

# Notes about the types of structural formulae of organic molecules

Unlike [molecular formulae](#),

**Structural formulae show how the atoms within organic molecules are joined together** by various (single, double or triple) chemical bonds and in some cases how the atoms and bonds are arranged in 3-dimensional (3D) space.

It is possible to draw the **structural formula** of an **organic molecule** in several different ways.

That is, there are different types of **structural formulae** which show different levels of detail and types of information, e.g. all the individual atoms (or not), all the individual bonds (or not), approx. bond-angles (or not), and representation in 2-dimensions or 3-dimensions.

The main types of structural formulae of organic molecules are:

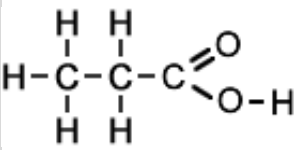
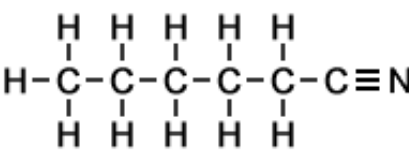
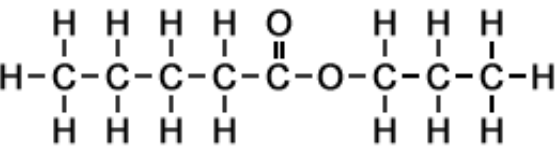
Descriptions and examples of each of these types of **structural formulae of organic molecules** follow below, together with links to more detailed information and further examples.

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## 1. Displayed Formulae

**Fully Displayed Formulae** of organic molecules include every atom and every bond between atoms drawn in full so that it is possible to see which atoms are connected to which other atoms and by which type of covalent bond.

### Examples of Fully Displayed Formulae

Propanoic Acid	Hexanenitrile	Propyl Pentanoate
		

Use of **fully displayed formulae** is common and very helpful when first studying organic chemistry and working out organic molecular structures using rules about how many other atoms each type of atom connects to, which bonds can be double or triple bonds, and so on.

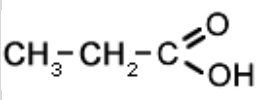
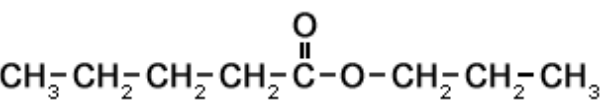
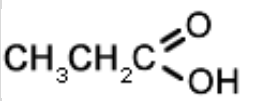
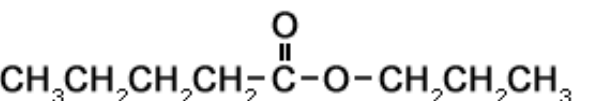
## 2. Simplified (Semi-Displayed) Formulae, e.g. incl. CH<sub>3</sub>

Fully displayed formulae can be simplified by grouping together the hydrogen atoms attached to each carbon atom in the chain(s), resulting in **semi-displayed formulae**, or **simplified displayed formulae**.

Depending on the level of "simplification", single covalent bonds between adjacent carbon atoms in a chain or branch may, or may not, be shown.

### Examples of Simplified Displayed Formulae

The examples of molecules shown below are the same as those represented by fully displayed formulae (above).



Propanoic Acid	Hexanenitrile	Propyl Pentanoate
	$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-C}\equiv\text{N}$	
OR, even shorter ...	OR, even shorter ...	OR, even shorter ...
	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{C}\equiv\text{N}$	

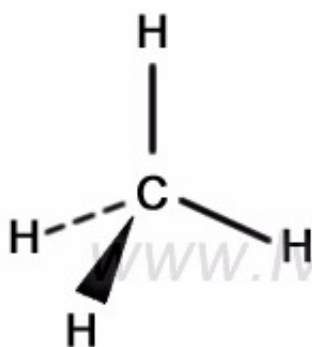
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### 3. 3D Structural Formulae (Sketched)

There is a standard system for representing the arrangement of atoms in organic molecules in 3-dimensions ("3D").

The symbols used are:

-  bonds oriented **towards the viewer** (so the approx. "centre" of the molecule would be further from the viewer than the atom or functional group attached to it by a bond extending towards the viewer)
-  bonds oriented **away from the viewer** (so the approx. "centre" of the molecule would be closer to the viewer than the atom or functional group attached to it by a bond extending away from the viewer).



Sketched 3-D Structural Formula of Methane



"Ball and Stick" Model of 3-D Structure of Methane

The purpose of **3D Structural Formula** is to convey more information than is included in a fully displayed formula by indicating approximate bond angles/orientations using these 3 styles of representation of bonds in 3D space.

#### Example of a sketched 3D formula of Methane (CH<sub>4</sub>)

Although it is useful to be able to draw 3D molecular structures of organic compounds, these diagrams can quickly become cumbersome and tricky to draw clearly. You are unlikely to have to draw 3D molecular structures of very complicated molecules for school chemistry tests. A common use of this type of representation of molecular structures is to explain isomerism, and optical isomerism in particular.

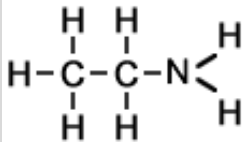
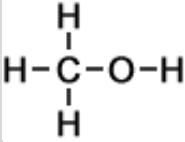
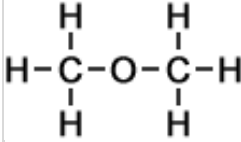
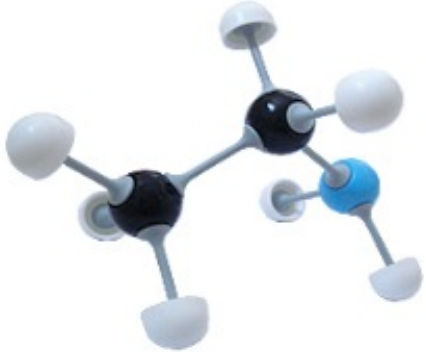
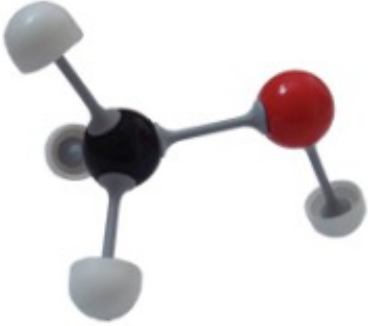
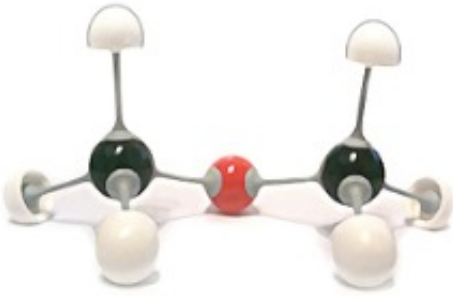
For more detail see: [How to Draw Organic Molecules in 3D](#).

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#### 4. 3D Structural Formulae using Models, e.g. "Ball and Stick"

Schools, colleges and universities have used "ball and stick" models to teach and explain molecular structures in organic chemistry for many years. Molecular modelling kits are available for sale online or in many good bookshops, especially on university campuses. Computer software has also become available to enable students and scientists to model molecular structures and rotate them in "3D space" on computer screens, interactive whiteboards, and similar.

##### Examples of 3D Models of Structural Formulae

<b>Ethylamine (C<sub>2</sub>H<sub>7</sub>N)</b>	<b>Methanol (CH<sub>3</sub>OH)</b>	<b>Methoxy Methane (C<sub>2</sub>H<sub>6</sub>O)</b>
Fully Displayed Formula: 	Fully Displayed Formula: 	Fully Displayed Formula: 
		 <p data-bbox="1008 1717 1430 1835">See also 3D Models of Organic Molecules (to be added).</p>

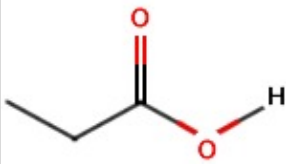

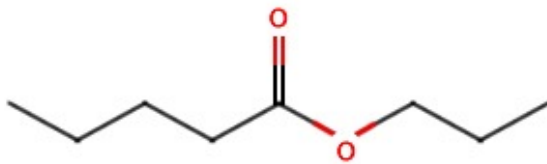
## 5. Skeletal Formulae

**Skeletal formulae** are the least detailed structural diagrams of organic molecules.

The hydrogen atoms (attached directly to carbons) are not shown, resulting in the appearance of a "**carbon skeleton**" with functional groups attached to it.

### Examples of Skeletal Formulae

The molecules represented below are the same as those whose **fully displayed formulae** appear in Section (1.) and whose **simplified displayed formulae** appear in Section (2.).

Propanoic Acid	Hexanenitrile	Propyl Pentanoate
		

For more detail about understanding and creating these diagrams see: [How to draw Skeletal Formulae of Organic Molecules](#).