RECALL:

Demo last class

$$:NH_3 + I_2 \longrightarrow INI_3 + (HI) + NH_4I$$

Explosive

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 H₂O, as the #C increases, the solubility decreases.

- Alcohol densities are usually $\rho < 1.0$ g/cm³.

- They have high boiling and melting points, again due to their hydrogen bonding capabilities.

Look at the following comparisons:

Name	Methanol	Ethane
Formula	CH ₃ OH	CH ₃ CH ₃
Molecular Weight (g/mol)	32	30
Boiling Point (° C)	65	-89
State (at room temp)	liquid	gas

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.

Miscibility of Alcohols with Water



Acidity of R-OH



- 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).

CH₃O-H	сн₃ё⊖
methanol	methoxide

Methoxide vs. Isopropoxide:



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

Conjugated/Aromatic R-OH



- More acidic than H₂O
- Resonance takes electron density away from the O atom, resulting in stabilization of the negative charge.

Example 1: Phenol



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





pKa = 9.3

Example 3: *p*-Nitrophenol





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



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.

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).

Ethers

<u>Recall</u>: The difference between ester and ethers



Nomenclature:

- In the absence of other functional groups, name the two alkyl groups attached to the O and add the word "ether"





In the presence of other functional groups, name ethers as a group, drop "yl" and add "oxy" as seen below:



methoxy



ethoxy



phenoxy

Example 1:



(Z)-3-methoxyhept-3-en-1-ol

- Alcohol (-OH) takes priority over other functional groups

- Number the longest C chain so as to give the OH group the lowest number possible

Example 2:

OH

2-phenoxyethan-1-ol or 2-phenoxy-1-ethanol

Example 3:



(E)-R-2-methoxyhex-4-en-1-ol

Ether Reaction Example:



Carbohydrates (C_NH_{2N}O_N)

sugars, saccharides

A familiar equation:

$$6 \text{ CO}_2 + 6 \text{ H}_2 \text{O} \xrightarrow{hv} \text{C}_6 \text{H}_{12} \text{O}_6 + 6 \text{ O}_2$$

- about $4 \ge 10^{11}$ metric tons of carbon dioxide is converted into glucose by plants
- the process of photosynthesis only uses 0.02% of the suns total energy on Earth
- the sugar produced is known as D-glucose, shown below in a Fischer Projection

Nomenclature of Sugars

General formula of sugars: $C_NH_{2N}O_N$ (approx.) The number of carbons is indicated as follows:	3 carbon sugar (C_3) – triose 4 carbon sugar (C_4) – tetrose 5 carbon sugar (C_5) – pentose 6 carbon sugar (C_6) – hexose
Example 1: Glycerol	он

ОН

HO

Example 2: D-Glucose

D-Glucose



The carbonyl group is indicated by the prefix:



Keto

Triose

Note: The sugar backbone is numbered such that the C=O is assigned the lowest number possible.

Additionally, an allocation of D or L is given to indicate the stereochemistry of the highest numbered (last) stereocentre.

D sugar – highest numbered stereocentre in R configuration. L sugar – highest numbered stereocentre in S configuration. Example 2: D-Fructose



Based on the above nomenclature, D-Fructose is a **ketohexose** (ketone, 6 carbons)

The above structure is labelled as "D" because the R configuration occurs at carbon 5 (note that carbon 6 is not a stereocentre).



Example 3: D-Ribose



An aldopentose (aldehyde, 5 carbons long). At the highest numbered stereocentre (carbon 4) the stereochemistry is R.

The name of this is D-ribose (found in RNA! – deoxyribose is in DNA)

Steroids



Groups above: β (beta)

Groups below: α (alpha)

Steroid Skeleton

Types of Steroids



Estrane Characterized by a methyl group in C13



Estradiol









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

Testosterone



Androsterone





Pregnane

- Characterized by two -CH₃ 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



Cholestane



Cortisol Stress Hormone



Cholesterol



Estradiol -Female sex hormone



Testosterone -Male sex hormone



Cortisol -Stress hormone

 \bigcirc Stereogenic centers