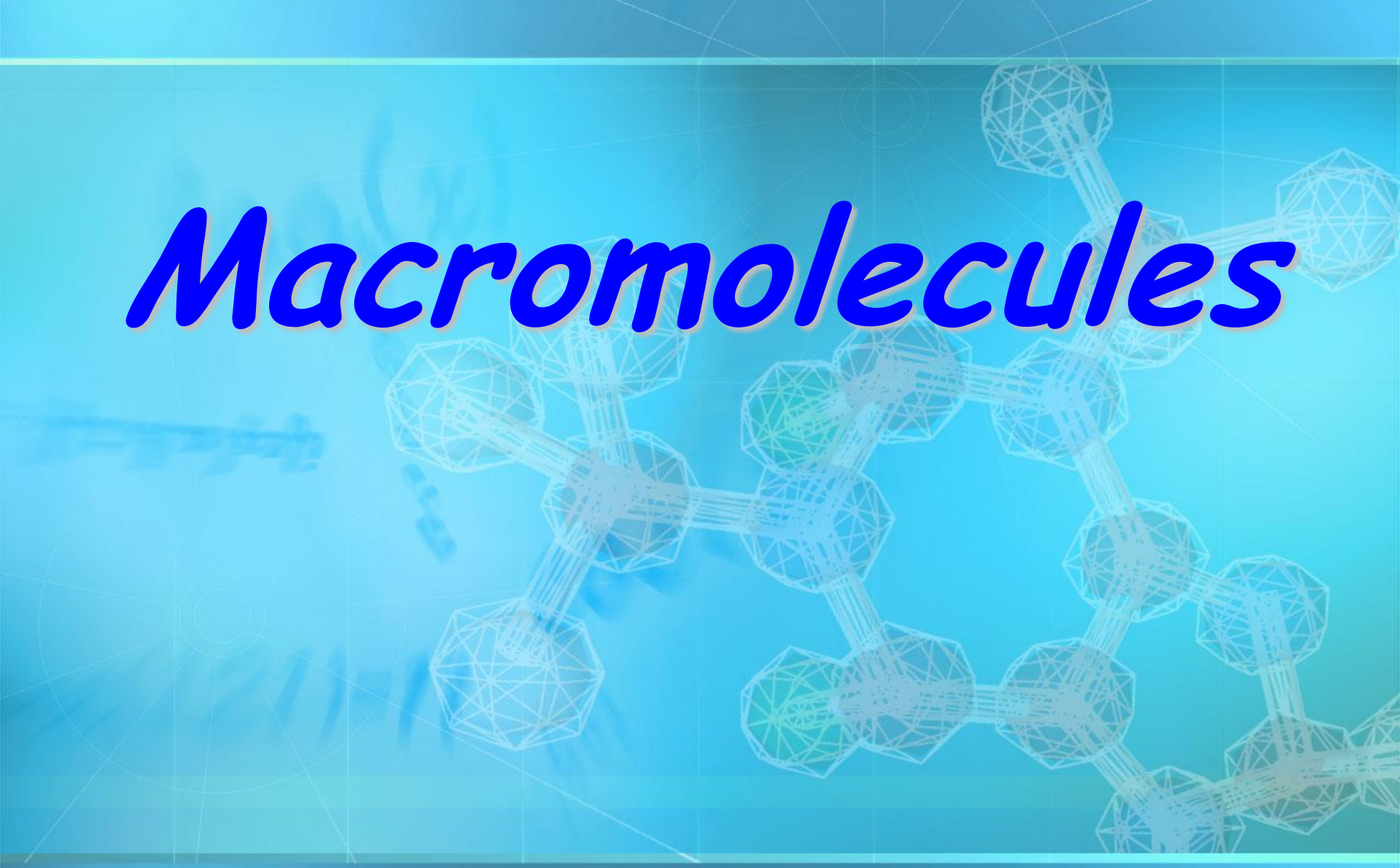
# Macromolecules



# Organic Compounds

- **Compounds** that contain **CARBON** are called **organic**.

- **Macromolecules** are large **organic molecules**.

# Carbon (C)

- Carbon has 4 electrons in outer shell.
- Carbon can form covalent bonds with as many as 4 other atoms (elements).
- Usually with C, H, O or N.
- Example: $CH_4$(methane)

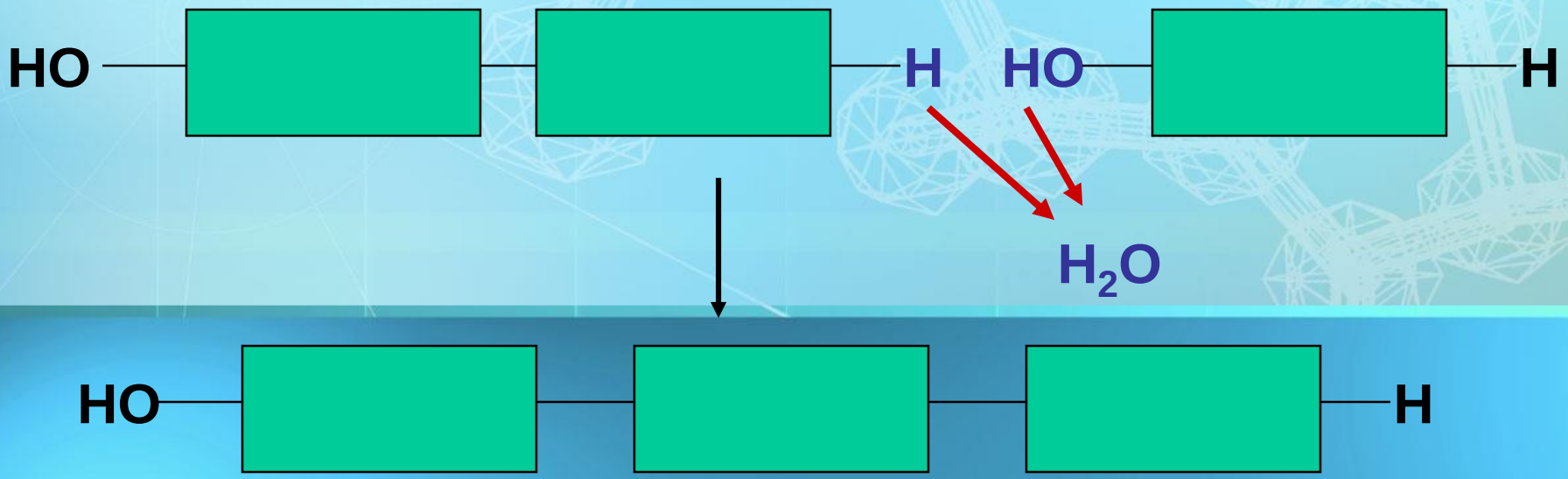
# Macromolecules

- Large organic molecules.
- Also called POLYMERS.
- Made up of smaller "building blocks" called MONOMERS.
- Examples:
    1. Carbohydrates
    2. Lipids
    3. Proteins
    4. Nucleic acids (DNA and RNA)

# Question: How Are Macromolecules Formed?

# Answer: Dehydration Synthesis

- Also called "condensation reaction"
- Forms polymers by combining monomers by "removing water".

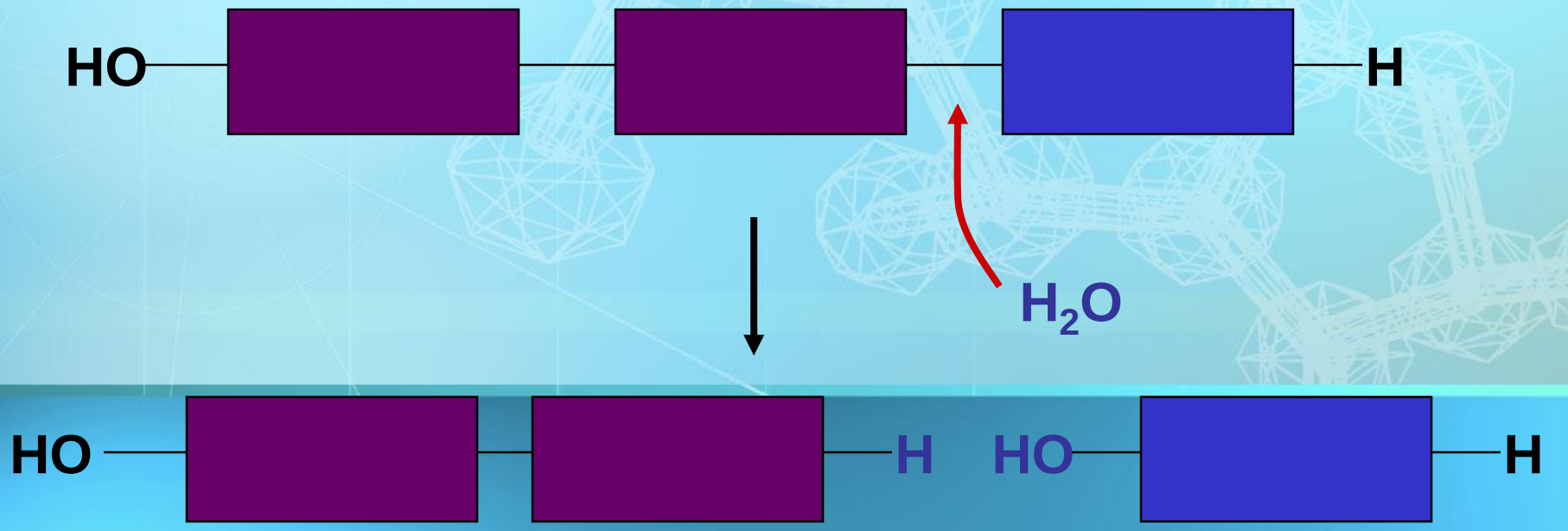


# Question:

## How are Macromolecules separated or digested?

# Answer: Hydrolysis

- Separates monomers by "adding water"



# Carbohydrates

# Carbohydrates

- Small sugar molecules to large sugar molecules.

- Examples:
  A. monosaccharide
  B. disaccharide
  C. polysaccharide

# Carbohydrates

**Monosaccharide: one sugar unit**

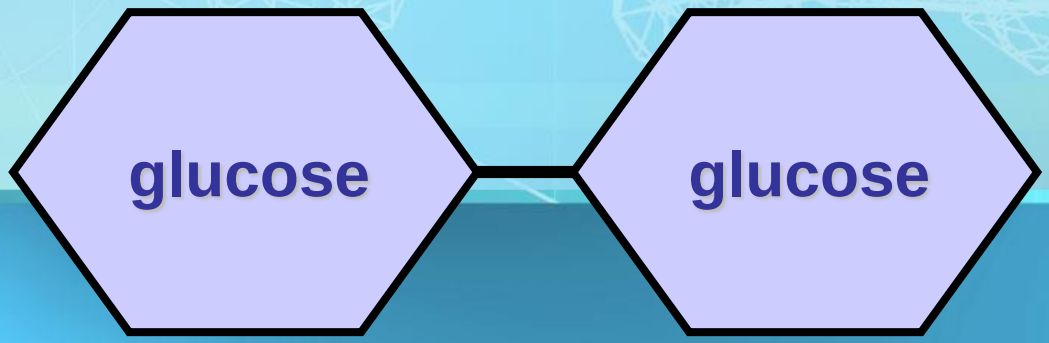
**Examples:** glucose ($C_6H_{12}O_6$)
deoxyribose
ribose
Fructose
Galactose

# Carbohydrates

Disaccharide: two sugar unit

Examples:

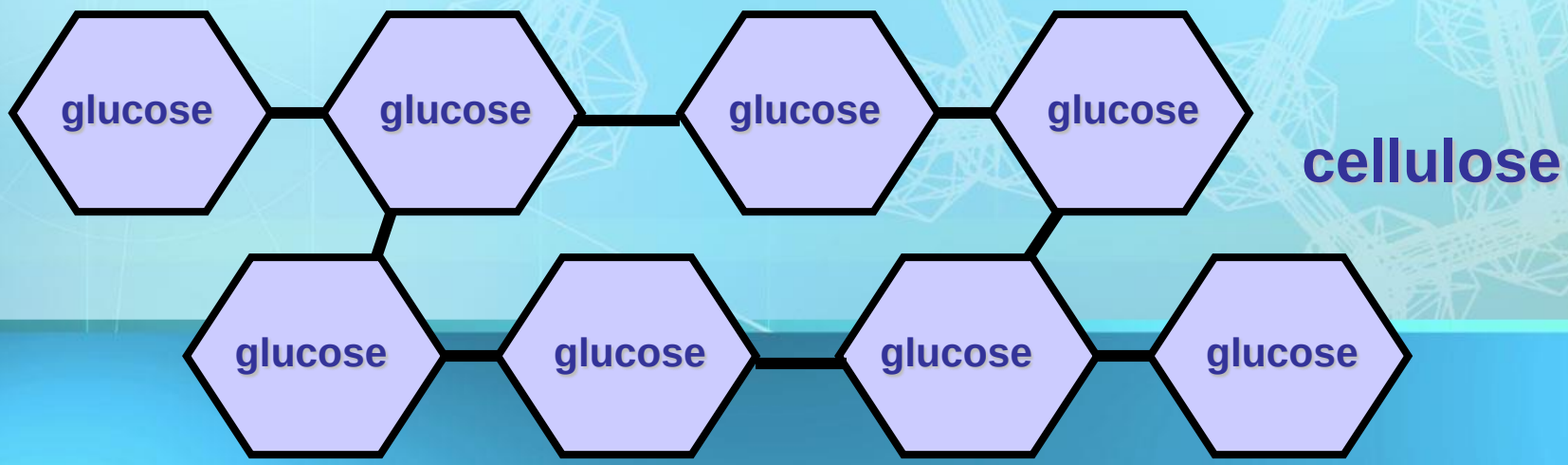
- Sucrose (glucose+fructose)
- Lactose (glucose+galactose)
- Maltose (glucose+glucose)



# Carbohydrates

**Polysaccharide: many sugar units**

**Examples:** starch (bread, potatoes)
glycogen (beef muscle)
cellulose (lettuce, corn)



# Lipids

# Lipids

- General term for compounds which are not soluble in water.
- Lipids are soluble in hydrophobic solvents.
- Remember: "stores the most energy"
- Examples:
  1. Fats
  2. Phospholipids
  3. Oils
  4. Waxes
  5. Steroid hormones
  6. Triglycerides

# Lipids

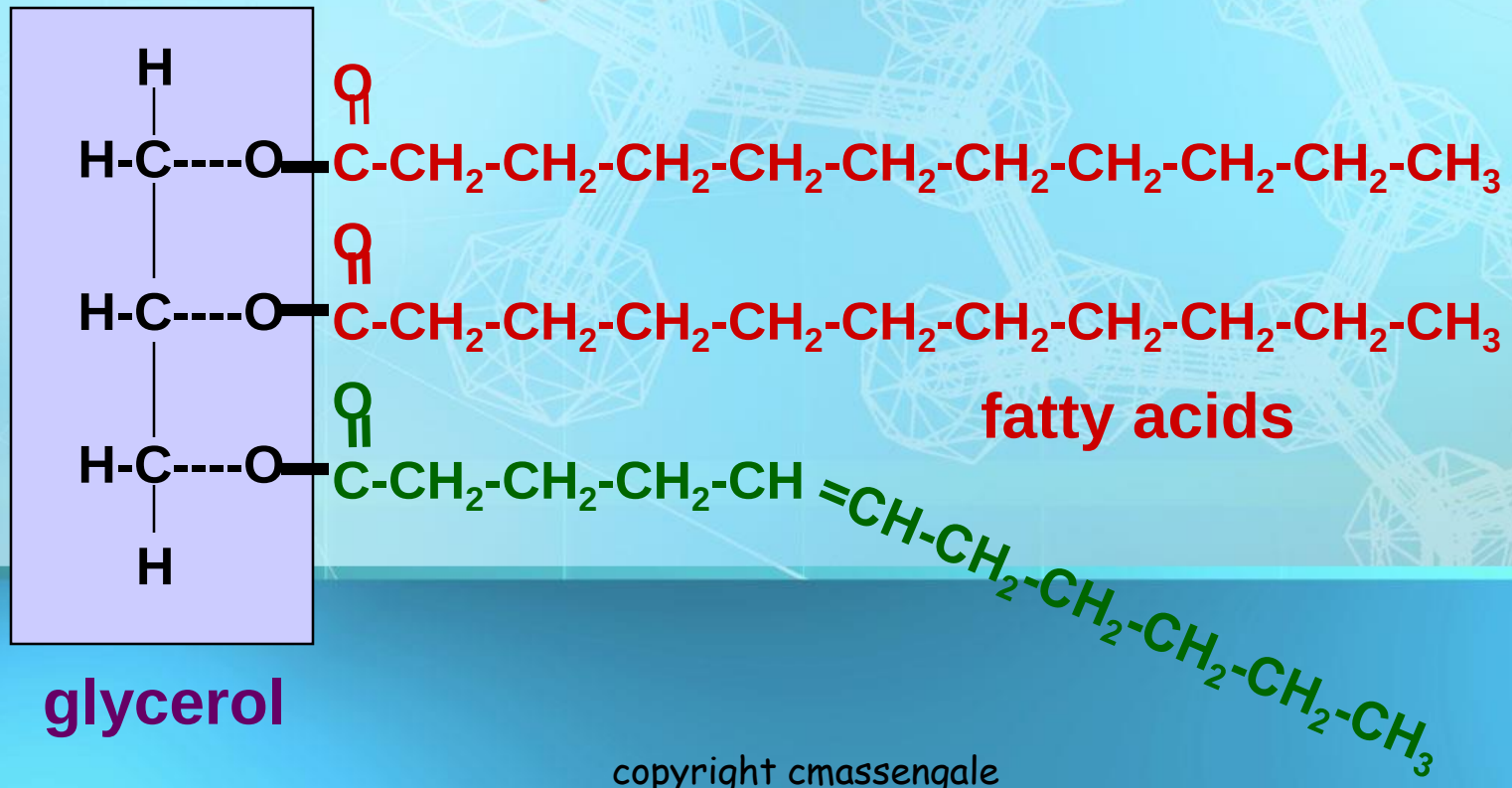
**Six functions of lipids:**

1. Long term energy storage
2. Protection against heat loss (insulation)
3. Protection against physical shock
4. Protection against water loss
5. Chemical messengers (hormones)
6. Major component of membranes (phospholipids)

# Lipids

## Triglycerides:

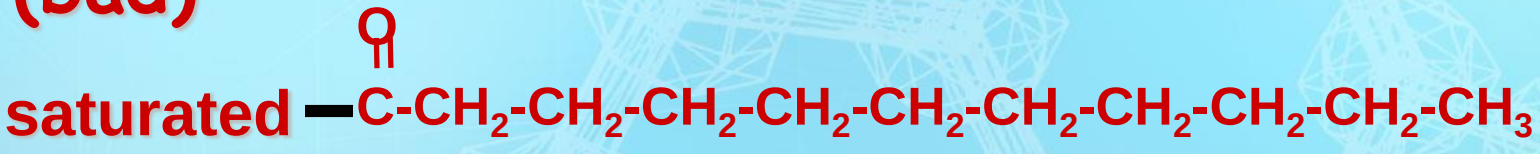
composed of 1 glycerol and 3 fatty acids.



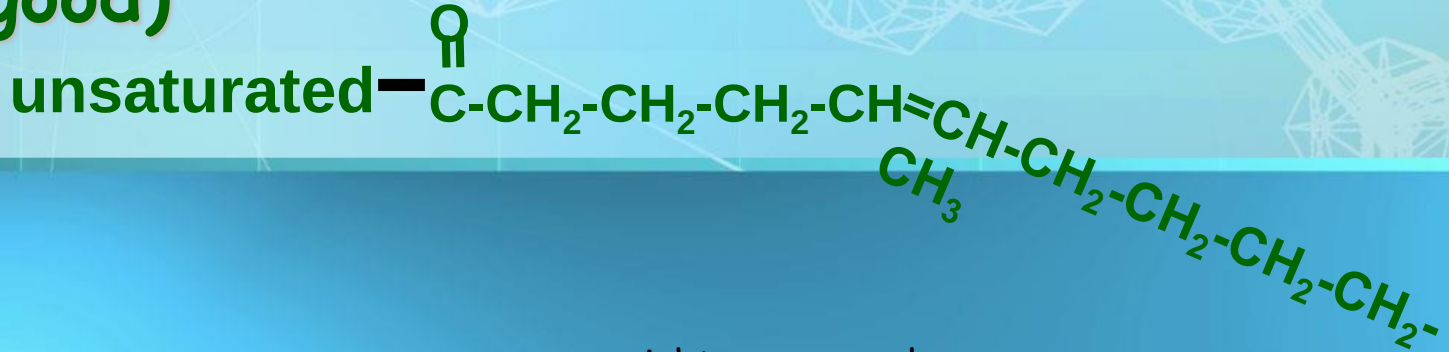
# Fatty Acids

There are two kinds of **fatty acids** you may see these on food labels:

1. **Saturated fatty acids:** no double bonds (bad)




2. **Unsaturated fatty acids:** double bonds (good)



# Proteins

# Proteins (Polypeptides)

- Amino acids (20 different kinds of aa) bonded together by peptide bonds (polypeptides).

- Six functions of proteins:
  1. Storage: albumin (egg white)
  2. Transport: hemoglobin
  3. Regulatory: hormones
  4. Movement: muscles
  5. Structural: membranes, hair, nails
  6. Enzymes: cellular reactions

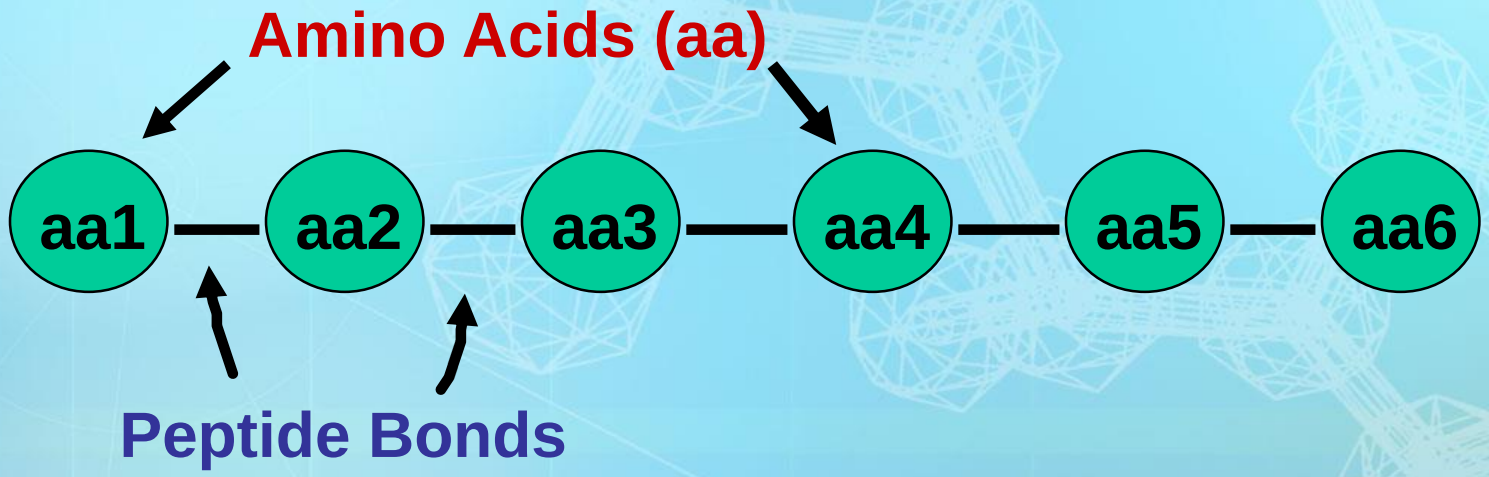
# Proteins (Polypeptides)

**Four levels of protein structure:**

A. Primary Structure
B. Secondary Structure
C. Tertiary Structure
D. Quaternary Structure

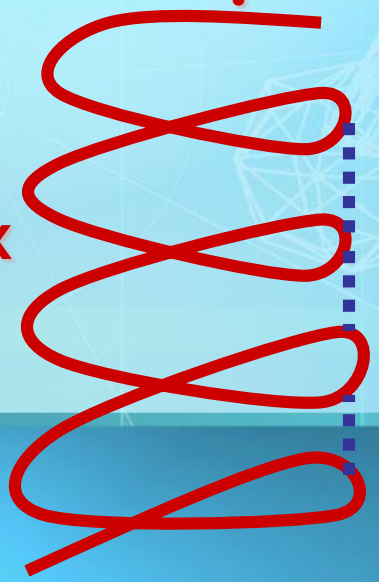
# Primary Structure

Amino acids bonded together by peptide bonds (straight chains)



# Secondary Structure

- 3-dimensional folding arrangement of a primary structure into coils and pleats held together by hydrogen bonds.
- Two examples:



Alpha Helix

Beta Pleated Sheet

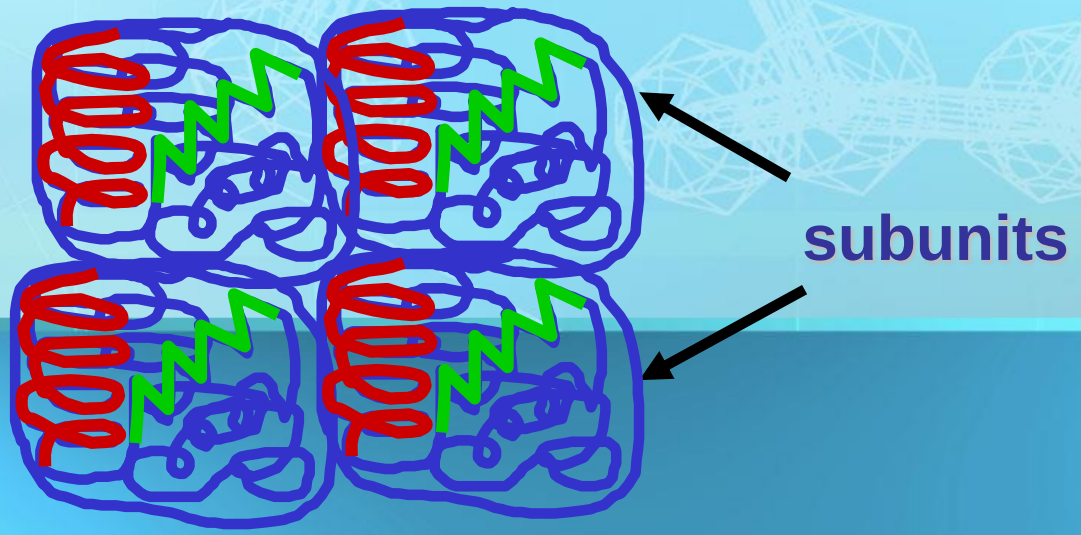
Hydrogen Bonds

# Tertiary Structure

- Secondary structures bent and folded into a more complex 3-D arrangement of linked polypeptides
- Bonds: H-bonds, ionic, disulfide bridges (S-S)
- Call a "subunit".

# Quaternary Structure

- Composed of 2 or more "subunits"
- Globular in shape
- Form in Aqueous environments
- Example: enzymes (hemoglobin)



# Nucleic Acids

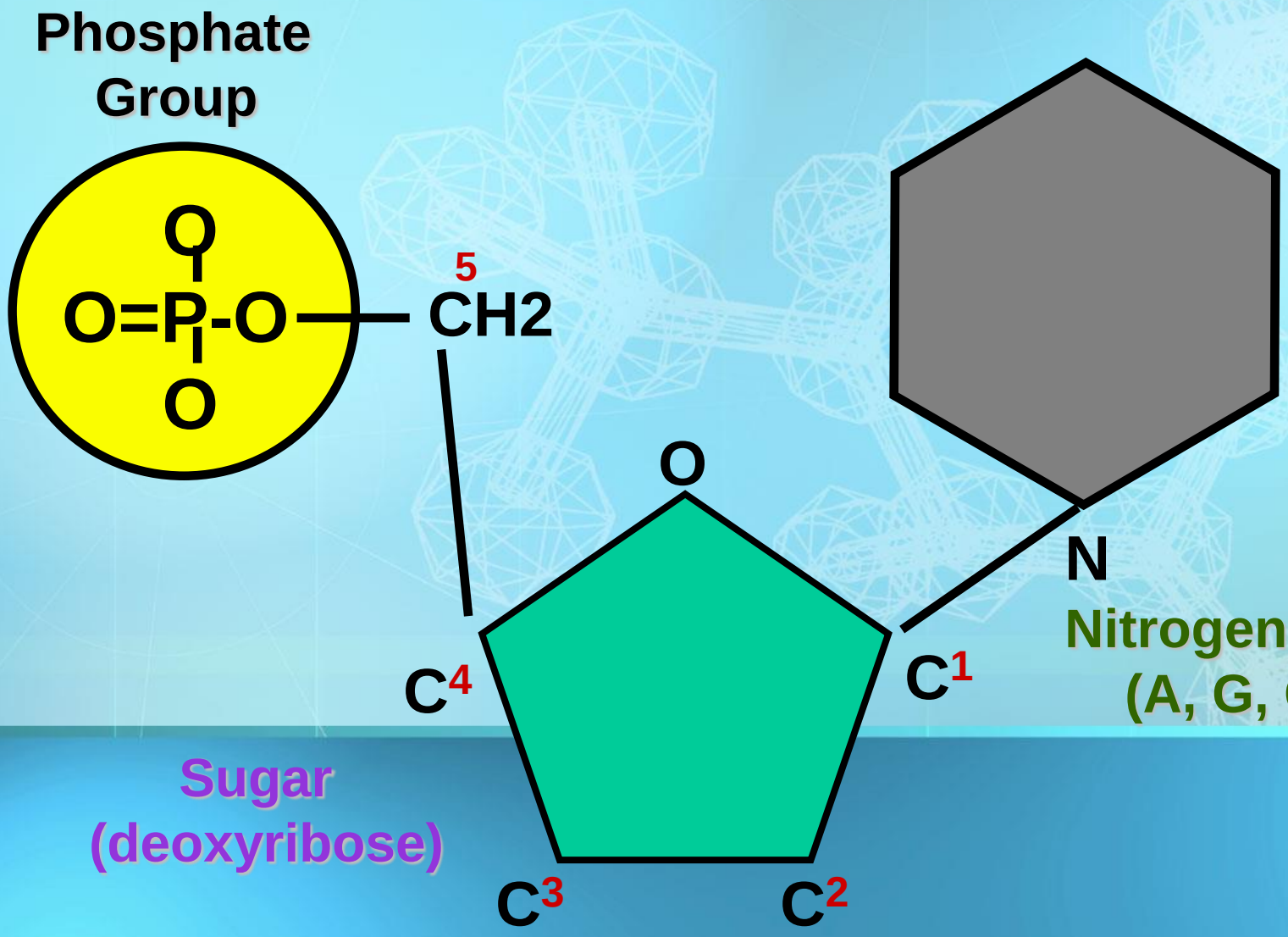
# Nucleic acids

- **Two types:**
  a. Deoxyribonucleic acid (DNA-double helix)
  b. Ribonucleic acid (RNA-single strand)
- **Nucleic acids** are composed of long chains of **nucleotides** linked by **dehydration synthesis**.

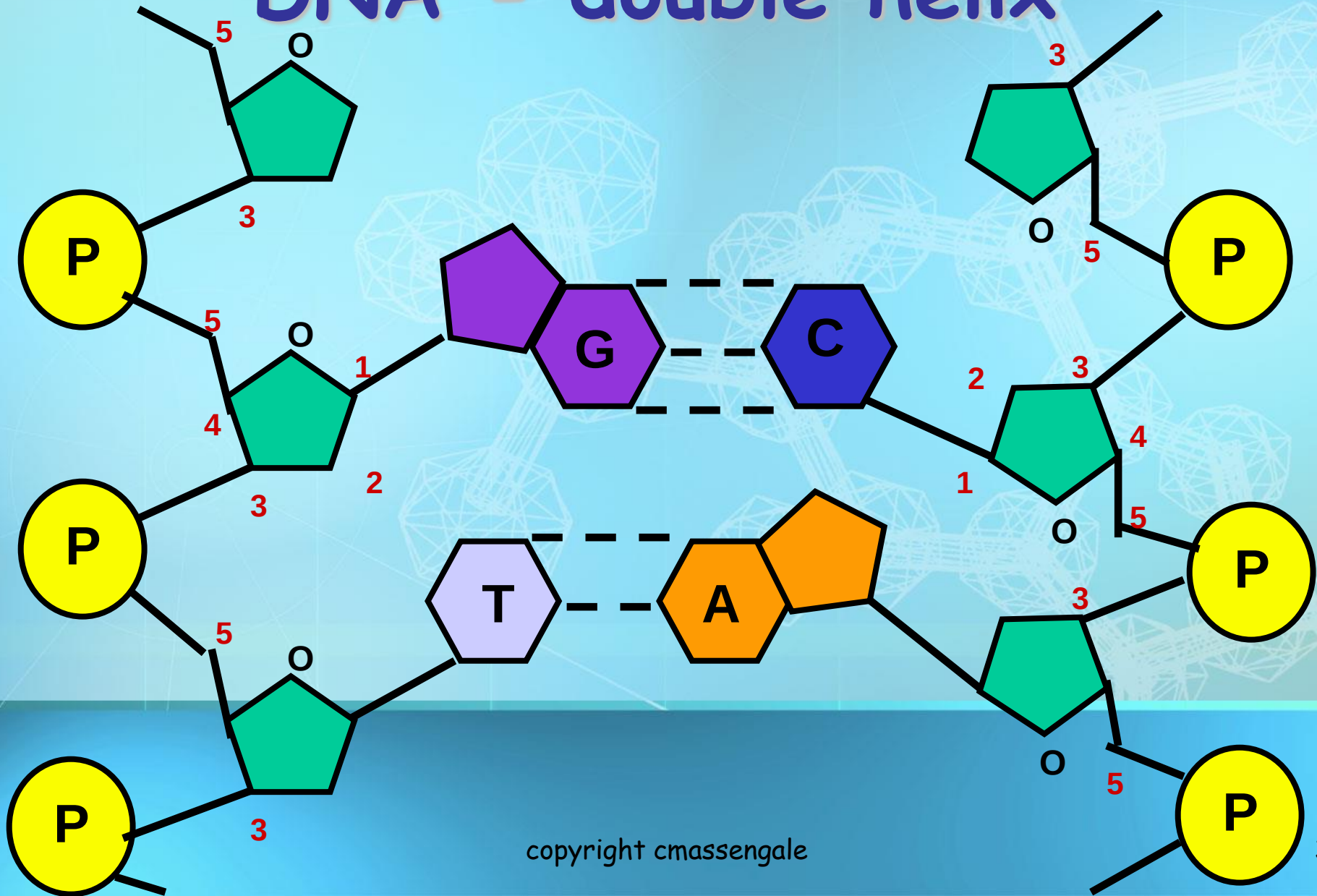
# Nucleic acids

- Nucleotides include:
  - phosphate group
  - pentose sugar (5-carbon)
  - nitrogenous bases:
    - adenine (A)
    - thymine (T) DNA only
    - uracil (U) RNA only
    - cytosine (C)
    - guanine (G)

# Nucleotide

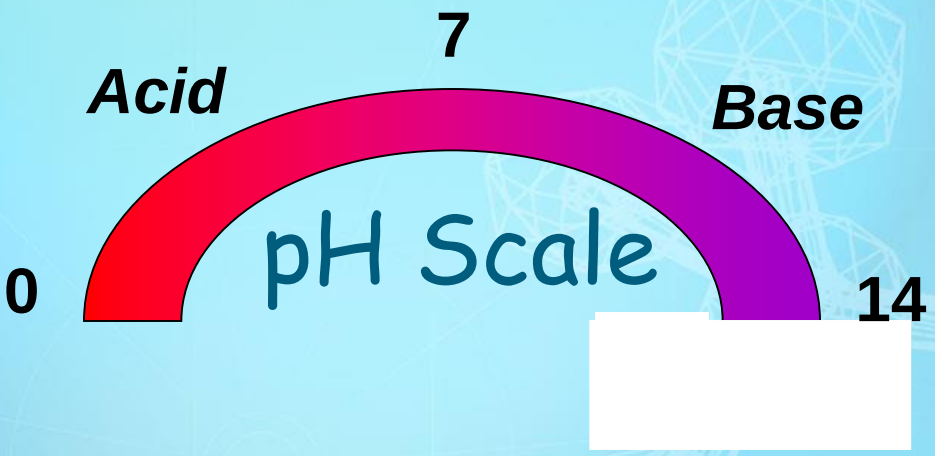

Phosphate Group
O
O=P-O
O
5
CH2
O
N
Nitrogenous base (A, G, C, or T)
C4
C1
C3
C2
Sugar (deoxyribose)

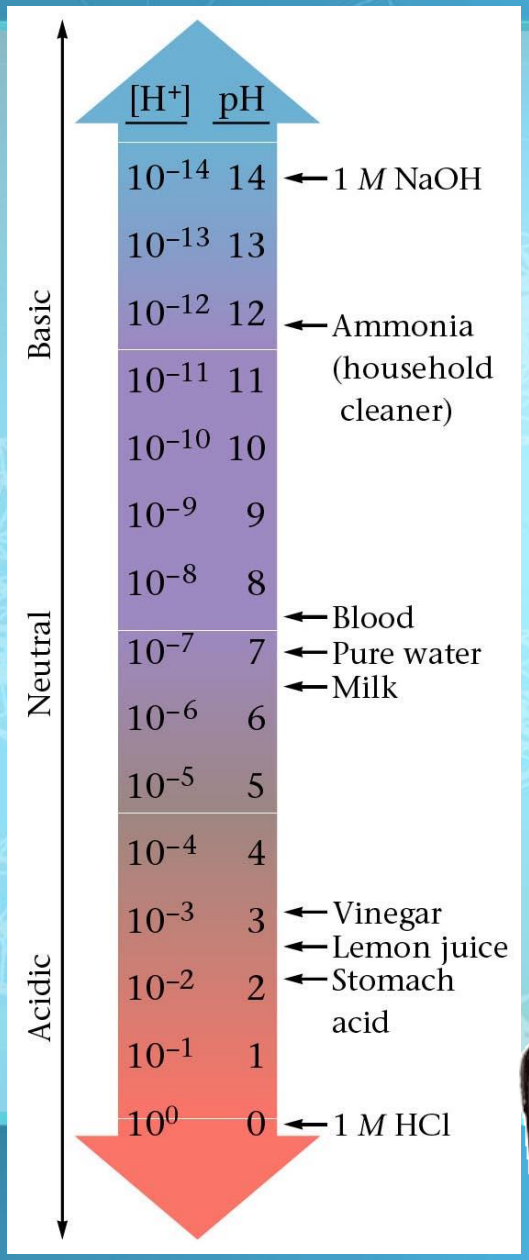
# DNA - double helix



# pH Scale

- **We use this scale to measure the strength of an acid or base.**
- **pH is defined as the –log[H+]**
- **pH can use the concentration of hydronium ions or hydrogen ions.**

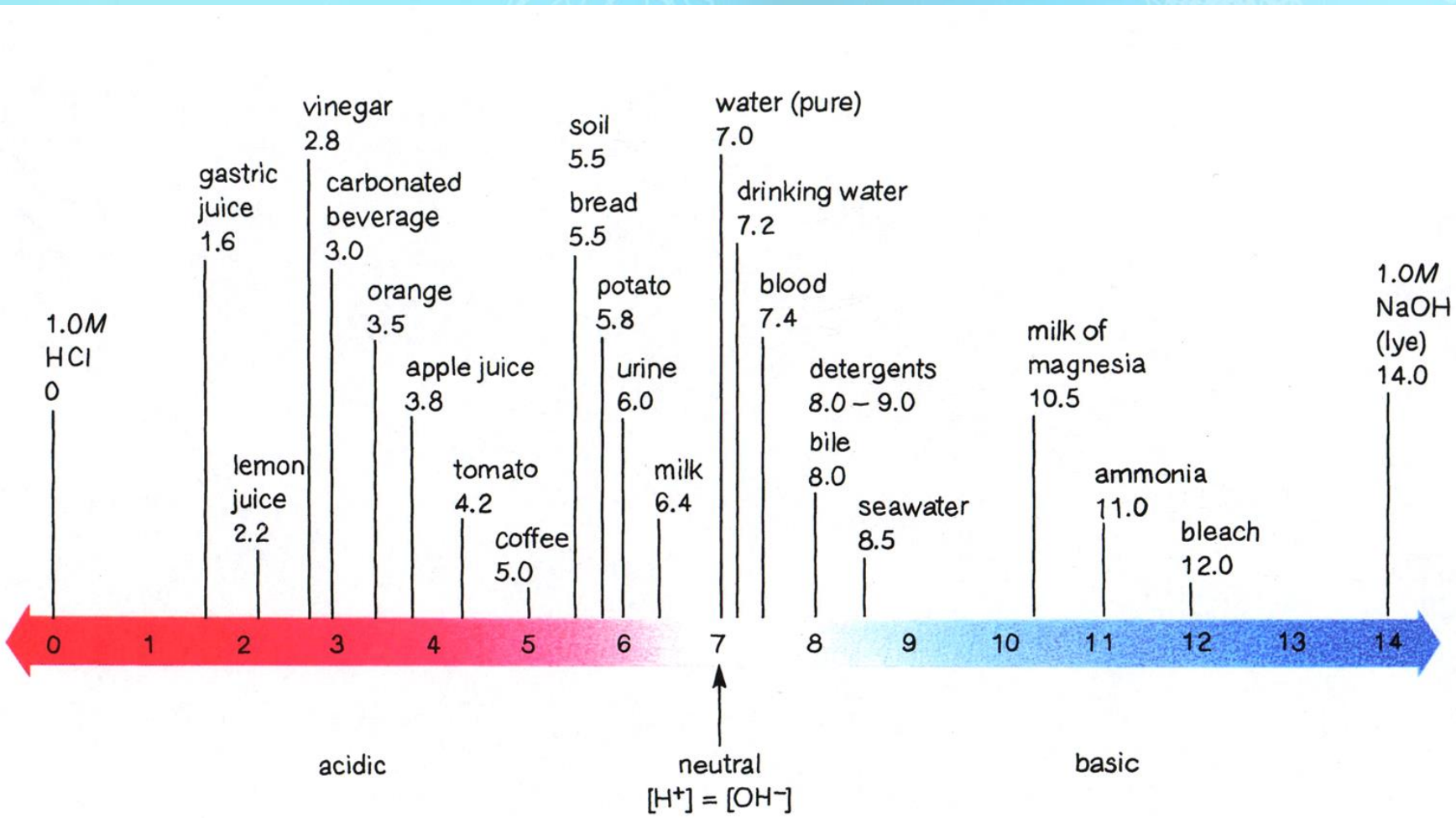

7
Acid
Base
0
pH Scale
14


[H+]
pH
Basic
Neutral
Acidic
10−14 14 ← 1 M NaOH
10−13 13
10−12 12 ← Ammonia (household cleaner)
10−11 11
10−10 10
10−9 9
10−8 8 ← Blood
10−7 7 ← Pure water ← Milk
10−6 6
10−5 5
10−4 4
10−3 3 ← Vinegar ← Lemon juice
10−2 2 ← Stomach acid
10−1 1
10^0 0 ← 1 M HCl


Drano

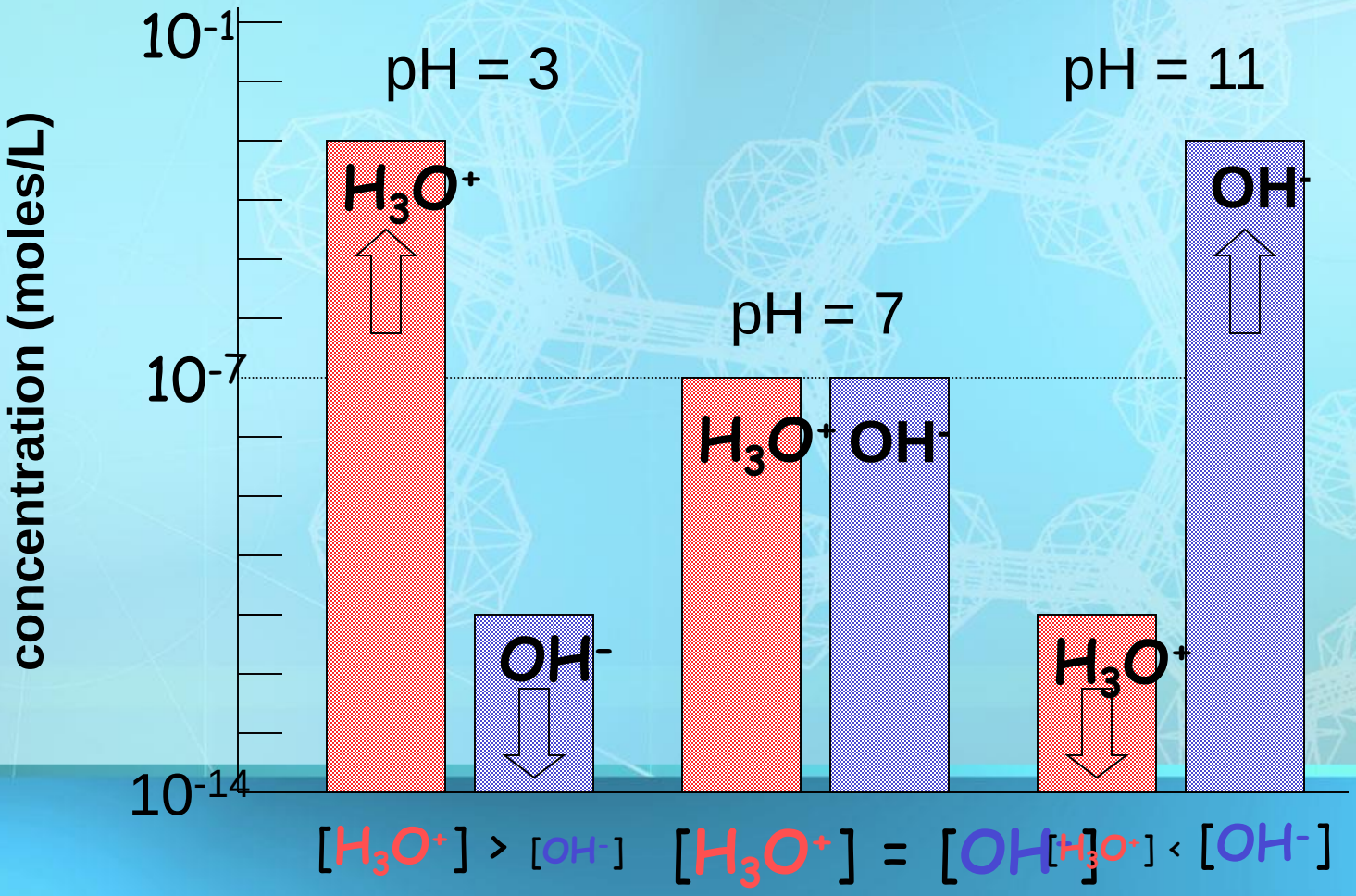

DieHard
DieHard

# pH of Common Substances




Timberlake, Chemistry 7th Edition, page 335

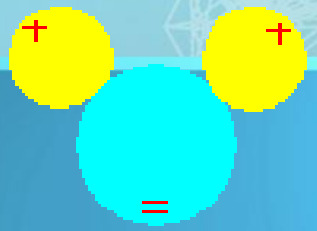
# Acid – Base Concentrations




Timberlake, Chemistry 7th Edition, page 332

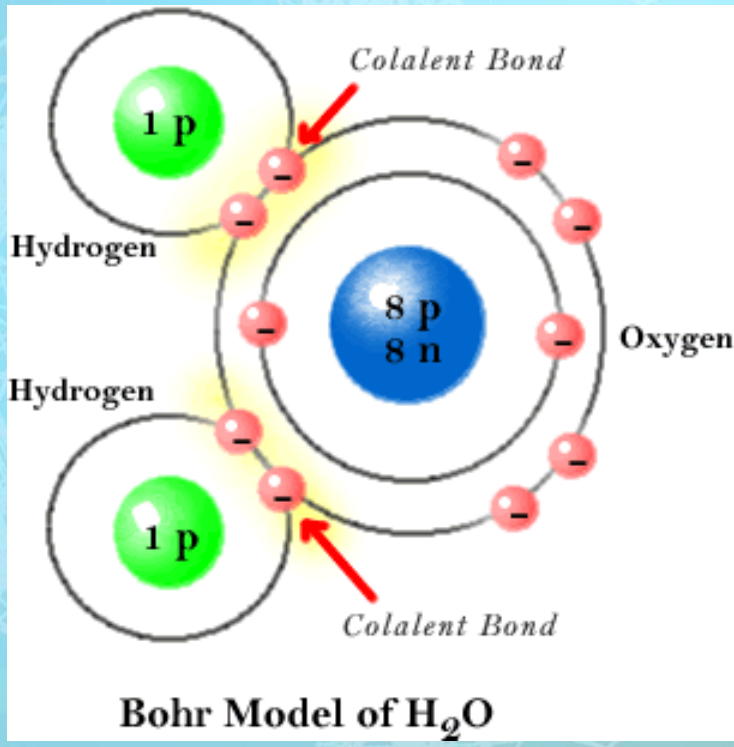
# Water Chemistry

- **A. _Water__ is the most abundant chemical in the body.**
- **B. Water has many characteristics that make it vital to our bodies.**
  - **1. _Size_ —water is a very small molecule, so it moves fast and can squeeze into tiny crevasses between other molecules.**



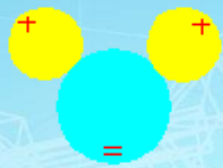
# II. Water Chemistry

- **B. Water has many characteristics that make it vital to our bodies.**
  - **2. Polarity --**
    **Hydrogen has a slightly positive charge while oxygen has a slightly negative charge. This makes it easy for water to pry apart other charged molecules, dissolving them. Called a Universal Solvent.**

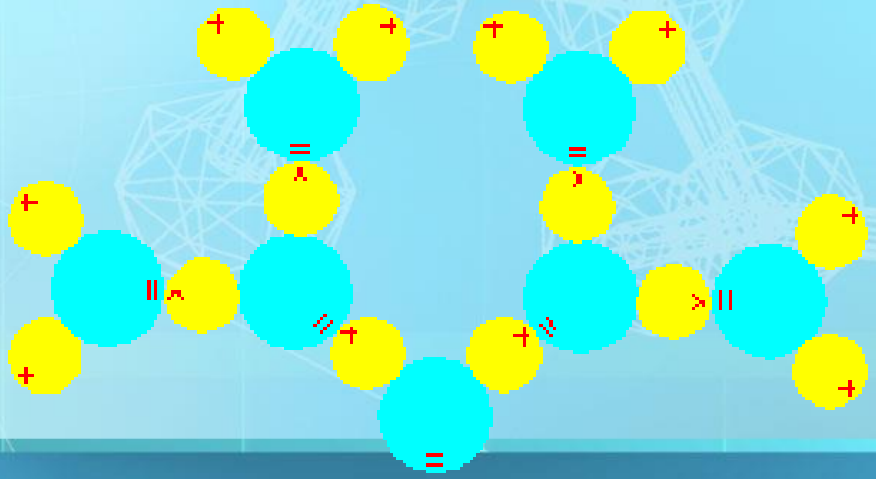


Bohr Model of $H_2O$

# II. Water Chemistry



- **B. Water has many characteristics that make it vital to our bodies.**
  - **3. _Crystal Structure__--Due to polarity, water forms a crystal structure that is less dense than liquid water.**

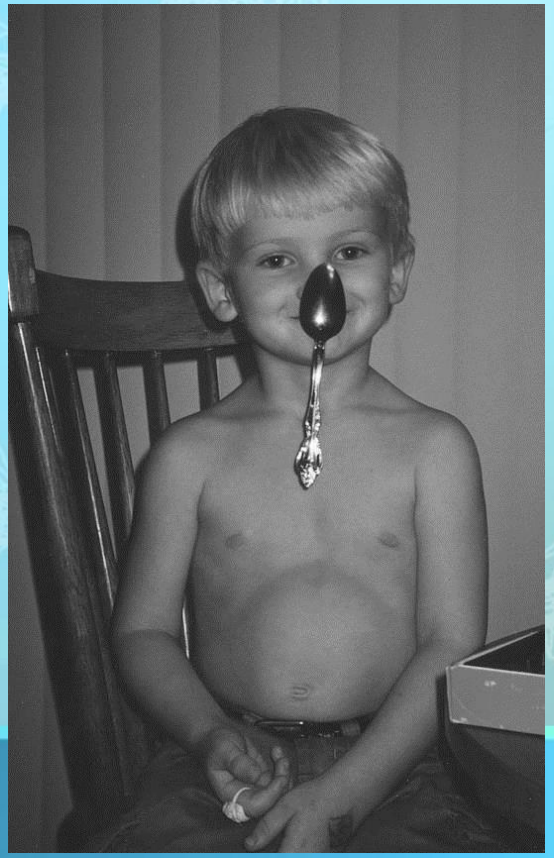


# II. Water Chemistry

- **B. Water has many characteristics that make it vital to our bodies.**
  - **4. _Heat Capacity_ --water absorbs and releases heat energy slowly, and can hold a great deal of heat energy. This helps organisms maintain their body temperature in the safe range.**

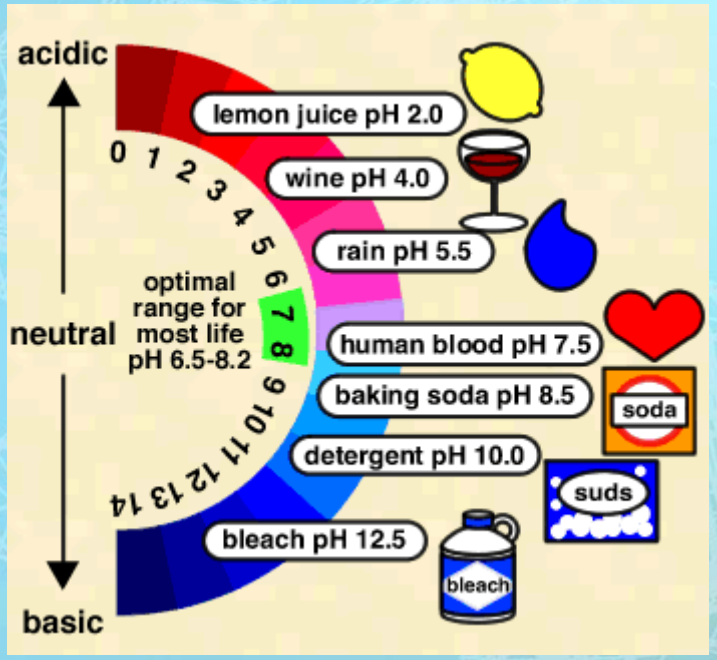
# II. Water Chemistry

- **B. Water has many characteristics that make it vital to our bodies.**
  - **5. __Cohesion & Adhesion____ -- Polarity allows water to stick to itself (cohesion) and to any charged material (adhesion). Water can glue materials together.**



# II. Water Chemistry

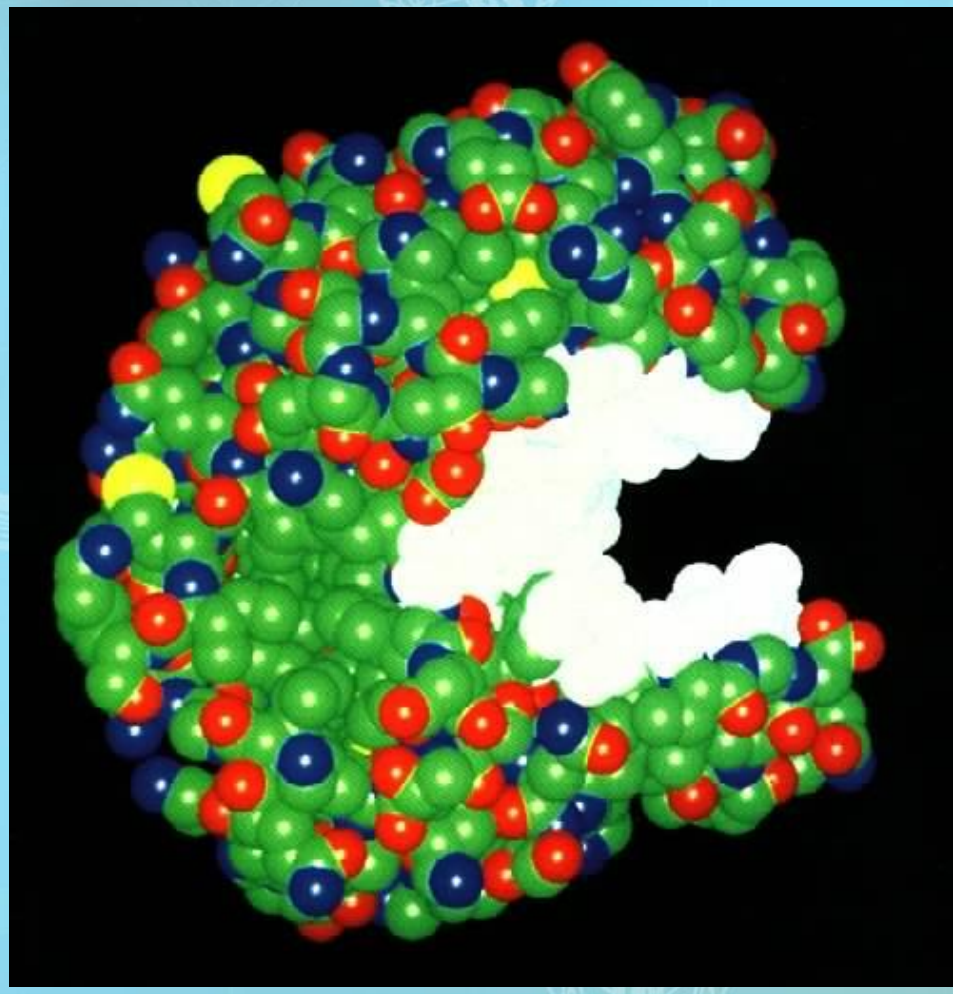
- **B. Water has many characteristics that make it vital to our bodies.**
  - **6. Buffer --Water can act as either an acid or a base, maintaining a stable pH in our bodies.**



# Enzymes

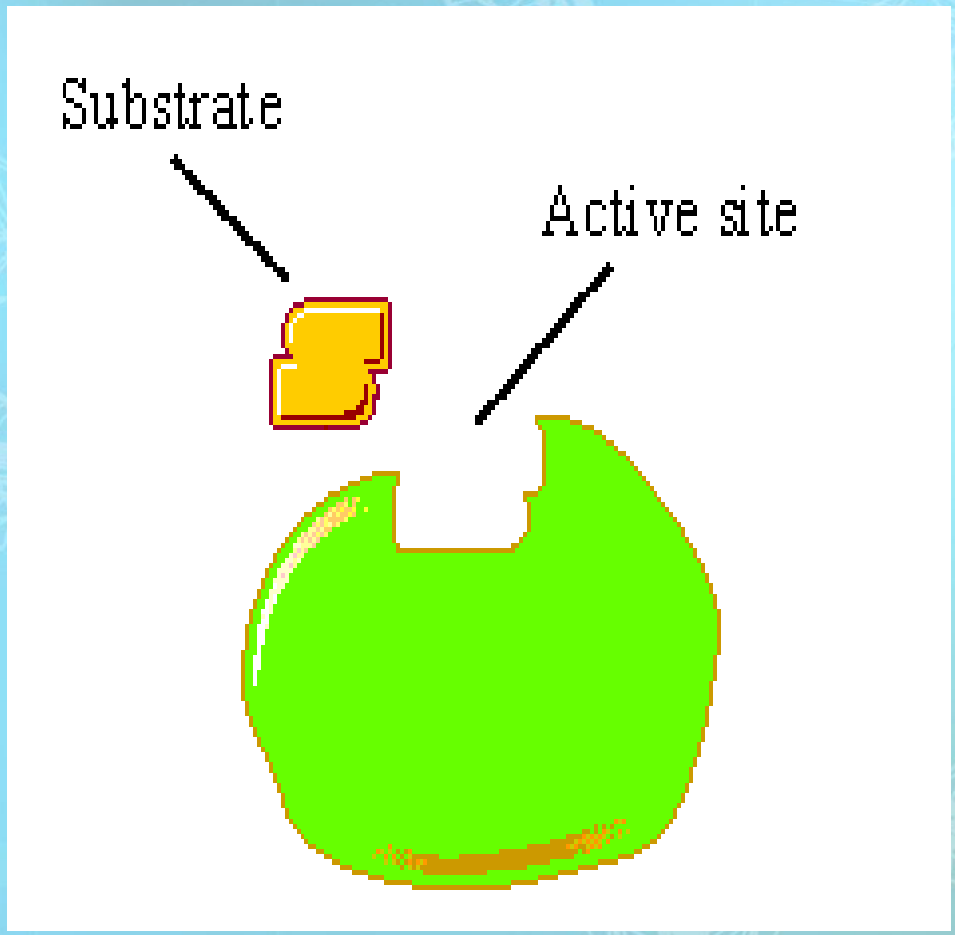
# What Are Enzymes?

- Most enzymes are Proteins (tertiary and quaternary structures)
- Act as Catalyst to accelerates a reaction
- Not permanently changed in the process



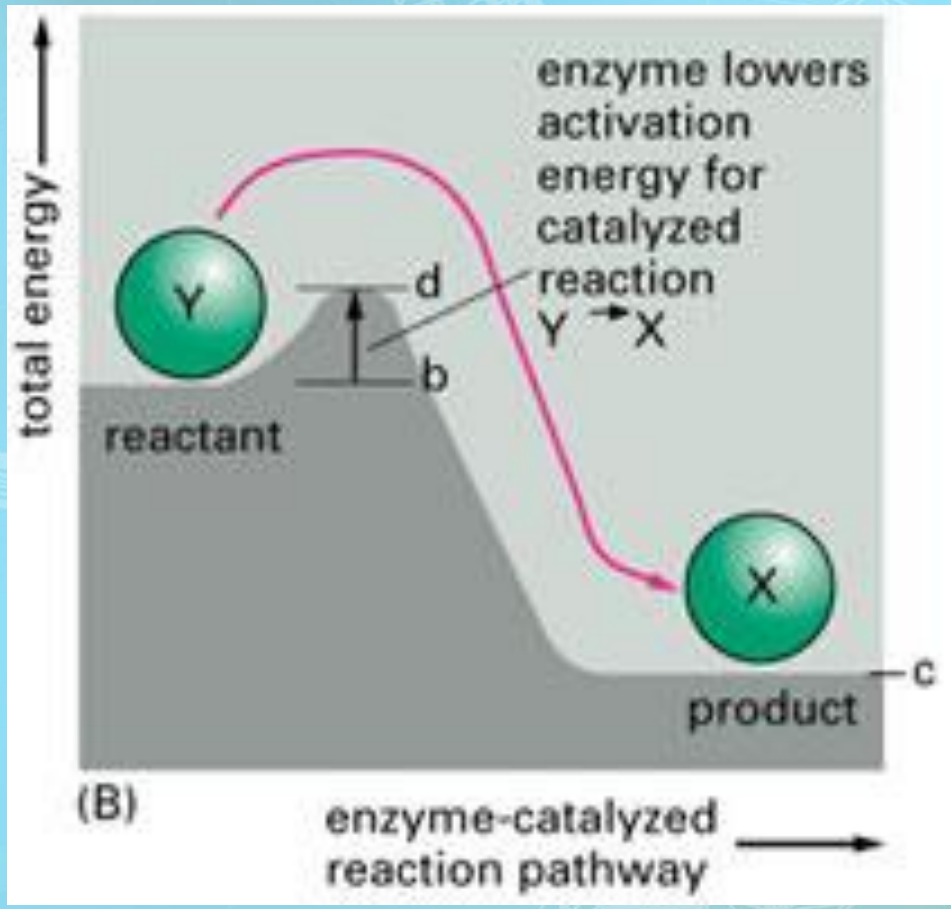
# Enzymes

- Are specific for what they will catalyze
- Are Reusable
- End in -*ase*
  - -*Sucrase*
  - -*Lactase*
  - -*Maltase*



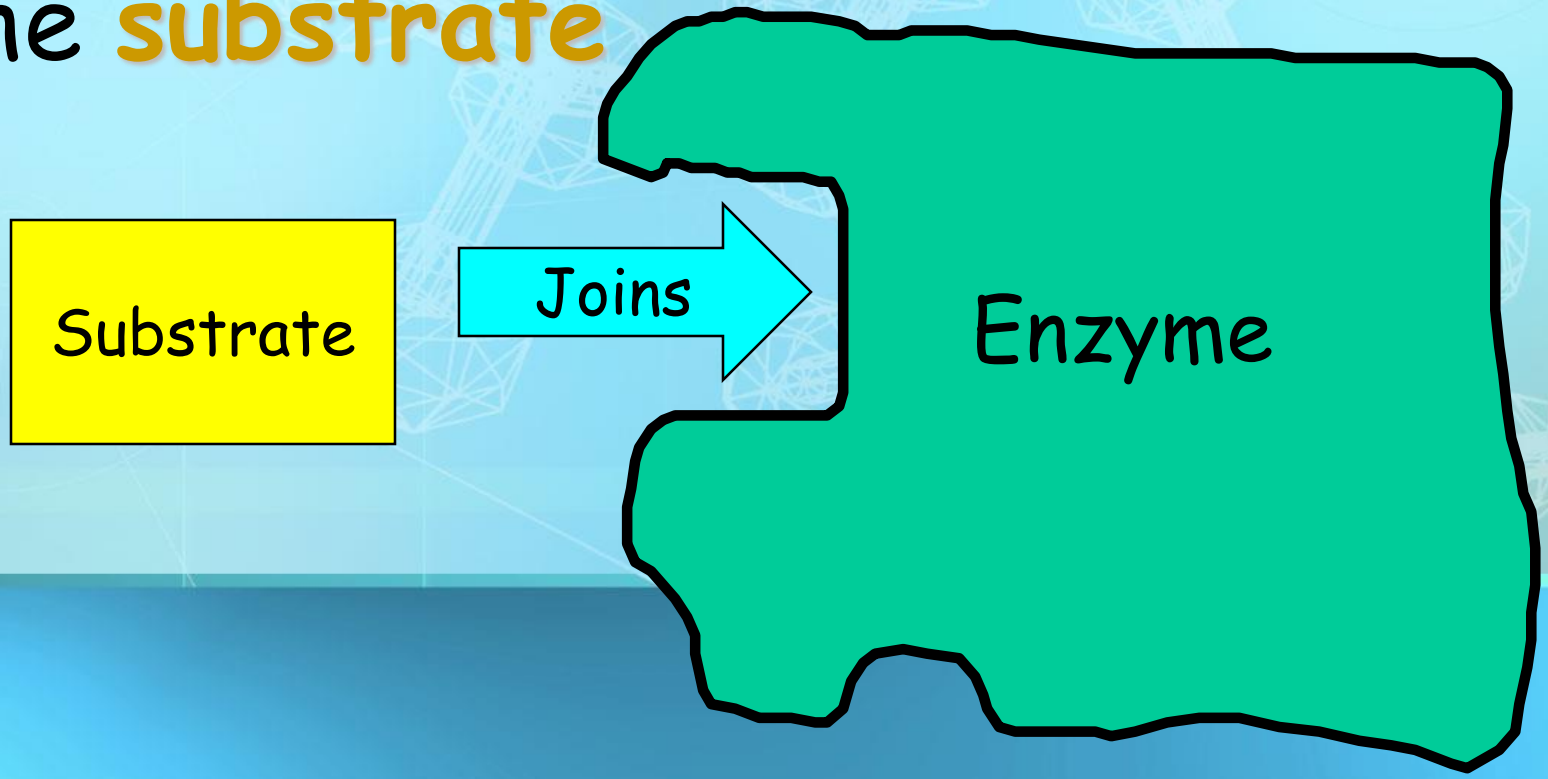
# How do enzymes Work?

Enzymes work by weakening bonds which lowers activation energy



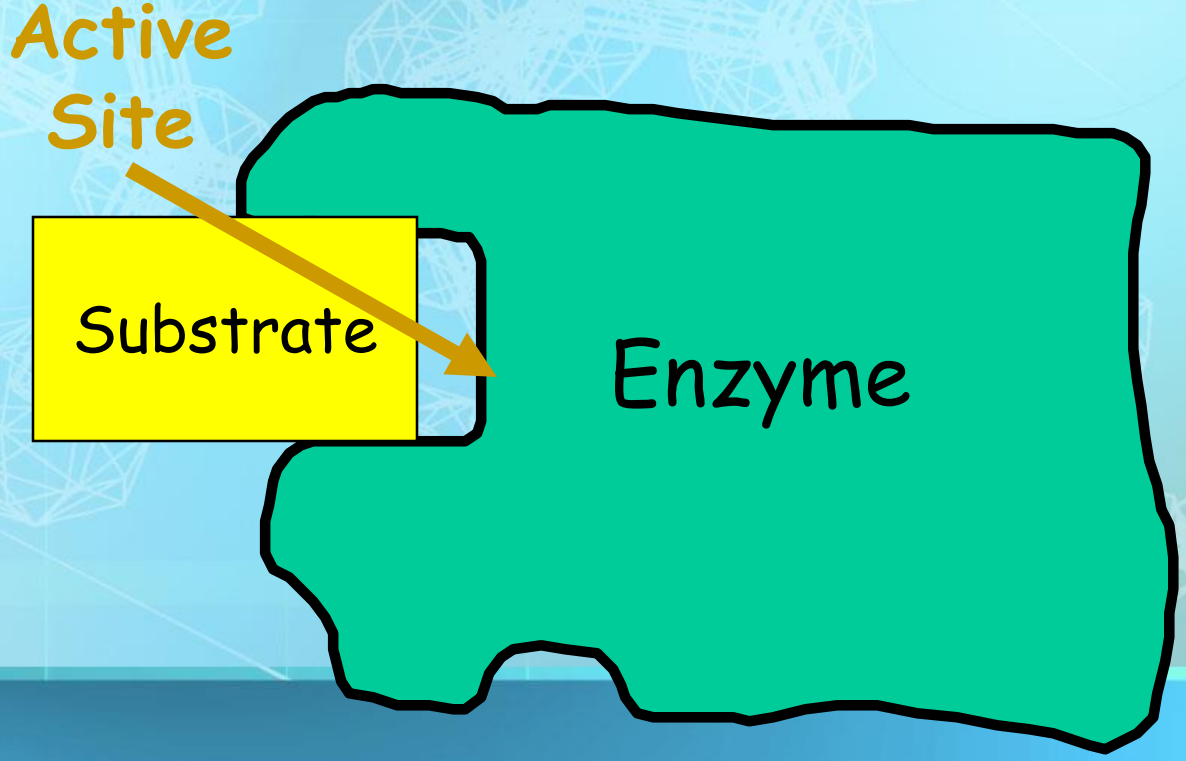
# Enzyme-Substrate Complex

The **substance** (reactant) an **enzyme** acts on is the **substrate**



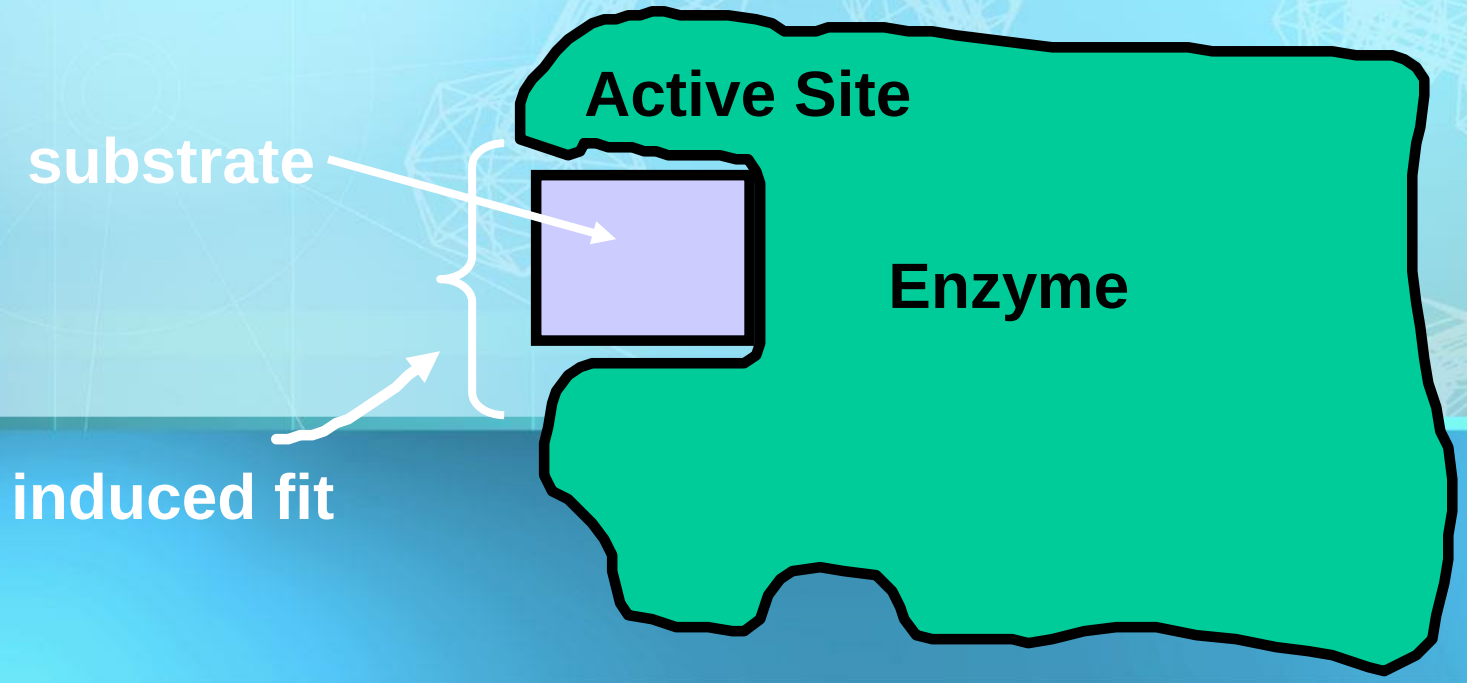
# Active Site

- A **restricted region** of an **enzyme** molecule which **binds** to the **substrate**.



# Induced Fit

- A change in the configuration of an enzyme's active site (H+ and ionic bonds are involved).
- Induced by the substrate.



# What Affects Enzyme Activity?

- Three factors:
  1. Environmental Conditions
  2. Cofactors and Coenzymes
  3. Enzyme Inhibitors

# Environmental Conditions

1. Extreme Temperature are the most dangerous

- high temps may denature (unfold) the enzyme.

2. pH (most like 6 - 8 pH near neutral)

3. Ionic concentration (salt ions)