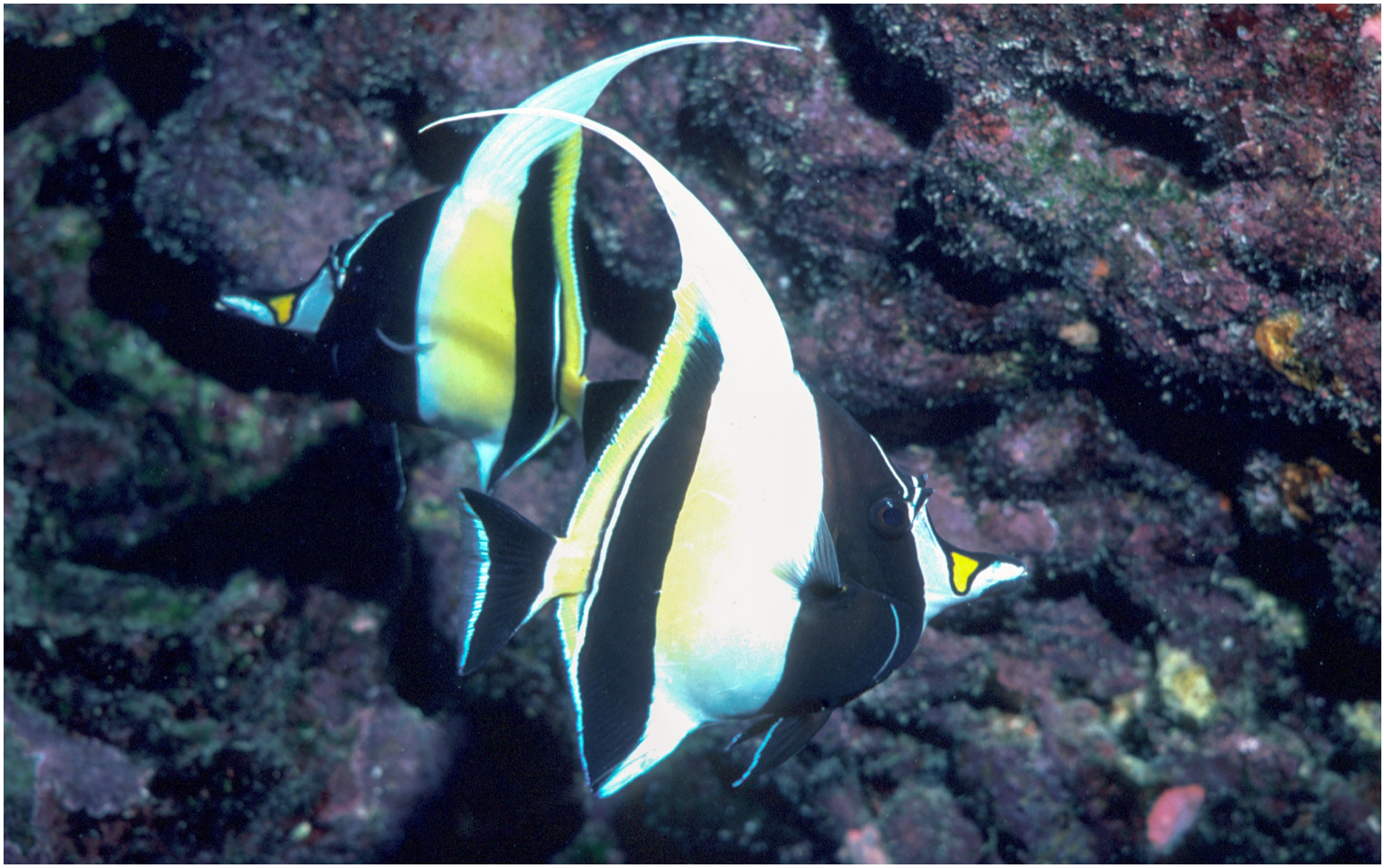
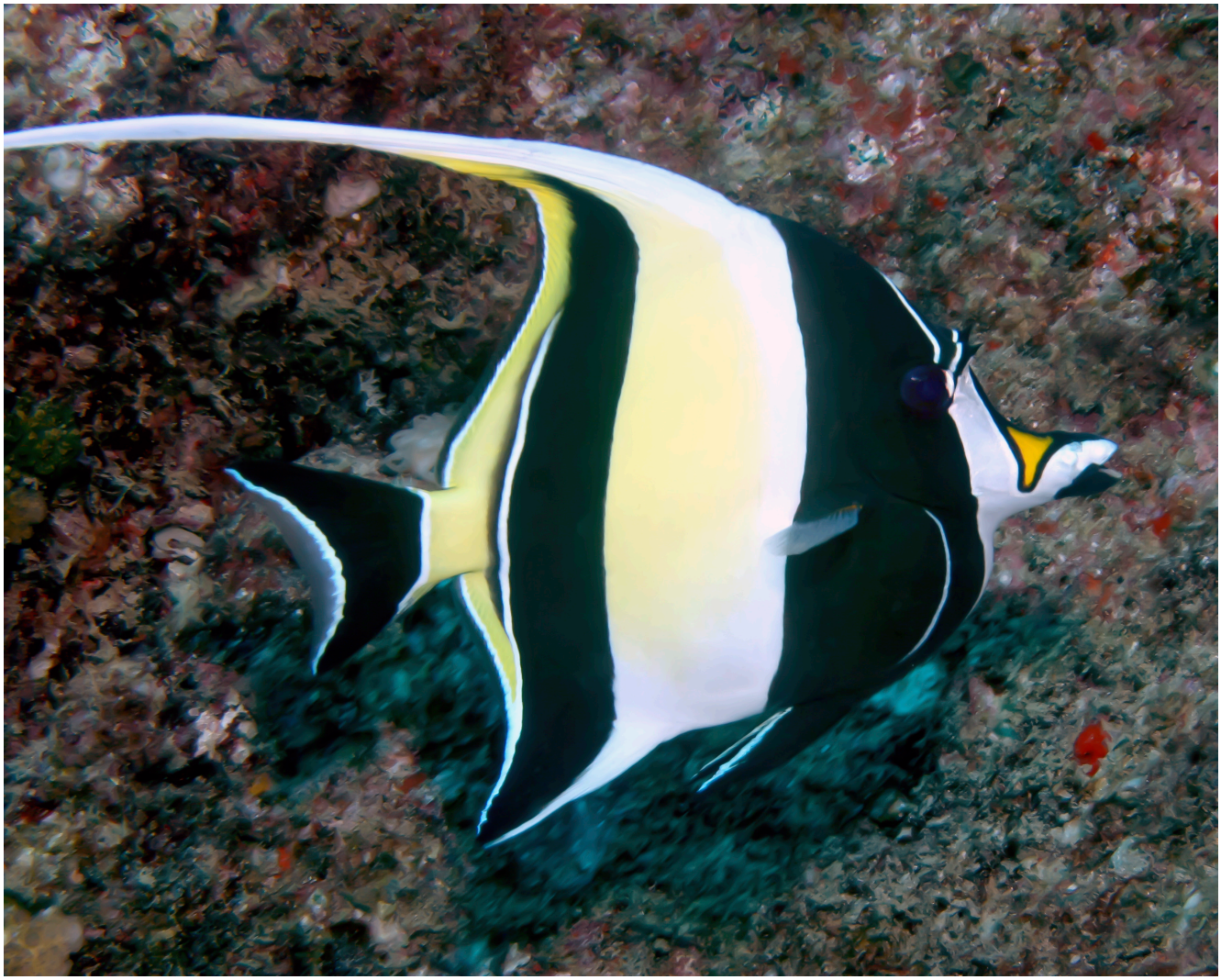
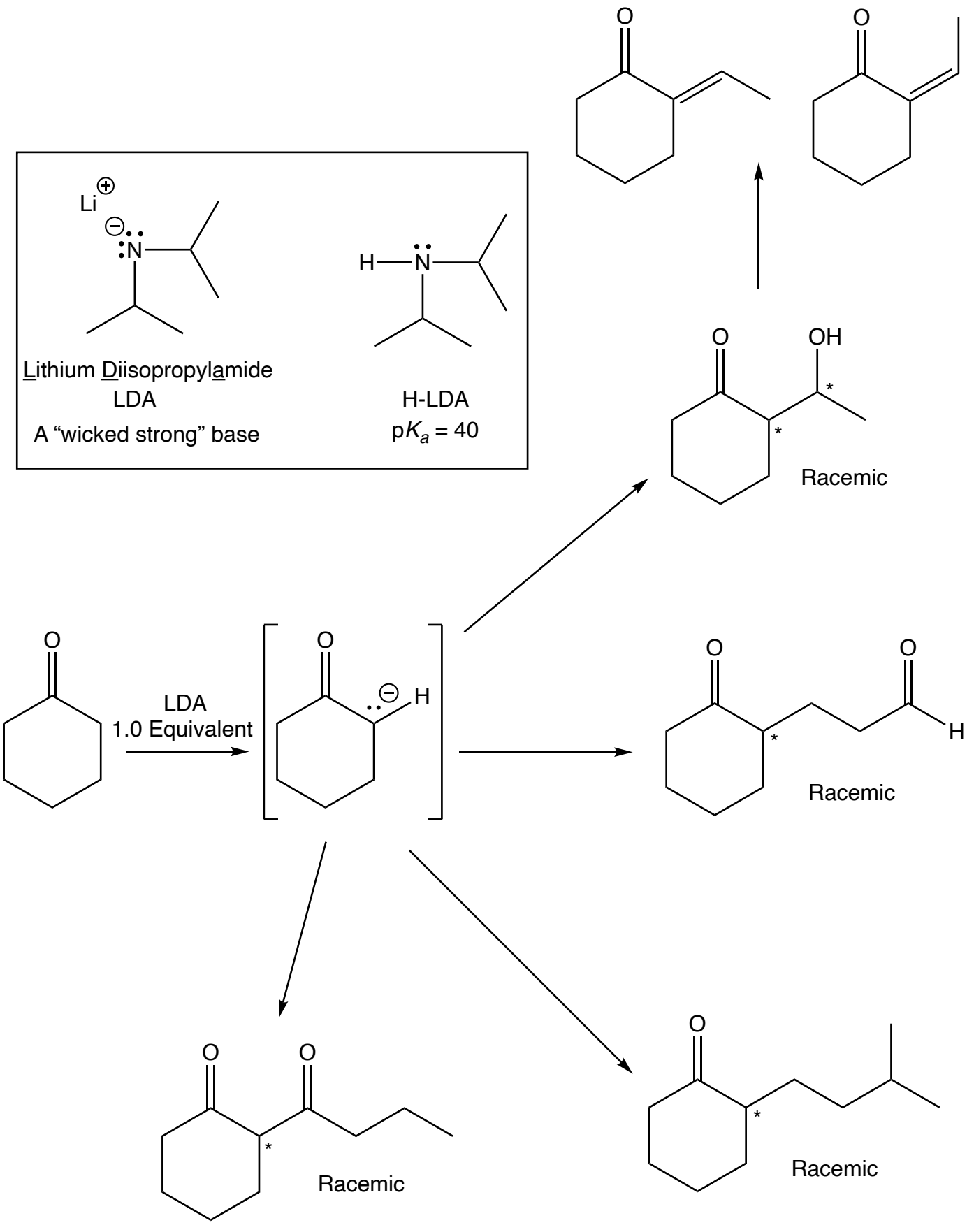





Li
N
H
N
Lithium Diisopropylamide
LDA
A "wicked strong" base
H-LDA
pKa = 40
O
O
O
OH
Racemic
LDA
1.0 Equivalent
O
H
O
O
H
Racemic
O
O
Racemic
O
Racemic

α,β-Unsaturated, nitriles, ketones, or esters

β-Substituted aldehydes, nitriles, ketones, or esters

β-Keto esters

α,β-Unsaturated aldehydes

Acid Chlorides

β-Hydroxy aldehydes

Aldehydes

Ketones

Carboxylic esters

β-Ketoaldehyde

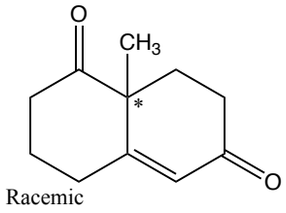
β-Diketone

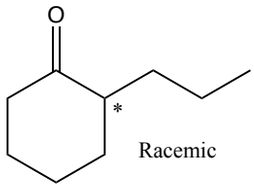
Carboxylic acids

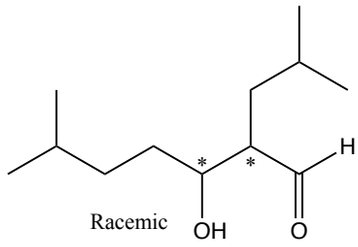
Substituted aldehyde

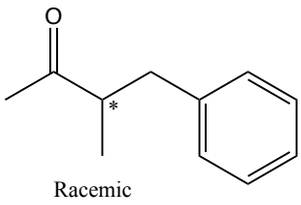
Substituted ketone

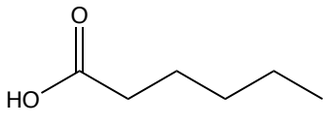
β-Diester

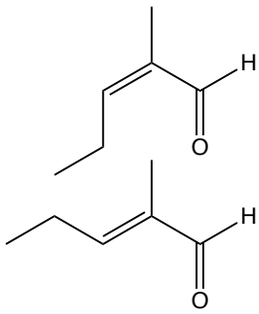

O
CH3
*
O
Racemic

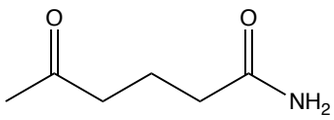

O
*
Racemic

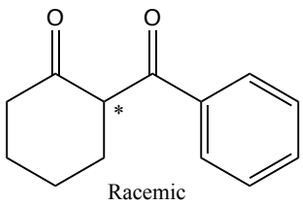

*
*
H
Racemic
OH
O

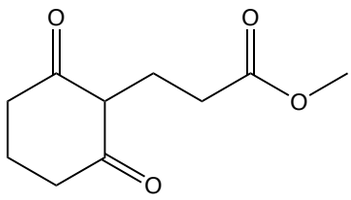

O
*
Racemic

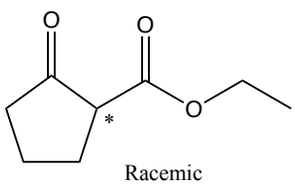

O
HO

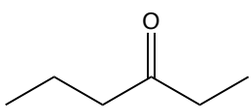

H
O
H
O

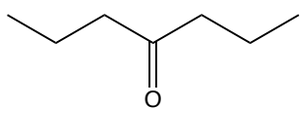

O
O
NH2

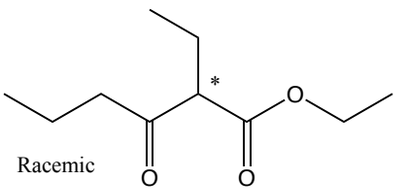

O
O
*
Racemic

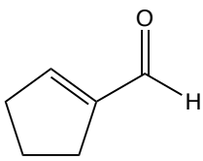

O
O
O
O


O
O
*
O
Racemic


O


O


*
O
Racemic
O
O


O
H

Electrons should be thought of as waves.

Orbitals are described by wave equations.

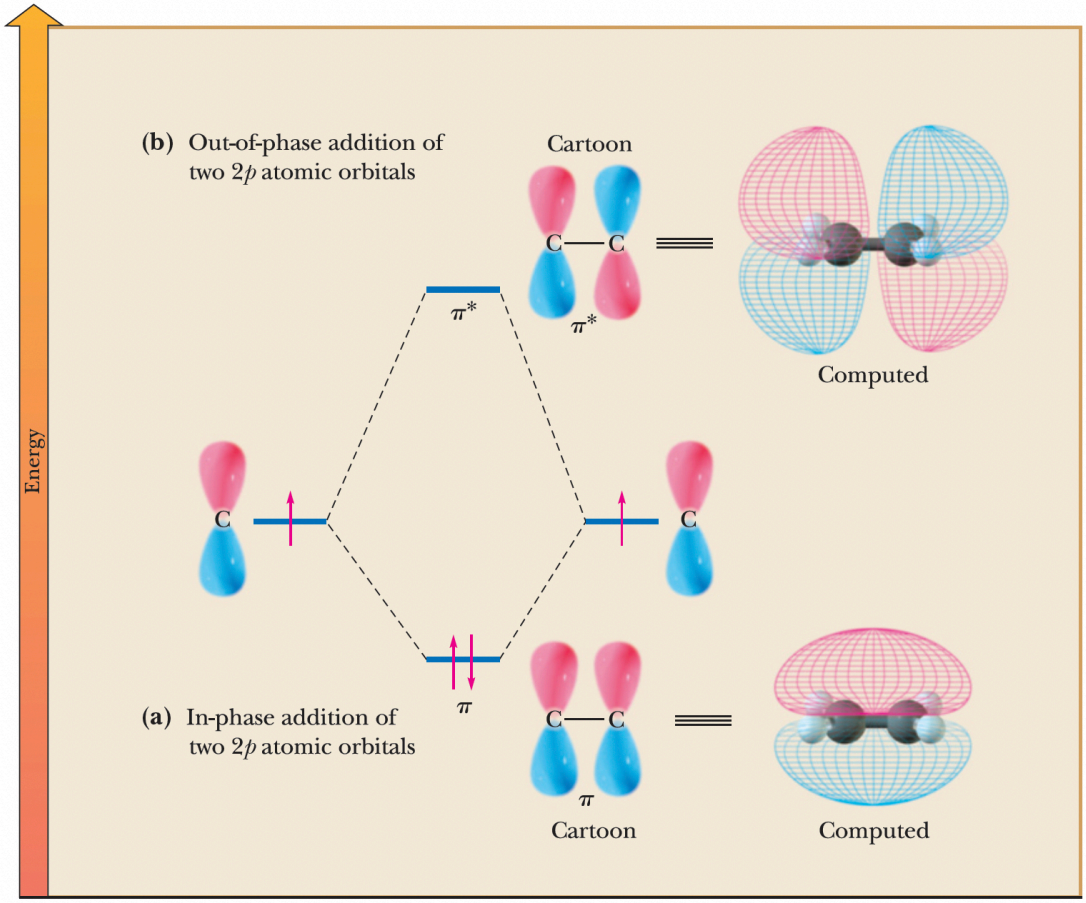
Like waves → orbitals can add constructively and destructively

When adding atomic orbitals, you get as many new molecular orbitals as there are component atomic orbitals

→ Half of these are bonding molecular orbitals.

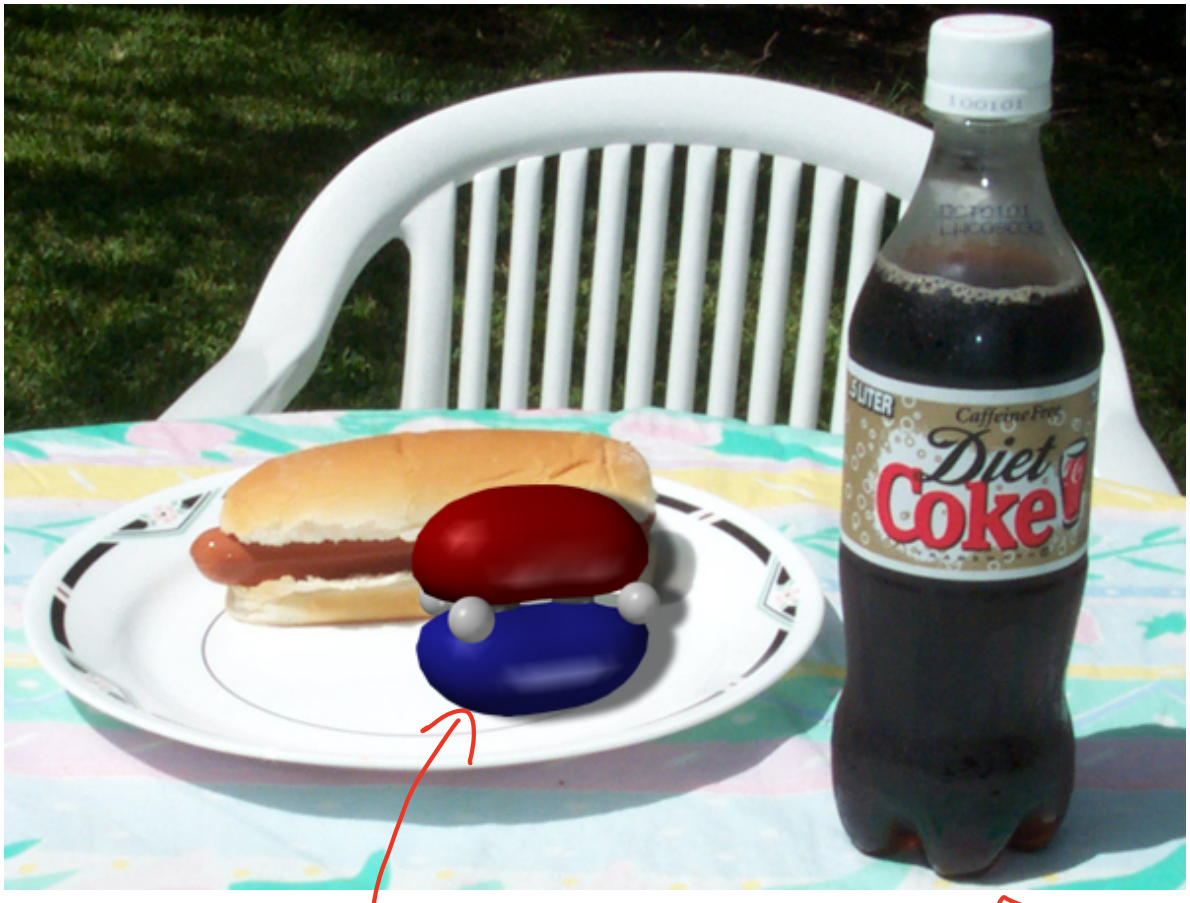
→ Half of these are antibonding molecular orbitals.

For molecules with adjacent 2p orbitals that overlap the resulting molecular orbitals extend over all of the atoms!



Watch a video explanation

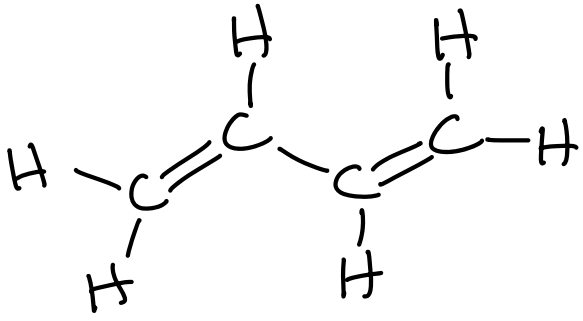
FIGURE 1.21 Molecular orbital mixing diagram for the creation of any C—C π bond. (a) Addition of two p atomic orbitals in phase leads to a π orbital that is lower in energy than the two separate starting orbitals. When populated with two electrons, the π orbital gives a π bond. (b) Addition of the p orbitals in an out-of-phase manner (meaning a reversal of phasing in one of the starting orbitals) leads to a π^* orbital. Population of this orbital with one or two electrons leads to weakening or cleavage of the π bond, respectively.



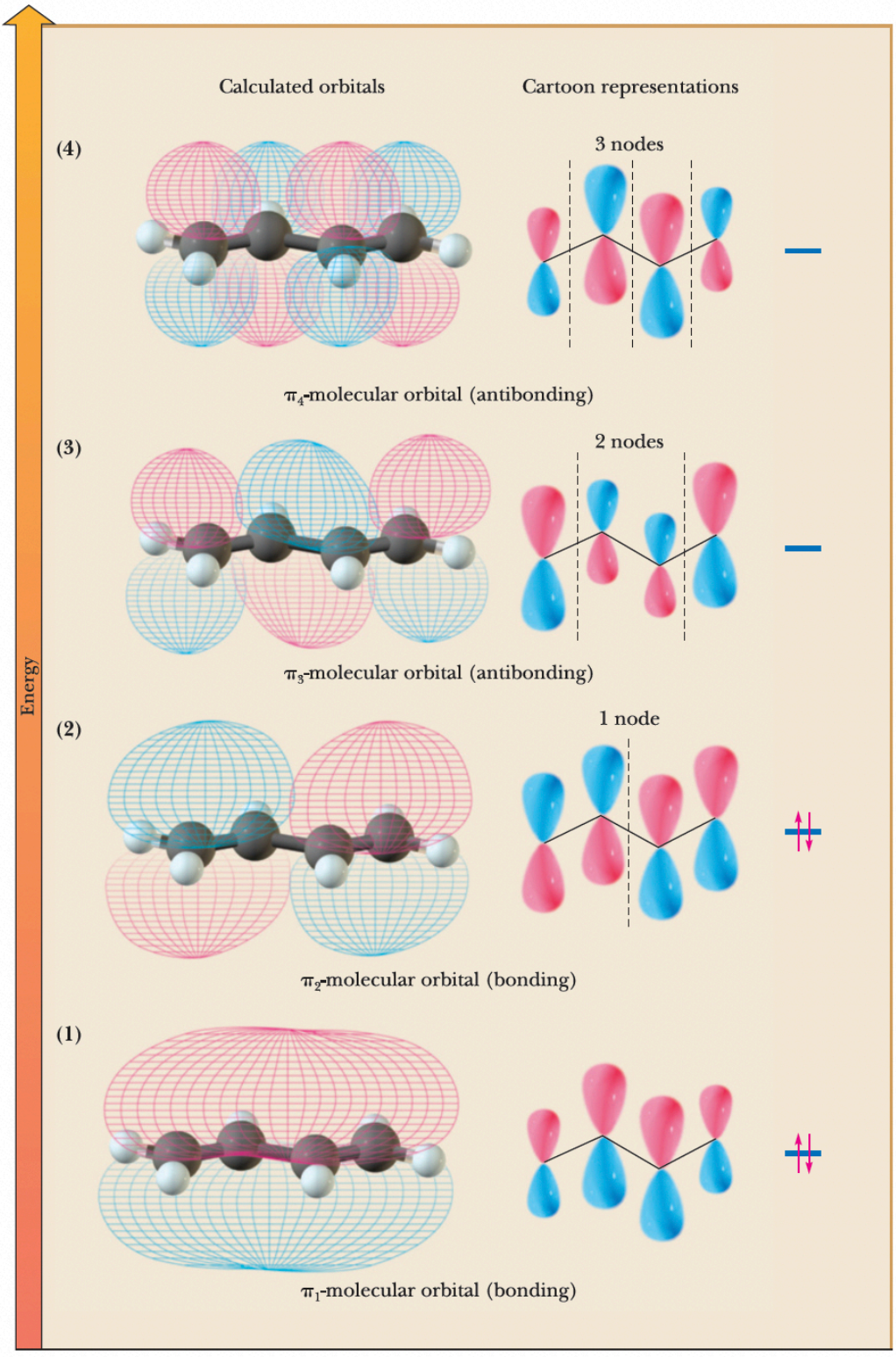
π bonding orbitals look like hot dog buns → formed from the overlap of 2p orbitals.

If you drink a lot of this you have 2p

The same applies when there are 4 atoms, each with an overlapping 2p orbital:



1,3-Butadiene

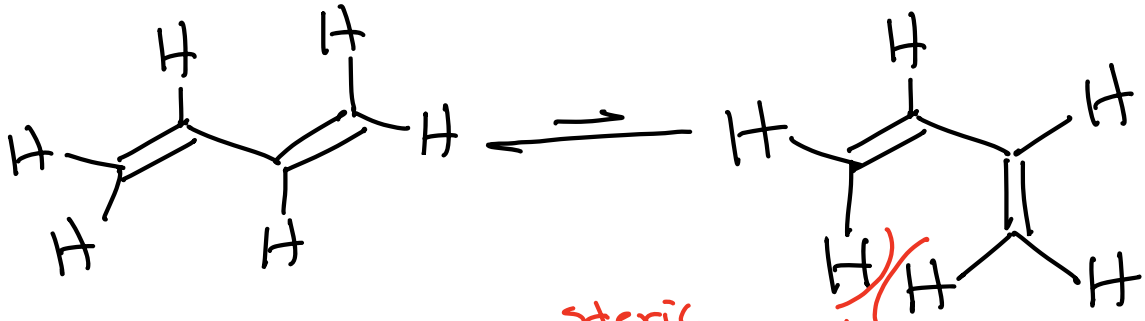


Watch a video explanation

FIGURE 20.2 Structure of 1,3-butadiene—molecular orbital model. Combination of four parallel 2*p* atomic orbitals gives two π-bonding MOs and two π-antibonding MOs. In the ground state, each π-bonding MO is filled with two spin-paired electrons. The π-antibonding MOs are unoccupied.

Consequence of the "π-way" molecular orbital → The bond between the middle 2 carbon atoms is not a normal sigma bond.

⇒ partial double bond because of lowest energy molecular orbital (π way)



s-trans

More stable

steric strain

s-cis

Less stable due to some steric strain

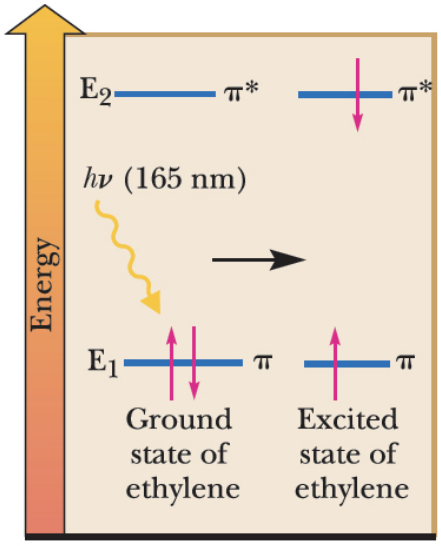


FIGURE 20.6 A $\pi \rightarrow \pi^*$ transition in excitation of ethylene. Absorption of ultraviolet radiation causes a transition of an electron from a π-bonding MO in the ground state to a π-antibonding MO in the excited state. There is no change in electron spin.

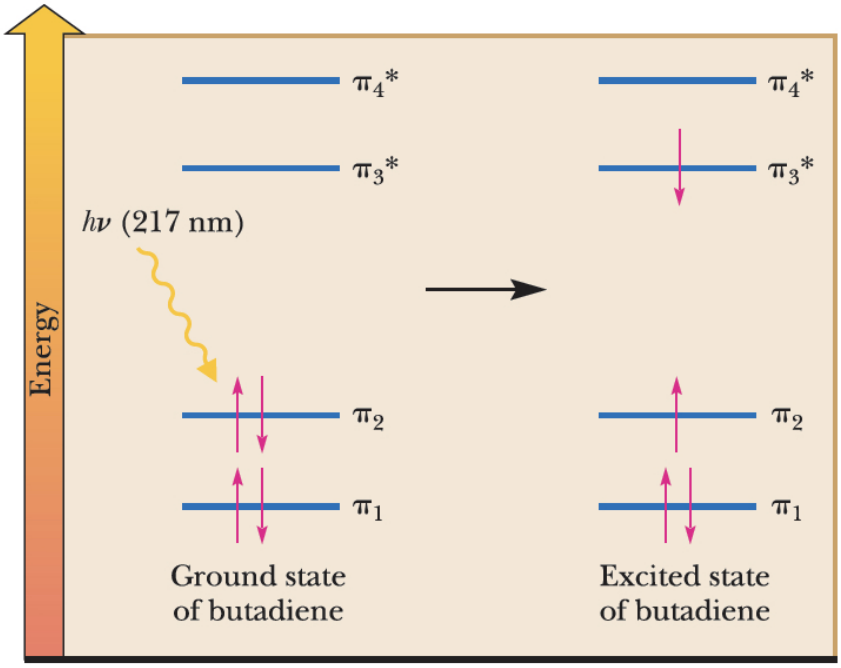


FIGURE 20.7 Electronic excitation of 1,3-butadiene; a $\pi \rightarrow \pi^*$ transition.

As you add 2p orbitals → the energy gap between the highest filled π molecular orbital and the lowest unfilled π molecular orbitals gets smaller ⇒ leads to longer wavelengths of light → to be correct energy to be absorbed

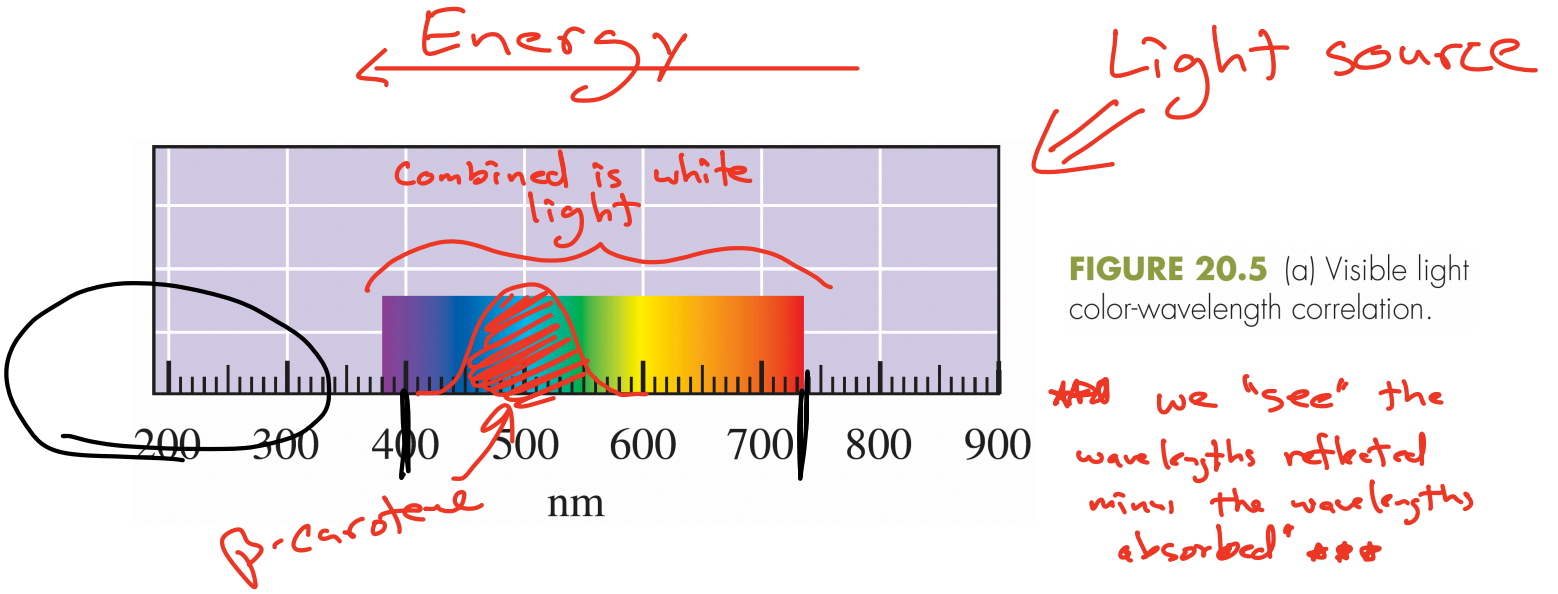
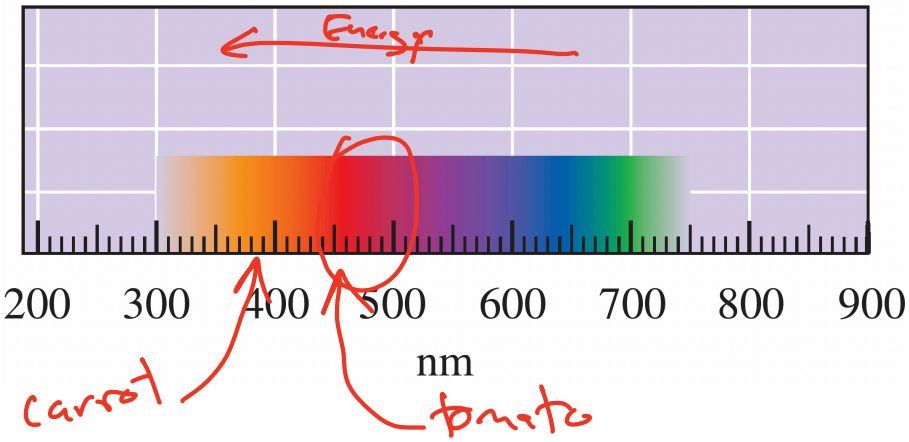
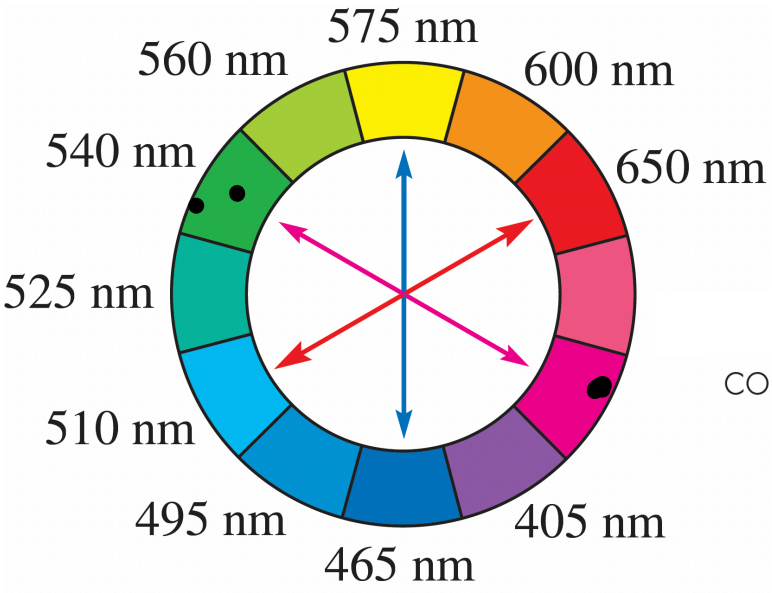


FIGURE 20.5 (a) Visible light color-wavelength correlation.

we "see" the wavelengths reflected minus the wavelengths absorbed

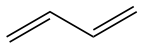


(b) Approximate color of substance (reflected light) if a single wavelength (i.e., the wavelength listed on the numerical scale of the *x*-axis) is absorbed.



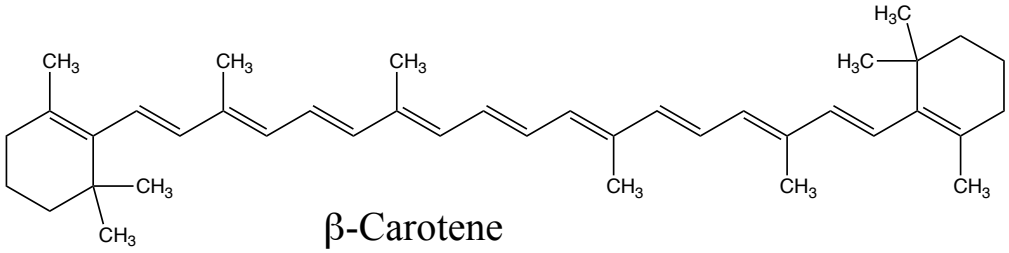
(c) Complementary colors on a color wheel.

Colored arrows are complementary



Butadiene

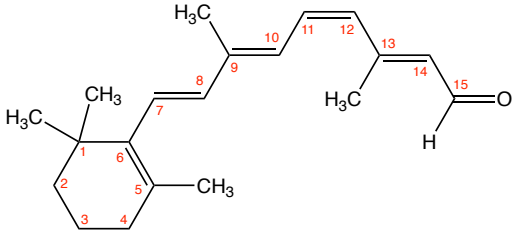
λ_{max} = 217 nm



β-Carotene

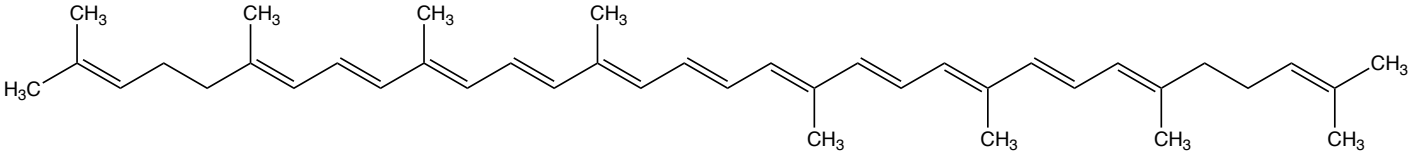
λ_{max} = 455 nm, 483 nm

Carrots



11-*cis*-Retinal

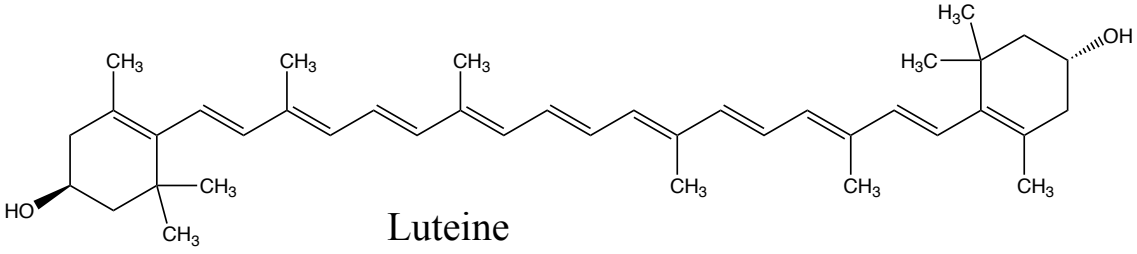
λ_{max} = 380 nm



Lycopene

λ_{max} = 443 nm, 471 nm, 502 nm

Tomato?!



Luteine

λ_{max} = 445 nm, 474 nm

<u>Organic Chemistry</u> is the study of carbon-containing molecules. This class has two points.

The first point of the class is to understand the organic chemistry of living systems. We will teach you how to think about and understand the most amazing molecules on the planet!!

You will learn how MRI scans work. 1/14/26

You will learn the basic principles of pharmaceutical science and how many drugs work. 1/21/26

You will learn about the special bond that holds carbohydrates such as glucose in six-membered rings, connects carbohydrate monomers together to make complex carbohydrate structures and is critical to DNA and RNA structure. 2/2/26

You will learn how soap is made from animal fat and how it works to keep us clean. 2/23/26

You will learn the important structural reason proteins, the most important molecular machines in our bodies, can support the chemistry of life. 2/16/26

You will learn how important antibiotics like penicillins work, including ones that make stable covalent bonds as part of their mode of action.

You will learn why carrots are orange and tomatoes are red. 3/25/26

You will learn the very cool reason that the DNA and RNA bases are entirely flat so they can stack in the double helix structure.

You will learn how energy drinks work.

You will learn even more about why fentanyl is such a devastating part of the opioid problem and how Naloxone is an antidote for a fentanyl overdose.

You will learn even more details about why Magic Johnson is still alive, decades after contracting HIV, and how the same strategy is being used to fight COVID.

You will learn about the surprising chemical reason the Pfizer and Moderna mRNA vaccines elicit strong immune responses.

The second point of organic chemistry is the synthesis of complex molecules from simpler ones by making and breaking specific bonds, especially carbon-carbon bonds.

You will learn how carbon-metal bonds lead to new carbon-carbon bonds. 1/21/26

You will learn how most reactions of carbonyl compounds involve only the four common mechanistic elements operating in only a few common patterns. 1/21/26

You will learn how, by simply adding a catalytic amount of base like HO^- to aldehydes or ketones, you can make new carbon-carbon bonds, giving complicated and useful products. 3/2/26

You will learn a reaction that can convert vinegar and vodka into a common solvent. 2/11/26 (Fischer esterification)

You will learn why molecules with six-membered rings and alternating double bonds are stable.

You will learn a reaction that can turn model airplane glue into a powerful explosive.

Most important, you will develop powerful critical thinking skills:

1. You will learn how to look at a molecule and accurately predict which atoms will react to make new bonds, and which bonds will break during reactions.
2. You will learn how to analyze a complex molecule's structure so that you can predict ways to make it via multiple reactions starting with less complex starting molecules.

White → reflects all wavelengths of visible light.

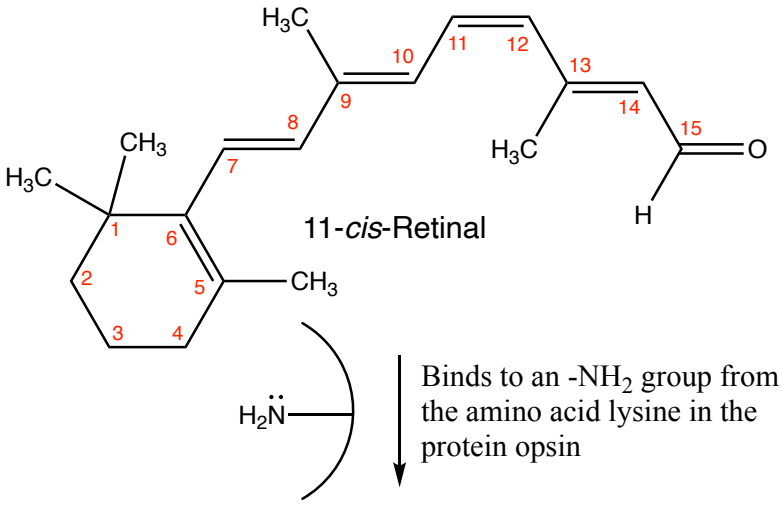
Black → absorbs all wavelengths of visible light.

Absorbs all light including orange — it will be black in an orange light.

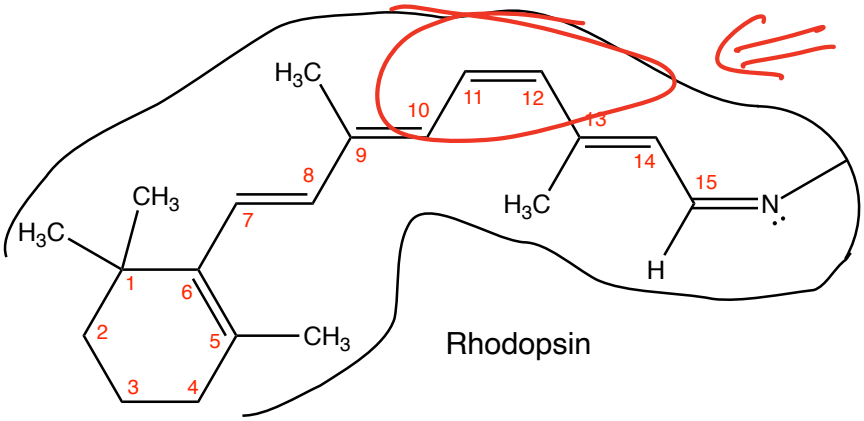
when illuminated under an orange light — both reflect all of it and look orange

How vision works, the final edition!

How vision works



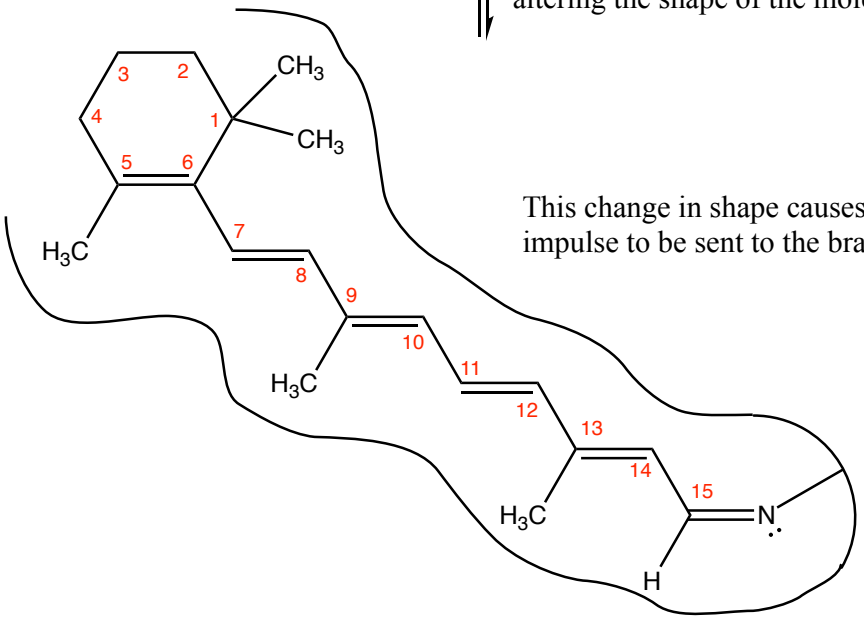
Binds to an -NH_2 group from the amino acid lysine in the protein opsin



Absorbing the photon puts an electron into an antibonding π orbital → weaken π bond, especially around $C_{11}=C_{12}$ so bond can rotate back to more stable trans geometry

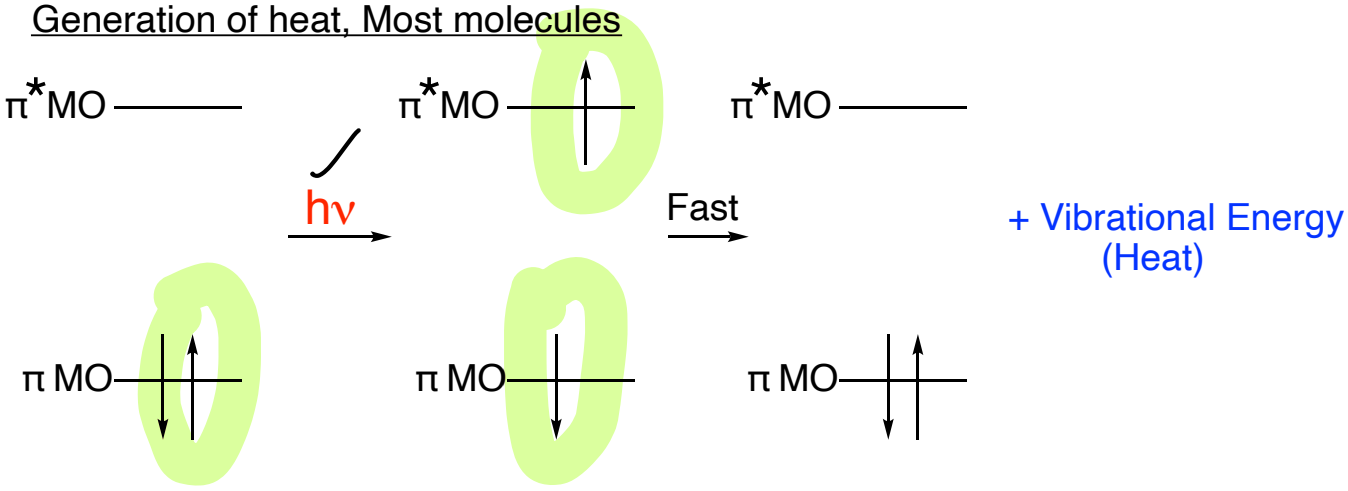
Molecule resets

A photon of visible light is absorbed by the retinal, isomerizing the *cis* bond to *trans*, dramatically altering the shape of the molecule

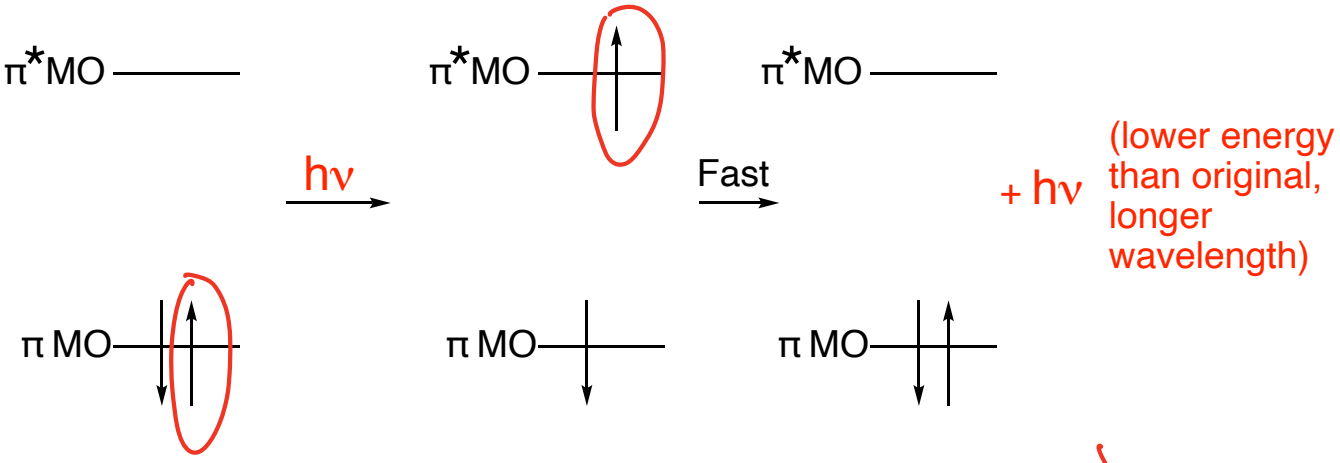


This change in shape causes a nerve impulse to be sent to the brain

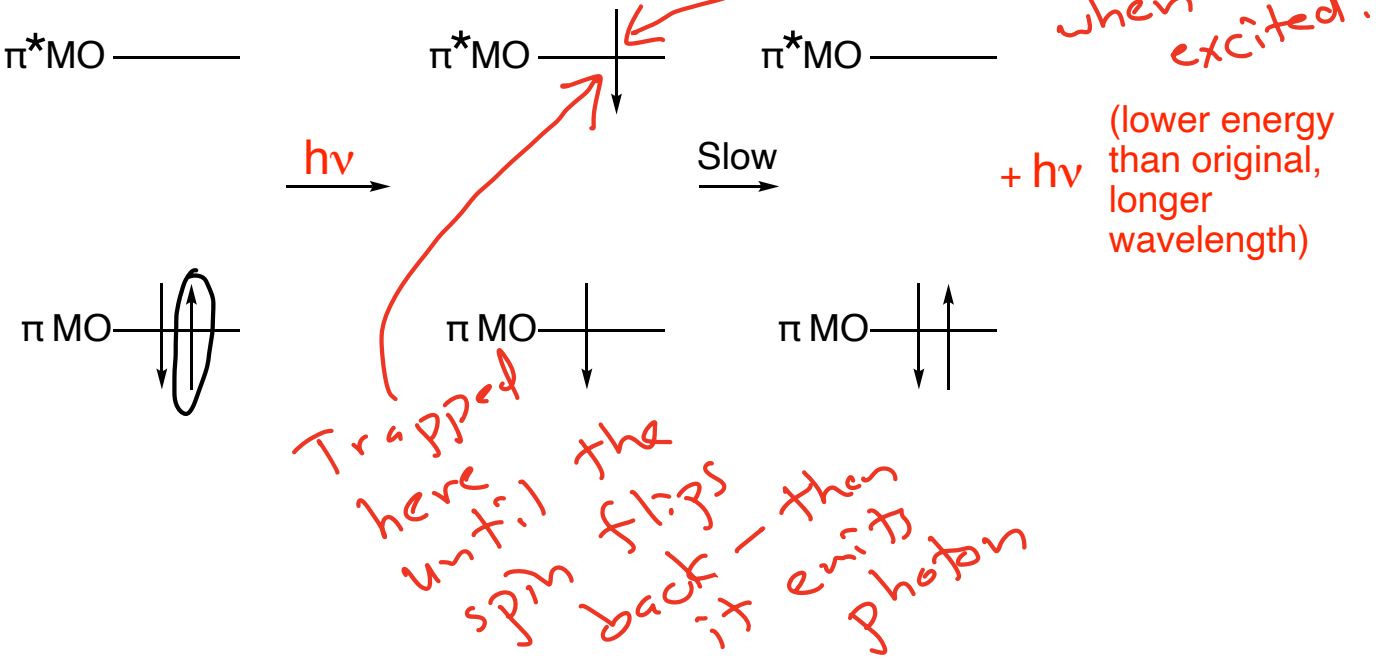
Generation of heat, Most molecules



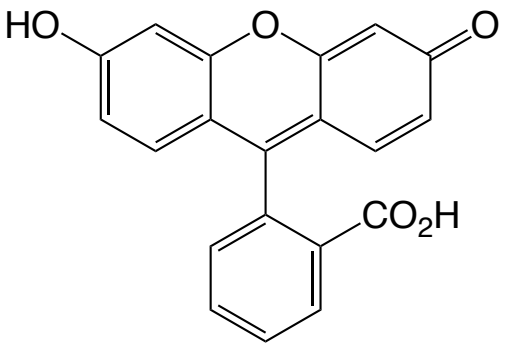
Flourescence - Rigid Molecules, Not uncommon



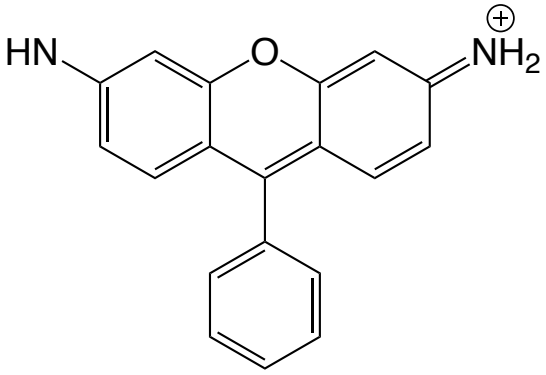
Phosphorescence - "Glow in the Dark", Rare



Flourescence - Rigid Molecules, Not uncommon

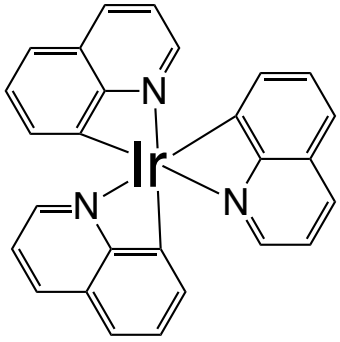


Fluorescein

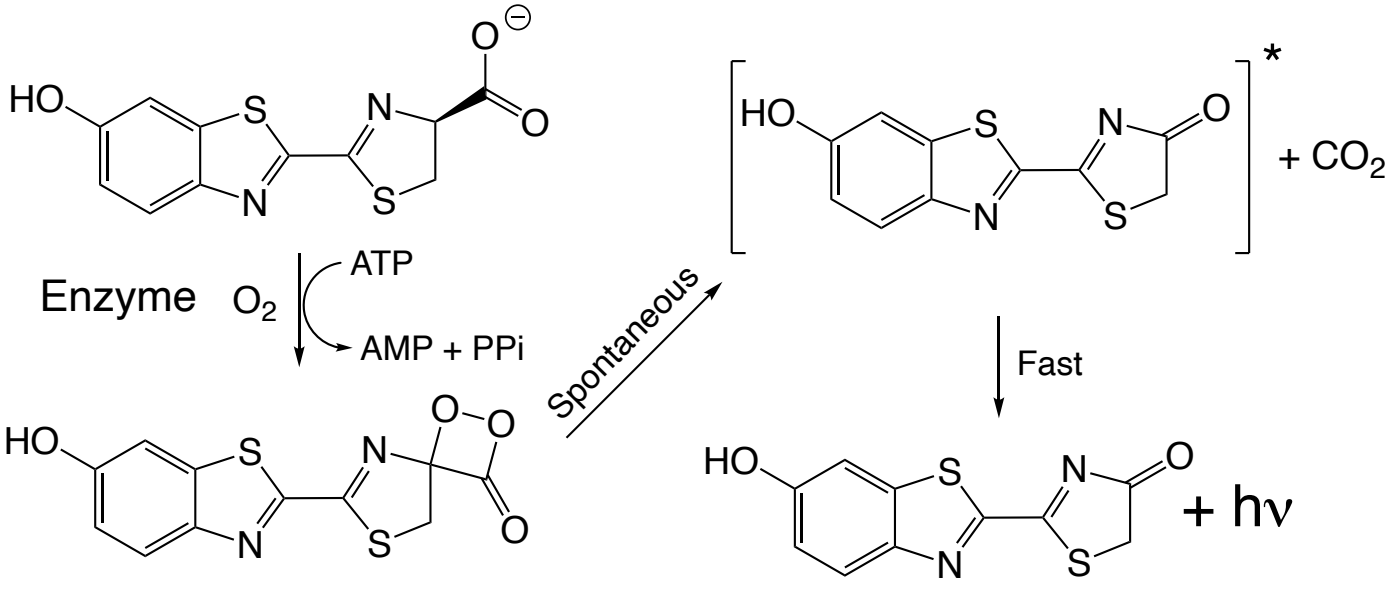


Rhodamine

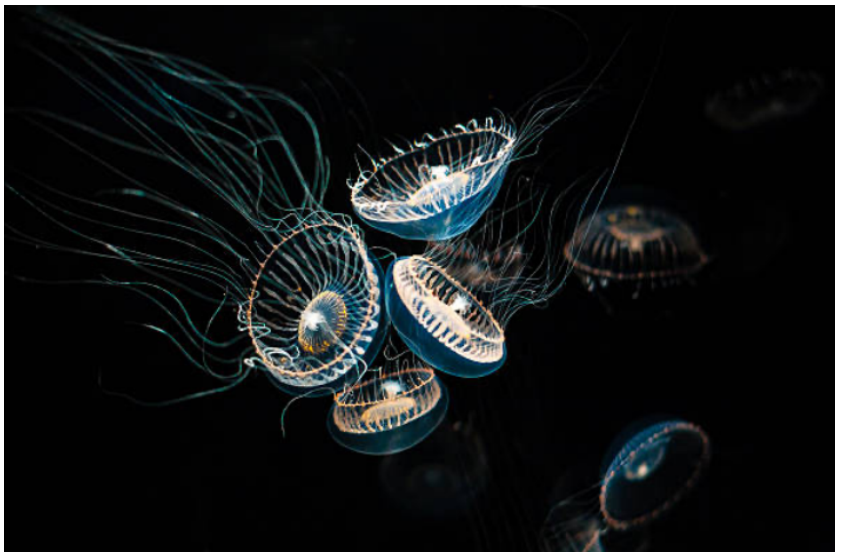
Phosphorescence - "Glow in the Dark", Rare

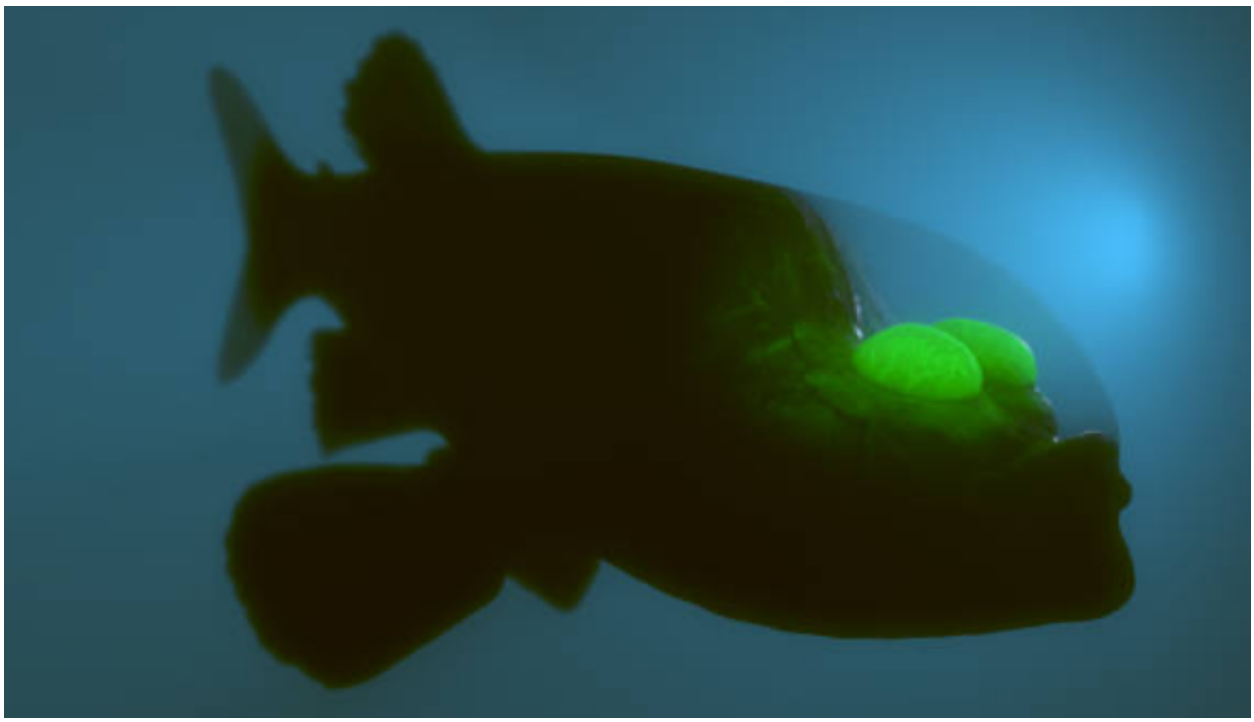


Bioluminescence - Fireflies, Deep Sea Creatures - Chemical Reactions



http://photobiology.info/Branchini2.html





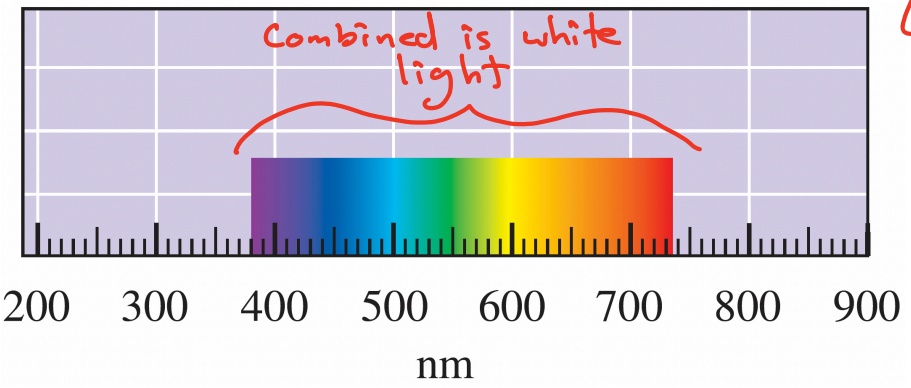
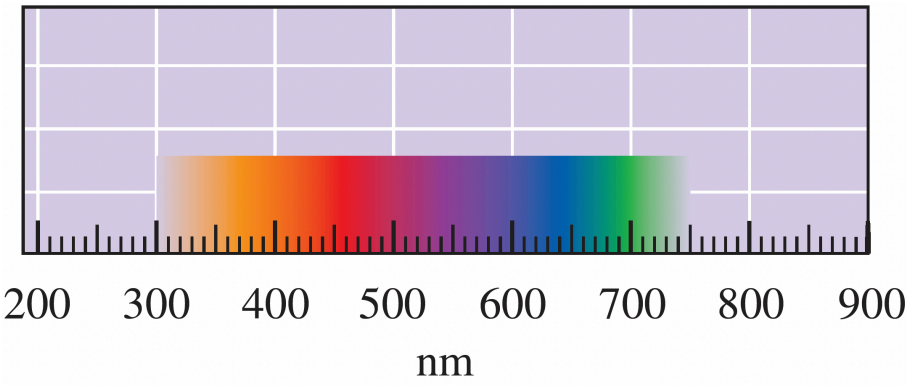
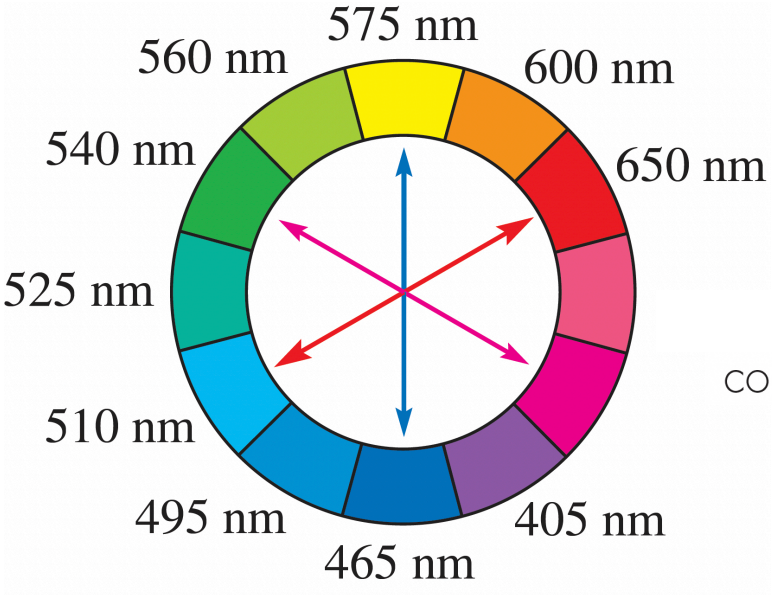


FIGURE 20.5 (a) Visible light color-wavelength correlation.

*** We "see" the wavelengths reflected minus the wavelengths absorbed ***



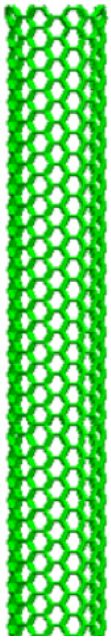
(b) Approximate color of substance (reflected light) if a single wavelength (i.e., the wavelength listed on the numerical scale of the *x*-axis) is absorbed.

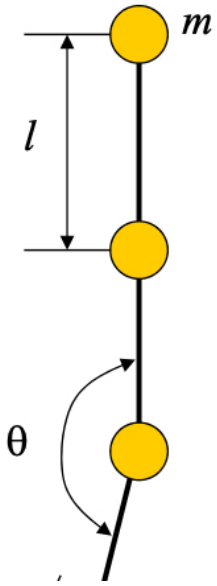


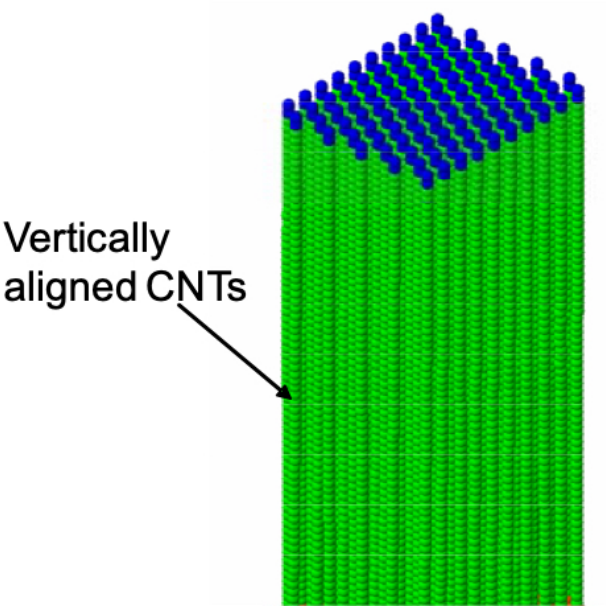
(c) Complementary colors on a color wheel.

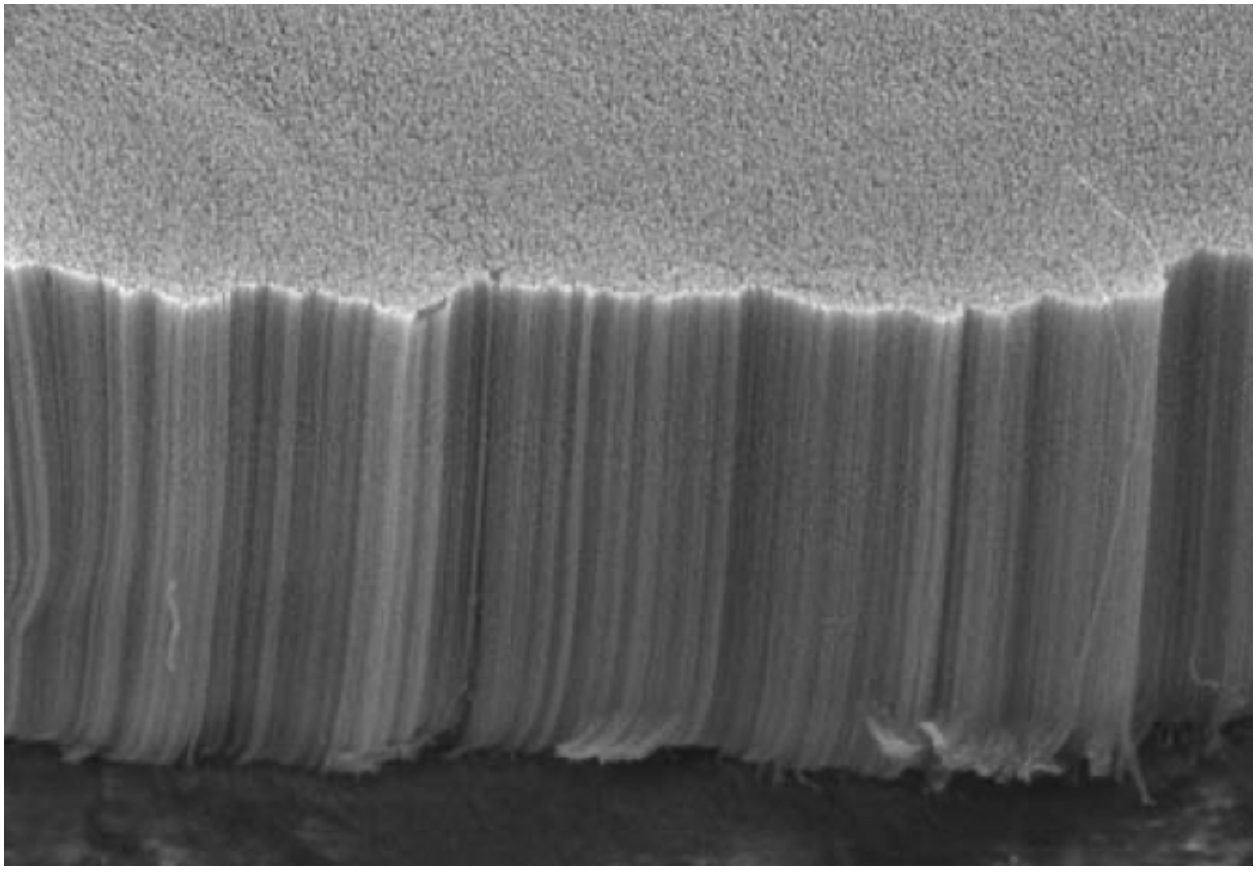
Colored arrows are complementary

Vanta Black → The "blackest" material









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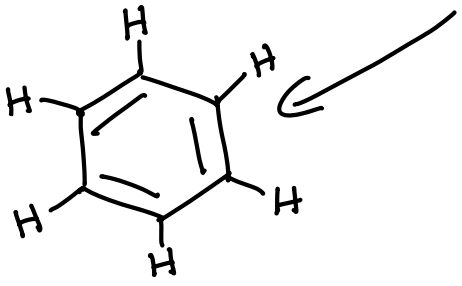
Preview



Extraordinarily Stable!

Benzene

Pericyclic Reactions → π bonds and σ bonds interchange