Date: Key

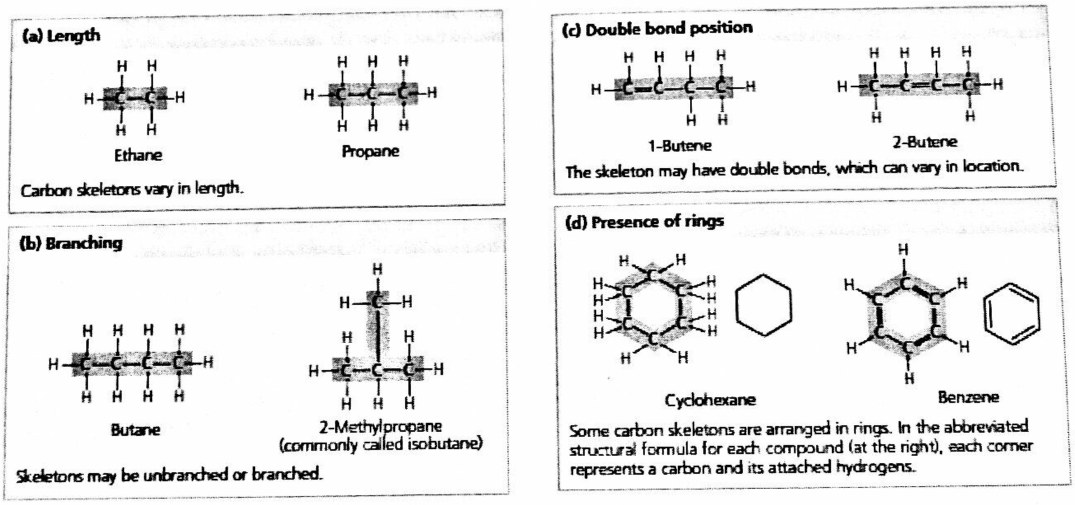
# Organic Chemistry: The Basics

**What is organic chemistry?**

- Strictly speaking, organic chemistry is the study of *organic compounds* – that is, compounds that possess carbon-hydrogen bonds.
- Practically speaking, organic chemistry is the study of molecules that are made within living organisms.

**What do organic compounds look like?**

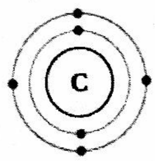
- They have "backbones" of carbon.
- Common variations in the carbon skeleton structure include:
  - o number of carbons in the backbone
  - o the presence of branches
  - o types of bond (single vs. double vs. triple)
  - o presence of ring structures
- Organic molecules may also possess other types of atom. O, N, P and S are elements commonly found in organic molecules.




**What's so special about carbon?**

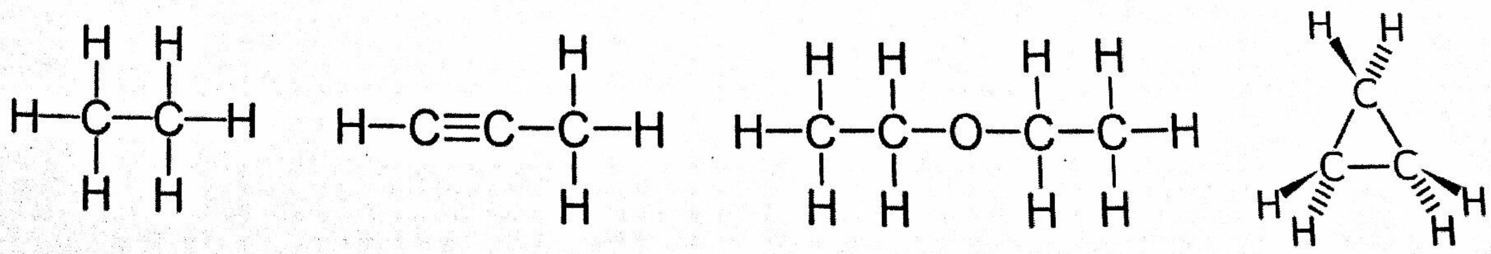
Why carbon is the basis of such diversity...

- Carbon forms four bonds. This means they can form long chains, but still bond to a lot of other stuff. This also means it has the ability to form double and triple bonds.




- Carbon is also a small atom. This means it can comfortably sit within very large molecules.

*Have a look: Carbon always forms four bonds...*

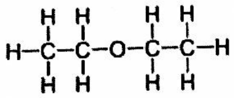
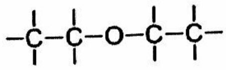
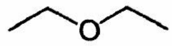


**Representing organic molecules**

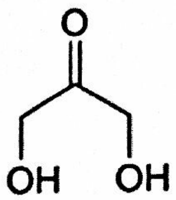
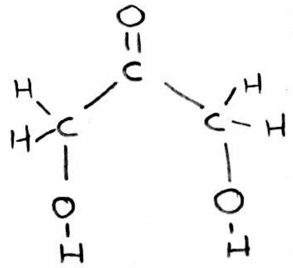
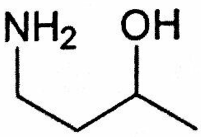
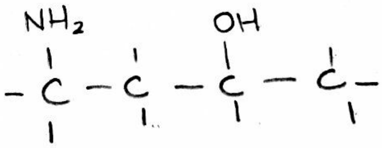
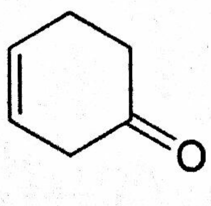
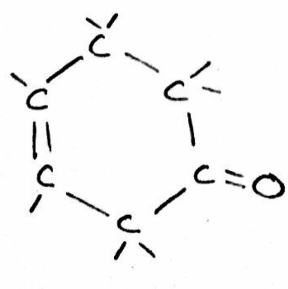
- It's not always practical to draw out the entire structural formula.
    - way too many H's!!

*So how can we simplify???*

Since C and H form the basis of all organic molecules, it's not always necessary to show every H. If no H is shown, its presence is *implied*. Below, have a look at four ways of representing the exact same molecule.

| Molecular formula | Structural formula | Modified structural formula | Line Diagram, aka Skeletal formula |
|---|---|---|---|
| $C_4H_{10}O$ |  |  Draw in bonds but leave out the H's. |  Every end and corner represents a C. Only non-hydrogen atoms are depicted. |

**Practice!**

| | Line Diagram | Structural Formula | Molecular Formula |
|---|---|---|---|
| a) |  |  | $C_3H_6O_3$ |
| b) |  |  | $C_4H_{11}ON$ |
| c) |  |  | $C_6H_8O$ |

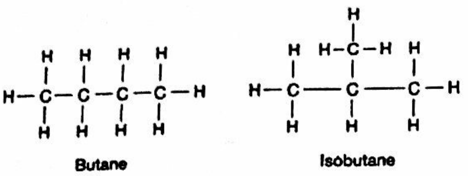
# Isomers

**Isomers are compounds that share the same molecular formula.**

- Though all the same types and numbers of elements are present, the exact physical arrangements is different.

Types of isomer

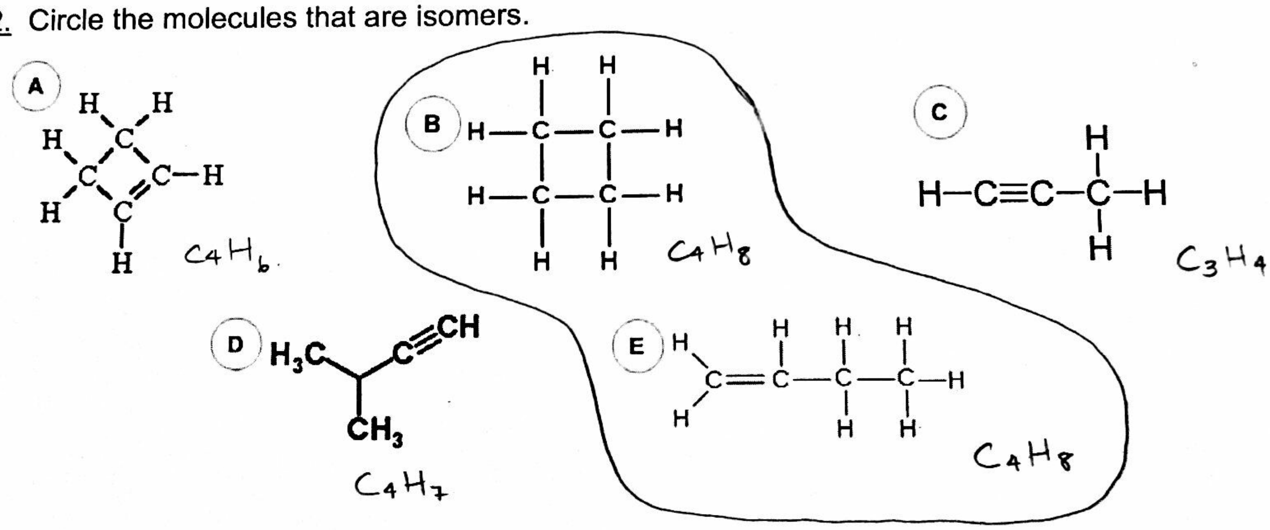
a) **Structural isomers** – The carbons are linked together in different ways




Example 1
Butane and isobutane are two compounds that have the exact same molecular formula.

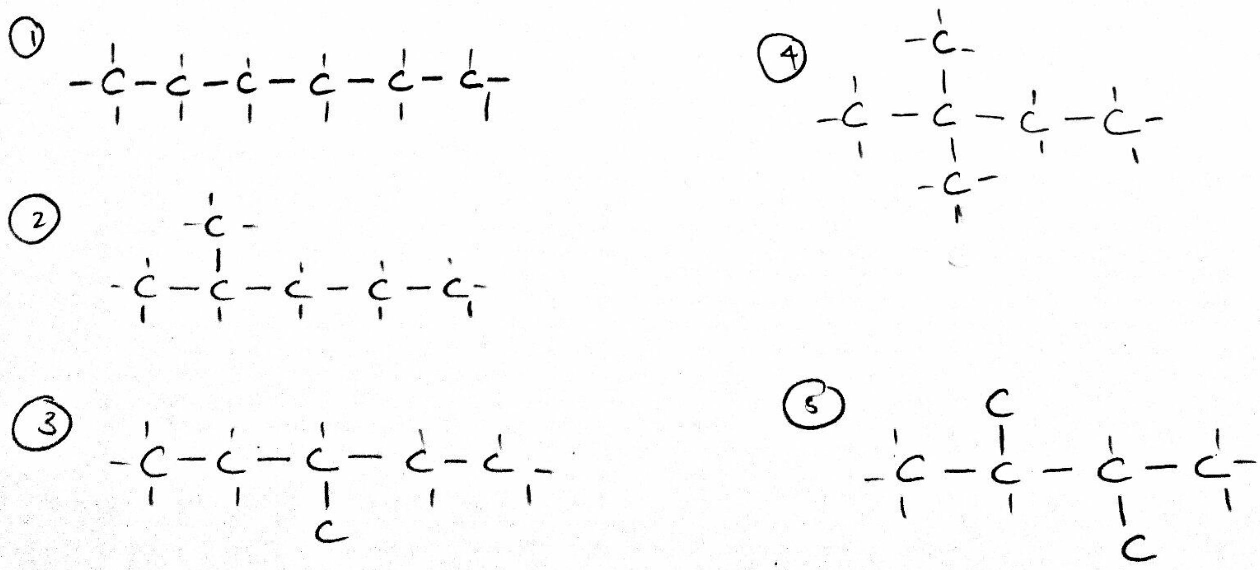
What is the molecular formula? $C_4H_{10}$

Example 2. Circle the molecules that are isomers.




Example 3. There are five isomers of hexane ($C_6H_{14}$)... **How many can you draw?**

Additional details: there are only single bonds, and there are no ring structures.

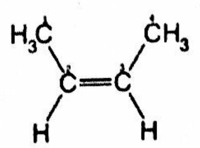


b) **Geometric Isomers** aka "cis/trans isomers" – Describes the relative orientation of substituent groups (non-hydrogen groups), around either a double bond or a ring structure.

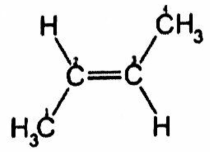
cis = Groups are on same side

trans = Groups are on different sides

Two isomers of 2-butene...

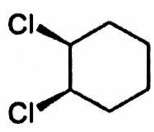


*cis*-2-butene

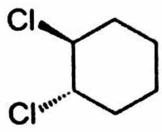


*trans*-2-butene

Two isomers of 1,2-dichlorocyclohexane...



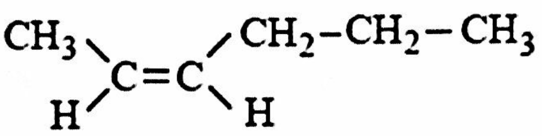
*cis*-1,2-dichlorocyclohexane



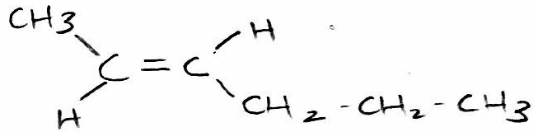
*trans*-1,2-dichlorocyclohexane

Example 4.

i) Complete the name of this cis/trans isomer.
ii) Draw and name the other geometric isomer of this molecule.



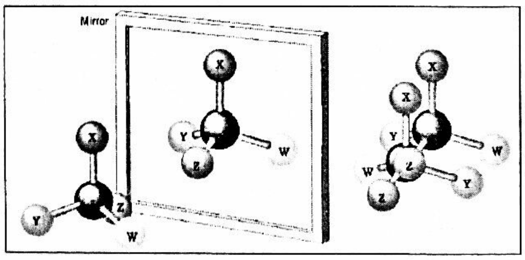
cis -2-hexene



trans -2-hexene

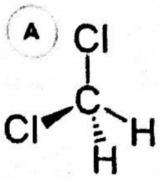
c) **Enantiomers** – Molecules that are mirror images of each other. They differ in their arrangement of atoms around a "chiral" carbon. A chiral carbon is one that is bonded to **four different atoms.**

Because they are mirror images, they are not superimposable. (On the other hand, molecules that are superimposable are identical to one another.)

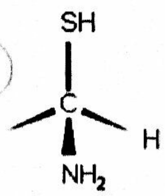



Example 5. Circle the molecules that can have enantiomers.

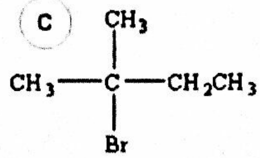
A



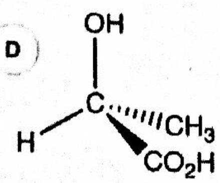
B



C



D



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