Photosynthesis – We Don't Just Eat It, We Also Breathe It

Most people are aware of the fact of photosynthesis taking place all around them. Plants absorb light from the sun and use the energy in that light to convert carbon dioxide (CO_2) into new plant material.

There is also good general understanding that photosynthesis is the basis of all life on this planet.

Photosynthetic organisms, plants on land, and algae and photosynthetic bacteria in the oceans, are at the base of all food chains. Organisms eat them and are eaten by other organisms, and they, in turn, are eaten by yet other organisms in a food pyramid that ultimately gets to the level of humans, more quickly if you are a vegetarian and a bit slower if you are not.

At this level of understanding of the process, it is obvious that if photosynthesis were to stop tomorrow, almost all life on earth would cease to exist, the exceptions being a limited number of organisms that make a living on inorganic chemicals found in certain unusual environmental circumstances (e.g., hydrogen sulfide found in hydrothermal vents in the deep ocean).

It turns out that we owe even more to photosynthesis than that. Delving into a bit more detail, photosynthesis as carried out by all land plants and algae, and many photosynthetic bacteria, involves converting CO_2, light and water into sugar plus oxygen (O_2). The sugar is used to generate new plant material, and oxygen, a byproduct of the process, is released.

Going back 2 to 3 billion years ago, when this version of photosynthesis (known as "oxygenic" photosynthesis for oxygen-producing) first appeared, there was no free oxygen in the atmosphere. In fact, for up to 1 billion years after the appearance of oxygenic photosynthesis, the oxygen that was released was rapidly converted to water. At some point between 1 and 2 billion years ago, free oxygen began to appear in the atmosphere. That was bad news for many organisms because oxygen is a pretty toxic molecule (but that is another story) and mass extinctions clearly resulted from this development.

However, the appearance of oxygen in the atmosphere was a seminal event for other organisms because it allowed for the evolution of aerobic respiration. That is the process by which organisms metabolize sugars to produce the energy needed to carry out all the reactions that go on in a living cell. Chemically, aerobic respiration converts sugar and oxygen to CO_2, water and energy, the exact reverse of photosynthesis.

The significance of aerobic respiration to evolution results from the fact that it produces 18 times more energy per unit of sugar used than energy metabolisms that take place in the absence of oxygen (e.g., fermentations). This had a huge effect on evolution because organisms were no longer forced to live on the edge energetically speaking; they suddenly had struck it rich. This led directly to the evolution of the first multicelled organisms because organisms now produced enough energy to make specialized cells and tissues, a process that has continued on a line through to the appearance of our own species.

Life could exist on earth without free oxygen, but it would be relegated to a collection of single-celled organisms living in aqueous environments. Because humans still rely on aerobic respiration, we have become totally dependent upon oxygen in the atmosphere, and the continued production of that commodity requires continued photosynthesis. As an aside, free oxygen in the atmosphere also led to the appearance of the ozone layer, without which organisms could not live on land, except possibly somewhere like under a rock.

There is much else about the details of photosynthesis that is fascinating. However, the primary point I would like to get across here is that humans are totally dependent upon photosynthesis, not only as the basis for all of our food production, but also for continuing to produce the oxygen needed to allow us to convert that food into all the components that make up our cells and tissues. Remember that, not only when you sit down to breakfast, but also beforehand during your morning jog.

Contributed by
James M. Siedow, Ph.D.
Vice Provost for Research,
Duke University

APRIL 5, 2003

1st Annual Korean Garden Festival

Celebrating the 100th Anniversary of Korean Immigration to the United States

The First Annual Korean Garden Festival will be held on Ayres Hall lawn on Saturday, April 5, from 9:00 am to 4:30 pm. This all-day cultural event will highlight the Korean culture in a garden setting, sharing with the community at large Korean traditional gardens, music, art, dance, and food.

For the day, Ayres Hall lawn will be transformed into a Korean Village. Several Korean Garden displays, designed by local Korean landscape designers, will highlight the festival. The Korean Village will also feature a food court with traditional Korean foods, various forms of traditional Korean music and dance (including a children's choir), Korean art exhibition, Tae Kwon Do demonstrations, and informal demonstrations and lectures on gardening.

DON'T MISS THIS EXCITING CLASS: The ABC's of Plants taught in Korean by Jae Soon Song on Saturday, April 19, from 2:00-4:00pm in Lecture Hall A. The cost is $15 for members and $18 non-members.