florology 101

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Why green is the one color you can't live without.

Green makes the world go 'round.

Well, the color green doesn't exactly cause the earth to spin on its axis. But of all the colors in the spectrum, green truly is the color of life. Without it, life as we know it wouldn't exist. The sun would scorch the planet. Earth's atmosphere would be toxic. There would be nothing to eat. There would be no available energy to fuel our bodies or run our machines. And it all comes down to one simple molecule: chlorophyll, the green pigment of plants.

As florists, we tend to take green for granted. You could even say that we have a love-hate relationship with it. After all, practically every leaf and stalk that we handle is green, and a lot of it goes into the garbage as we strip away the foliage and re-cut the stems of our fresh flowers. It stains our skin and our clothing. It gets under our fingernails. Untold tons of chlorophyll get trashed every day in flower shops around the globe.

We really ought to have a little more respect for the stuff, because chlorophyll drives the process of photosynthesis—the miraculous mechanism by which plants take air, water and sunlight and turn it into food, releasing oxygen along the way. It's photosynthesis that makes life on earth possible, converting solar energy into chemical energy, producing carbohydrates that may be used for food or fuel, and even generating the breathable atmosphere. On top of all that, photosynthesis actually purifies the air that we breathe by removing carbon dioxide and other gases from it. Let's take a closer look, starting with a little chemistry lesson.

Turning sunlight into carbs

Photosynthesis is a chemical process that takes place within the cells of leaf tissue, in specialized structures called chloroplasts. You could think of leaves as solar energy collectors, crammed full of photosynthetic cells. Chloroplasts are like miniature carbohydrate factories, fueled by photosynthesis, cranking out the food and raw building materials that plants need to survive and grow.

The chemical equation that takes place during photosynthesis is the reaction between carbon dioxide and water, catalyzed by sunlight, to produce glucose (a simple sugar) and a "waste product"—oxygen. The equation can be represented like this:

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

In a chemical equation, the total number of atoms on one side of the reaction must equal the total number on the other side. In this case, six molecules of carbon dioxide (CO_2) plus six molecules of water (H_2O) are broken apart and recombined by the action of sunlight and chlorophyll to form one glucose molecule ($C_6H_{12}O_6$) and six molecules of oxygen vapor ($6O_2$). The total number of six carbon atoms, 18 oxygen atoms and 12 hydrogen atoms is the same on either side.

That's not so hard, is it?

Photosynthesis actually takes place in two stages. In the first stage, known as the Light Reactions, light strikes the chlorophyll molecule and water is broken into oxygen atoms, hydrogen protons, and a couple of stray electrons. These charged, stray electrons capture the light's energy, which is then stored and used to fuel the second stage. The oxygen is released into the atmosphere through minute pores, called stomates, which occur mostly on the underside of the leaf's surface. The oxygen, of course, is used by plants, humans and other animals to sustain life.

In the second stage, called the Dark Reactions, carbon dioxide is captured from the atmosphere through the stomates. By a process known as the Calvin Cycle, the carbon dioxide is combined with the hydrogen protons from the first stage to form glucose, a simple carbohydrate.

Plants at work

Just in case you think that most plants are just standing around, doing nothing, consider this: it's been estimated that one large maple tree—with, say 500 pounds of leaves—can produce two tons of simple carbohydrates during one nice sunny day. That's a lot of work!

Glucose is "burned" by plants to fuel the process of respiration. Or, it can be used to form more complex sugars and starches that are stored for later use. Tuberous root crops, like potatoes, carrots and beets, are obvious example of those kinds of starches. Glucose is also a component of cellulose, the supporting structural tissue of plants—the kind that gets stuck in your teeth when you munch on a stalk of celery.

All of this is able to happen because of chlorophyll and its ability to capture the energy of sunlight. The chlorophyll molecule has a ring-like structure composed of carbon and nitrogen, with a magnesium atom at the center. The structure is actually quite similar to the hemoglobin molecule that carries oxygen through our own bloodstreams, except that hemoglobin has iron at the center of the ring. Both kinds of molecules are constructed in a way that allows them to readily bind with and give up oxygen ions.

It is the presence of chlorophyll that allows plants to obtain practically all their energy needs from the blue and red parts of the spectrum, leaving a large spectral region where very little light is absorbed. This light is in the green part of the spectrum, and since it is reflected rather than absorbed by the chlorophyll pigment, most plants appear green. In fact, chlorophyll absorbs light so strongly that it can mask other, less intense colors. Some of these more delicate colors, like yellows and oranges from pigments such as carotene and quercetin, are revealed only when the chlorophyll molecule fades away with the shorter days of autumn. In some trees, like maples, excess glucose trapped in the leaves after photosynthesis stops will break down to create anthocyanins, turning red in the bright days and cooler nights of fall. Then, due to the action of a plant hormone called abcissic acid, those leaves will fall to the ground. Soil-borne microbes will gradually decompose them, releasing and returning to the soil essential nitrogen, carbon, and other trace elements so that they may nourish and support the growth of future generations of plants.

There is an elegant economy of materials and energy in this endless cycle of growth and decomposition—endless, that is, unless mankind interferes and breaks the cycle through irresponsible agricultural practices and the destruction of the world's rain forests.

It is no exaggeration to say that life as we know it could not exist were it not for the presence of chlorophyll. Until about 400 million years ago, when vascular plants first began to colonize the land, the earth's atmosphere did not have enough oxygen in it to support life. Before then, there had been a very slow buildup of oxygen through the actions of certain bacteria, beginning about 2 billion years ago. After a time (a really long time), sufficient oxygen was present in the stratosphere to be acted upon by sunlight and form the ozone layer, which shields the earth from most of the sun's harmful ultraviolet rays. Only then could plants safely exist on land, and with the abundance of carbon dioxide present in the atmosphere at that time, they flourished. The bulk of the oxygen in the atmosphere began to be formed once terrestrial life commenced on the planet, principally through the process of photosynthesis. Eventually there was enough oxygen present to support higher life forms.

Because photosynthesis allows plants to convert light energy into food energy, they are the foundation of every food chain. Plants are eaten by insects, rabbits, deer, and other herbivores. Even microscopic algae are consumed by tiny shrimp. These herbivores are then preyed upon by carnivores, like snakes, foxes and fish. Carnivores in turn are eaten by other carnivores, such as bears, mountain lions, and human beings. Of course, if you had a salad for lunch, you've skipped a couple of steps. Still, at every level of the food chain, energy is passed from one stage to the next. And it all starts with chlorophyll.

Air-purifying plants

Chlorophyll even helps plants purify the air. Indoor environments often harbor dangerous chemicals, such as formaldehyde (found in carpets, pressed wood products, foam insulation, cigarette smoke and more) and benzene (in solvents, inks, adhesives, plastics, etc.), to name just a few. These chemicals can become a significant problem in structures like office buildings where, for purposes of energy conservation, the environment is more or less sealed, without ventilation to the outside air. "Sick building syndrome" occurs when there is a buildup of such compounds in closed or poorly ventilated offices or homes, leading to multiple symptoms of illness among the human occupants.

Fortunately, houseplants are extremely effective at scrubbing the air clean of these harmful compounds. In the process of photosynthesis, impurities in the air are drawn in along with carbon dioxide through the stomates of many plants and then broken down or sent south to the roots and eliminated. In fact, plants can remove from three to ten times the maximum permitted levels of occupational indoor air concentrations of these chemicals in 24 hours—and the system actually gets better with repeated exposure. Some of this air-purifying activity can be attributed to microbes in the potting soil. But the plants are directly involved there too. Different species develop unique soil microorganisms around their roots, creating a species-specific symbiotic relationship for optimal growth. Plants sometimes expend, via their roots, from 25% to 45% of the net photosynthetic product of their leaves just to keep the microbes growing!

A number of years ago, NASA did some experiments to determine which green and flowering plants were most efficient at removing potentially toxic substances from the air indoors. This can be a great selling point for your customers. Using these plants in a home or office will not only create a more visually appealing environment, it will also improve the quality of the air to make it a more pleasant place to live and work; a place where people feel better, perform better, and enjoy life more.

If you're curious to know how many houseplants you need to clean up the air in your own living room, the recommendation is one six-inch-pot-sized plant per 100 square feet of room—and the leafier, the better.

Hence, as you can see, green really does make the world go 'round (it's just a coincidence that green is also the color of money in the U.S.). We owe our lives—not just our livelihoods—to chlorophyll and the photosynthetic process it makes possible. It kind of makes you look at that poor bedraggled spathiphyllum standing there in the dark corner with a little more respect. So when you finally give it a drink of water, think about its place in the grand and global scheme of things, and let the photosynthesis begin!

NASA'S Top Ten List of Air-Purifying Plants

Bamboo palm
Chamaedorea seifritzii

Chinese evergreen
Aglaonema modestum

English ivy
Hedera helix

Gerbera daisy
Gerbera jamesonii

Janet Craig dracaena
Dracaena fragrans 'Janet Craig'

Dracaena marginata
Dracaena marginata

Corn plant
Dracaena fragrans 'Massangeana'

Mother-in-law's tongue
Sansevieria trifasciata

Pot mum
Chrysanthemum morifolium

Peace lily
Spathiphyllum floribundum

Striped dracaena
Dracaena deremensis 'Warneckii'

Flowers&