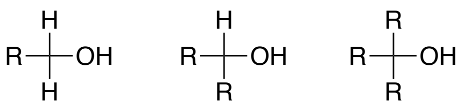
Alcohol and Ether Nomenclature

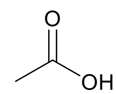
Alcohol	Ether
R-OH	R-O-R



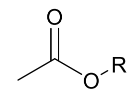
Primary 1° | Secondary 2° | Tertiary 3°

R ≠

Carbonyl



Acid



Ester

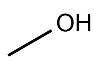
Alcohols are classified as primary (1°), secondary (2°), or tertiary (3°), depending on the number of organic groups bonded to the hydroxyl bearing carbon.

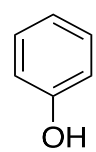
Note: –OH is called hydroxyl, hydroxy or alcohol
-OR is called Alkoxy group
Naming:

1. Find the longest chain, with the maximum number of OH groups.
2. Number in such a way to give the **first OH** the lowest number
3. Drop the "e" of the alkane name, add "ol"

Note: the alcohol (-OH) takes priority over ethers, multiple bonds, and halogens
Examples:

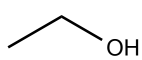
H_3C-OH
methanol
-toxic
wood alcohol





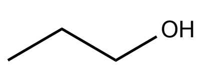
Hydroxybenzene
Phenol
C_6H_6O

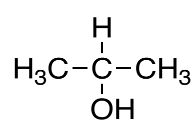
CH_3CH_2OH
ethanol
grain alcohol



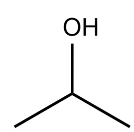
$CH_3CH_2CH_2OH$

1-propanol
n-propanol
propan-1-ol
propyl alcohol

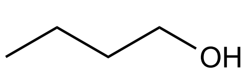




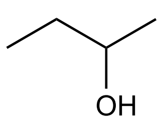
2-propanol
propan-2-ol
Isopropyl alcohol
isopropanol



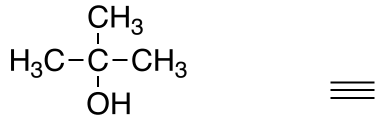
2° alcohol

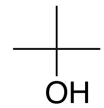


1-butanol
n-butanol

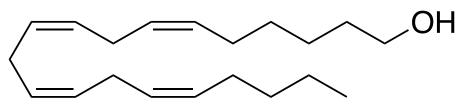


2-butanol

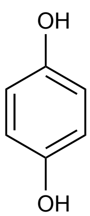




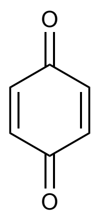
2-methyl-2-propanol
tertiary butyl alcohol
t-BuOH
tert-butyl alcohol



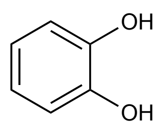
Eicosa-6Z,9Z,12Z,15Z-tetraen-1-ol



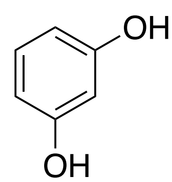
hydroxyquinone



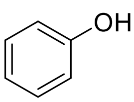
quinone



catechol

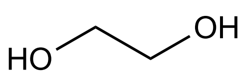


Resorcinol

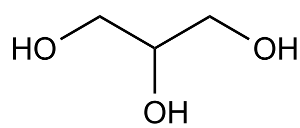


Phenol

Phenol is very common in nature, phenol based structures occurred in lignin
Catechol: part of some neural transmitter



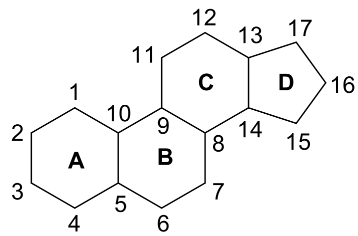
ethan-1,2-diol
ethylene glycol
1,2-ethane-diol



1,2,3-propantriol
glycerol
glycerine

Note: most alcohols are flammable, however, as the chain gets longer, the molecules would tend to stick together (i.e., intermolecular forces) and would be less flammable.

Steroids

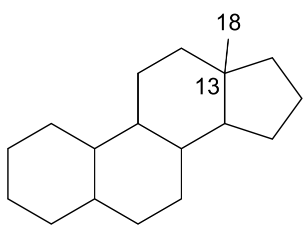


Steroid Skeleton

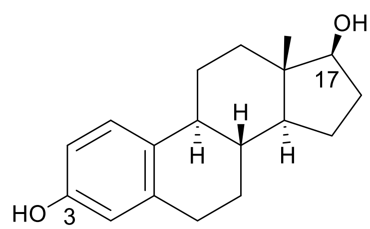
Groups above: β (beta)

Groups below: α (alpha)

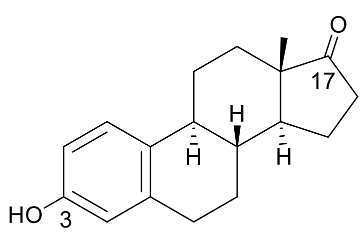
Types of Steroids



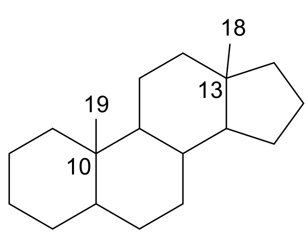
Estrane
Characterized by a methyl group in C13



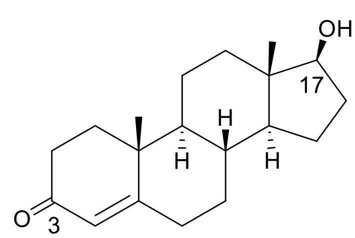
Estradiol



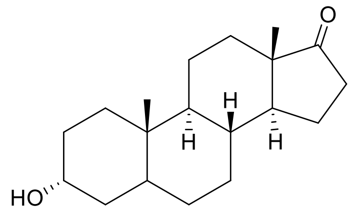
Estrone



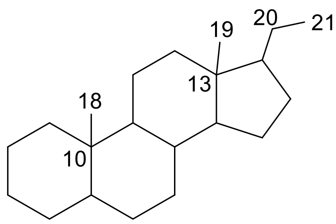
Androstane
Characterized by the presence of $-CH_3$ groups in C10 and C13



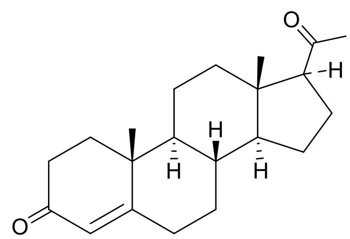
Testosterone



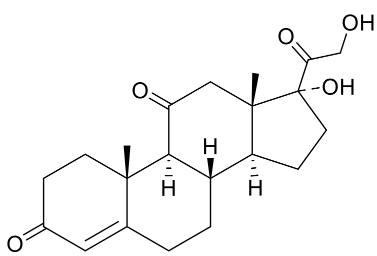
Androsterone



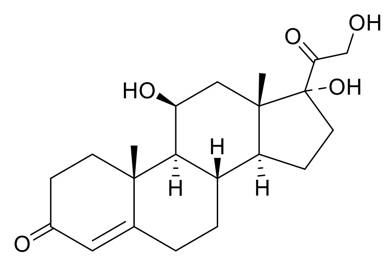
Pregnane
- Characterized by two $-CH_3$ groups in C10 and C13, and a substituent in C17.
- Not biologically active



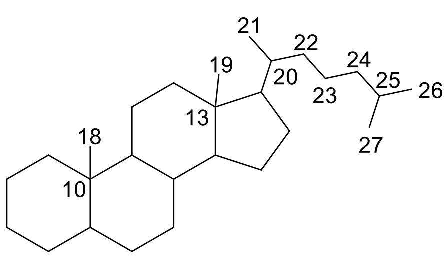
Progesterone
Pregnancy Hormone



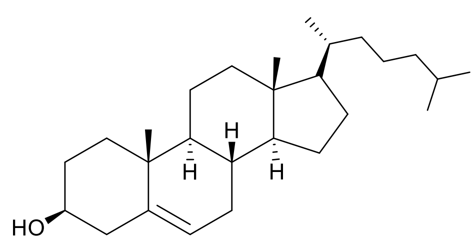
Cortisone
(Adrenocorticoid)
Characterized by a carbonyl at C11 and pregnane skeleton



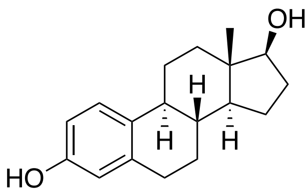
Cortisol
Stress Hormone



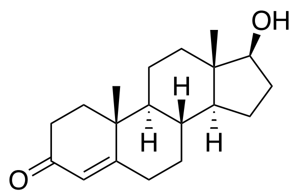
Cholestane



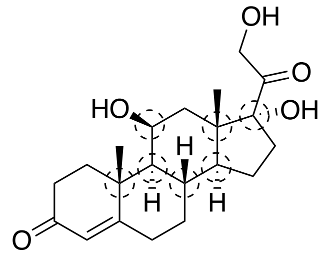
Cholesterol



Estradiol
-Female sex hormone



Testosterone
-Male sex hormone



Cortisol
-Stress hormone

Stereogenic centers

Polyols:

If more than one hydroxyl group is present, a prefix is added to the "ol" :

2 OH's diol (glycol)
3 OH's triol
4 OH's tetraol
5 OH's pentaol

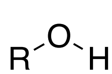
Physical Properties of Alcohols

- The hydroxyl group is a very polar group. This allows small alcohols (methanol, ethanol, propanols) to be miscible with water (if the number of C < 4) as they are good hydrogen bond donors *and* acceptors.
- Soluble in H_2O, as the #C increases, the solubility decreases.
- Alcohol densities are usually **ρ** < 1.0 g/cm^3.
- They have high boiling and melting points, again due to their hydrogen bonding capabilities.

Look at the following comparisons:

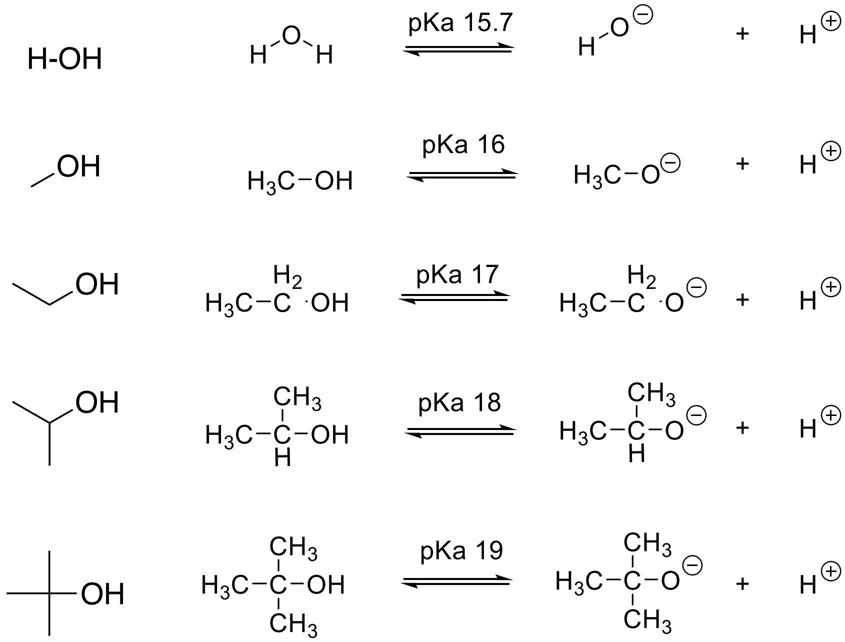
Name	Methanol	Ethane	Ethanol
Formula	CH_3OH	CH_3CH_3	CH_3CH_2OH
Molecular Weight (g/mol)	32	30	46
Boiling Point (° C)	65	-89	78.5
State (at room temp)	liquid	gas	liquid

Ethane has almost the same molecular weight as methanol. However, the boiling point is much lower than methanol. Methanol molecules like to stick together via H-bonding while ethane molecules interact with each other via hydrophobic interactions.



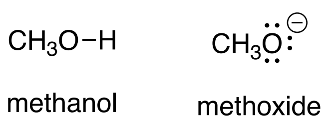
O-H bond - easy to break
R-O bond - hard to break; always needs a strong acid to break and can proceed either S_N-1 / S_N-2, or E1 / E2

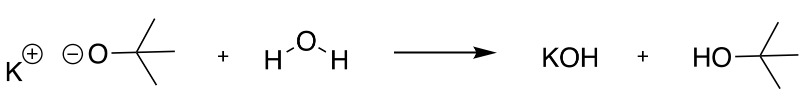
Acidity of R–OH



- pKa depends on conjugated base stability

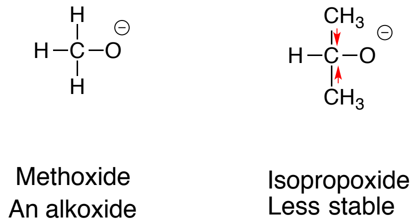
- Harder to make a t-butoxide than methoxide. The alkyl group donates electron density to the C–O bond and destabilizes the negative charge (less favorable).





Stronger base | Stronger Acid | Weak base | pKa 19 weaker acid

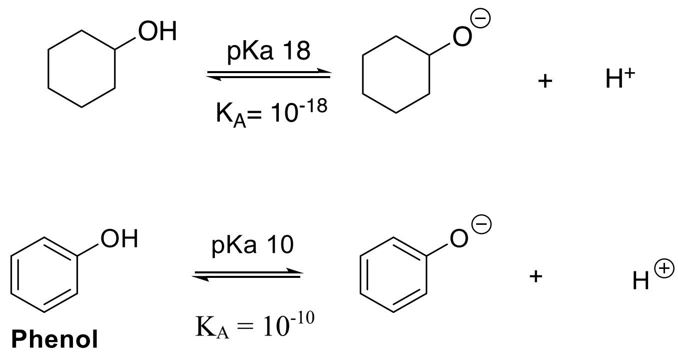
Methoxide vs. Isopropoxide:



Alkyl groups donate electrons through single bonds, destabilizing the negative charge (Inductive Effect), therefore, isopropoxide is less stable than methoxide

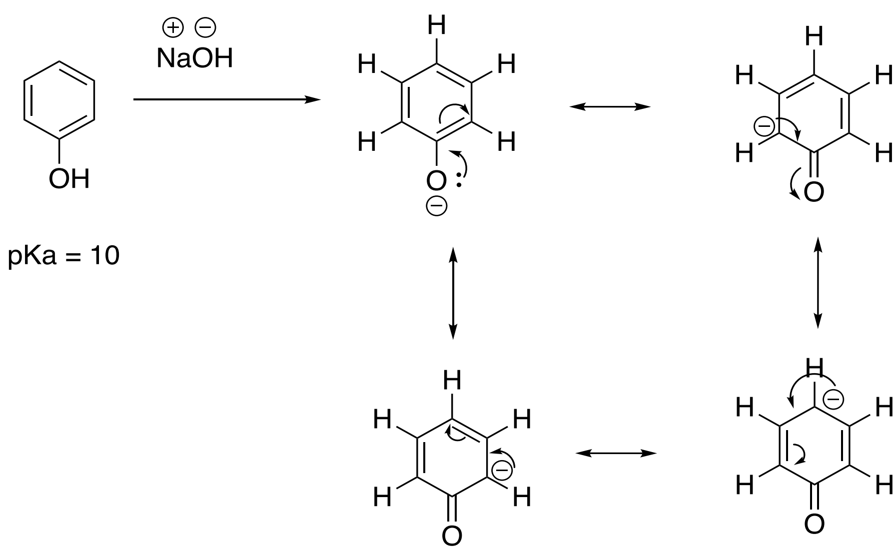
- Inductive effect – donation or withdrawal through single bonds

Conjugated/Aromatic R–OH



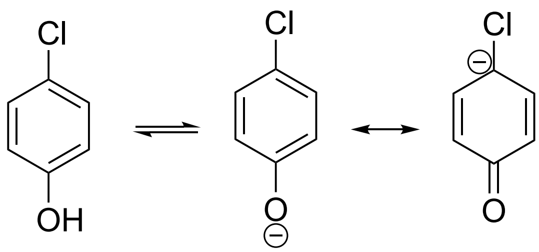
- More acidic than H_2O
- Resonance (resonance effect) takes electron density away from the O atom, resulting in stabilization of the negative charge.
- Resonance effect is strong through π system

Example 1: Phenol



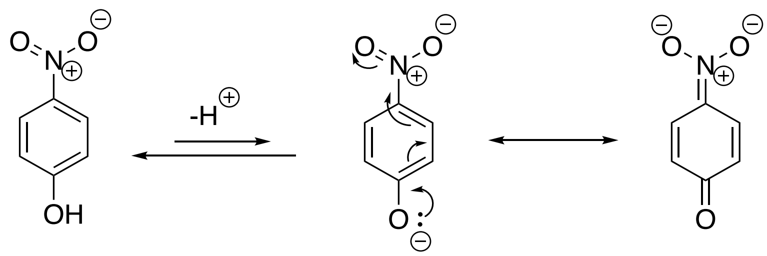
The alkoxide of phenol is a conjugated anion and is therefore much more acidic

Example 2: *p*-Chlorophenol



pKa = 9.3

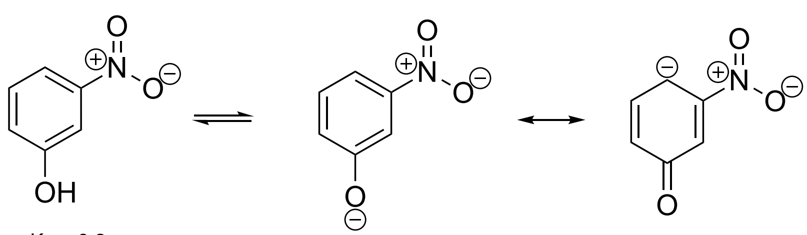
Example 3: *p*-Nitrophenol



pKa = 7.3

p-Nitrophenol is more acidic than phenol because on top of the resonance forms that phenol contains, *p*-nitrophenol also contains the above extra resonance form, making the proton on the alcohol even more acidic.

Example 4: *m*-Nitrophenol

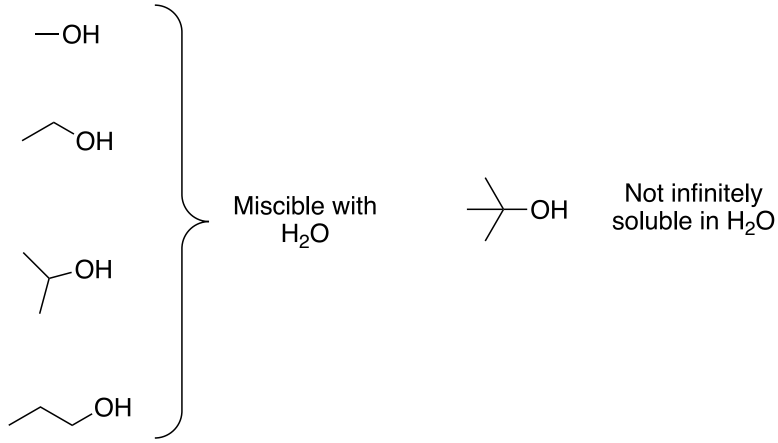


pKa = 9.3

not stabilized
except by induction

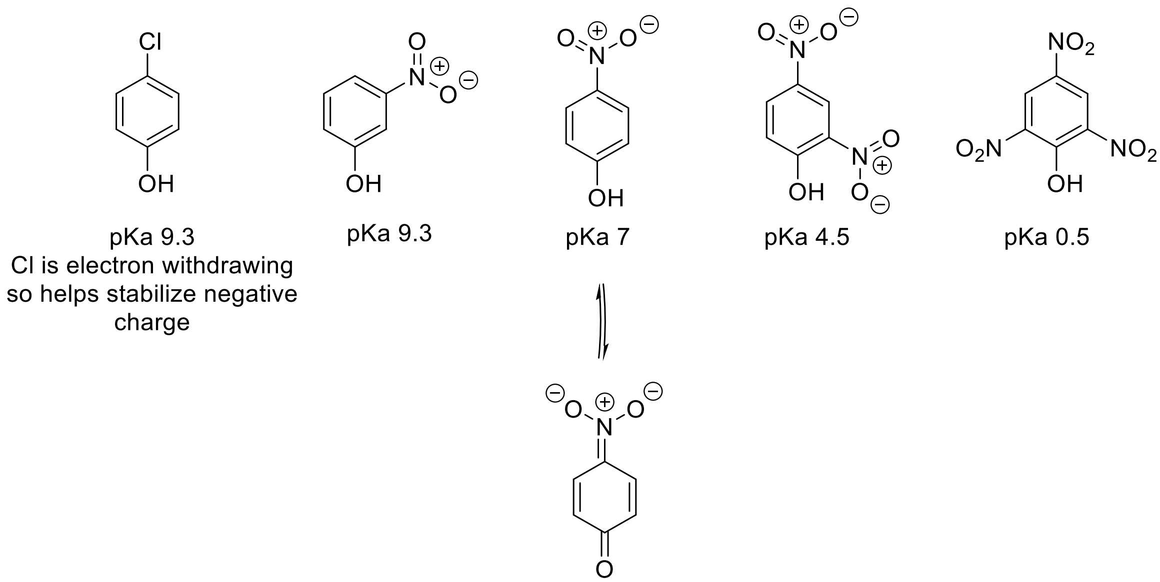
Less acidic than *p*-nitrophenol because there is less stabilization of the negative charge. The negative charge is not conjugated with the nitro group double bond.

Miscibility of Alcohols with Water



*butanol is soluble in H_2O but not miscible

More examples:



- As you get more resonance possibilities, the negative charge is more spread out across the molecules, and is more stabilized, resulting in lower pKa (more acidic).