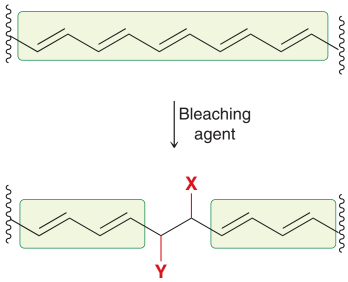
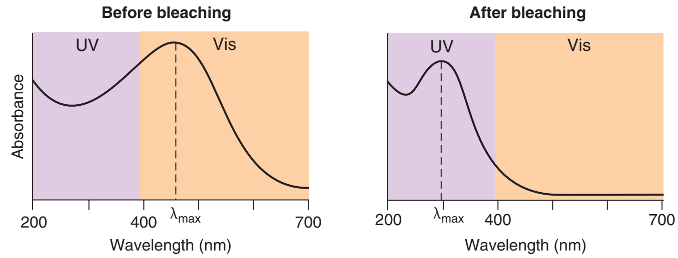
WorldLinks | Bleach

Now that we understand the origin of color in organic compounds, we are finally able to explore how bleaches function. Most bleaching agents react with conjugated π systems, disrupting the extended conjugation:



In this way, a conjugated π system that previously absorbed visible light is converted into smaller π systems that absorb UV light instead.

Notice the value of λ_{max} in each case. Before bleaching, the compound absorbs visible light and is colored. After bleaching, the compound absorbs only UV light and is therefore colorless.



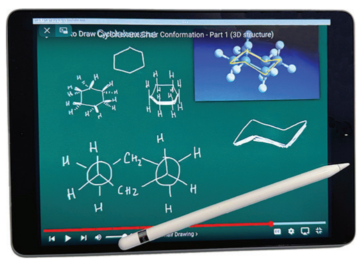
There are many different agents that will function as bleaches. Some act by oxidizing the double bonds, while others act by reducing the double bonds. Common household bleach (such as Clorox) is an aqueous solution of sodium hypochlorite (NaOCl) and is an oxidizing agent. When a stain is bleached, it has not been washed away. Rather, it has just been chemically altered so that it can no longer be seen. When placed under a UV lamp, the compound will glow, and its presence can be detected!

Structural Color

The color wheel demonstrates the complementary relationship between the wavelengths of visible light that are absorbed and those that are reflected. But how do the iridescent colors in bird feathers work? Why would a color ever change based on your viewing angle?

The ability of bleach to remove colors was described in the previous WorldLinks application: when a π bond in a chromophore undergoes a chemical reaction (*e.g.*, an addition or oxidation reaction) the conjugated π system is disrupted, and colors can disappear. Upon exposure to sunlight, the colored fabric on outdoor furniture usually fades over time, so how does a lizard keep its brightly colored skin from being "bleached" by the sun?

The secret behind these brilliant and beautiful colors is that they do not arise from absorption of light or electronic transitions. Rather than being produced by a pigment molecule, iridescent colors are produced by the interaction of light with the microscopic structure of a surface. As the light hits various structural features, such as thin films or nanoscale-sized parallel grooves, it undergoes diffraction (in other words, it separates). When the diffracted light waves recombine in various ways, they create new colors. Structural coloration is responsible for the luster of mollusk shells and mother-of-pearl, fish scales, bird feathers and iridescent beetles. The dazzling colors in butterfly wings are generated by thin layers of chitin (KY-tin), the organic material from which the exoskeletons of insects are built. Some colors in nature come from a combination of pigments and structural features. Such is the case for lizards and chameleons. A chameleon has a lattice of guanine nanocrystals in its skin that can be "tuned" to change its color.



Perhaps taking a cue from nature, chemists have applied the structural theory of color to develop liquid crystal displays that can be "tuned" to different colors. The molecules in a liquid crystal can move (like a liquid) but are somewhat organized (like a solid). Like a chameleon, the color of a liquid crystal can be changed by modifying its microscopic structure by using an electrical current (*e.g.*, LCD screens) or by varying the temperature (*e.g.*, mood rings).