

Photosynthesis



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The dark reaction takes place in the stroma within the chloroplast, and converts CO₂ to sugar. This reaction doesn't directly need light in order to occur, but it does need the products of the light reaction (ATP and another chemical called NADPH). The dark reaction involves a cycle called the Calvin cycle in which CO₂ and energy from ATP are used to form sugar. Actually, notice that the first product of photosynthesis is a three-carbon compound called glyceraldehyde 3-phosphate. Almost immediately, two of these join to form a glucose molecule.

Most plants put CO₂ directly into the Calvin cycle. Thus the first stable organic compound formed is the glyceraldehyde 3-phosphate. Since that molecule contains three carbon atoms, these plants are called C₃ plants. For all plants, hot summer weather increases the amount of water that evaporates from the plant. Plants lessen the amount of water that evaporates by keeping their stomates closed during hot, dry weather. Unfortunately, this means that once the CO₂ in their leaves reaches a low level, they must stop doing photosynthesis.

Even if there is a tiny bit of CO₂ left, the enzymes used to grab it and put it into the Calvin cycle just don't have enough CO₂ to use. Typically the grass in our yards just turns brown and goes dormant. Some plants like crabgrass, corn, and sugar cane have a special modification to conserve water. These plants capture CO₂ in a different way: they do an extra step first, before doing the Calvin cycle. These plants have a special enzyme that can work better, even at very low CO₂ levels, to grab CO₂ and turn it first into oxaloacetate, which contains four carbons.

Thus, these plants are called C4 plants. The CO₂ is then released from the oxaloacetate and put into the Calvin cycle. This is why crabgrass can stay green and keep growing when all the rest of your grass is dried up and brown. There is yet another strategy to cope with very hot, dry, desert weather and conserve water. Some plants (for example, cacti and pineapple) that live in extremely hot, dry areas like deserts, can only safely open their stomates at night when the weather is cool. Thus, there is no chance for them to get the CO₂ needed for the dark reaction during the daytime.

At night when they can open their stomates and take in CO₂, these plants incorporate the CO₂ into various organic compounds to store it. In the daytime, when the light reaction is occurring and ATP is available (but the stomates must remain closed), they take the CO₂ from these organic compounds and put it into the Calvin cycle. These plants are called CAM plants, which stands for crassulacean acid metabolism after the plant family, Crassulaceae (which includes the garden plant Sedum) where this process was first discovered.