Homologous Series and IUPAC Naming

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Organic chemistry handles millions of compounds by organising them into families and naming them systematically. A student who understands the homologous series concept and can apply IUPAC rules can name any compound on the syllabus and predict its properties without memorising each one individually.

Homologous Series

A **homologous series** is a family of organic compounds that:

- 1. Share the same **general formula**
- 2. Have the same **functional group** (which gives the series its characteristic reactions)
- 3. Show a **gradual, regular change** in physical properties (boiling point, density, viscosity) as chain length increases
- 4. Have similar **chemical properties** — all members react in the same way
- 5. Differ from adjacent members by **one CH,unit** (molecular mass increases by 14 each step)

The four homologous series required for CSEC:

Series	Functional group	General formula	Example
Alkanes	None (C–H bonds only)	CH,™Š,	Methane, CH„
Alkenes	C=C double bond	CH,™	Ethene, C‚H„
Alcohols	–OH (hydroxyl)	CH,OH Š•	Ethanol, C‚HƒOH
Alkanoic (carboxylic) acids	–COOH (carboxyl)	CH,COOH Š•	Ethanoic acid, CH‚COOH

IUPAC Naming

Knowing which series a compound belongs to tells you its reactions. The IUPAC system then gives it a name from its chain length and functional group.

Organic compounds are named systematically. The name is built from:

- A **prefix** indicating the number of carbons in the longest continuous chain
- A **suffix** indicating the functional group (and therefore the series)

Prefixes:

Carbons	Prefix
1	meth–
2	eth–
3	prop–
4	but–
5	pent–
6	hex–

Suffixes:

- Alkanes: **–ane**
- Alkenes: **–ene**
- Alcohols: **–ol**
- Carboxylic acids: **–anoic acid**

Examples: ethanol = eth (2 carbons) + ol (alcohol); propane = prop (3 carbons) + ane.

For alkenes and alcohols, the position of the double bond or –OH group is given by a number. Propan-1-ol has the –OH on carbon 1; propan-2-ol has it on carbon 2.

For **branched alkanes**, identify the longest continuous chain as the parent name. Name branches as alkyl groups (methyl, ethyl, etc.) and give each branch a position number, counting from the end of the chain that gives branches the lowest numbers.

> 📋 **Example**
> 2-methylbutane: a 4-carbon chain (but– 'butane) with a methyl group on carbon 2.
> Condensed formula: $CH_3CH(CH_3)CH_2CH_3$

Drawn Structural Formulae

A name tells you what a compound is. A drawn structure shows how the atoms are connected. CSEC questions use both, so you need to be comfortable converting between them.

Organic structures can be written in two ways:

Condensed structural formula: shows the bonding arrangement without drawing every bond, e.g. CH_3CH_2OH for ethanol.

Fully displayed (structural) formula: shows every bond and atom explicitly.

Key Alkanes

The Functional Groups

Structural Isomerism

The same molecular formula can correspond to more than one structural arrangement. These different structures are called isomers, and they come up often in exam questions.

Structural isomers are compounds with the same molecular formula but different structural arrangements of atoms. Because atoms are connected differently, isomers have different physical properties (such as boiling point).

Chain Isomerism

The carbon skeleton is arranged differently (straight vs. branched).

> 📋 **Example**
> C_4H_{10} has two chain isomers:
>
> **Butane** — straight chain: $CH_3CH_2CH_2CH_3$
>
> **2-methylpropane** — branched: $CH_3CH(CH_3)CH_3$
>
> Both have the same molecular formula C_4H_{10} but different structures and different boiling points.

Positional Isomerism

The functional group or double bond is at a different position on the same carbon skeleton.

> 📋 **Example**
>
> C_4H_8 alkene isomers:
>
> **But-1-ene:** $CH_2=CHCH_2CH_3$ (double bond on carbon 1)
>
> **But-2-ene:** $CH_3CH=CHCH_3$ (double bond on carbon 2)

More branched isomers generally have lower boiling points because their compact shape reduces surface contact area and weakens intermolecular forces.

> 📝 **Exam Tip**
>
> Isomers must have exactly the same molecular formula. To check: count every atom in both structures — if the total differs, they are not isomers.