chemistry and living systems
Unit One Part 1: introduction

- Introduction to (organic) chemistry and living systems
- Interpretation of various styles of representing molecules

Kekulé representation (1859)

Loschmidt representation (1861)

ball and stick

space filling

C
H
O
Why do we need organic chemistry?

- To understand living systems we have to understand the molecules that make up those systems.
- Haem carries oxygen in the blood.
Understand molecules, understand biology?

- Understanding how molecules in our body function when we healthy buts us in a position to understand disease.
- Organic chemistry lies at an interface between chemistry and biology that is vital for medicine.
- Understanding isomers helps us explain the visual cascade and sight.

Rhodopsin
11-cis-retinal
(aldehyde not imine)

all trans-retinal
starts VISUAL CASCADE
Medicinal chemistry

- Penicillin G (antibacterial)
- aspirin
- paracetamol (analgesic/antipyretic)
- Prozac (antidepressant) - US$5 million per day! (1996)
- vancomycin
- Lipitor (cholesterol treatment) - US$12.9 billion (2006)
- quinine (antimalarial)
- Plavix (heart disease) - US$5.9 billion (2006)
- Zovirax (antiviral - herpes)
- caffeine (food group)
We will focus on **microscopic** and **symbolic**

But always remember there is *real stuff* (as you'll see in the lab...)
Microscopic representations

Molecular orbital representation mathematically accurate model

Space filling representation very useful

Ball and stick representation closest to our drawings
Symbolic representation: chemical formulae

Formulae for hexane

Empirical formula \( C_3H_7 \)
simply ratio of atoms

Molecular formula \( C_6H_{14} \)
number of atoms in molecule (but not bonding)

Structural formula
shows all atoms and the shape (but cumbersome)

Condensed structural formula
\( CH_3CH_2CH_2CH_2CH_2CH_2CH_3 \)
quick but can cause a lot of confusion

Skeletal (structural) formula
ace! easy to draw and all information (but a lot is implied)
- Does the chemist set out to confuse?
- Probably not...but they do a fine job of it...

- There are many other representations we use depending on job
- Many representations can be mixed as

- Some representations should not be used!
- The flat form below is an abomination...

- Quick and easy it maybe...but it is very misleading about the shape
Skeletal (structural) formulae

- Most common representation so we must understand it...
- Therefore we have to learn to count to 4

Carbon normally has 4 pairs of electrons or 4 bonds.
Hydrogen has just 1 pair of electrons or 1 bond.

- line represents a covalent bond
  - 2 electrons being shared

4 bonds
4 bonds
4 bonds
Skeletal (structural) formulae II

- So few exceptions to this idea (4 bonds) that we miss out hydrogens

**Example 1**

- Erase hydrogens
- Erase carbons

**Example 2**

**Example 3: warning**

- Only condense carbon - not heteroatoms / functional groups
Skeletal (structural) formulae: heteroatoms

- Keep hydrogen attached to functional groups (normally heteroatoms)

- Omit hydrogens (and C–H bonds) unless part of functional group or useful
- Use lines to represent C–C or C–X bonds (omit carbons)
- Explicitly label all heteroatoms
- Remember we will leave atoms in if they are a useful focus
Skeletal formula to structural formula

- If you can count to 4 this is easy...
- First, draw a carbon at the end of every line with no heteroatoms attached
- Add hydrogens to make every carbon have 4 bonds (4 lines)

\[
\text{HO-CH} = \text{C} \quad \text{HO-C} = \text{C} < \text{O} \\
\text{HO-CH} = \text{C} \quad \text{HO-C} = \text{C} < \text{O} \\
\text{HO-CH} = \text{C} \quad \text{HO-C} = \text{C} < \text{O}
\]

- Add hydrogens to make every nitrogen have 3 bonds (3 lines)
- Add hydrogens to make every oxygen have 2 bonds (2 lines)

\[
\text{HO-C} = \text{C} \quad \text{HO-C} = \text{C} < \text{O} \\
\text{HO-C} = \text{C} \quad \text{HO-C} = \text{C} < \text{O} \\
\text{HO-C} = \text{C} \quad \text{HO-C} = \text{C} < \text{O}
\]

- We write the condensed formula of **functional groups** so there should not be any ambiguity about hydrogens
- Still 4 lines to carbon and 2 lines to oxygen
Skeletal formula to structural formula II

• Take care with functional groups; just remember carbon = 4 bonds
Overview

What have we learnt?
- The relevance of organic chemistry to living systems
- Different ways to represent molecules

What's next?
- Nomenclature (how to name molecules)
- Functional groups, their names and common examples