Organic Chemistry

Large number of compounds due to:

- 4 valence pairs
- single / double / triple bonds
- cyclic (ring) structures

Properties of hydrocarbons

- *Saturated* - all C-C bonds are single
- Insoluble in water
- Almost non-polar (similar electronegativities)
- Only dispersion forces (valence e-)
- Dispersion forces increase with length
- Branched molecules have lower density

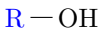
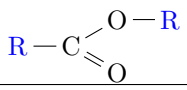
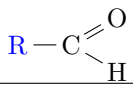
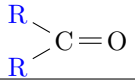
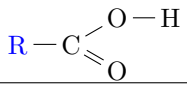
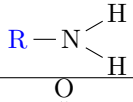
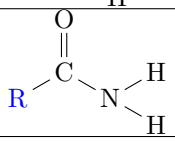
Linear (aliphatic)

Alkanes: $C_n H_{2n+2}$
Alkenes: $C_n H_{2n}$
Alkynes: $C_n H_{2n-2}$

Naming hydrocarbons

- Branches end with *-yl*
- Indicate number of branches with di-, tri- etc.
- Longest unbranched carbon chain includes function group

Functional groups

Alcohols	–OH	
Esters	–OCO–	
Aldehydes	–CHO	
Ketones	–CO–	
Carboxylic acids	–COOH	
Ethers	–O–	
Amines	$-NH_2$	
Amides	CO–NH	

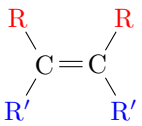
Isomers

- **Structural isomers** - same molecular formula, different arrangement
- **Positional isomers** - different position of functional group (affects polarity)

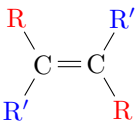
- **Chain isomers** - affects boiling point (more branches *implies* lower boiling point)
- **Stereoisomers** - same structural configuration, different orientation

- **Optical/chiral isomers (enantiomers)** - chiral centre, 4 groups bonded to C, non-superimposable mirror image. Racemic mixture: 50/50 of each enantiomer. Affects optical polarity of light.
- **Geometric isomers** - C=C double bond, 2 groups bonded to carbon atoms
  - **Cis** - same horizontal plane (symmetrical)
  - **Trans** - diagonal (asymmetrical)

cis



trans



Flash point

Lowest temperature at which the liquid gives off enough vapour to be ignited. Flammable $\implies$ flash point $>$ 37.8 °C.

Reactions

Cracking - split moluecules with heat/pressure/catalyst

Alkanes

- Relatively inert
- Non-polar solvent
- Non-soluble in H_2O
- Combusts in O_2 (forms $CO_2 + H_2O$)
- Reacts with halogens (**substitution** of H)

Alkenes

- More reactive than alkanes
- **Addition reactions**: C=C bond is broken (energy released)
- **Addition polymerisation**

Alcohols

- Can be formed from haloalkane substitution reaction
- **Oxidation** (combustion)
- Oxidation state $\propto$ no. of atoms connected to C
- **Substitution** of functional group, e.g. $ROH + NH_3 \longrightarrow RNH_2 + H_2O$
- Primary alcohols oxidise to aldehydes then carboxylic acids
- Secondary alcohols oxidise to ketones

Carboxylic acids

- Weak acids
- **Hydrolysis**: $RCOOH + H_2O \rightleftharpoons RCOO^- + H_2O^+$
- Rxn with amines - carboxylic acid + amine $\rightarrow$ ammonium salt $\rightarrow$ amide + water

Esterification

- **Condensation reactions** (esterification): $RCOOH + R'OH \longrightarrow RCOOR' + H_2O$
- This is reversed by **hydrolysis**: ester + water $\rightarrow$ carboxylic acid + alcohol
- Polyesters

Summary of reactions

Combustion: $C_x H_y + z\, O_2 \longrightarrow x\, CO_2 + \frac{y}{2} H_2O$ where $z = x + \frac{y}{4}$
Substitution: e.g. halogenation/chlorination, catalysed by UV (alkanes) or compounds (alcohols etc.) which creates free radicals (unpaired e-)
Addition: C=C bond is broken, catalyst is required
Addition polymerisation: uses addition to form a polymer
Condensation polymerisation: produces H_2O
Oxidation: occurs in alcohols to form aldehydes with catalysts $H^+/MnO_4{}^-$ (aq) or H^+/Cr_2O_72- (aq) - see combustion equation
Cracking: heat/pressure/catalyst to break molecules