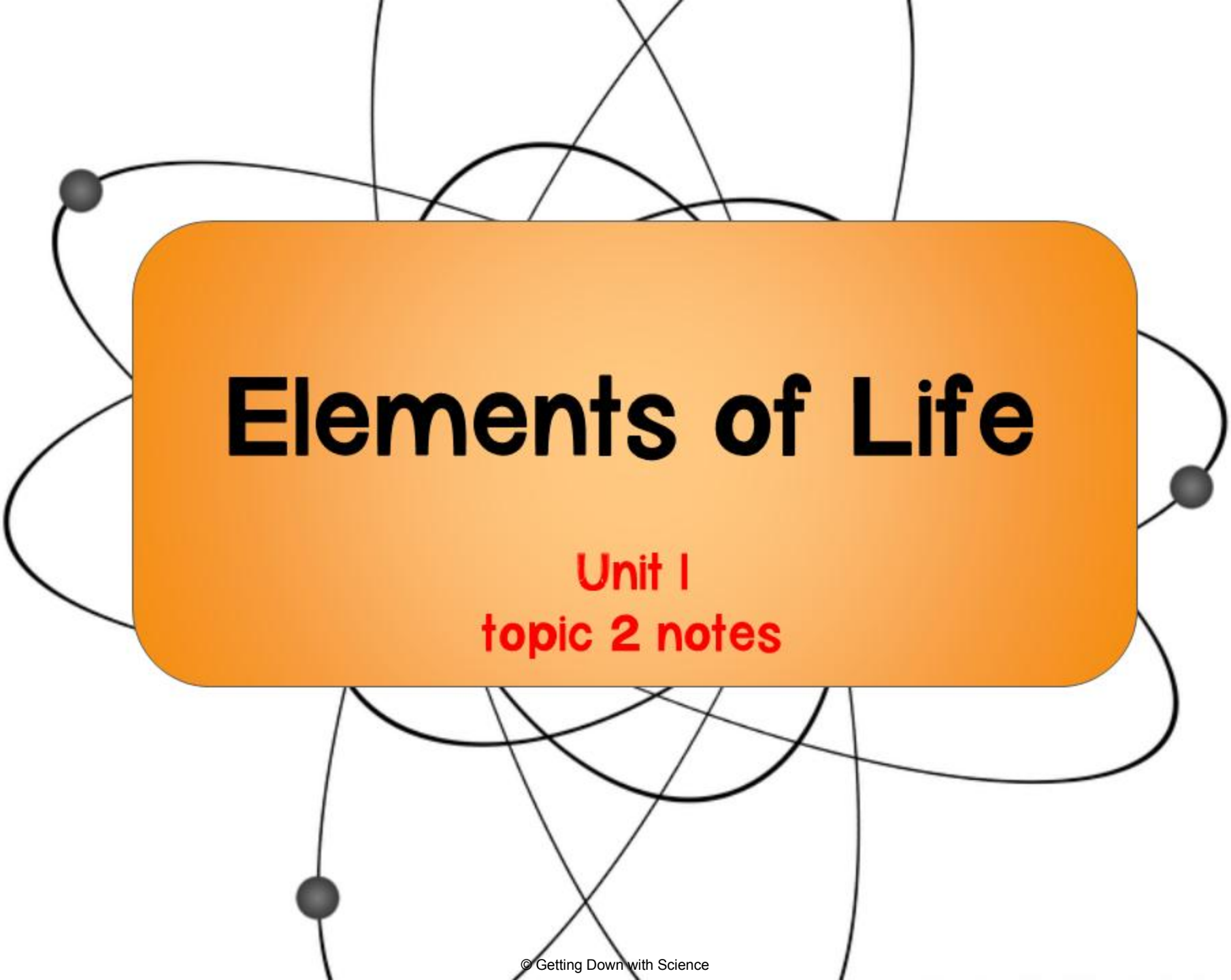
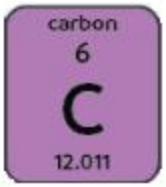


Elements of Life

Unit I
topic 2 notes

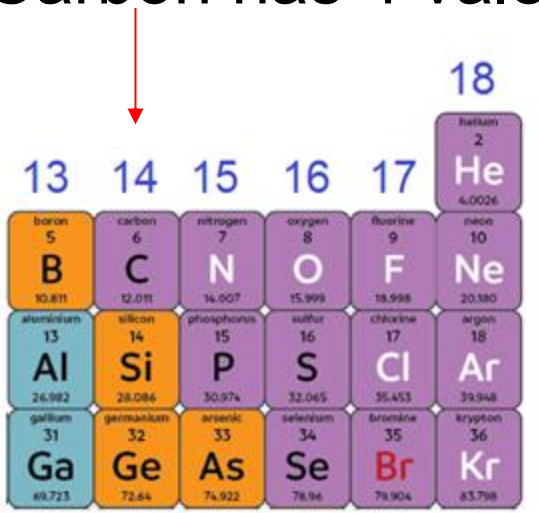
Carbon

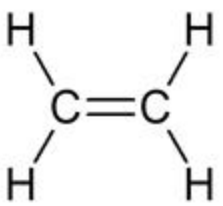


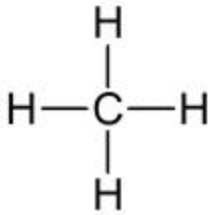
Organic chemistry: the study of compounds with covalently bonded carbon

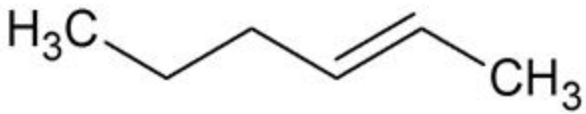
Organic compounds: compounds that contain carbon and hydrogen

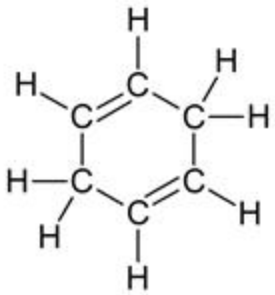
Carbon has 4 valence electrons



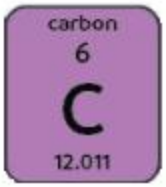








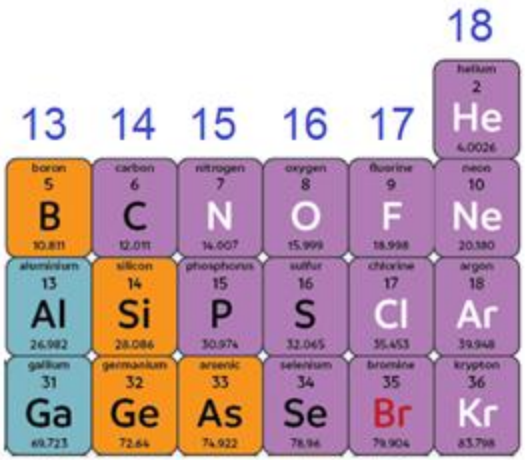
Carbon

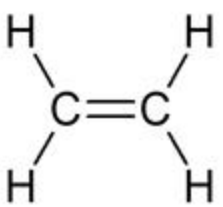


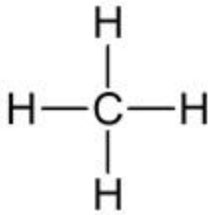
Carbon can form single, double, or triple covalent bonds

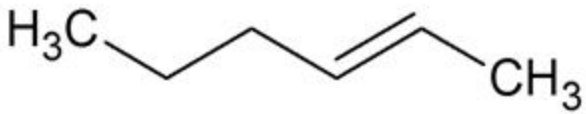
- A single carbon can form up to four covalent bonds!
  - Can form LONG chains
- Most commonly formed with hydrogen, oxygen, and nitrogen

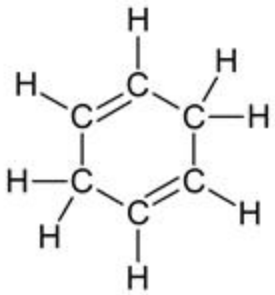
The type and number of covalent bonds carbon forms with other atoms affects the length of the carbon chain and shape of the molecule







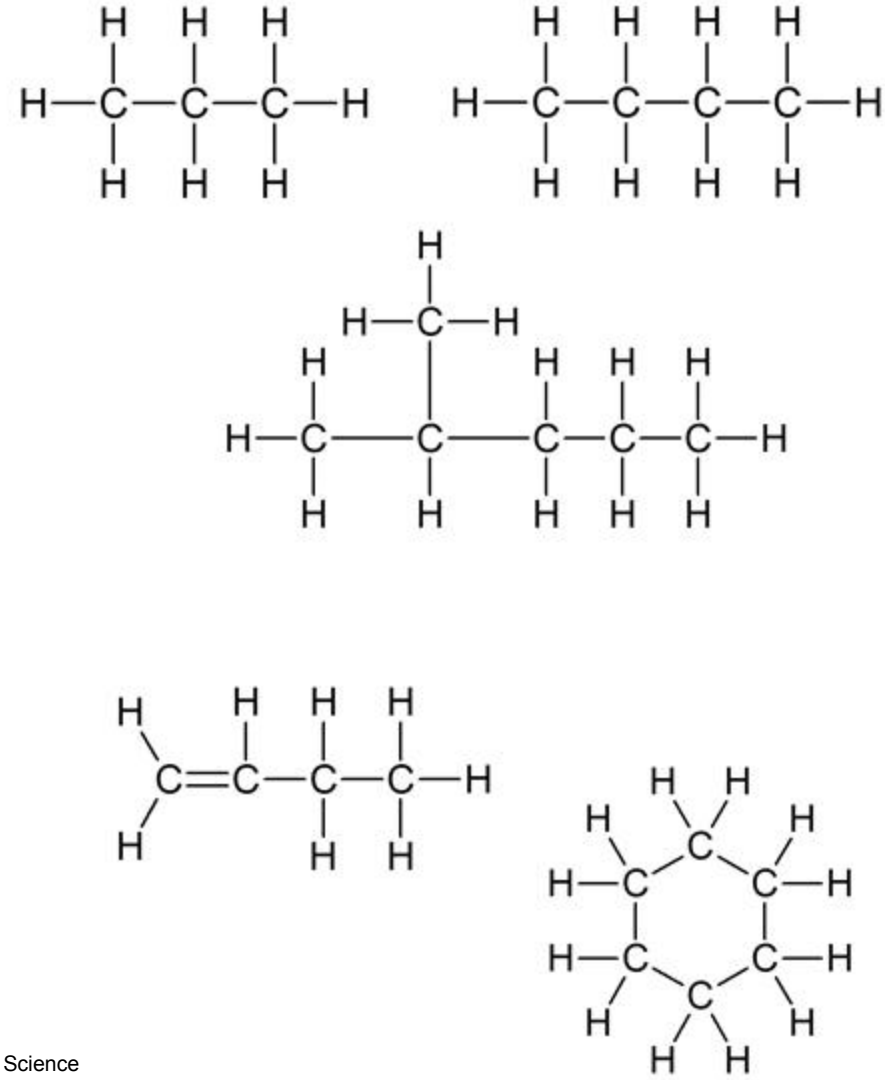




Carbon Chains

Carbon can use its valence electrons to form covalent bonds to other carbons

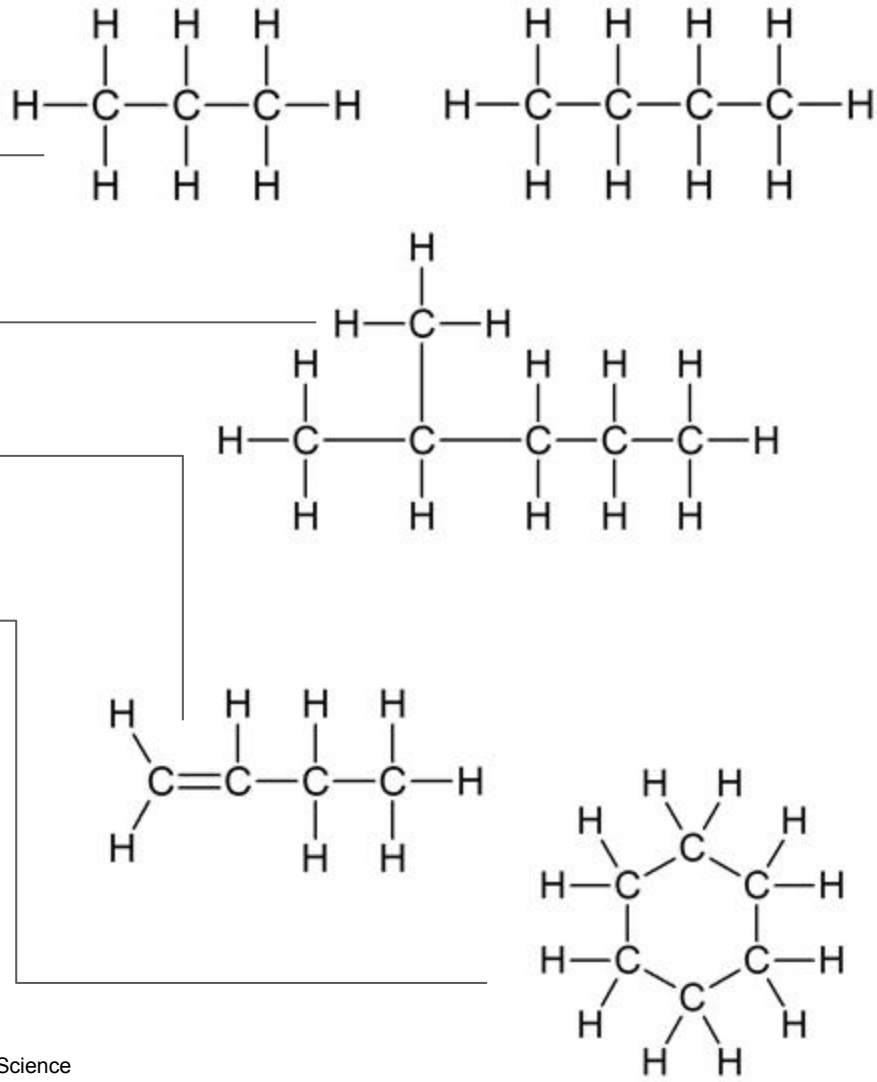
- This links the carbons into a chain
- Hydrocarbons- organic molecules consisting only of carbon and hydrogen (think: simple framework for more complex organic molecules)



Carbon Chains

Carbon chains form the skeletons of most organic molecules

- Skeletons can vary in:
  - Length
  - Branching
  - Double bond position
  - Presence of rings
- Many regions of a cell's organic molecules contain hydrocarbons

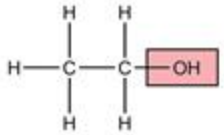


Functional Groups

Functional groups: chemical groups attached to the carbon skeleton that participate in chemical reactions

Hydroxyl group

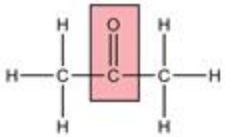
-OH



Ethanol

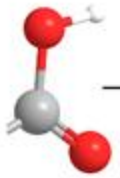
Carbonyl group

C=O

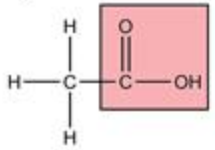


Acetone

Carboxyl group



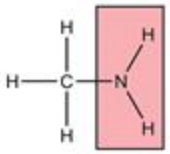
—COOH



Acetic Acid

Amino group

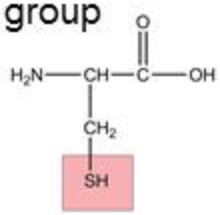
$-NH_2$



Methylamine

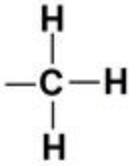
Sulfhydryl group

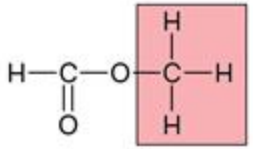
—SH



Cysteine

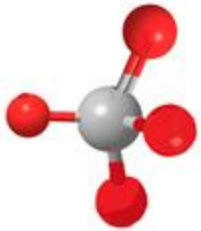
Methyl group



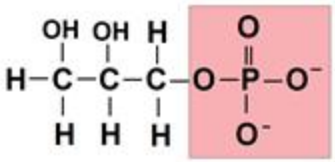


Methyl formate

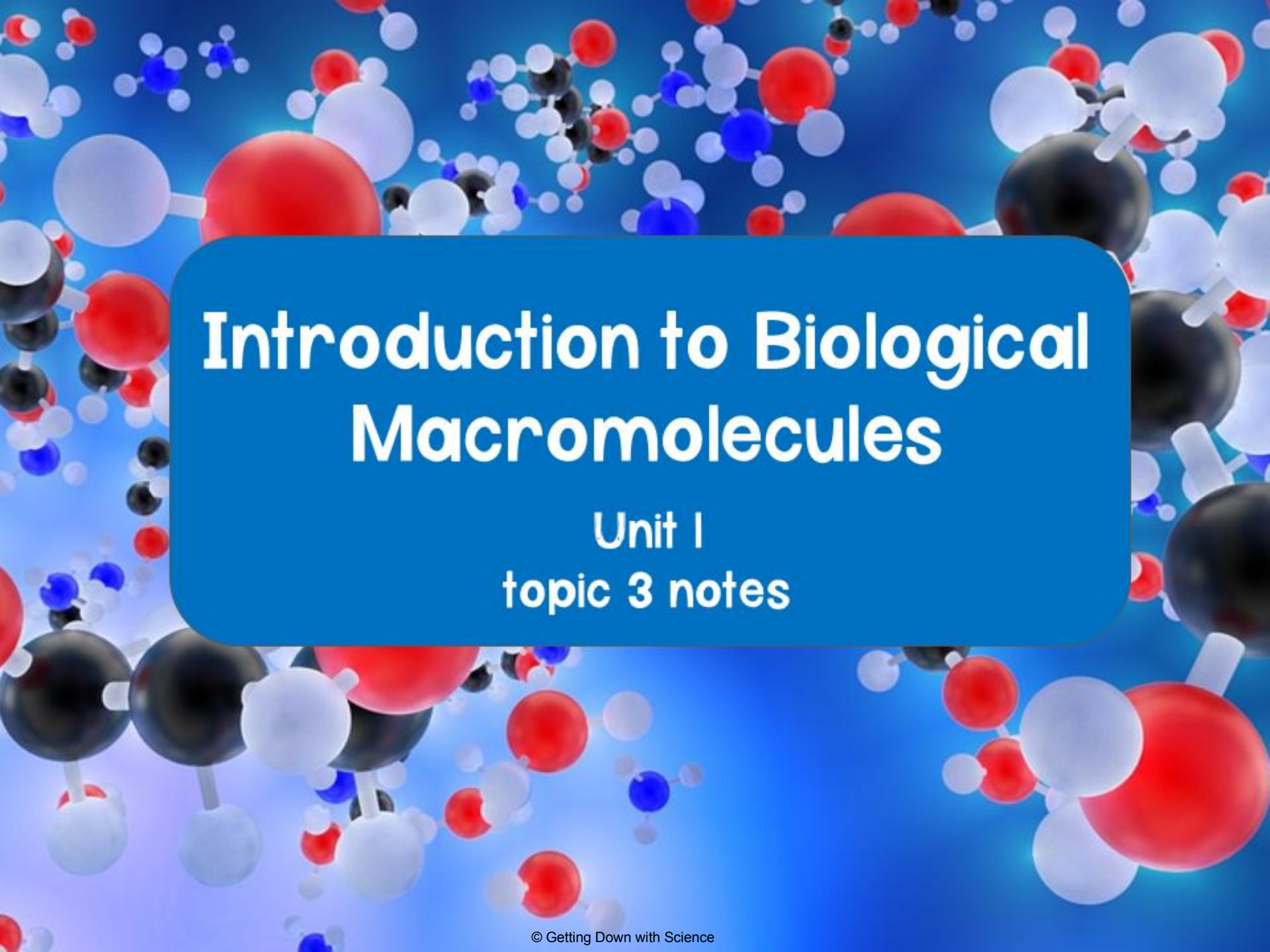
Phosphate group



$-OPO_3^{2-}$



Glycerol phosphate



Molecular Diversity due to Carbon

- Variations in carbon skeletons allows for molecular diversity
- Carbon can form large molecules known as macromolecules
- Four classes of macromolecules (molecules made of smaller subunits):

1. Carbohydrates
2. Proteins
3. Nucleic acids
4. Lipids

Polymers

Does not include true polymers and are hydrophobic molecules

NOTE: Along with carbon, nitrogen is an important element for building proteins and nucleic acids. Phosphorus is important for building nucleic acids and some lipids

Formation and Breakdown of Macromolecules

Polymers: chain like macromolecules of similar or identical repeating units that are covalently bonded together

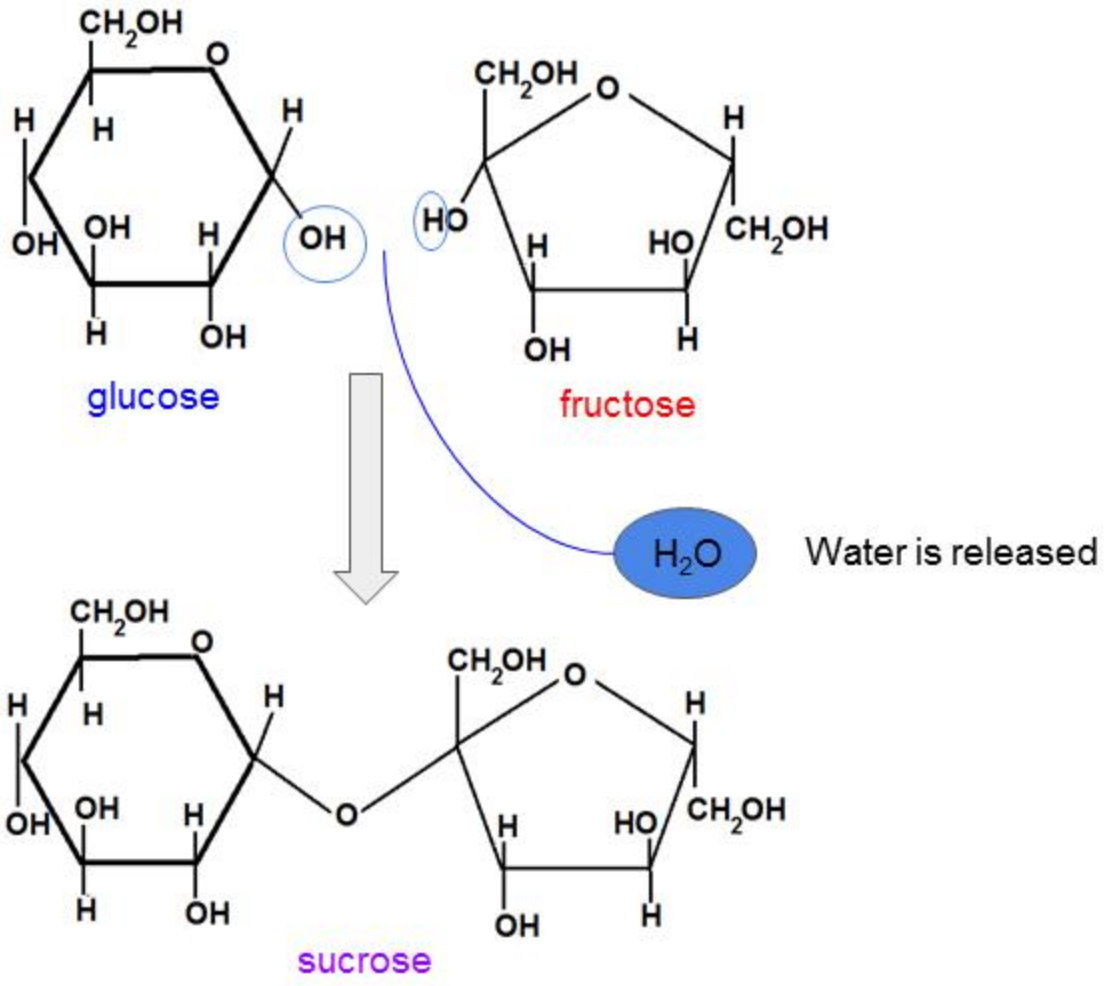
Monomers: the repeating units that make up polymers

Formation and Breakdown of Macromolecules

Dehydration reaction: bonds two monomers with the loss of H_2O

- The -OH of one monomer bonds to the -H of another monomer forming H_2O, which is then released
  - $A+B \rightarrow AB + H_2O$

Dehydration Reaction

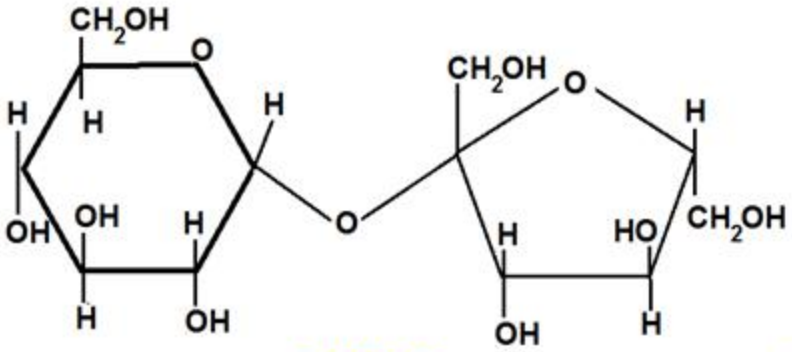


Formation and Breakdown of Macromolecules

Hydrolysis: breaks the bonds in a polymer by <u>adding</u> H_2O

- One -H of the H_2O bonds to one monomer and the remaining -OH of the H_2O attaches to the other monomer
  - $AB + H_2O \rightarrow A+B$

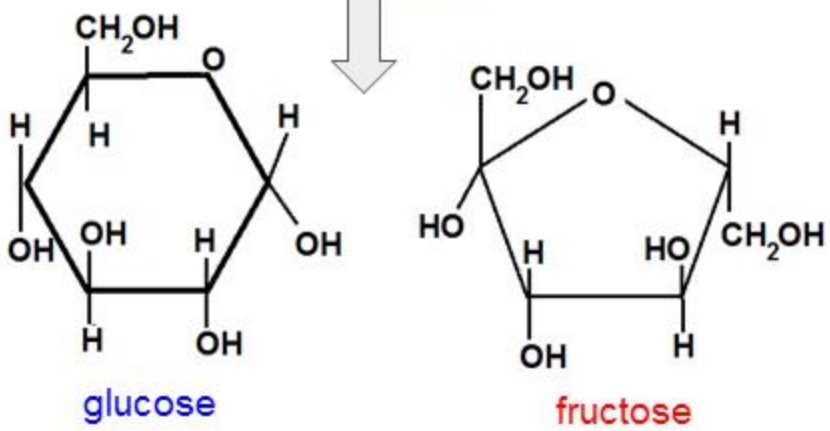
Hydrolysis



sucrose

H_2O

Water is added



glucose

fructose

Concept Check

1. You are performing an experiment that involves a hydrolysis reaction. The polymer that you are working with is amylose starch. There are 300 monomers of glucose that make up this polymer. How many water molecules will you need to completely hydrolyze the amylose starch polymer?

- Answer: 299

Concept Check

2. Describe the properties of carbon that make it an element essential for life.
3. Look at the periodic table and find silicon. What do you notice about its position in comparison to carbon. What does that tell us about silicon?