The Outside Story

How Flowers Get Their Color

By: Frank Kaczmarek

To quote the French dramatist Jean Giradoux, "The flower is the poetry of reproduction. It is an example of the eternal seductiveness of life." Flowering plants fill our summer fields and gardens, bring bright spots of color to our woods, and – since their arrival on the scene some 130 million years ago – have evolved along with animal life to become an essential part of the food web.

There are approximately 300,000 species of flowering plants – about 80-90 percent of all known plants – and scientists estimate that 85 percent of these rely on insects, birds, or bats to reproduce. Many of these pollinators seek out flowers in part by distinguishing their colors. A hummingbird, for example, may hone in on red flowers. A nectaring bat will seek out pale, night-blooming flowers that glow in the moonlight. Bees are attracted to "bee's purple," a color that combines yellow and ultraviolet light and is outside the range of human vision.

Flower color mostly comes from pigments, molecules that selectively absorb some wavelengths of light while reflecting others. Those reflected wavelengths are what we see. While the color produced in a few species stems from a single pigment, most result from a mixture of pigments. Generally speaking, structurally simple flowers usually display a single color, while flowers exhibiting a greater degree of structural complexity will often display more color combinations.

The most abundant family of pigments involved in the production of flower color is flavonoids, from which anthocyanins and anthoxanthins are derived. Flower colors in the indigo to red range, such as blue delphiniums and red geraniums, are formed from anthocyanins. Yellow and some white flowers – daffodils, for example – get their color from anthoxanthins.

Flavonoids aren't only in flower tissues. These water-soluble pigments are dispersed throughout the cell sap, and along with carotenoid pigments contribute to autumnal color, as the masking green of chlorophyll empties from leaves. They're also dynamic. The intensity and hue of flavonoid flower color may

change depending on such factors as acidity, temperature, and metabolic activity.

Another major family of color pigments is the carotenoids. These pigments are localized inside cell structures called plastids and produce rich, vibrant yellow and orange colors such as those in sunflowers and the California poppy. Carotenoids also serve as accessory pigments aiding in photosynthesis and in protecting the plant cell from light damage.

Other floral pigments include tannins, which give rise to browns and blacks, betalains, and chlorophyll. Betalains are found in a limited number of plant families, primarily the cacti and related species, and produce a range of colors. Chlorophyll, the ubiquitous green pigment in plant foliage and the key player in photosynthesis, can color a flower green as well.

A flower's color is typically most intense when the pollen is ready for release. Pigment molecules have a limited lifespan, however, and after fertilization, or simply because of aging, they begin to break down. As the degraded molecules accumulate, flower color fades.

As with birds, some flowers also owe their appearance to structural color. While some white petal flowers derive their color from pigments, the pure white petals of most flowers, such as the common water lily, are actually colorless. They appear white due to air spaces interspersed within their petals' tissue. These spaces reflect back all the visible wavelengths of light causing the petals to appear bright white.

Another example is that of the common buttercup flower. The flower's glossy, highly reflective yellow color is due to a unique interaction of light with three different tissue layers within its petals.

Pigments and structure are the main sources of flower color, but the ways that flowering plants combine these elements and respond to environmental factors such as sun, rain, wind, and soil, is endlessly complex. Although not completely understood, flower color production remains a fascinating aspect of plant biology and a pleasing aesthetic that continues to nurture the human spirit.

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