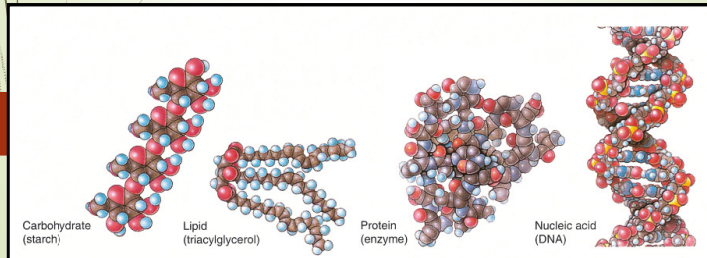


# Macromolecules

## Chapter 2.3



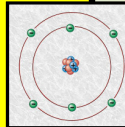
E.Q. What are the 4 main macromolecules found in living things and what are their functions?

## Carbon-Based Molecules

- Why is carbon called the building block of life?

► Carbon atoms are the basis of most molecules found in living things

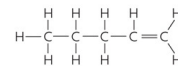
► Carbon's unique bonding properties allow it to form covalent bonds with at least 4 other atoms



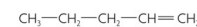
## Carbon-Based Molecules

- 3 Fundamental Structures
  - Straight chain
  - Branched chain
  - Ring

Straight chain

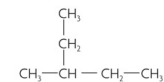


A simplified structure can also be shown as:



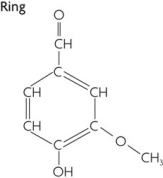
Pentene

Branched chain



Hexane

Ring



Vanillin

## Carbon-Based Molecules

- ▶ **Monomers** are small molecules that make up larger molecules called **polymers**.
- ▶ Monomers are individual subunits
  - ▶ Ex: amino acids, fatty acids
- ▶ Polymers (macromolecules) are made of many monomers
  - ▶ Ex: proteins, lipids

## Carbon-Based Molecules

### Four main types of Macromolecules

All organisms are made up of:

- ▶ Carbohydrates
- ▶ Lipids
- ▶ Proteins
- ▶ Nucleic acids

## Four main types of Macromolecules

### 1. Carbohydrates


- ▶ Building blocks:
  - ▶ Made of carbon, hydrogen, and oxygen
- ▶ Monosaccharides are simple sugars
  - ▶ Ex: glucose, fructose
- ▶ Polysaccharides are polymers of monosaccharides
  - ▶ Ex: starch, cellulose, and glycogen

## Carbohydrates

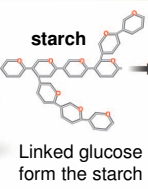
Glucose

## Carbohydrates

- Used as a source of energy for living things



**starch**

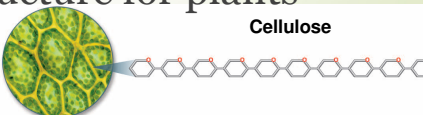


Linked glucose molecules form the starch in pasta.

Cells break down starch into glucose which is used for energy.

- Provide structure for plants

Cellulose is a long chainlike molecule that forms part of a plant's structure.



**Cellulose**

## Carbohydrates

What is the monomer that makes up carbohydrates called?

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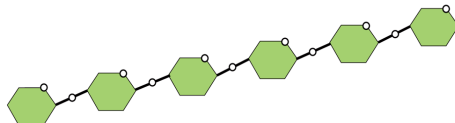
**Polymer (starch)**



Starch is a polymer of glucose monomers that often has a branched structure.


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**Polymer (cellulose)**





Cellulose is a polymer of glucose monomers that has a straight, rigid structure


What do you eat to obtain a lot of carbohydrates?










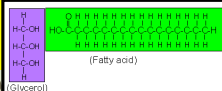





## Four main types of Macromolecules

### 2. Lipids

- Building Block:
  - Made up of Carbon, hydrogen, and oxygen
- Includes:
  - Fats, oils, cholesterol, waxes
- Consist of 3 fatty acid chains bonded to glycerol called **Triglycerides**.



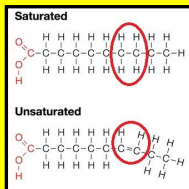
(Fatty acid)



(Glycerol)

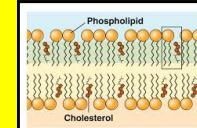
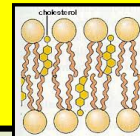
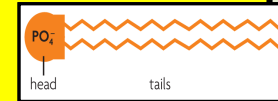
# Lipids

- Uses of lipids by organisms: Functions
  - Mainly used as a source of energy (stored)
    - Saturated fats :Animals store chemical energy in fats
    - Unsaturated fats: Plants store chemical energy in oils



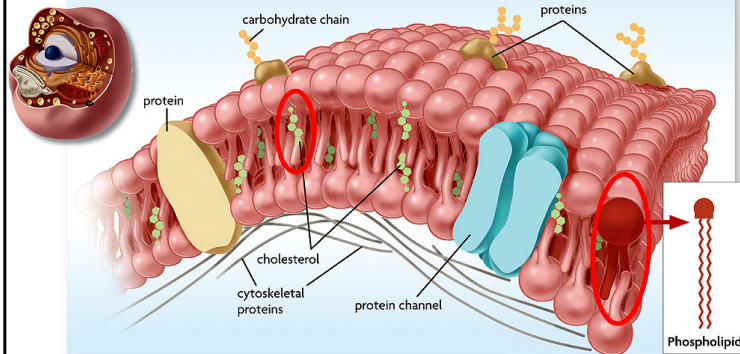
# Lipids

- Uses of lipids by organisms:
  - Make up cell membranes
    - Phospholipids =A glycerol, 2 fatty acids, and a phosphate group
      - Polar phosphate “head”
      - Nonpolar fatty acid “tails”
  - Used to make hormones
    - Cholesterol-Part of the cell membrane



# Cell Membrane

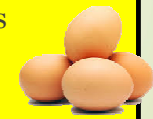
The cell membrane is made of two phospholipid layers embedded with other molecules, such as proteins, carbohydrates, and cholesterol.



## Four main types of Macromolecules

### 3. Proteins

- Building Blocks
  - Made up of C, H, O, N, & sometimes S
- Includes:
  - Keratin, Hemoglobin, Antibodies, Enzymes
- Made of monomers called amino acids
- There are 20 different amino acids
  - Your body can make 12 of these.
  - 8 come from meats, beans, & nuts



## Proteins

- All Amino acids have: a hydrogen atom, amino group (NH<sub>3</sub>), and a carboxyl group (COOH).
- Amino acids differ in side groups (**R groups**)
- Amino acids are linked together by covalent bond called peptide bonds
- Amino acids are linked into chains called polypeptides.

Amino group      Carboxyl group

General structure      Alanine      Serine

peptide bonds

## Proteins

Dear Protein,  
 Thank for building and repairing the awesome body of mine. I wouldnt have muscle, bone, hair, nails, or lips without you!  
 xoxo

- Functions of Proteins:
  - Control rates of chemical reactions
  - Regulate cell processes
  - used to form bone & muscle
  - transport substances into/out of cells
  - fight disease

## Cell Membrane

The cell membrane is made of two phospholipid layers embedded with other molecules, such as proteins, carbohydrates, and cholesterol.

## Proteins

- Amino acids interact to give a protein its shape.
- Incorrect amino acids change a protein's structure and function.

Structural Proteins

Hair is made of a structural protein called **keratin**. The keratin molecule is shaped like a coil.

Transport Proteins

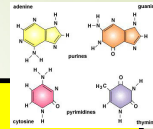
Hemoglobin carries oxygen in blood. One part of **hemoglobin**, called myoglobin.

## Four main types of Macromolecules

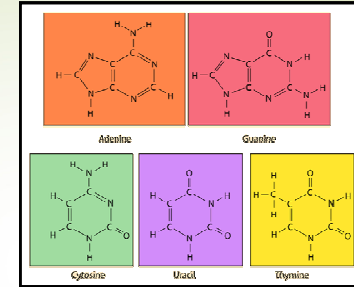
### 4. Nucleic Acids

#### Building Blocks

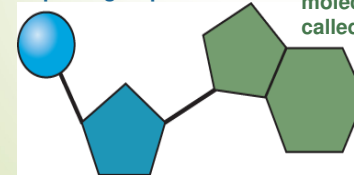
- Made of carbon, hydrogen, oxygen, nitrogen, and phosphorus
- Made of monomers called **nucleotides**
- Nucleotides are composed of a sugar, a phosphate group, and nitrogenous base



#### Types of Nucleic Acids



A phosphate group



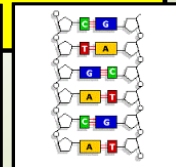
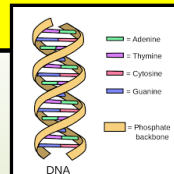
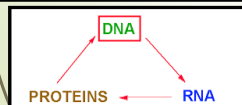
nitrogen-containing molecule, called a base

Example Of nucleotide

### Nucleic Acids

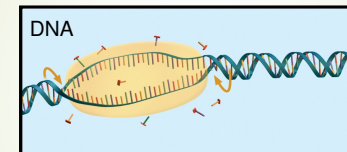
#### Functions of Nucleic Acids:

- Instructions for making proteins
- Contain genetic information passed on to offspring
- DNA & RNA are formed from nucleotides.



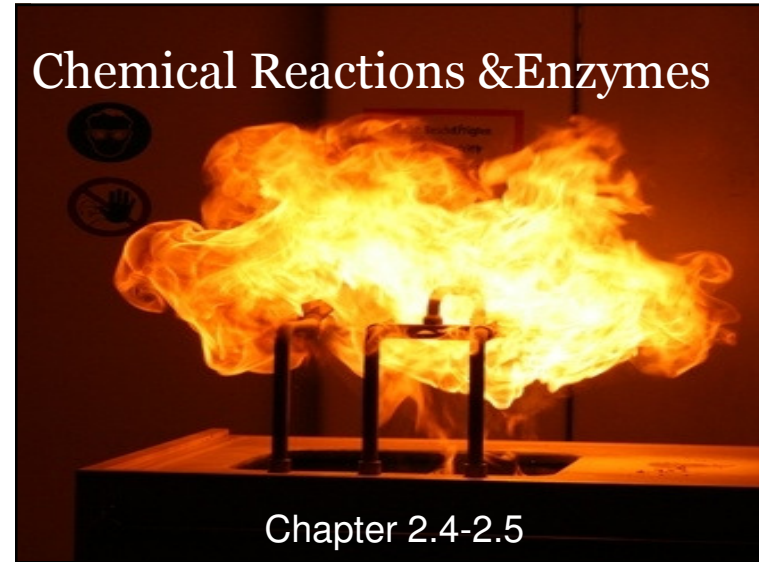
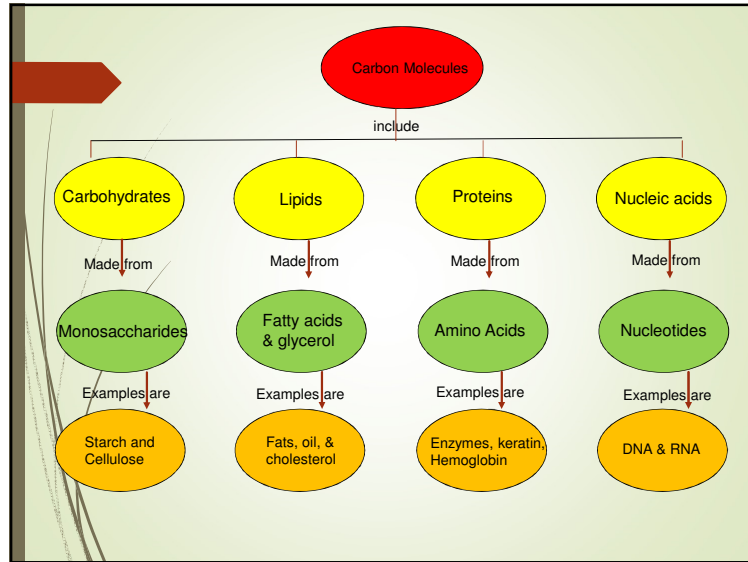
### Nucleic Acids

DNA stores genetic information.



RNA builds proteins.





## Essential Question

How are chemical reactions & enzymes related?

## Chemical Reactions

- Chemical reaction: process that changes one set of chemicals into another set of chemicals by breaking & forming chemical bonds

- Contain reactants & products
- Example: Photosynthesis

$$6\text{H}_2\text{O} + 6\text{CO}_2 + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

## Chemical Reactions

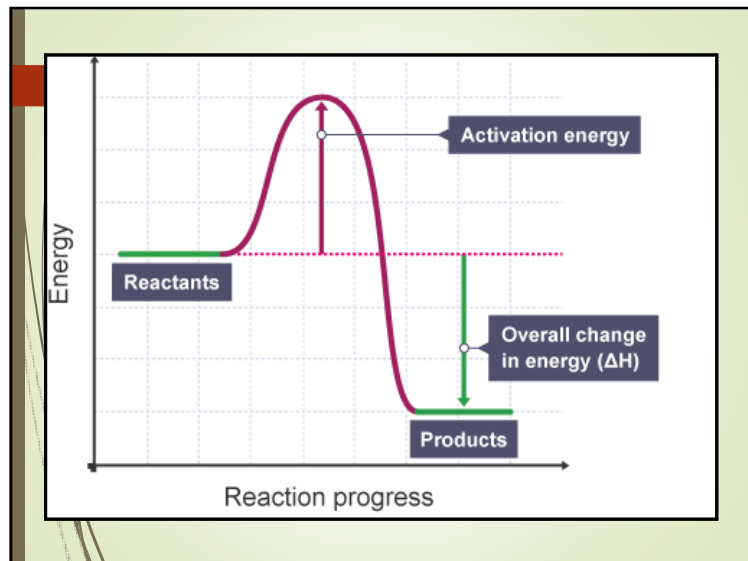
- **Reactants:** chemicals that start a reaction
- **Products:** chemicals that are made in a reaction

$$6\text{H}_2\text{O} + 6\text{CO}_2 + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

Reactants
Glucose
Products

## Chemical Reactions

- In order for a chemical reaction to take place, a certain amount of energy is needed to get it started.
- **Activation energy:** amount of energy needed to start a reaction




## Enzymes

- **Catalysts:** any substance that speeds up a chemical reaction
- Catalysts speed up reactions by lowering the amount of activation energy needed to start the reaction
- **Enzymes:** biological catalysts that speed up reactions in living things
  - Lower activation energy needed to start reaction
  - Increase reaction rate


### Enzyme Action




# Enzymes



**Proteolytic enzymes**  
**Protease**  
Meat, seafood, soybean, etc




**Fats-degrading enzyme**  
**Lipase**  
Butter, ice cream and fresh cream, egg yolk, cheese, etc



**Sugar-degrading enzyme**  
**Amylase**  
Chocolates, cake, biscuits, cookies, soft drinks, alcohol

- Most Enzymes are Proteins
  - Example: Lactase (-ase) means it's an enzymes
  - Amylase- found in your mouth
- An enzyme's function is dependent upon its structure
- An enzyme's shape allows only certain molecules to bind with it to produce a new product

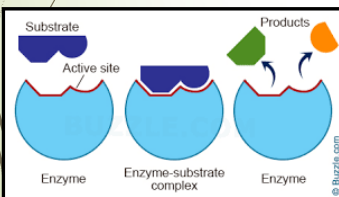


substrate

Enzyme

# Enzymes

- **Substrate:** reactant that binds with an enzyme
- An enzyme & a substrate fit together like a lock & key
- **Active site:** specific place where substrate and enzyme bind



Substrate

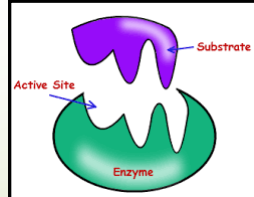
Active site

Enzyme

Enzyme-substrate complex

Enzyme

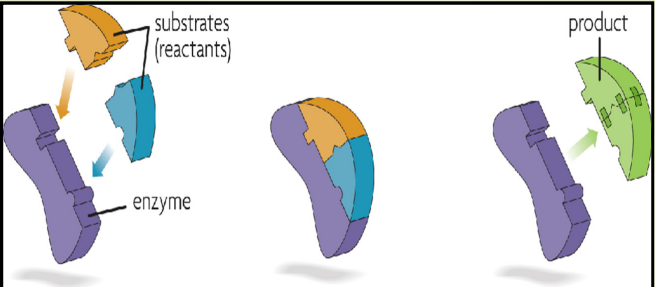
Products



Substrate

Active Site

Enzyme



substrates (reactants)

enzyme






product

**Substrates bind to an enzyme at certain places called active sites.**


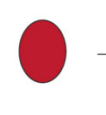

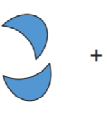

**The enzyme brings substrates together and weakens their bonds.**

**The catalyzed reaction forms a product that is released from the enzyme.**

# Enzymes

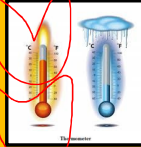
|   |      |   |        |   |              |   |      |   |
|---|------|---|--------|---|--------------|---|------|---|
| Enzyme  | plus | substrates  | yields | ES complex  | resulting in | a product   | plus | enzyme  |
|  | +    |  | →      |  | →            |  | +    |  |

|   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|
|  | + |  | → |  | → |  | + |  |
|---|---|---|---|---|---|---|---|---|

# Enzymes

- ▶ Enzymes will keep making products until something stops it.
- ▶ Causes for Enzymes to stop functioning:
  - ▶ Disruptions in homeostasis
  - ▶ Very high or very low temperatures
  - ▶ Wrong pH levels *acids, basic*
  - ▶ No more substrates
- ▶ Changes in these conditions may affect the shape & function, or activity of an enzyme
  - ▶ ex. When people run a temperature above normal, the hydrogen bonds in enzymes may be broken and it may lose its ability to function



How many products will be made from that one enzyme?

