Organic Chemistry

- Classification of Chemistry
  - Physical Chemistry
  - Inorganic Chemistry
  - Analytical Chemistry
  - Organic Chemistry

- Definition of Organic Chemistry

  'the chemistry of the carbon compounds'

  - **stable covalent bonds** to other carbon atoms as well as to heteroatoms (O, N, S, P, X, etc.)
  - exceptions: CO, CO_2, Na_2CO_3, etc.

Death of the Vital Force Theory

- The Vital Force Theory
  1. Only a living organism can make an organic compound
  2. Organic compounds obtained from living organisms still contained some of the force of the organism that made them (vitamin C, saponin, etc.)

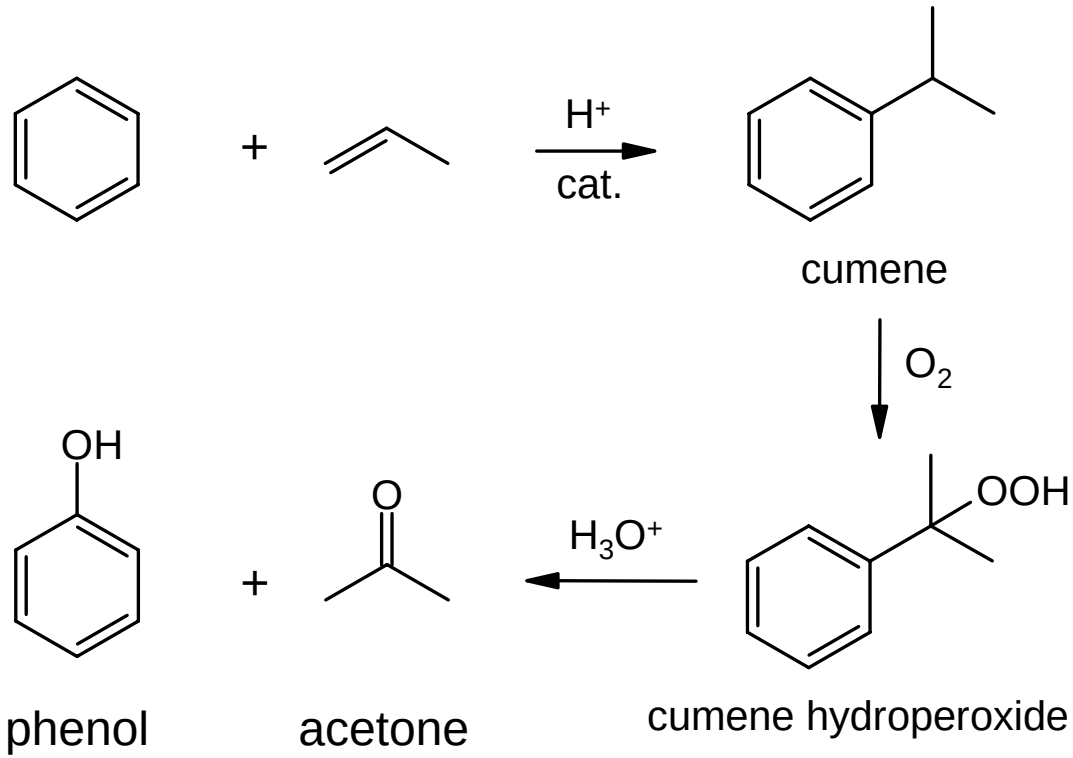
- Evidences against the Vital Force Theory
  1. Laboratory synthesis of urea from ammonium cyanate: F. Wöhler, 1828
  2. Lab synthesis of acetic acid (H. Kolbe, 1844), formic acid & methane from CO (M. Berthelot, 1860)
  3. Fermentation from yeast extracts, free of living cells: E. Büchner, 1897 (Nobel Prize in 1907)

Why study *Organic Chemistry* ?

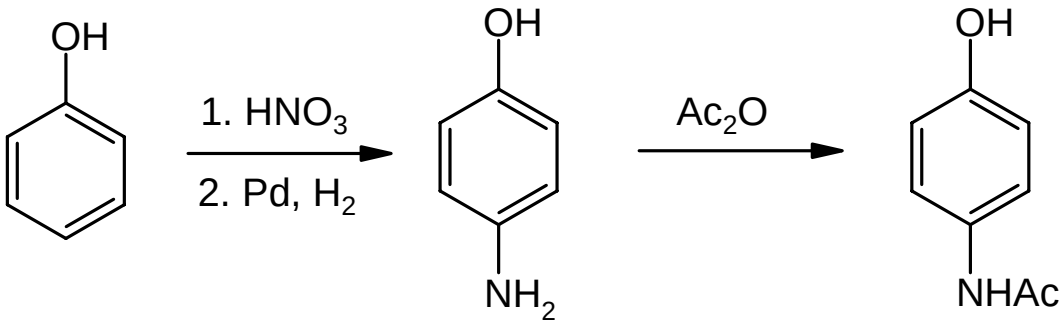
- Indispensable to many fields of science and technology

  - Petrochemicals
  - Agrochemicals
  - Dyes & Pigments
  - Food (Additives)
  - Biology & Biochemistry
  - Display materials
  - and so on…..
  - Pharmaceuticals
  - (Bio)Polymers
  - Cosmetics
  - Household products
  - Electrochemicals
  - Organic electronics

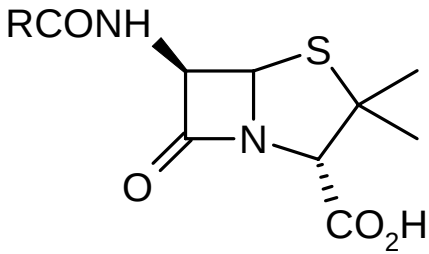
Petrochemicals



Pharmaceuticals & Medicinal Chemistry

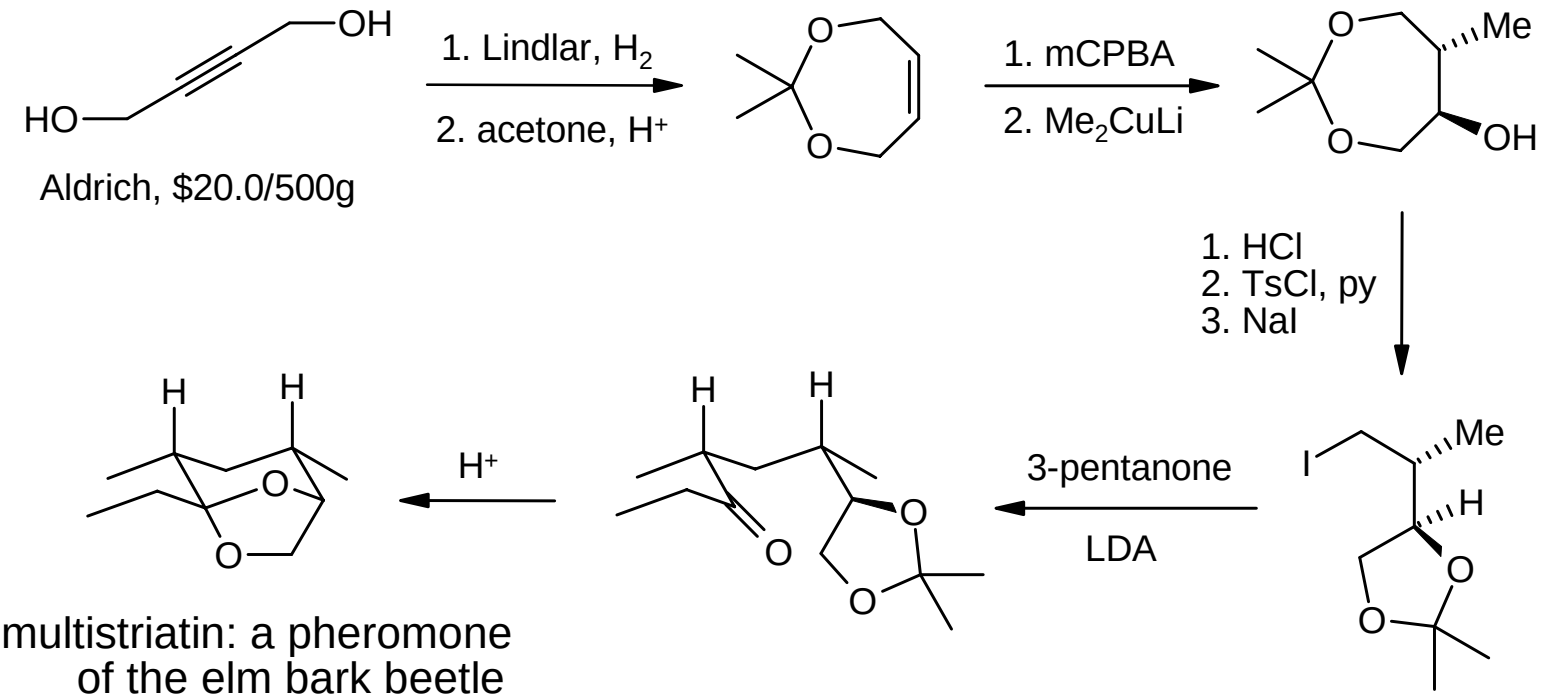


Tylenol



R = $PhCH_2$; Pen G
R = $PhCH(NH_2)$; ampicillin
R = (4-OH)-PhCH(CH2);
amoxycillin

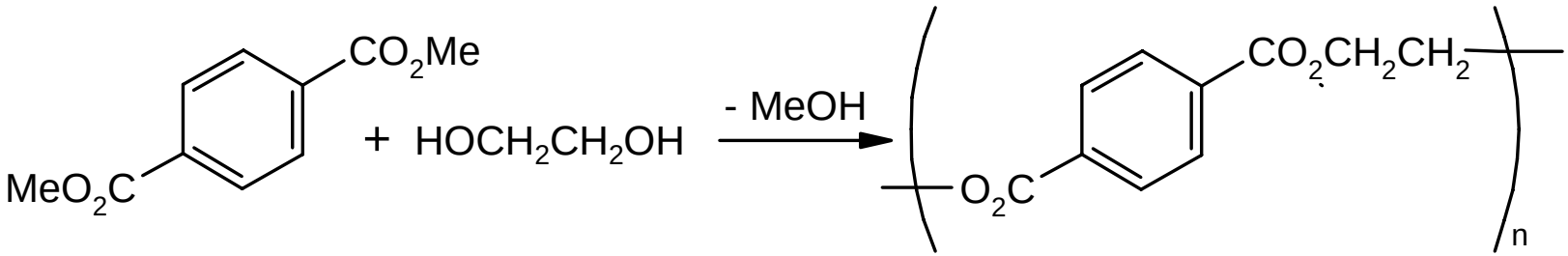
Agrochemicals



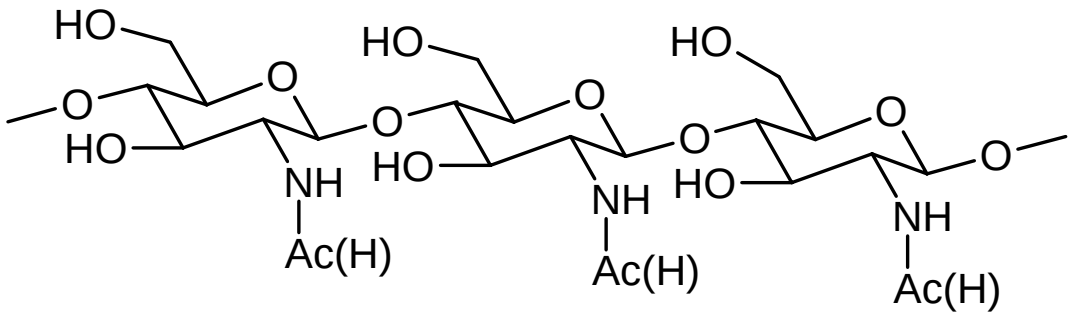
Aldrich, $20.0/500g

multistriatin: a pheromone of the elm bark beetle

Polymers & Biopolymers

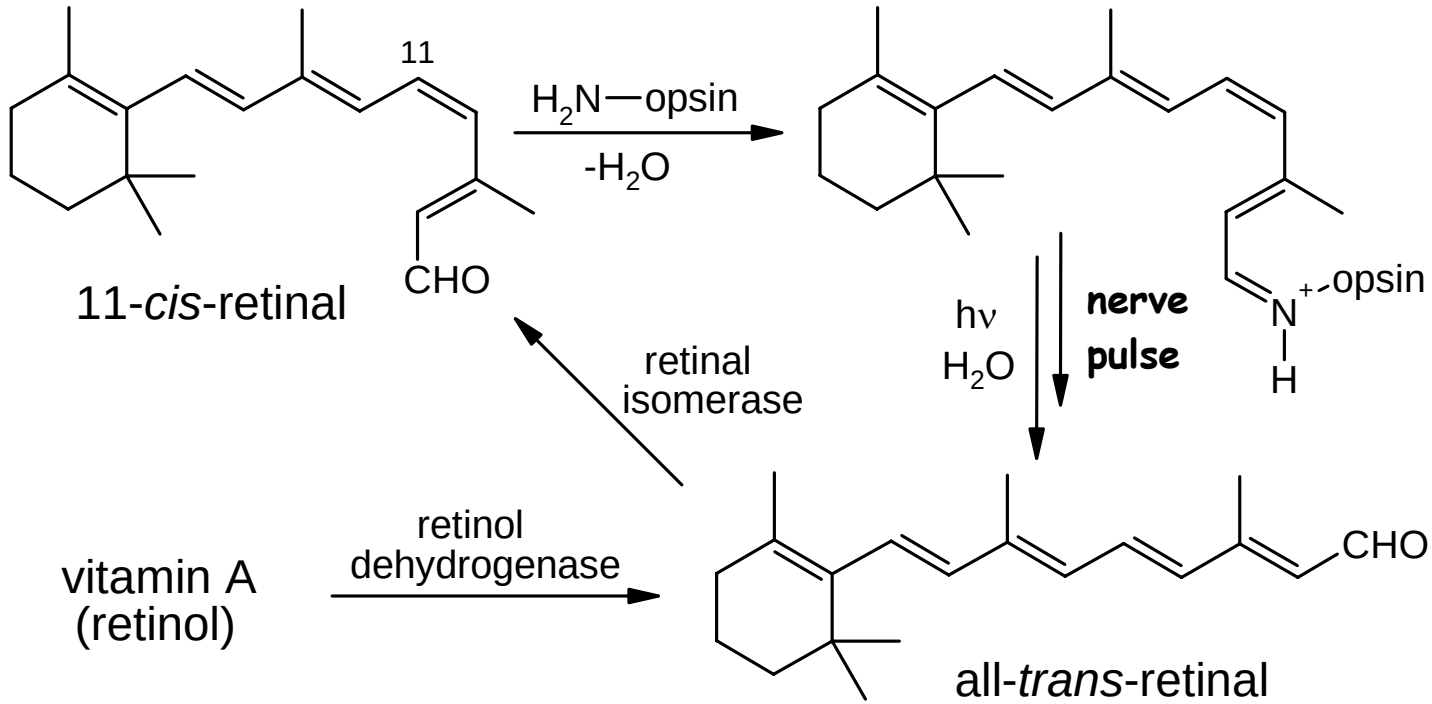


polyester (Dacron)

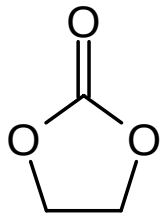


chitin (chitosan)

Biology & Biochemistry

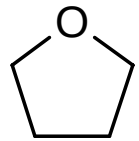


Electrochemicals



ethylene carbonate

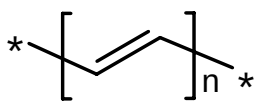
(better electrolyte)



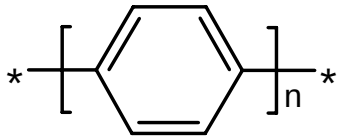
THF

(poor electrolyte)

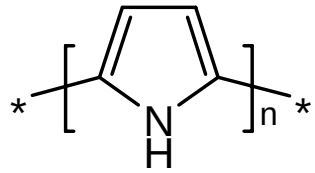
Display Materials



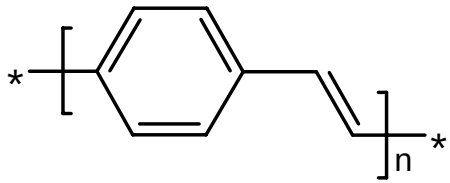
polyacetylene



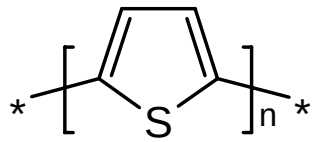
PPP



polypyrrole

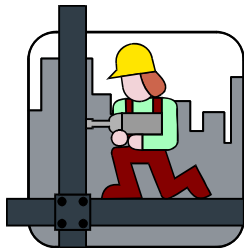


PPV

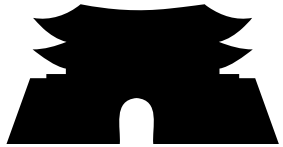


polythiophene

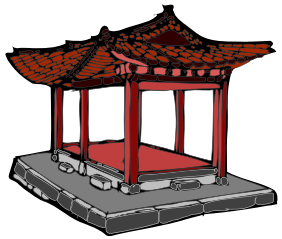
Targets of *Organic Chemistry I & II*



Reactions



Organic Compounds



Structure: bonding (analysis)

Mechanism

공부하는 방법

"그저 익숙하도록 읽는 것뿐이다. 글을 읽는 사람이, 비록 글의 뜻은 알았으나, 만약 익숙하지 못하면 읽자마자 곧 잊어버리게 되어, 마음에 간직할 수 없을 것은 틀림없다.

이미 읽고 난 뒤에, 또 거기에 자세하고 익숙해질 공부를 더한 뒤라야 비로소 마음에 간직할 수 있으며, 또 흐뭇한 맛도 있을 것이다." - 퇴계 이황 (금장태 著)

Chapter 1. A Simple Model for Structure

- What to master
  - Draw Lewis structures
  - Determine formal charges
  - Estimate stabilities of structures
  - Understand and draw resonance structures
  - Identify polar bonds and determine polarities
  - Determine shapes of molecules
  - Determine dipole moments of molecules

Simple Models for Structure

- Simple atomic structure: Lewis structure

valence electrons →

◆ 📖 3, Figure 1.1

- Simple Molecular Bonding Models
  - ◆ stabilizing effect gained by filling outer shell of electrons: the octet rule (a noble gas configuration)

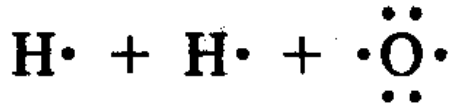
1. Ionic bonding: between ions with opposite charges
   - ❍ a high-melting solid; 📖 4 Figure 1.2
2. Covalent bonding: sharing electrons between atoms; 📖 5
   - ❍ due to unstable high charge/volume ratio
   - ❍ weak intermolecular bonding: lower boiling point

❖ Simple Models for Molecular Bonding (I)

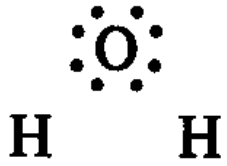
- Lewis structure for molecules: H_2O; 📖 6 Figure 1.3
  - common number of bonds formed: 📖 7 Table 1.1
  - exceptions: the 3rd and subsequent periods of elements
  - determination of stability: 📖 8 top & Problem 1.5
  - writing a Lewis structure: 📖 9-10; CH_4O Figure 1.4, C_2H_4 1.5 & HCN 1.6

- Covalent ions: ions composed of covalent bonds
  - calculation of charges: 📖 11 top

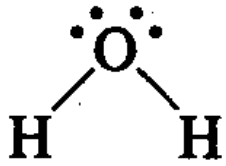
1. Counting No. of (protons - electrons)
   - N: 5 + 4 - 8 = +1, Cl: 7 - 8 = -1
2. Balancing the charges
   - N: 0 + 1 (H) = +1, Cl: 0 - 1 (H) = -1



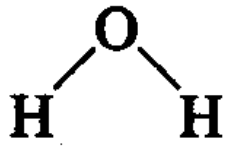
combine to form water



complete Lewis structure



Shared pairs of electrons are often shown as dashes.



Unshared pairs of electrons are sometimes not shown (but they are still present).

H_2O

Atoms bonded to the same atom are grouped together.

❖ Simple Models for Molecular Bonding (II)

- Formal charge: covalent molecules; 🕮 12-13 Fig. 1.7-1.8
  - approximate charge distribution among the atoms
  - each atom: valence e^- - unshared e^- - (shared e^-)/2
  - total charge of a molecule: sum of the formal charges on all the atoms of a molecule: 🕮 13, Practice 1.3
  - refined estimate of stability of molecules: HCN
    - 🕮 14 middle & Problem 1.9: 🕮 14 bottom

- Resonance: CH_3NO_2; 🕮 15-16, Figure 1.9-10
  - when any Lewis structure can not represent a real molecule, the actual structure is a resonance hybrid
  - resonance (stabilization) energy & arrow
  - change only the positions of unshared e^- & multiple bonds

❖ Simple Models for Molecular Bonding (III)

- Polar (covalent) bonds: $\overset{\delta^+}{H}—\overset{\delta^-}{Cl}$ $\quad\overset{+\longrightarrow}{H—Cl}$
  - atoms of much different electronegativities; 🕮 17 Table 1.2
  - affects physical properties & chemical reactions
  - dipole moment (μ) = (charge amount) x (distance)
  - molecular dipole: $\vec{\Sigma}$ individual bond dipoles, $\propto$ 3-D structure

- Shapes of molecules
  - VSEPR (valence shell electron pair repulsion) theory:
    - Rule 1: 🕮 19 top; 🕮 19 Figure 1.11
    - Rule 2: 🕮 20 middle; 🕮 21, Figure 1.13
    - Rule 3: 🕮 20 bottom; 🕮 21, Figure 1.14
  - Molecular dipole moments: 🕮 23, Figure 1.15