florology 101

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Hue and eye make a beautiful pair!

What is color? And why do humans—or birds or bees or Spanish bulls for that matter—respond so strongly to it?

We know that color tends to be the first thing that a person notices about a flower arrangement, and that we can use that information to make the arrangement more appealing to a potential customer. But where does color come from? And what makes it so important?

This article is the first in a series about the flowers and plants we handle every day. Mostly it will explore fun and useful facts relating to botany. This month, however, we need to start with a little physics lesson.

Color comes from that portion of the energy continuum known as the visible spectrum—wavelengths of light energy vibrating at specific frequencies that allow us to see red, orange, yellow, green, blue, and violet, along with all the hues, tints, tones, and shades that exist in, around, and between them. Now, if the idea of a visible spectrum conjures up the idea of a non-visible one, you're on the right track. In fact, there are wavelengths of light energy at either end of the visible spectrum—the infrared and the ultraviolet—that we can't see. But other creatures among us can, which, as it turns out, is a good thing for the flowers.

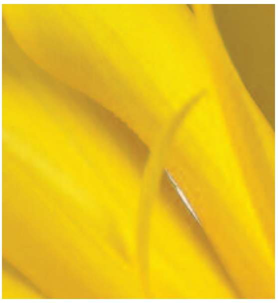
The retina at the back of a human eye is composed of two types of cells: the rod cells and the cone cells, so named because of their shapes when viewed through a microscope. The rod cells are sensitive to light, even at very low levels. It is the cone cells, however, that allow us to see color. When light energy is reflected off of whatever it is we're looking at and absorbed by these cone cells, they convert the light energy into chemical energy that stimulates a nerve cell. From there the impulses travel along the optic nerve to the brain, where they are decoded into the images we know as vision.

In the human eye, there are many more rod cells than cone cells, but in other animals the ratio is different. Hawks, for example, have a much greater number of cone cells than humans do, allowing them to see the colors of the various small animals that make up their prey from great distances. Furthermore, some animals and insects see a different spectral range of colors than humans do. Bees, as a matter of fact, aren't able to see the long wavelengths of light that we perceive as the color red, but they are able to see the short wavelengths of light in the ultraviolet range. On the other hand, hummingbirds can most easily see colors that have red in them, including orange, red-purple, hot pink, etc.

Flowers appear to be the colors they are because of the presence of pigments in their petals. Pigments are chemical compounds found within the cells of plants that are involved in the plant's life processes. They also serve as visual cues to attract animals for pollination and seed dispersal. They are important as well to humans and other herbivores for their nutritional and antioxidant values.There are three different groups of plant pigments—flavenoids, carotenoids and chlorophyll—that, when combined in different proportions, give color to flowers. The flavenoids include the pigments that are responsible for reds, blues and purples seen in flowers and foliage. The carotenoid group produces yellows and oranges, as well as some reds. Chlorophyll is green and plays the critical role in photosynthesis. It's the sandwich-like layering of pigments, one on top of another with minute spaces in between, that produces the velvety surface appearance that we see in flowers like roses and gloxinias.

The reason flowers appear to be the colors they do is because the pigments absorb all the wavelengths of light energy except for the ones they reflect back to your eyes, which you experience as color. Simple, huh?

We all know that human beings typically have emotional responses to color. We speak of a psychology of color, which tells us that the so-called "warm colors"—magenta, red, orange, yellow, chartreuse—can get people excited or motivated, make them feel happy or excited, whereas the "cool colors"—violet, blue, turquoise, green—have a calming or soothing effect, or can even expresss sadness or depression. It's ironic that blue is the number-one favorite color in America, yet when someone is down in the dumps, we say they're feeling blue. Go figure.



Flowers don't care about any of that. All they care about is getting pollinated, and all those colorful petals exist solely to attract the attention of a pollinator. If their pollinator of choice is a hummingbird, they're going to be red. If it's a honeybee, they'll be yellow or purple. Flies? Blossoms will be purplish-brown (the color of rotting meat). Some flowers, generally in the tropics, are even pollinated by bats. Given that most bats are nocturnal, color is pointless since you need light to see it. So bat-pollinated flowers are usually big and white so as to show up in the dark of night.

In addition to colors and all their myriad variations, many flowers also sport markings in the form of stripes, speckles, or spots. We humans find the stripes in the throat of an alstroemeria blossom or the speckles on the petals of certain lilies to be charming—part of the flower's appeal. But flowers use these markings as part of their advertising strategy. Known as nectar guides, the spots and stripes serve as directional signals, pointing the way for a bee or a butterfly to find the sweet nectar deep within the recesses of the petals. Some nectar guides are actually invisible to humans because the markings reflect ultraviolet light. A classic and extremely successful example of this is the black-eyed susan. Not only are its petals bright yellow (one of a bee's favorite colors), but unbeknownst to you it has surrounded its center with an ultraviolet ring, creating something of a target with a bull's eye that a bee can't miss.

Humans, too—although for different reasons—crave colorful flowers with beautiful markings, keeping hybridizers and geneticists busy working to come up with that next new thing. Take roses, for example. Through decades of careful selection and breeding, we have literally hundreds of varieties at our disposal: splashy patterns like Abracadabra and Henri Matisse; flamboyant bi-colors like Circus and Fire & Ice; subtle shadings like Sahara and Lollipop; unheard-of hues like the nearly brown Leonidas and the startling Super Green. Is it red you want? There are dozens of choices, from the tomatoey Rouge Baiser to the mysterious Black Baccara.

Through patience, intuition, and luck, breeders have been able to develop flowers in an incredible range of colors. But there are some colors that will never appear as the result of conventional hybridizing techniques. The reason is that the expression of color is contained within the genetic code of the plant. A rose has the genetic raw materials to potentially express as color almost any possible combination of its available pigments; any color, that is, except blue. There simply is no genetic code in a rose's DNA to create blue pigments, such as delphinidin and cyanidin (both flavenoids).

That elusive blue rose is something of a Holy Grail among breeders, and with modern science's gene splicing techniques, it may not be too far off. After all, they've already managed to pull the right gene sequence out of corn and insert it into petunias to create orange flowers. And it's the genes from petunias that have produced those cool new purple Florigene carnations. But there's a glitch. Colors expressed by certain pigments are influenced by the pH of the cellular environment. So if we take a blue gene from a petunia, which has a cell pH that is more acidic than that of a rose, and insert it into the rose's DNA, it may be expressed as pink. But if we tinker with the rose to change the pH of its cells, we run the risk of altering all kinds of other cellular functions. The flower might then be blue, but it may not resemble a rose as we know it. So don't hold your breath waiting for a blue rose; you'll turn blue long before the rose does. To humans, color means emotion. To plants and their pollinators, color is a vital aspect of biology.

Which brings up an interesting question: if bees can't see red, what happens when they get angry?