**Functional Groups**

See CD-ROM Screens 11.5 & 11.6

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**Alcohols**

- Characterized by –OH group
- Name: add –ol to name of hydrocarbon

**Structures of Alcohols**

\[ \text{C}_3\text{H}_5\text{OH}: \text{how many structural isomers?} \]

- 1-propanol
- 2-propanol

**Naming**

Add -ol to name of 3-C hydrocarbon. Indicate position of OH with number.

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**Alcohol Properties**

- Alcohols are a derivative of water
- Many alcohols dissolve in water

- Methanol dissolves in water.
- Butanol is NOT soluble in water.

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**“Sterno”**

- Alcohols burn in air
- A mixture of ethanol + calcium acetate = STERNO

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**GLYCOLS**

Alcohols with Two OH Groups

- Ethylene glycol
- Propylene glycol
**Alcohol Reactions**

Screen 11.6

- Substitution
- Elimination—the reverse of addition

**Sugars: Related to Alcohols**

- Sugars are carbohydrates, compounds with the formula $C_n(H_2O)_m$.

**Sucrose and Ribose**

- Open chain form

What is the difference between $\alpha$- and $\beta$-D-glucose?

**Amines**

- Alcohols are derivatives of $H_2O$ (R–OH)
- Amines are derivatives of $NH_3$

- Methylamine
- Dimethylamine
- Trimethylamine

**Amines**

- Amines generally have terrible odors!

**Amines**

- Amines, like $NH_3$, are bases

$2C_2H_5NH_2(aq) + H_2SO_4(aq) → 2C_2H_5NH_3^+(aq) + SO_4^{2-}(aq)$
Amines

Many natural products and drugs (such as nicotine and cocaine) are bases.

Compounds with Carbonyl Group

Aldehyde Carboxylic acid Ketone

Structures of Aldehydes

Cinnamaldehyde Odors from aldehydes and ketones

Carboxylic Acids

Benzolic acid

Acids are found in many natural substances: bread, fruits, milk, wine

Carboxylic acid group with acidic H⁻ All are WEAK acids

Carboxylic Acids

Formic acid, HCO₂H, gives the sting to ants.

Aspirin, acetylsalicylic acid

Acids + Alcohols --> ESTERS

Esters have generally pleasant odors
Acids + Alcohols --> ESTERS

\[ \text{Acetic acid} \quad + \quad \text{Ethanol} \quad \rightarrow \quad \text{Ethyl acetate} \]

One of the important reactions in nature!

Glycerol

Alcohol with 3 OH Groups

Combine this with long chain acids -------> ???
Fatty acids --> fats and oils

Fats and Oils

R = organic group with NO C=C bonds
- C_{12} = Lauric acid
- C_{16} = Palmitic acid
- C_{18} = Stearic acid

What is the functional group in a fat or oil?

Fats and Oils

Oleic acid: a monounsaturated fatty acid

Fats with C=C bonds are usually LIQUIDS

Saturated fats are more common in animals.

Fats with saturated acids (no C=C bonds) are SOLIDS.
**Fats and Polar Bears**

- Bears gorge on blubber in the winter.
- During the summer bears rely on stored fat for energy.
- Burn 1-1.5 kg of fat per day.
- Water for metabolism comes from fat burning.

**Trans Fatty Acids**

- Oleic acid is a mono-unsaturated cis-fatty acid.
- Trans fatty acids have deleterious health effects.
- Trans fatty acids raise plasma LDL cholesterol and lower HDL levels.

**Fats and Oils: Saponification**

Glyceryl stearate, a fat + NaOH

\[
\text{CH}_3-\text{O}-\text{R} + 3 \text{NaOH} \rightarrow \text{CH}_3-\text{O}-\text{R} + 3 \text{NaC}_16\text{H}_{33}\text{CH}_3
\]

\[
\text{O--H} + 3 \text{NaOH} \rightarrow \text{O--H} + 3 \text{NaC}_16\text{H}_{33}\text{CH}_3 + \text{Sodium stearate, a soap}
\]

**Acids + Amines --> AMIDES**

- Acetoaminophen: Tylenol, Datril, Momentum, ...

**Alpha-Amino Acids**

Alanine

H₂N

\[
\text{H} \quad \text{O}
\]

H₂C

\[
\text{CO}_2\text{H}
\]

Chiral \(\alpha\)-carbon

H₂N

\[
\text{H} \quad \text{O}
\]

H₂C

\[
\text{CO}_2\text{H}
\]
**Peptides and Proteins**

Alanine + Serine

\[ \text{alanine} + \text{serine} \rightarrow \text{protein bond} \]

Adding more peptide links \(\rightarrow\) PROTEIN

**Polymers**

- Giant molecules made by joining many small molecules called **monomers**
- Average production is 150 kg per person annually in the U.S.

**Polymer Classifications**

- **Thermoplastics** (polyethylene) soften and flow when heated
- **Thermosetting** plastics — soft initially but set to solid when heated. Cannot be resoftened.
- Other classification: plastics, fibers, elastomers, coatings, adhesives

**Polymer Preparation**

- **Addition** polymers — directly adding monomer units together
- **Condensation** polymers — combining monomer units and splitting out a small water (water)

**Polyethylene: Addition Polymer**

\[ n \, \text{CH}_2 - \text{CH}_2 \rightarrow \underbrace{\text{CH}_2 \ldots \text{CH}_2}_{\text{polyethylene}} \]

A polymer with a molar mass of 1e6 has about 360,000 units.
Types of Polyethylene

- Linear, high density PE (HDPE)
- Branched, low density PE, LDPE
- Cross-linked PE, CLPE

Polystyrene

- Polystyrene is nonpolar material and dissolves in organic solvents.
- PS foam is mostly air, and when it dissolves it collapses to a much smaller volume.

Polyesters, PET

- Jackets made from recycled PET soda bottles
- Soda bottles, mylar film.
**Polyesters: Mechanism**

Each monomer has 6 C atoms in its chain.

**Polyamides: Nylon**

- A polyamide link forms on elimination of HCl
- Result = nylon 66
- Proteins are polyamides

**Polymer Recycling Symbols**

- LDPE = Low density PE = 0.910-0.925 g/cm³
- HDPE = High density PE = 0.941-0.965
- PP = Polypropylene = 0.90
- V = PVC (Vinyl chloride) = 1.30-1.58