

Biomedical
Science

Molecular
Genetics



BMS 23010c | Fall 2026-2027

Organic Chemistry

Introduction



Free Session

A+ is more than just a platform



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Organic Compounds

- ▶ **Organic chemistry** is the study of carbon-containing compounds — particularly compounds containing **carbon (C) and hydrogen (H)**.
- ▶ Organic compounds may also contain other elements.

Oxygen (O)

Nitrogen (N)

Sulfur (S)

Phosphorus (P)

Halogens

EXAMPLES

Sugars, fats, proteins, medicines, and many synthetic materials.

DOES "ORGANIC" MEAN "NATURAL"?

No! "Organic" describes the **chemical structure** — not how or where a compound was produced.



Natural or Synthetic



Natural

Sugars, fat, protein...etc.



Synthetic

Drugs, polymers/plastics, colors/dyes... etc.

Organic compounds

```
graph TD; OC[Organic compounds] --> N[Natural<br/>Sugars, fat, protein<br/>....etc.]; OC --> S[Synthetic<br/>Drugs, polymers/plastics,<br/>Colors/dyes....etc.]
```

Natural

Sugars, fat, protein
....etc.

Synthetic

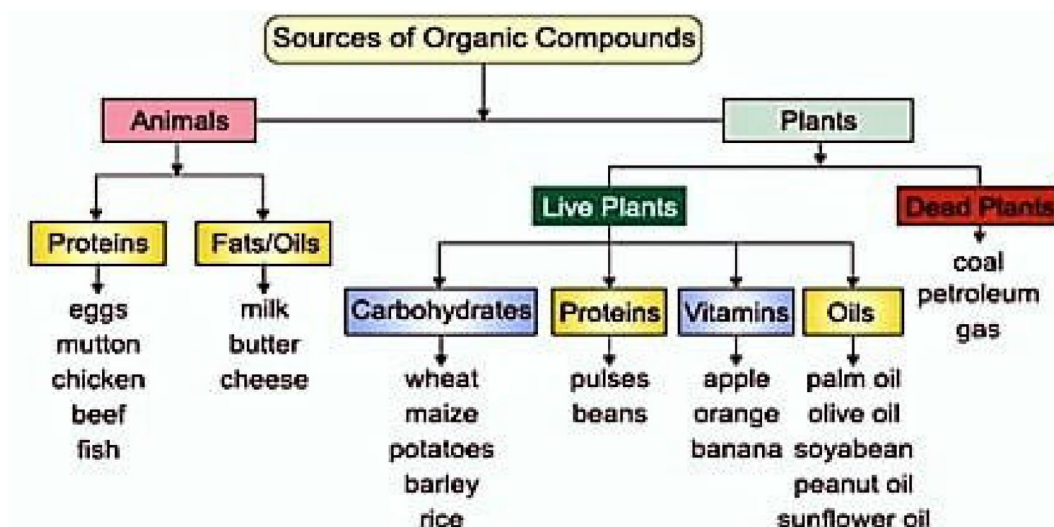
Drugs, polymers/plastics,
Colors/dyes....etc.

CONCEPT CHECK

True or False: If a compound is made in a laboratory, it cannot be an organic compound.

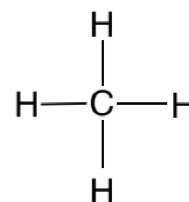


Sources of Organic Compounds



What an Organic Compound Contains

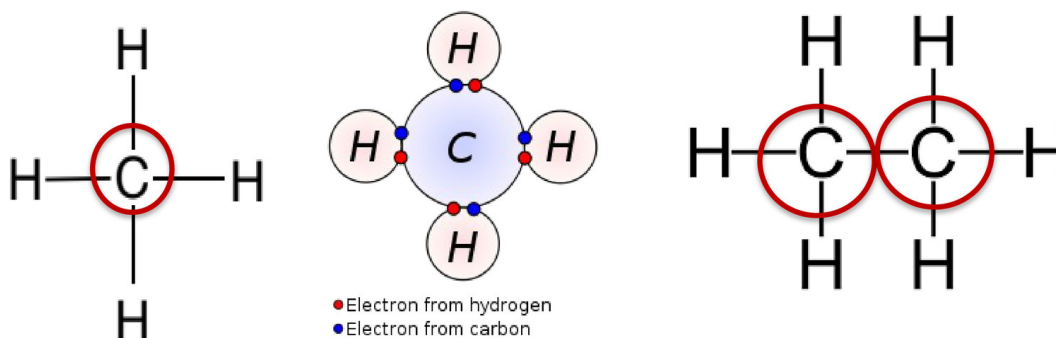
- Always contains **carbon and hydrogen** atoms.
- May also contain other nonmetals such as oxygen, sulfur, nitrogen, phosphorus, or a halogen.
- Organic compounds that contain **only carbon and hydrogen** are called **hydrocarbons** — e.g. methane CH₄.



Methane

CARBON ALWAYS FORMS FOUR BONDS

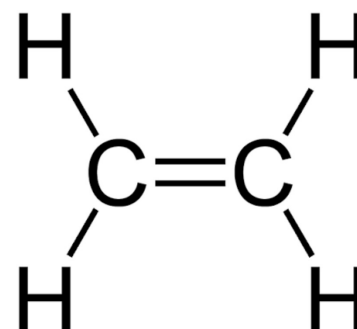
- In organic molecules, **every carbon has four bonds.**
- In methane (CH₄), the carbon atom forms an **octet** by sharing its four valence electrons with four hydrogen atoms.





Concept Check

How many bonds does each carbon form in **ethene**?



Representation of Structural Formulas



Expanded

Also called the **dash** structural formula.



Condensed

Condensed structural formula.

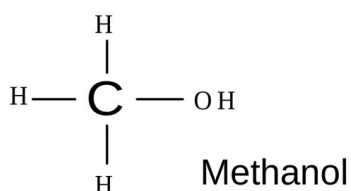


Line angle

Line angle structural formula.

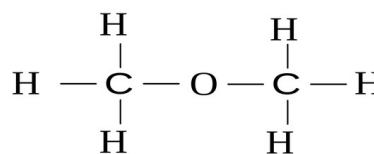
EXPANDED STRUCTURAL FORMULA

- Shows **all of the atoms and the bonds** connected to each atom.
- It is **time consuming** and requires much space.



Methanol

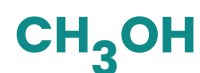
General Organic and Biological Chemistry: Structures of Life, 5/e



Dimethylether

CONDENSED STRUCTURAL FORMULA

- Are **easier to write** than the dash formula.
- All atoms (H or any atom) attached to a particular carbon are written **immediately after that carbon.**



methanol

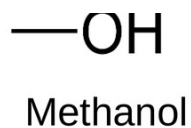
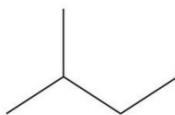
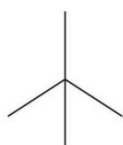


dimethylether



Line Angle Structural Formula

It is the **quickest of all to write** because it shows only the **carbon skeleton**.



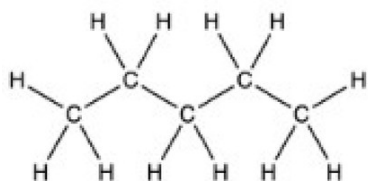
HOW TO READ ONE

- ▶ Line-angle formulas simplify organic structures by showing the **carbon skeleton**.
- ▶ Each **end or corner** of a line represents a carbon atom.
- ▶ Carbon atoms are usually **not written**.
- ▶ Hydrogen atoms attached to carbon are usually **not shown**.
- ▶ Other atoms, such as **O and N**, are shown.

TIP

Count the **ends and corners** — not the lines.

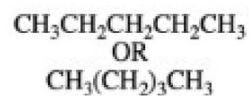
Lewis / Kekule
or Line-Bond Structure



Skeletal or Line Drawing



Condensed Formula



S

son Education



Properties of Organic Compounds

Organic compounds **typically...**



Covalent bonds

Organic compounds have **covalent bonds**.



Low melting and boiling points

They have **low melting and boiling points**.



Flammability

They may be **flammable** and undergo combustion.



Water solubility

Varies with structure — e.g. sugar vs. oil. Sugar dissolves in water but oil does not, yet **both contain organic compounds**.

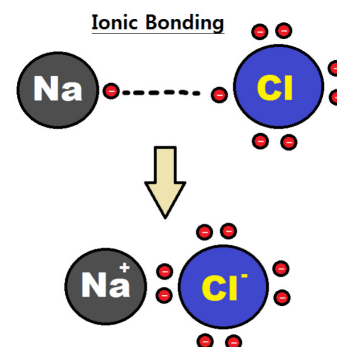
THE MOLECULAR STRUCTURE MATTERS!

- Structure affects **polarity and solubility**.
- Polar molecules/groups interact **more strongly** with water; nonpolar molecules interact **poorly**.
- **"Like dissolves like."**



Inorganic Compounds

- ◆ Compounds that **don't contain C and H together.**
- ◆ Those important for living organisms include **water, oxygen, carbon dioxide, nitrogen and minerals.**
- ◆ Many have **high melting and boiling points.**
- ◆ Those that are **ionic** are usually soluble in water.



EXAMPLES IMPORTANT IN LIVING SYSTEMS

Water

Oxygen

Carbon dioxide

Minerals

NOTE

Some carbon-containing compounds, such as **CO₂**, are classified as inorganic.

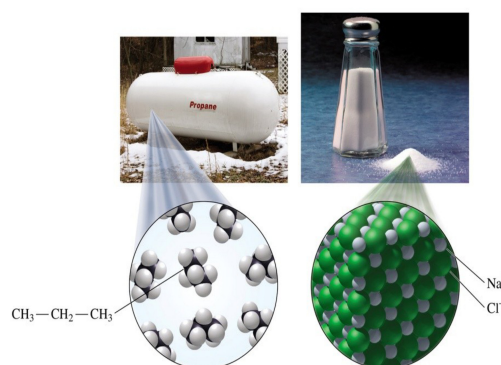
WHAT IS AN ION?

An ion is an atom or molecule with an **electrical charge**. An ionic compound contains **oppositely charged ions** held together by attraction.



Organic and Inorganic Compounds

- Propane, **C₃H₈**, is an **organic compound** used as a fuel.
- NaCl, salt, is an **inorganic compound** composed of **Na⁺** and **Cl⁻** ions.





Organic vs Inorganic: Side by Side

PROPERTY	ORGANIC COMPOUNDS	INORGANIC COMPOUNDS
Common elements	C and H; may include O, N, S, P, halogens	Many different elements
Bonding	Mostly covalent — share an electron	Often ionic — transfer charged electron; may be covalent
Melting & boiling points	Often lower	Often higher
Flammability	Many are flammable	Generally less flammable
Water solubility	Varies with molecular structure	Many ionic compounds are water-soluble
Examples	Glucose, fats, proteins	Water, NaCl, minerals



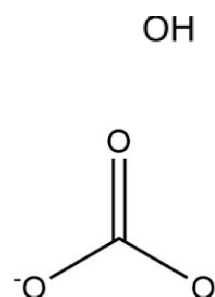
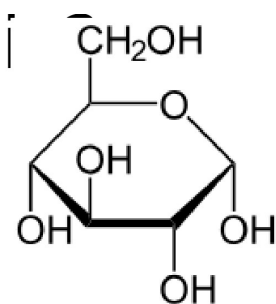
Concept Check — Organic or Inorganic?



Glucose



Calcium



STUDY CHECK — ORGANIC OR INORGANIC?



A



B



C



D



E



Classification: Different Skeletons

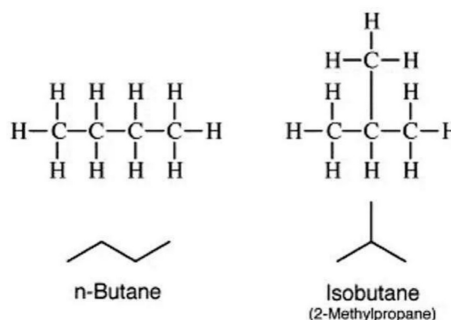
Organic compounds can have **different skeletons**.



Open-chain compounds

Carbon atoms are arranged in **straight or branched chains**.

Examples: **butane** and **isobutane**.

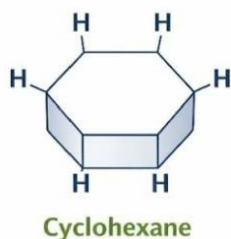
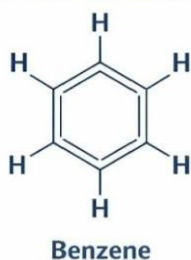


Cyclic compounds

Carbon atoms form a **ring**.

Example: **cyclohexane**.

Structure of **Benzene** and **Cyclohexane**



Heterocyclic compounds

Ring structures containing **at least one atom other than carbon** in the ring.

Common heteroatoms include **N, O and S**; many biologically important compounds are heterocyclic.



Aromatic compounds

A special class of cyclic compounds with a **particular electron arrangement**.

Example: **benzene**.



Isomers: Same Formula, Different Structures



Structural isomers

Same molecular formula, **different arrangement / connectivity** of atoms.



Geometric isomers (cis/trans)

Same connectivity, **different spatial arrangement** around a rigid bond.



Optical isomers

Mirror-image forms of a molecule.



What Is a Functional Group?

- ▶ Organic compounds are organized by their **functional groups**.
- ▶ A functional group is the **reactive site** of an organic molecule.
- ▶ Compounds with the same functional group have **similar physical and chemical properties**.



Alcohol



Aldehyde



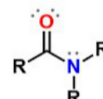
Amine



Ether



Ketone



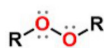
Amide



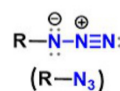
Epoxide



Carboxylic Acid



Peroxide



Azide

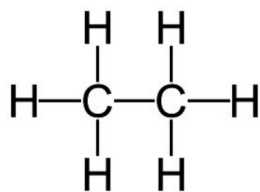


Alkanes, Alkenes and Alkynes



Alkanes

- Only carbon and hydrogen
- All single bonds
- Name ends with **-ane**

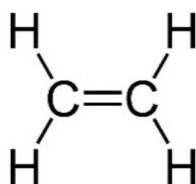


Ethane



Alkenes

- Only carbon and hydrogen
- A carbon to carbon double bond
- Name ends with **-ene**



Ethene



Alkynes

- Only carbon and hydrogen
- All carbon to carbon triple bond
- Name ends with **-yne**



Ethyne

CONCEPT CHECK

Which is alkane, alkene, alkyne?

C-C

C=C

C≡C

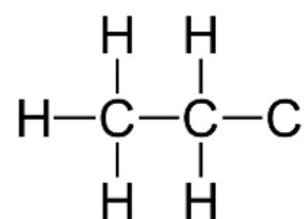


Alkyl Halide and Alcohol

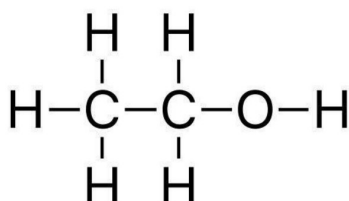


Alkyl halide

- Contains a **halogen** attached to a carbon chain
- General structure: **R-X**, where X = F, Cl, Br, or I
- Example: **chloroethane**



Chloroethane



Ethanol



Alcohol

- Contains a **hydroxyl group**: **-OH**
- General structure: **R-OH**
- Names commonly end in **-ol** — e.g. ethanol



Common Functional Groups — What to Look For

CLASS	LOOK FOR
Alcohol	-OH
Ether	C-O-C
Aldehyde	C=O at end of chain
Ketone	C=O within chain
Carboxylic acid	-COOH
Ester	-COO-
Amine	N-containing group
Alkyl halide	F, Cl, Br or I attached to carbon



Classes, Formulas and Examples — I

CLASS	GENERAL FORMULA	FUNCTIONAL GROUP	SPECIFIC EXAMPLE
Alkane	RH	-	H ₃ C-CH ₃ · ethane
Alkene	R-CH=CH ₂	C=C	H ₂ C=CH ₂ · ethylene
Alkyne	R-C≡CH	C≡C	HC≡CH · acetylene
Alkyl halide	RX	-X (Cl, F, Br, I)	H ₃ C-Cl
Alcohol	R-OH	-OH	H ₃ C-OH
Ether	R-O-R	C-O-C	H ₃ C-O-CH ₃

R = Alkyl group



Classes, Formulas and Examples — II

CLASS	GENERAL FORMULA	FUNCTIONAL GROUP	SPECIFIC EXAMPLE
Aldehyde	R-CH=O	$-\text{CH=O}$	$\text{H}_3\text{C-CH=O}$
Ketone	R-CO-R	$-\text{C=O}$	$\text{H}_3\text{C-CO-CH}_3$
Carboxylic acid	R-CO-OH	$-\text{CO-OH}$	$\text{H}_3\text{C-CO-OH}$
Ester	R-CO-OR	$-\text{CO-OR}$	$\text{H}_3\text{C-CO-O CH}_3$
Amine	R-NH_2	R-NH_2	$\text{H}_3\text{C-NH}_2$



Common Types of Organic Reactions

**Addition**

Atoms/groups are **added** to a molecule.

**Substitution**

One atom/group is **replaced** by another.

**Elimination**

Atoms/groups are **removed**, often forming a multiple bond.

**Oxidation / Reduction**

Changes involving **oxygen, hydrogen, or electron distribution**.

ACTIVITY

Practice what we learned today!