

# Major types of Macromolecules

**Carbohydrates**

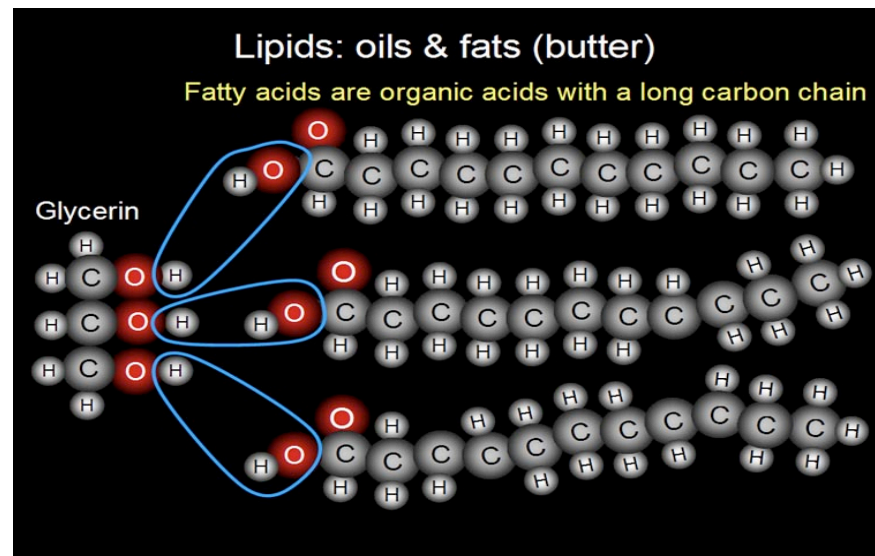
**Lipids (Fats)**

**Proteins**

**Nucleic Acids (DNA, RNA)**

# Macromolecules are Organic Compounds

- Compounds that contain **carbon**
- **Hydrogen, oxygen, nitrogen, phosphorus** and **sulfur** can also be found in organic compounds

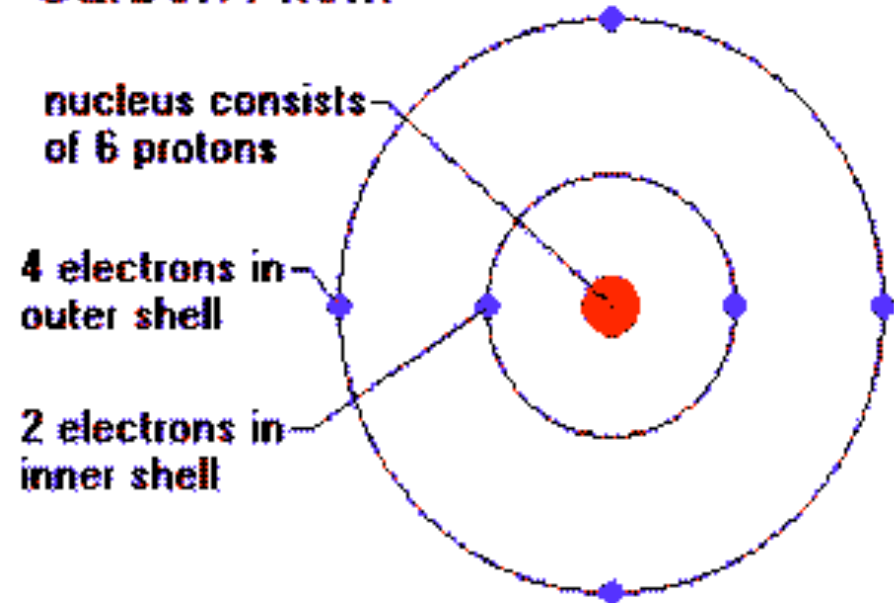


A lipid (a.k.a. fat)

# Why Carbon?

- Carbon can form more bonds than any other element (4)
- This property allows carbon based molecules to be quite large and diverse

**Carbon Atom**



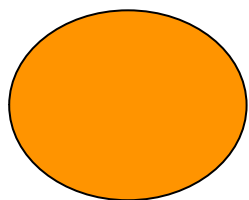
## *Types of bonds*

**C—C**      **Single Bond (one pair of e<sup>-</sup> shared)**

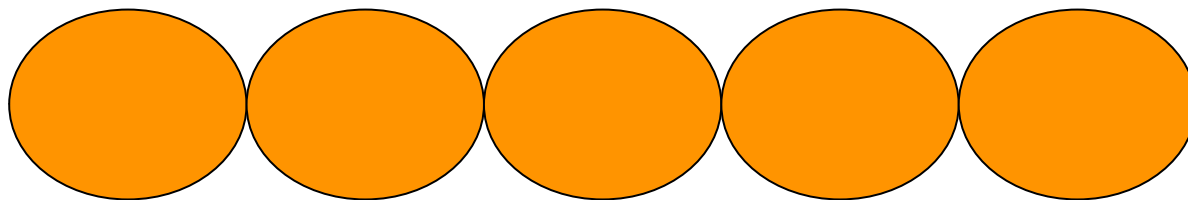
**C=C**      **Double Bond (2 pairs of e<sup>-</sup> shared)**

**C≡C**      **Triple Bond (3 pairs of e<sup>-</sup> shared)**

# Monomers and Polymers



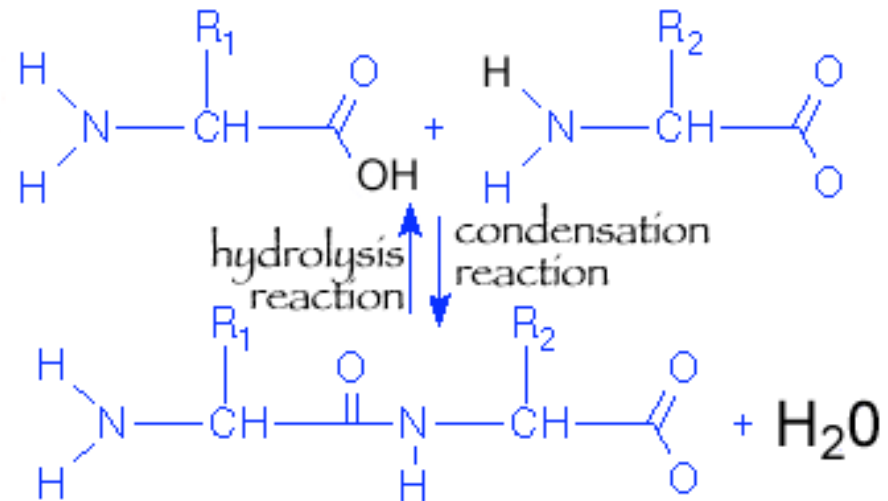
Organic compounds are made of **monomers** - individual subunits



Many monomers form **polymers** - larger molecules

# Condensation and Hydrolysis Reactions

- **Hydrolysis** reactions break large molecules (polymers) into smaller ones by adding water
- **Condensation, or dehydration synthesis** builds large molecules from smaller ones by removing water



Two amino acids are shown at the top. In condensation, the amino acids are combined into a dipeptide. In hydrolysis, the dipeptide is split into two amino acids again.

All carbohydrates consist of the following molecules:



## **Mono-saccharide**

*contains one saccharide molecule*



## **Di-saccharide**

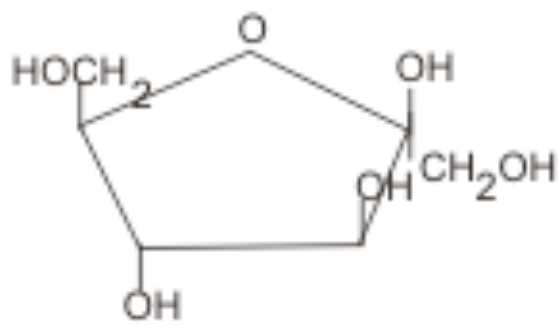
*contains two saccharide molecules*



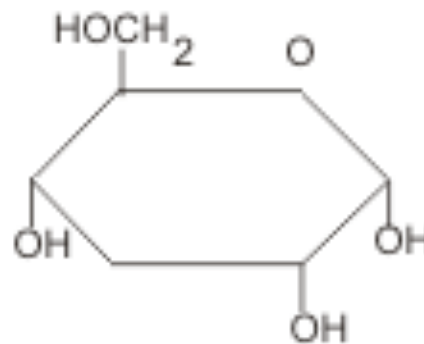
## **Poly-saccharide**

*contains many saccharide molecules*

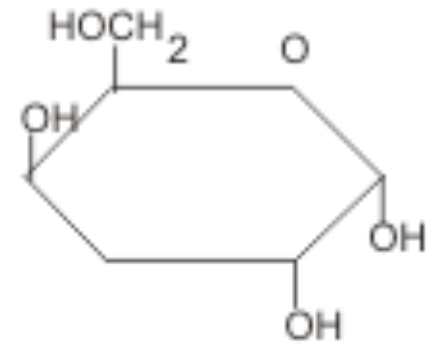
# Monosaccharides (glucose, fructose, galactose)



Fructose



Glucose

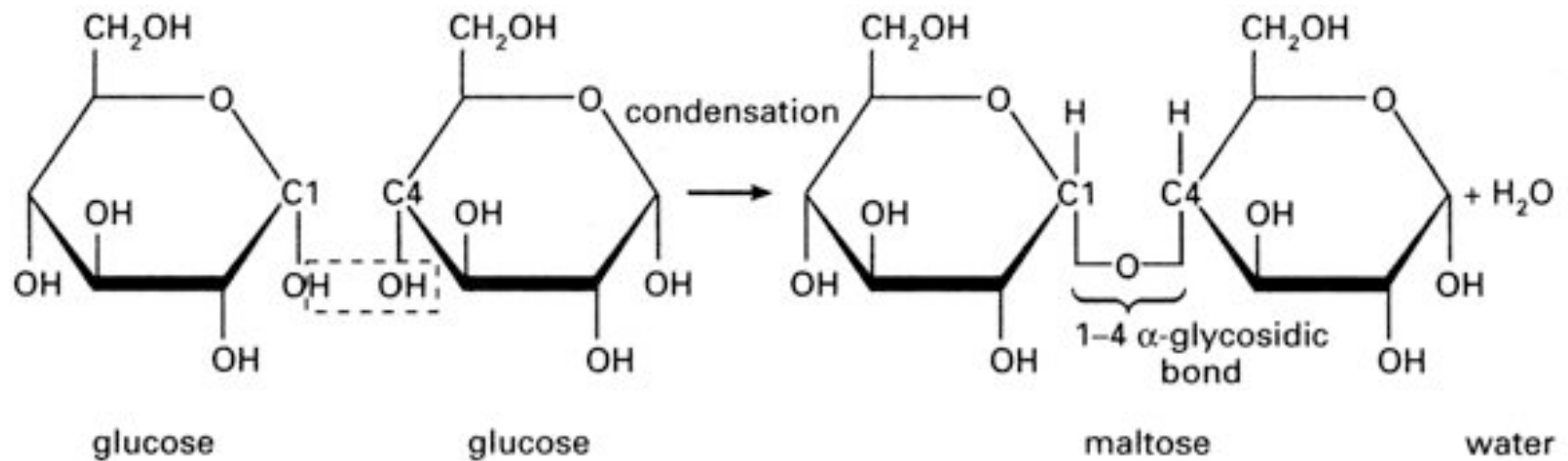


Galactose

Monosaccharides

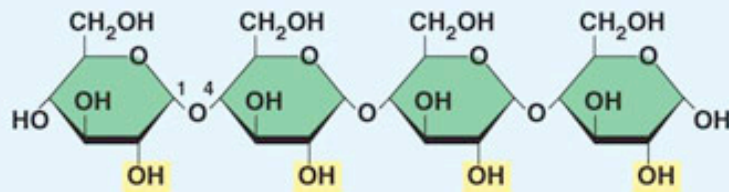
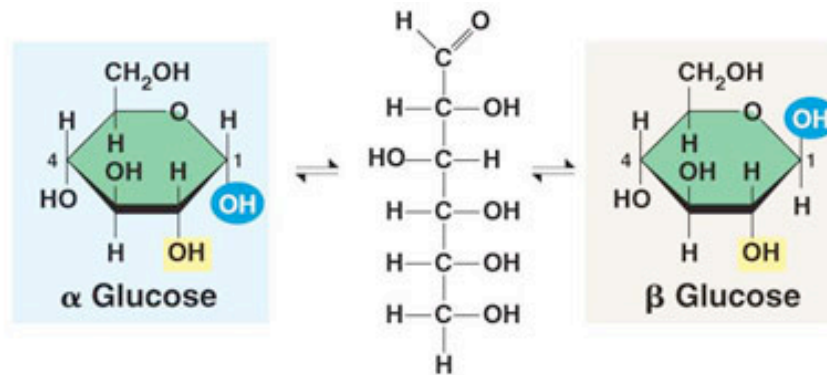


# Condensation Reaction (forming maltose – a disaccharide)

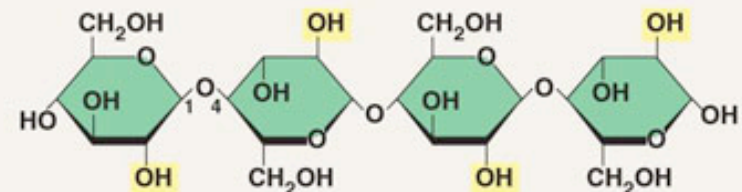


# Polysaccharides (starch vs. cellulose)

(a)  $\alpha$  and  $\beta$  glucose ring structures

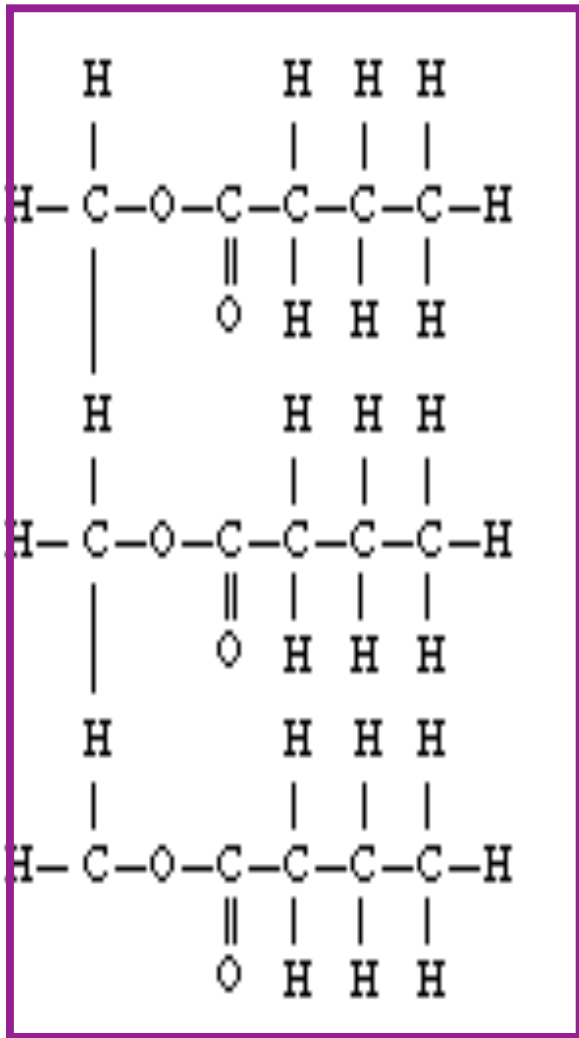


(b) Starch: 1-4 linkage of  $\alpha$  glucose monomers  
digestable in animals by amylase

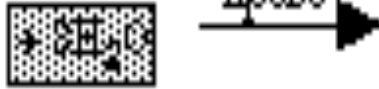


(c) Cellulose: 1-4 linkage of  $\beta$  glucose monomers  
not digestable in animals (requires cellulase)

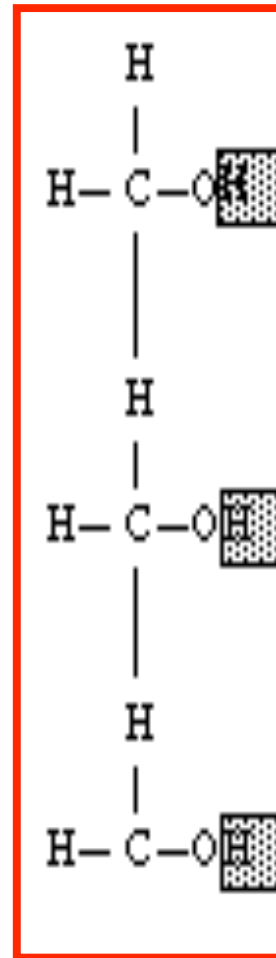
Lipid (polymer)



Tributyrin (a lipid)

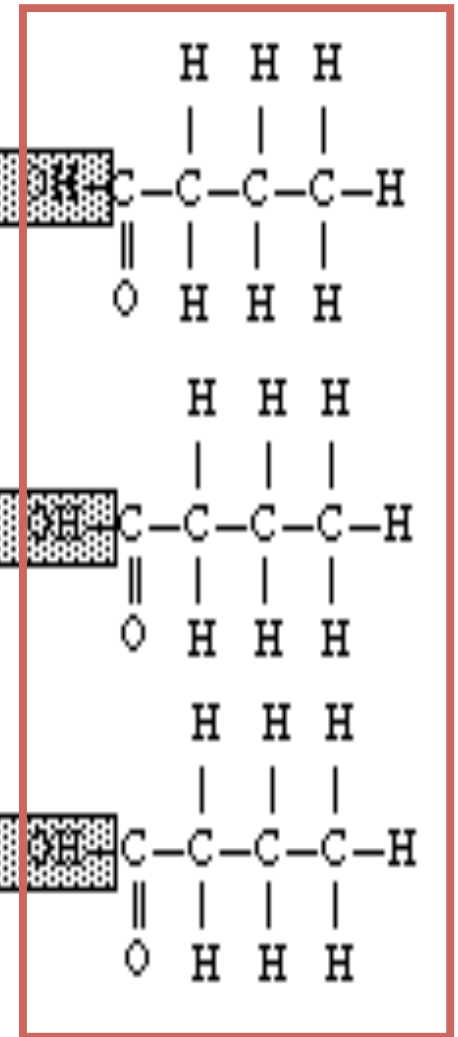


Glycerol  
(monomer)



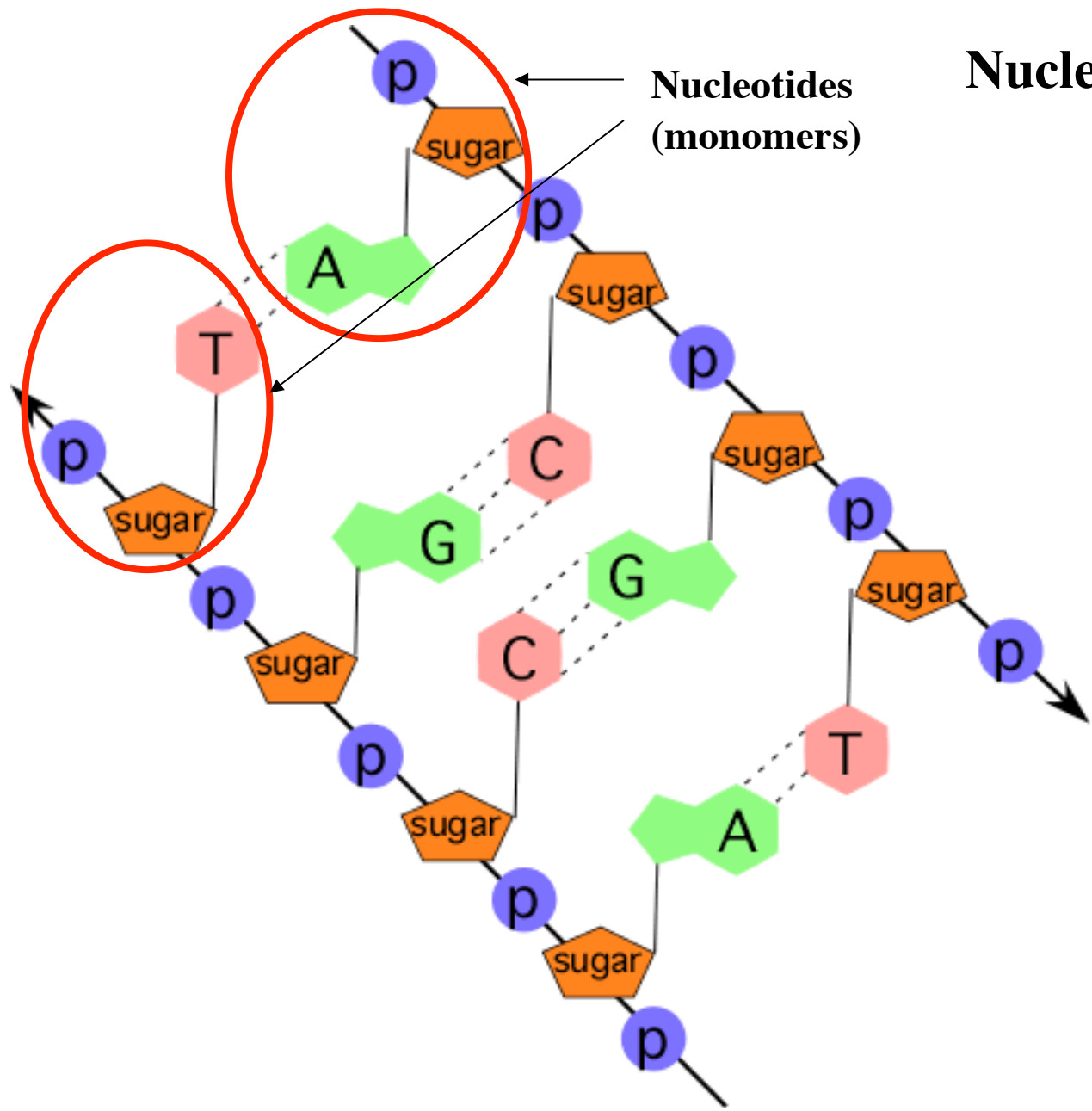
Glycerol

3 Fatty acids  
(monomers)



3 molecules of  
butyric acid



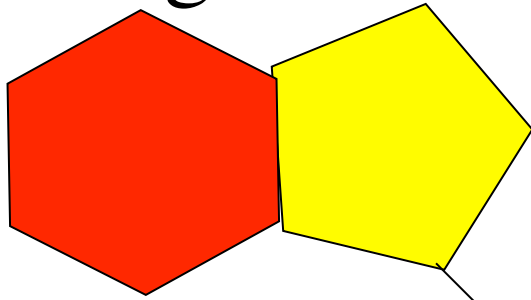


Nucleotides  
(monomers)

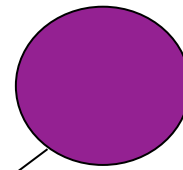
**Nucleic Acid (polymer)**

# Nucleotide

Nitrogen base



Phosphate group

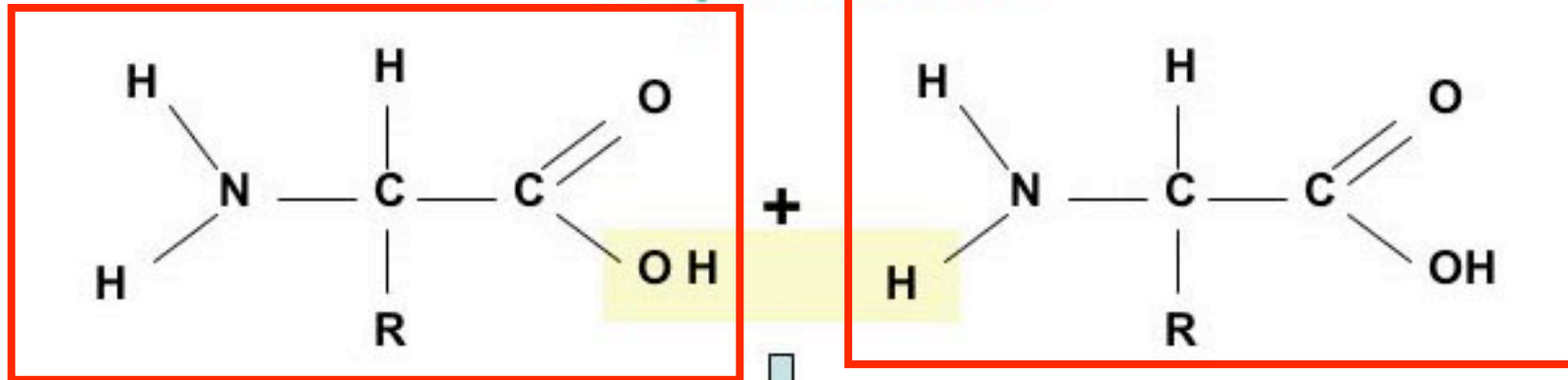


Five carbon sugar

Amino acid (monomer)

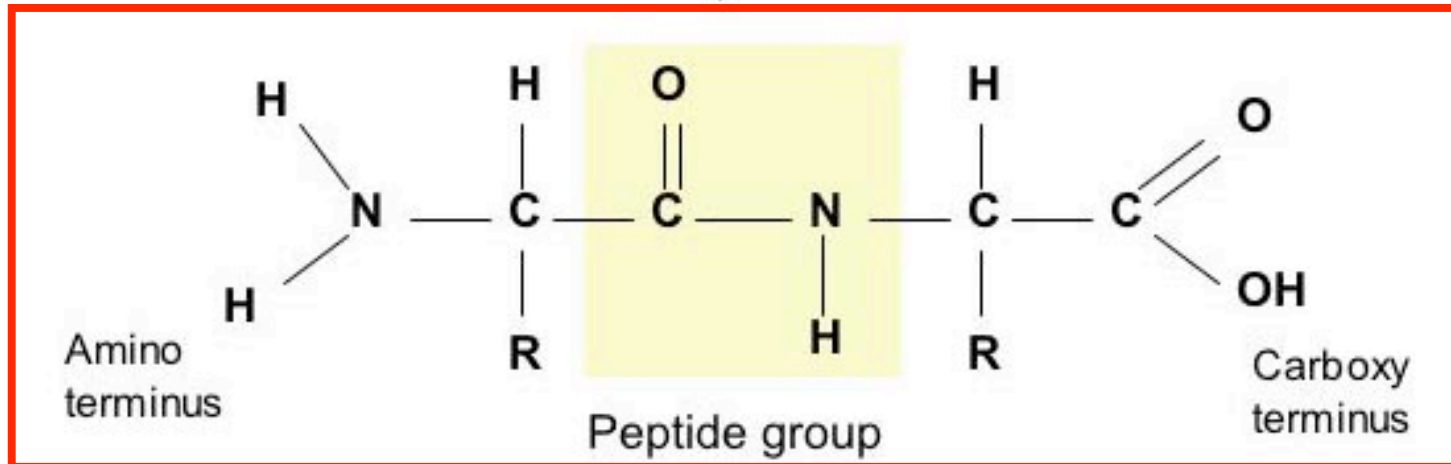
Peptide Bond

Amino acid (monomer)



Dehydration  
Reaction

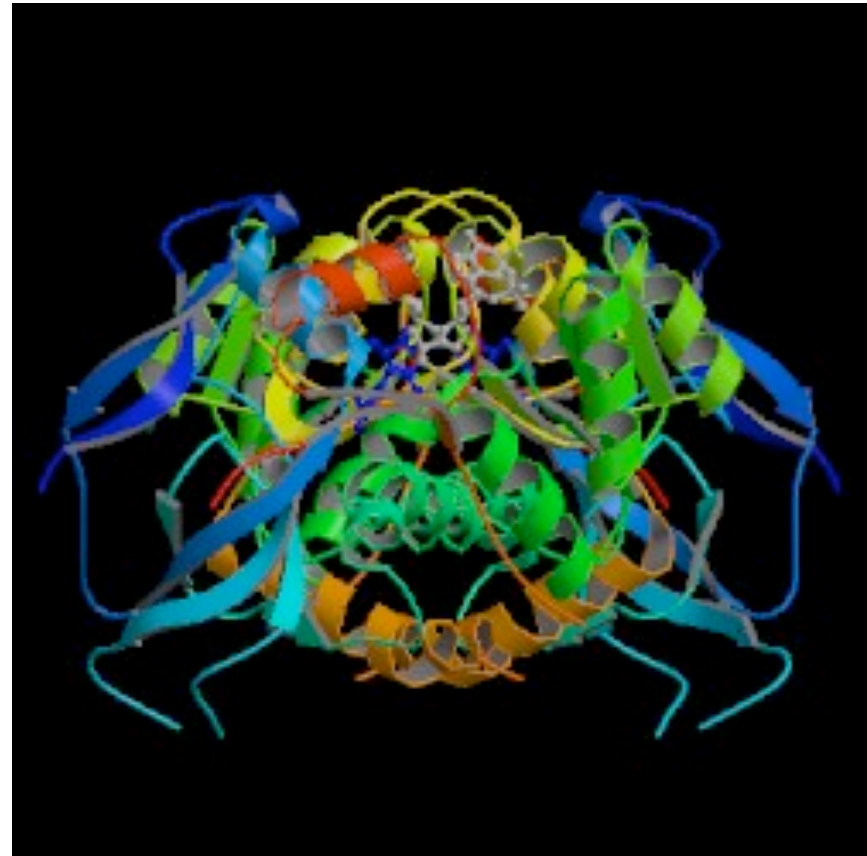
H<sub>2</sub>O



Two amino acids bonded together (dipeptide - polymer)

# Protein Structure

- Proteins are polymers made of amino acid monomers
- The shape of a protein determines its function
- The shape is determined by the order of amino acids in the protein

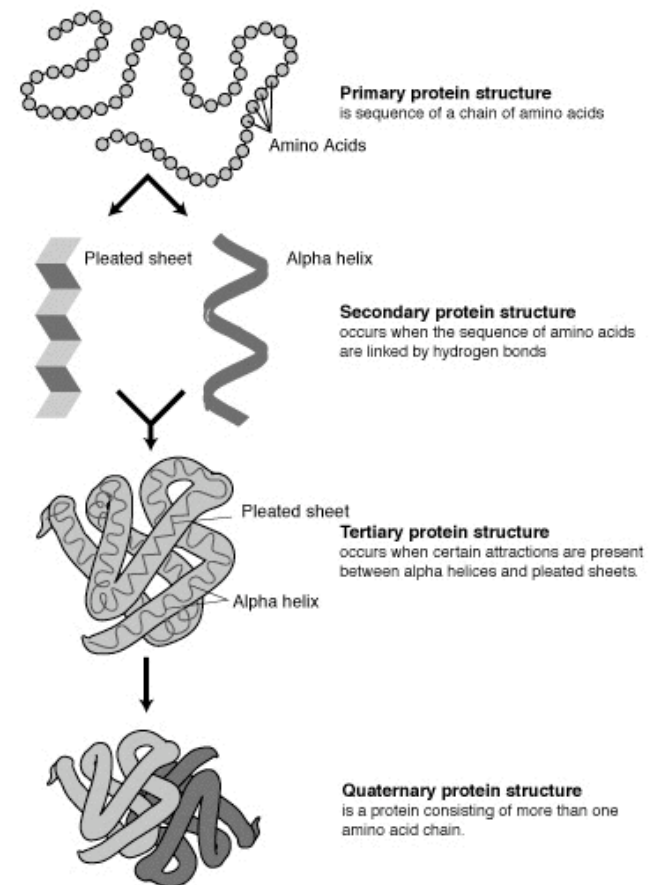


p53 tumor suppressor protein



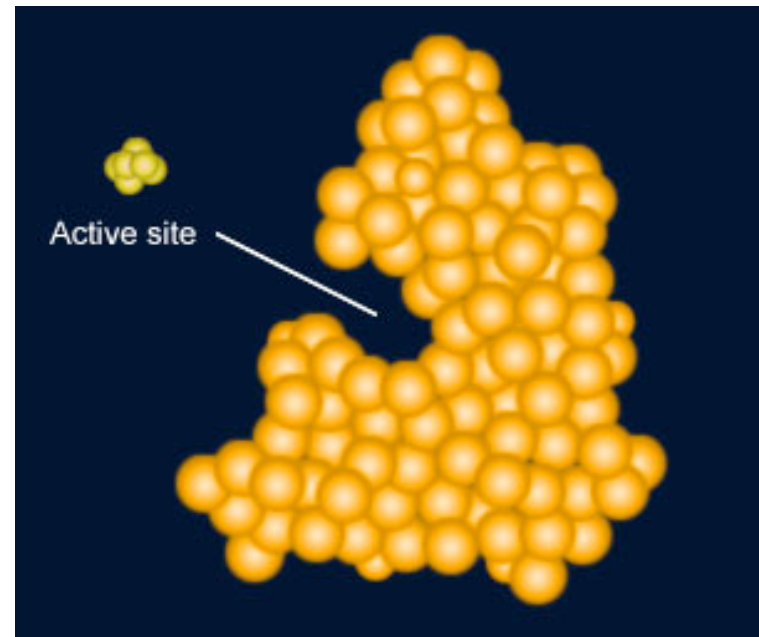
# Four Levels of Protein Structure

- **Primary**- order of a chain of amino acids
- **Secondary** – formation of hydrogen bonds between amino acids in the polypeptide chain
- **Tertiary** – folding of whole polypeptide chain
- **Quaternary** – attractions between more than one polypeptide chain (results in the complete protein)

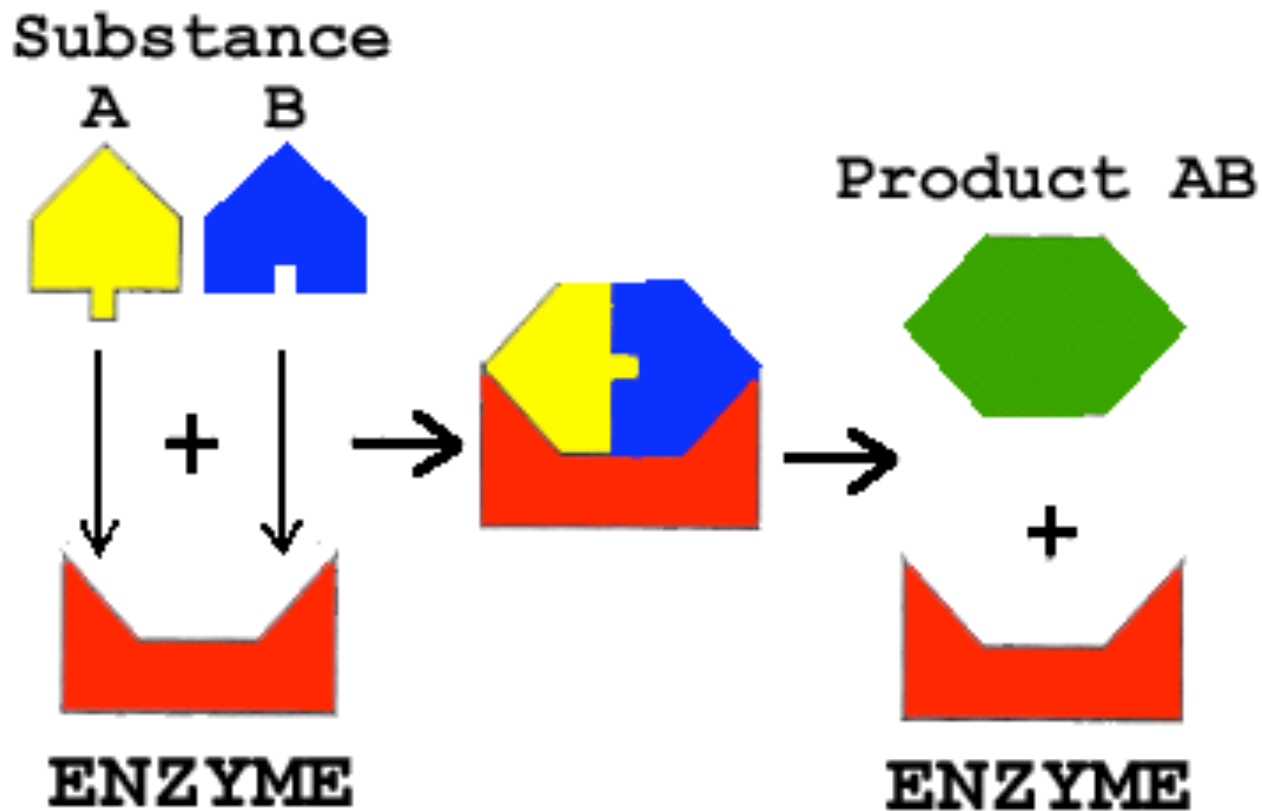


# Enzymes

- Proteins that regulate chemical reactions in an organism



# Enzymes act as *Catalysts*

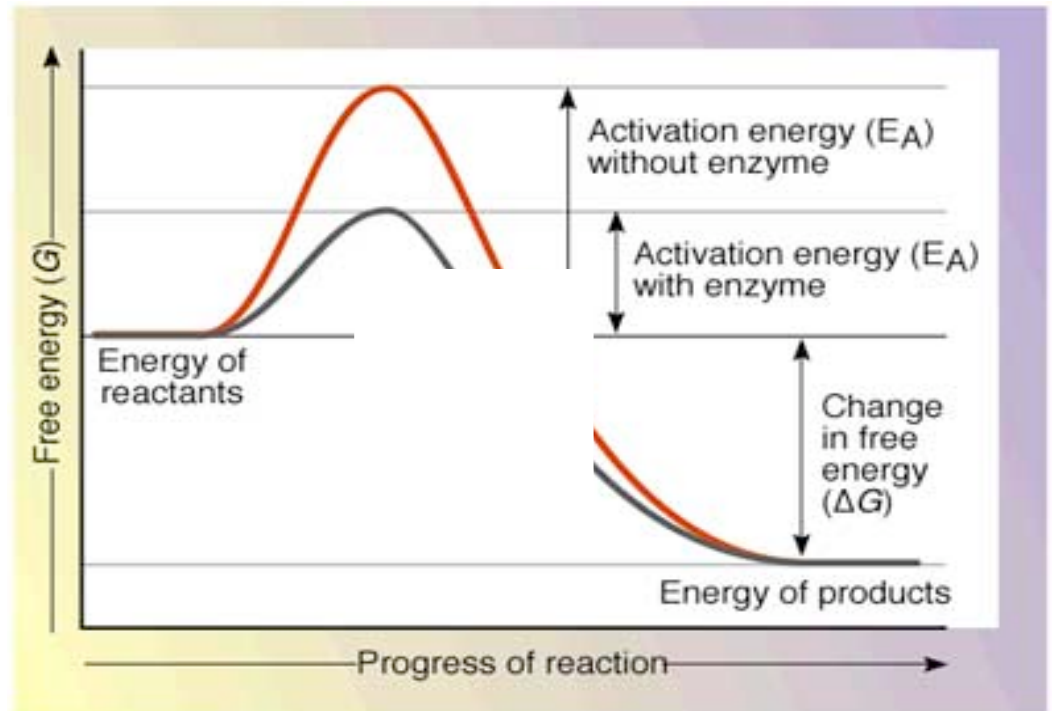


**Catalysts speed up chemical reactions  
without being used up or changed  
during the reaction**



# How do Enzymes Speed up Chemical Reactions?

- The energy required to get a chemical reaction started is the activation energy
- Enzymes work by lowering the activation energy to speed up the reaction



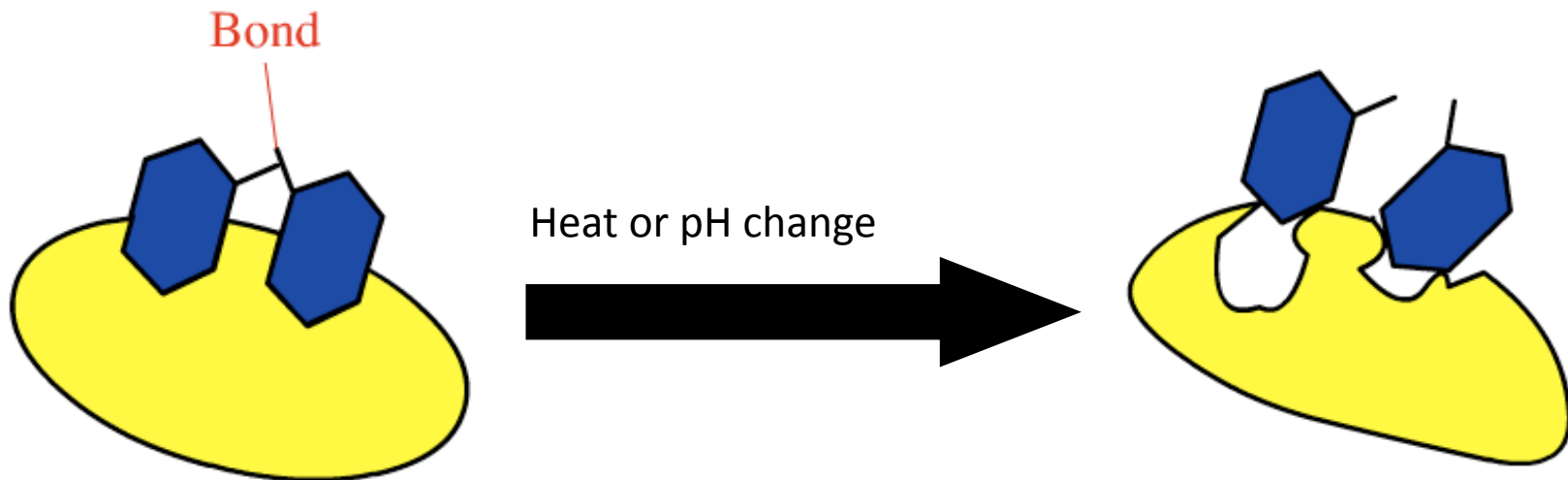
# Factors affecting the rate of a reaction

- Amount of enzyme present
- Amount of substrate present
- Temperature and pH

# Enzyme Denaturation

*Enzyme is shown in yellow*

*Blue molecules are the substrate*



Reaction takes place normally

No reaction occurs  
(active site is damaged and substrate no longer fits)