

# The Star of The Show

Organic?

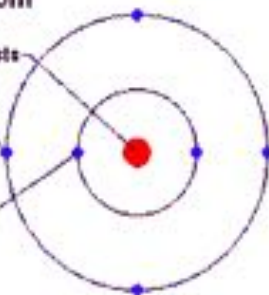


## Carbon Atom

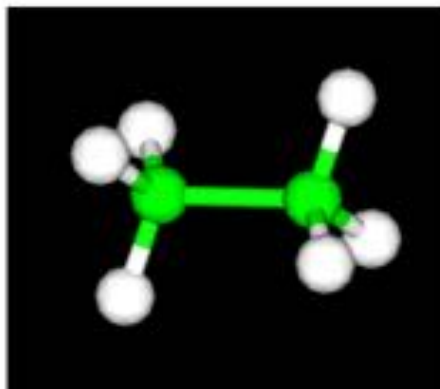
nucleus consists of 6 protons

4 electrons in outer shell

2 electrons in inner shell



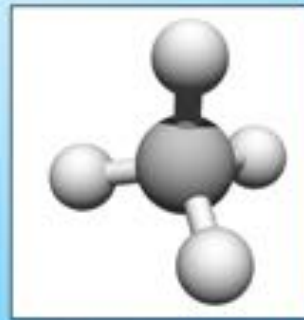
CARBON ↓



## Building with Carbon: Hydrocarbons

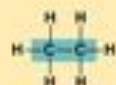
– non-polar

- not soluble in H<sub>2</sub>O
- Hydrophobic

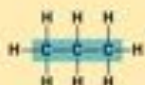


**methane**  
(simplest HC)

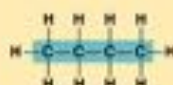
# Hydrocarbons can grow



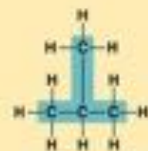
Ethane



Propane



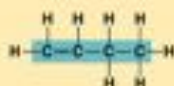
Butane



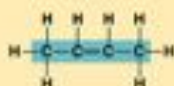
Isobutane

(a) Length

(b) Branching

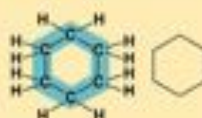


1-Butene

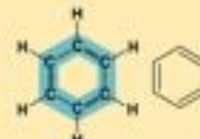


2-Butene

(c) Double bonds



Cyclohexane



Benzene

(d) Rings

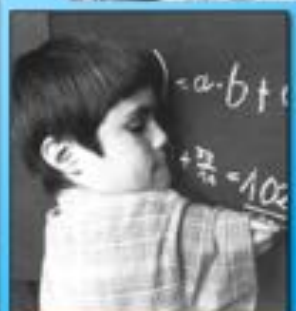
## Let's Build with Carbon

- Build the simplest Hydrocarbon:  $\text{CH}_4$  (Methane)
- Build Butane:  $\text{C}_4\text{H}_{10}$
- Build a Structural Isomer of Butane:  $\text{C}_4\text{H}_{10}$
- Build Geometric Isomers:  $\text{C}_2\text{H}_2(\text{OH})_2$ 
  - Cis-
  - Trans-
- Build Enantiomers (mirror images):
  - Left & Right Amino Acids

Double bonds Build Ethen-1,2-diol (Cis/Trans)

## Form affects function

- Thalidomide
  - prescribed to pregnant women in 50s & 60s in Europe
  - reduced morning sickness, but...
  - enantiomer caused severe birth defects



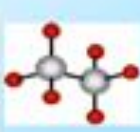
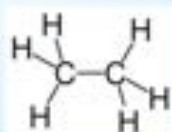
Today, thalidomide is sold by Celgene, mainly as a treatment of certain can

Thalidomide is racemic – it switches easily between the mirror image for

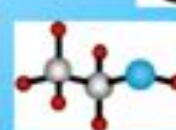
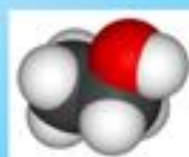
Laboratory tests after the thalidomide disaster showed that in some animal:

## Diversity of molecules

- Substitute other atoms or groups around the carbon



ethane (C<sub>2</sub>H<sub>6</sub>)



ethanol (C<sub>2</sub>H<sub>5</sub>OH)

Use Binder Page 57

**PLEASE, GO MASS  
YOUR PLANTS!!!  
RECORD RESULTS!**

**GET OUT BINDER PAGE 57**

# Viva la difference!

- Basic structure of male & female hormones is identical
  - identical carbon skeleton
  - Different FUNCTION!!



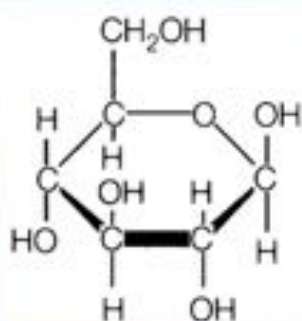
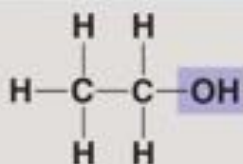
For example the male and female hormones, testosterone and estradiol, differ from each





(may be written HO—)

# Hydroxyl



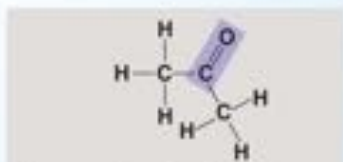
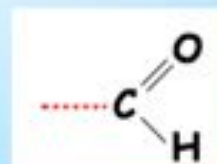
... hydrophylic

**Table 4.1 Functional Groups of Organic Compounds**

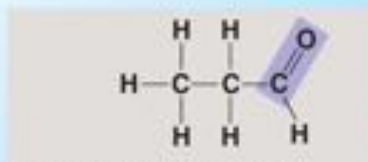
Functional Group	Formula	Name of Compounds	Example
Hydroxyl	$-\text{OH}$	Alcohols	$  \begin{array}{c}  \text{H} \quad \text{H} \\    \quad   \\  \text{H}-\text{C}-\text{C}-\text{OH} \\    \quad   \\  \text{H} \quad \text{H}  \end{array}  $ <p>Ethanol (the drug of alcoholic beverages)</p>



# Carbonyl



Acetone, the simplest ketone

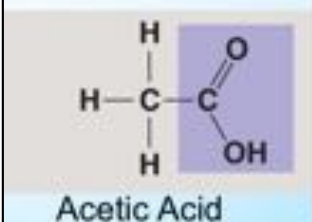
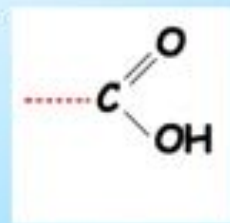
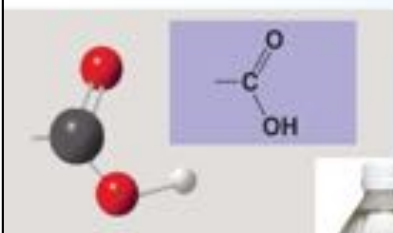


Propanal, an aldehyde

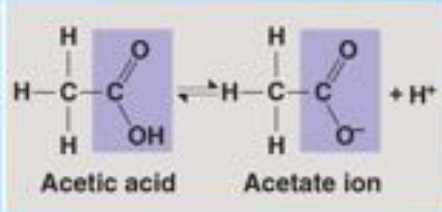
Table 4.1 Functional Groups of Organic Compounds

Functional Group	Formula	Name of Compounds	Example
Carbonyl		Aldehydes	 Propanal
		Ketones	 Acetone

# Carboxyl or Acid Group



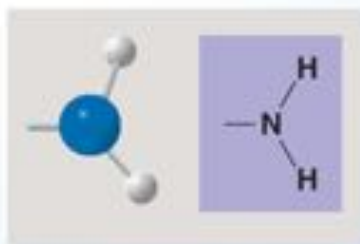
Acetic Acid



Acetic acid

Acetate ion

Table 4.1 Functional Groups of Organic Compounds			
Functional Group	Formula	Name of Compounds	Example
Carboxyl	$\text{---C(=O)OH}$ (non-ionized) $\text{---C(=O)O}^-$ (ionized)	Carboxylic acids	$\text{H}_3\text{C-C(=O)OH}$ Acetic acid* (the acid of vinegar)



# Amino

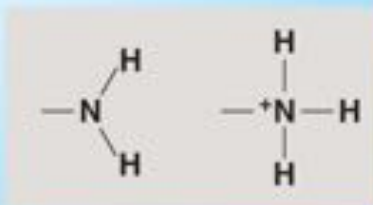
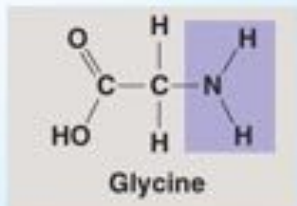
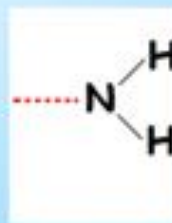


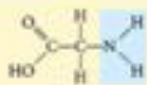
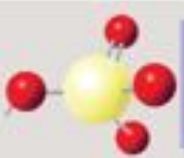


Table 4.1 Functional Groups of Organic Compounds			
Functional Group	Formula	Name of Compounds	Example
Amino	 (non-ionized)	 (ionized)	 Glycine*

# Sulfhydryl

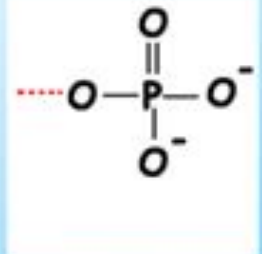


Functional Group	Formula	Name of Compounds	Example
Sulfhydryl	—SH	Thiols	$  \begin{array}{c}  \text{H} \quad \text{H} \\    \quad   \\  \text{H} - \text{C} - \text{C} - \text{SH} \\    \quad   \\  \text{H} \quad \text{H} \\  \text{Ethane-1-thiol}  \end{array}  $



$$\begin{array}{c} \text{O} \\ || \\ -\text{O}-\text{P}-\text{O}^- \\ | \\ \text{O}^- \end{array}$$

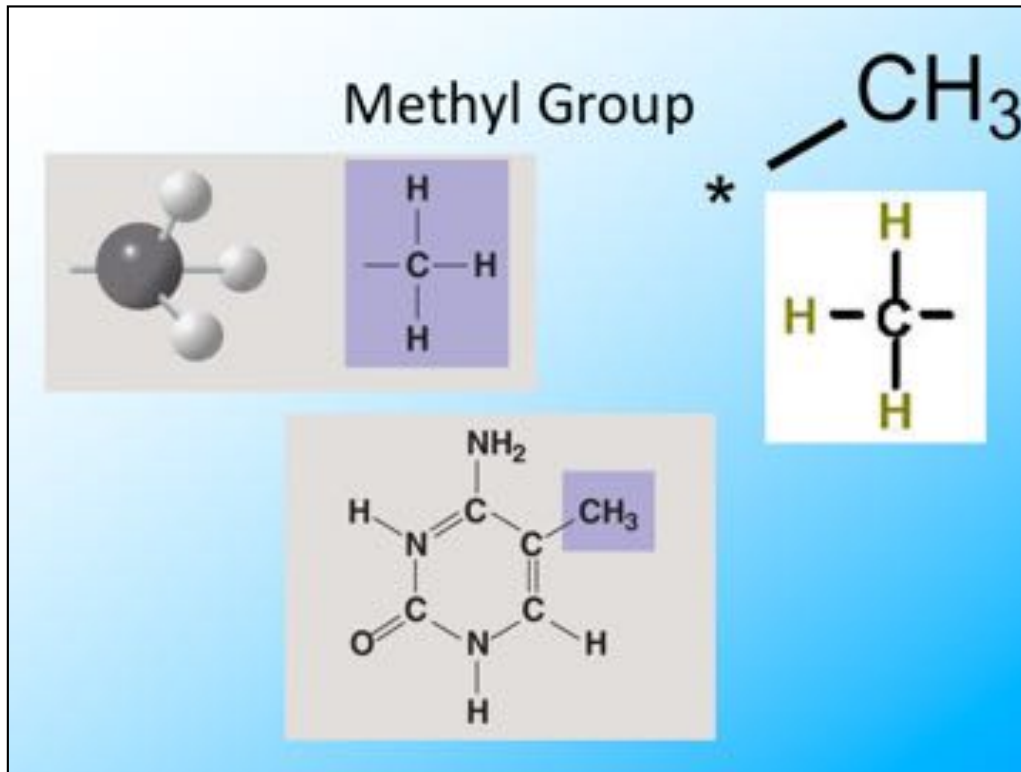
# Phosphate



$$\begin{array}{ccccccc} & \text{OH} & \text{OH} & \text{H} & & \text{O} & \\ & | & | & | & & || & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{O} & -\text{P} & -\text{O}^- \\ & | & | & | & & | & \\ & \text{H} & \text{H} & \text{H} & & \text{O}^- & \end{array}$$

**Glycerol phosphate**

Table 4.1 Functional Groups of Organic Compounds			
Functional Group	Formula	Name of Compounds	Example
Phosphate	$\begin{array}{c} \text{O} \\    \\ -\text{O}-\text{P}-\text{O}^- \\   \\ \text{O}^- \end{array}$	Organic phosphates	$\begin{array}{ccccccc} & \text{OH} & \text{OH} & \text{H} & & \text{O} & \\ &   &   &   & &    & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{O} & -\text{P} & -\text{O}^- \\ &   &   &   & &   & \\ & \text{H} & \text{H} & \text{H} & & \text{O}^- & \end{array}$ <p><i>Glycerol phosphate</i></p>



Add to DNA to affect gene expression

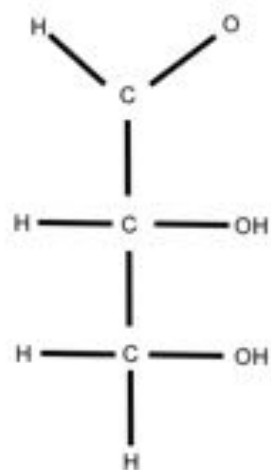
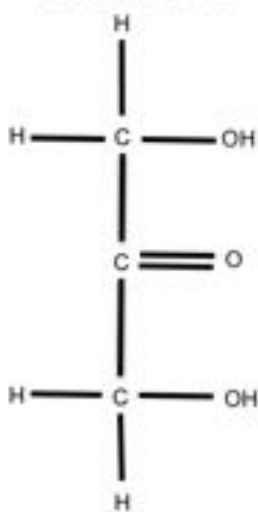
Add to Steroid Sex hormones change function

Move to the Organic Molecules  
Presentation



## Review Questions

## What are the Functional Groups?



A. R-OH

B. R=O

C. R-COOH

D. R-SH

E. R-PO<sub>4</sub>  
R-CH<sub>3</sub>

F.

1. Produces OH ions in water
2. Placement determines whether the molecule is an aldehyde or a ketone
3. Contains the major high energy bond in biological molecules
4. Used in proteins to stabilize structure
5. Presence of this group classifies molecules as alcohols.



## Why study Carbon?

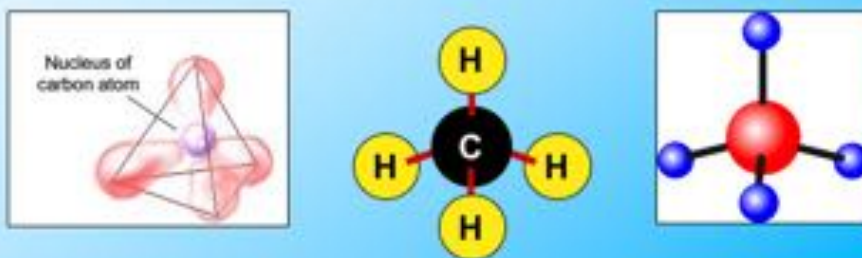
- All of life is built on carbon
- Cells
  - ~72% H<sub>2</sub>O
  - ~25% carbon compounds
    - carbohydrates
    - lipids
    - proteins
    - nucleic acids
  - ~3% salts
    - Na, Cl, K...



Why do we study carbon -- is it the most abundant element in living organisms  
H & O most abundant  
C is the next most abundant

## Chemistry of Life

- Organic chemistry is the study of carbon compounds
- C atoms are versatile building blocks
  - bonding properties
  - 4 stable covalent bonds



Carbon chemistry = organic chemistry

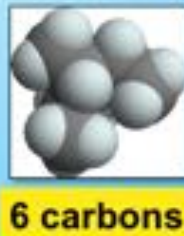
Why is it a foundational atom?

What makes it so important?

Can't be a good building block if you only form 1 or 2 bonds.

## Isomers

- Molecules with same molecular formula but different structures (shapes)
  - different chemical properties
  - different biological functions

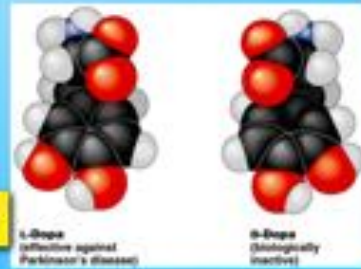
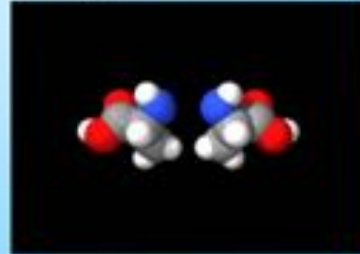


Same formula but different structurally & therefore different functionally. Mo

Ex. Isomers may be ineffective as medicines

## Form affects function

- Structural differences create important functional significance
  - amino acid alanine
    - L-alanine used in proteins
    - but not D-alanine
  - medicines
    - L-version active
    - but not D-version
  - sometimes with tragic results...



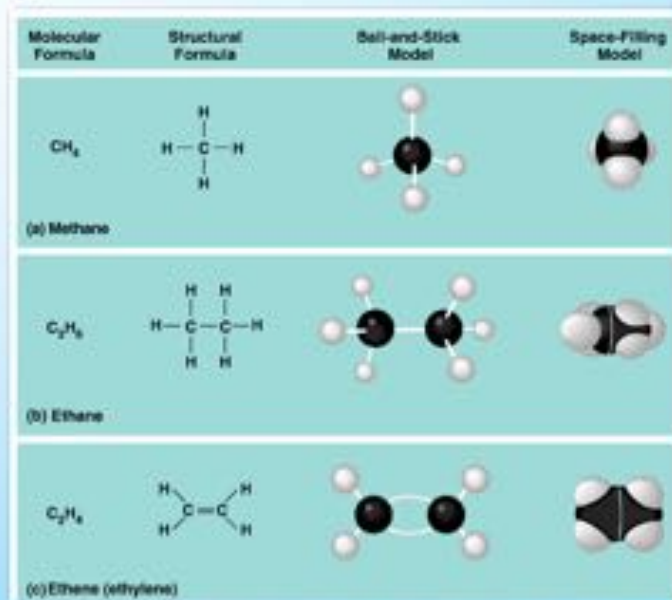
**stereoisomers**



## Functional groups

- Parts of organic molecules that are involved in chemical reactions
  - give organic molecules distinctive properties
    - hydroxyl
    - amino
    - carbonyl
    - sulfhydryl
    - carboxyl
    - phosphate
- Affect reactivity
  - makes hydrocarbons hydrophilic
  - increase solubility in water

## Complex molecules assembled like TinkerToys



Like sugars:  $\text{C}_6\text{H}_{12}\text{O}_6$

But can be arranged in different ways

- glucose
- galactose
- dextrose

## Writing AP Bio Essays

- First One: #129:

The unique properties (characteristics) of water make life possible on Earth. Select three properties of water and:

- a. For each property, identify and define and explain it in terms of the physical/chemical nature of water.
- b. For each property, describe one example of how the property affects the functioning of living organisms.