to space).