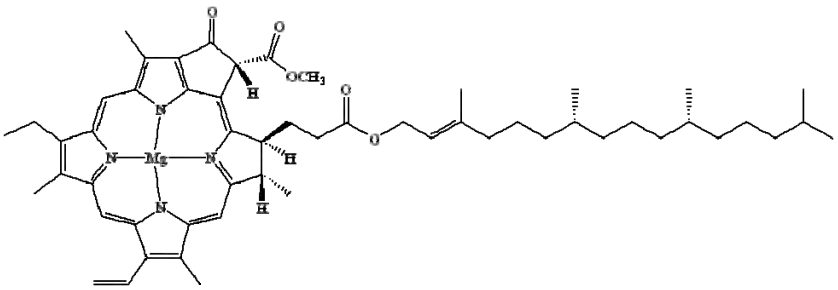
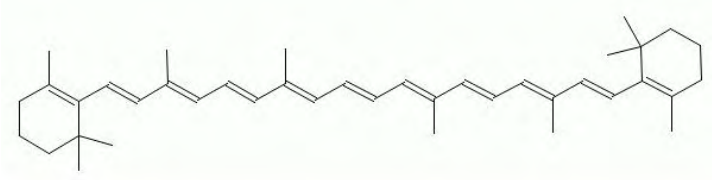
Coumarin

Plants are defined by their ability to capture light energy and utilize it to create an electrical gradient across a membrane. In subsequent steps, this gradient is used to generate the energy currency common to all living cells, ATP, which may then be used to perform the various forms of work that plants must do in order to grow and live. Chloroplasts are the organelles within plant cells that actually do this job - adding a phosphate group to ADP - in a process called photophosphorylation, or more commonly, photosynthesis. As it turns out, chloroplasts are remnant prokaryotic endosymbionts**:** in ultrastructural, chemical, and genetic detail, they look a lot like bacteria, because that's what they were, before they were internalized and developed codependency with primitive eukaryotic cells to become plants.



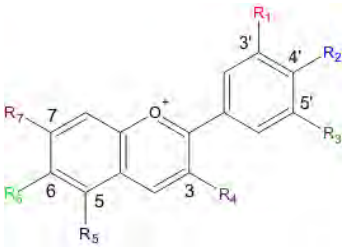
chlorophyll

Chlorophyll is the pigment that mediates conversion of absorbed light energy into electron-flow across the inner membrane of the chloroplast. Although chlorophyll is required for photosynthesis, however, other pigments – such as carotenoids – may also directly absorb photon energy and then transfer the captured energy along to a chlorophyll molecule at the photosynthetic reaction center. Carotenoids play a role in protecting the reaction center from oxidative damage and give a bright orange or red color to plant parts in which they are concentrated.

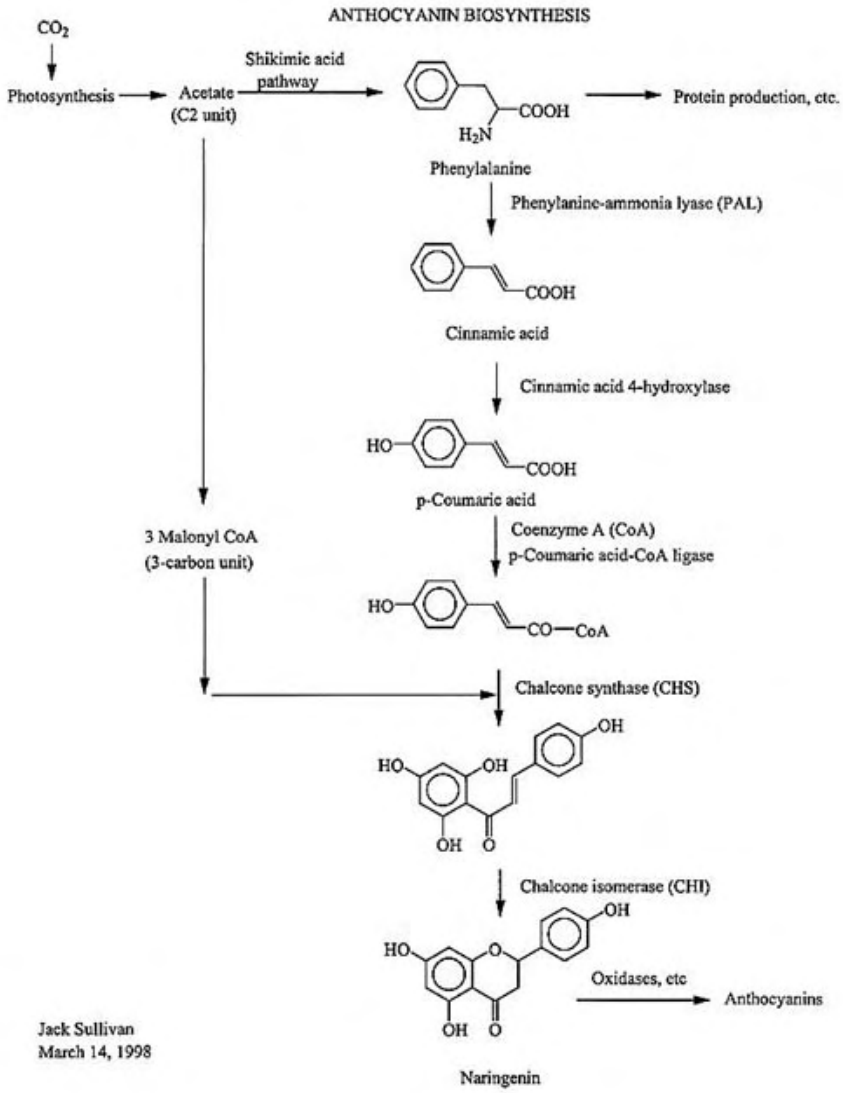


carotenoid

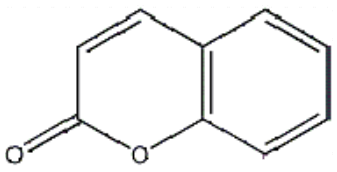
Additional pigments also serve to protect the photosynthetic reaction center and provide color to leaves and flowers of plants. These include the anthocyanins (also antioxidants), which are derived from the flavonoid class of plant metabolites. Anthocyanin accumulation is responsible for the intense red color of certain leaves in the fall and for the bright red, blue, and purple colors of many flowers (the color variation is in part due to ambient cellular pH, similar to the litmus reaction).



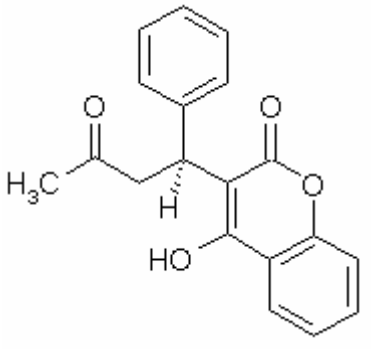
anthocyanin



Anthocyanin biosynthesis proceeds from acetate (formed as a product of photosynthetic fixation of atmospheric CO_2 and water) to the amino acid phenylalanine and then ultimately to anthocyanin. Coumarin is an intermediary in this pathway. Coumarin is responsible for the slightly vanillic smell of fresh-cut clover. The presence of a coumarin derivative (4-hydroxycoumarin) in clover was found to be responsible for the development of hemorrhagic illnesses in cattle that ingested moldy silage containing significant quantities of sweet clover.



coumarin



Coumadin (warfarin)

Subsequent research by the **W**isconsin **A**lumni **R**esearch **F**oundation resulted in the development of the anticoagulant warfarin (Coumadin), which was later found to act by interfering with the function of the enzyme epoxide reductase, resulting in depletion of vitamin K, inhibiting prothrombin activity.