

Life's Construction Materials

THE BIOMOLECULES

The 4 major classes of biomolecules

Carbohydrates

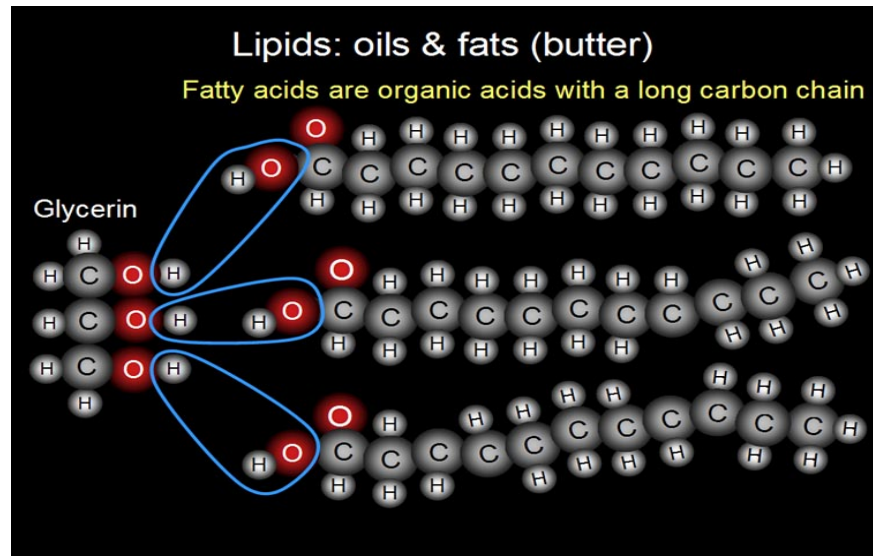
Lipids (Fats)

Proteins

Nucleic Acids (DNA, RNA)

The Biomolecules are *Organic Compounds*

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

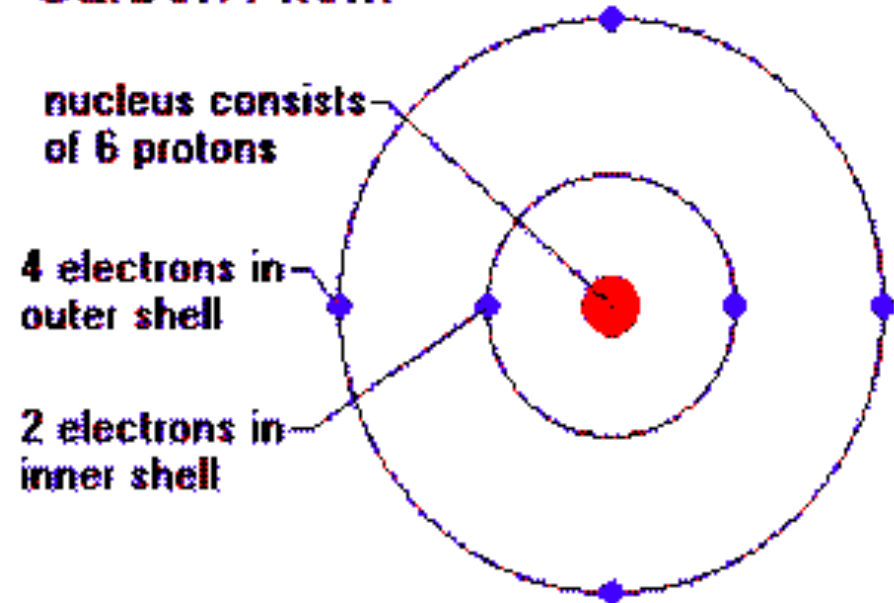


A lipid (a.k.a. fat)

Why is carbon special?

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

Carbon Atom



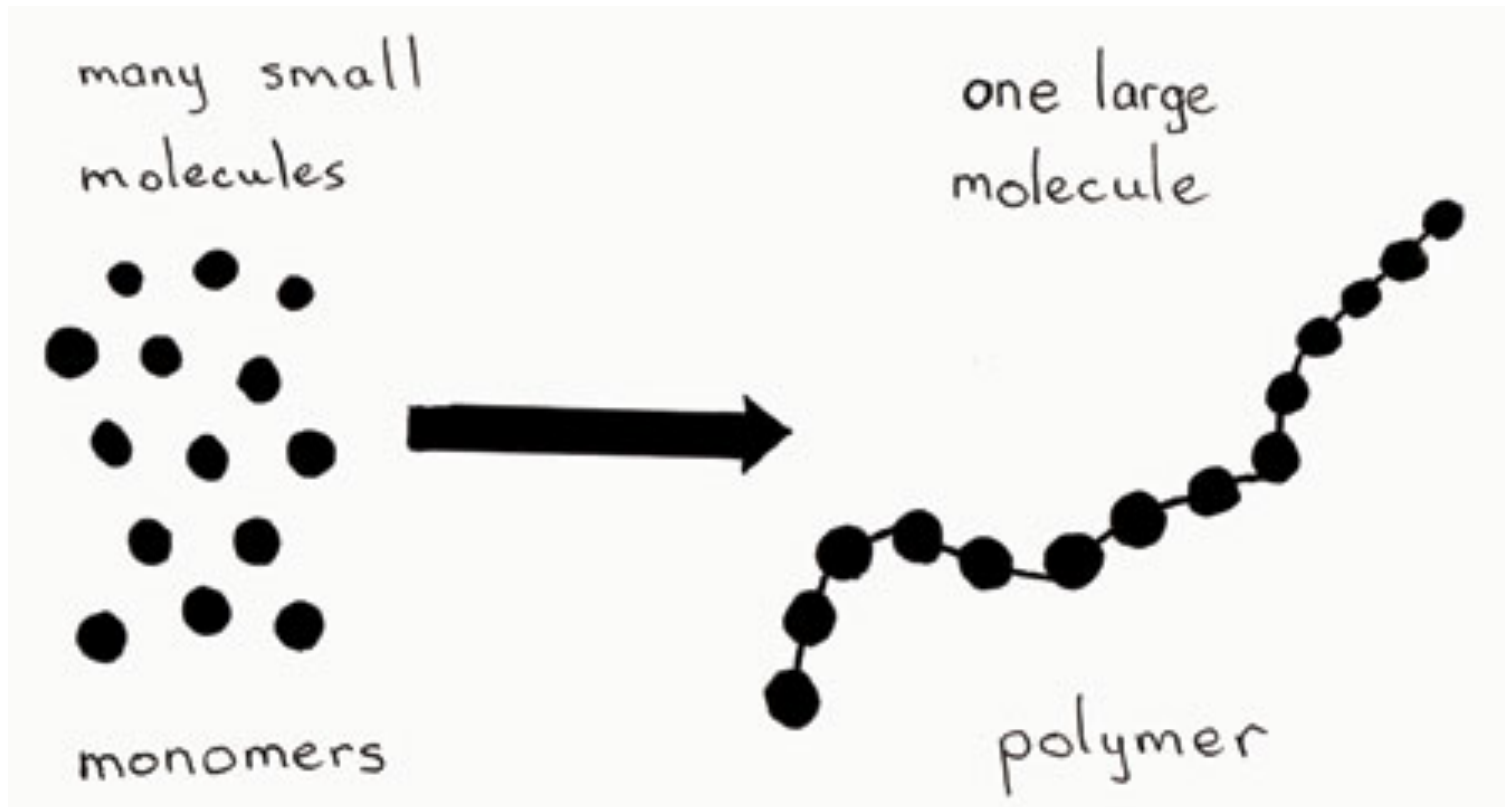
Symbolizing chemical bonds

**C—C Single Bond (one pair
of e⁻ shared)**

**C=C Double Bond (2 pairs
of e⁻ shared)**

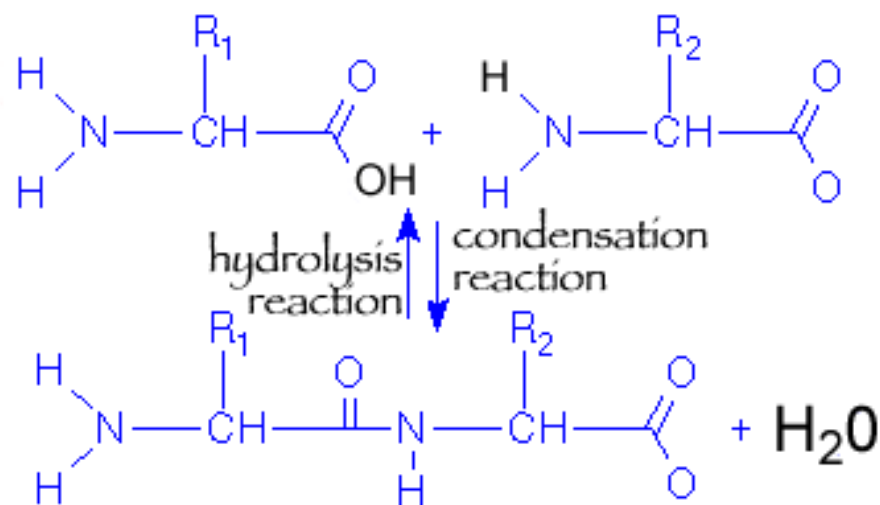
**C≡C Triple Bond (3 pairs
of e⁻ shared)**

Monomers vs. Polymers



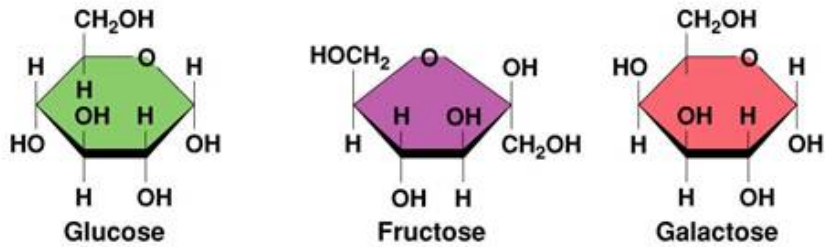
Condensation and Hydrolysis Reactions

- **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

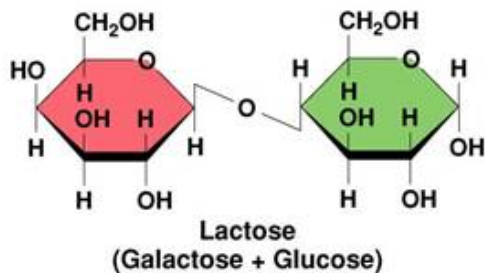
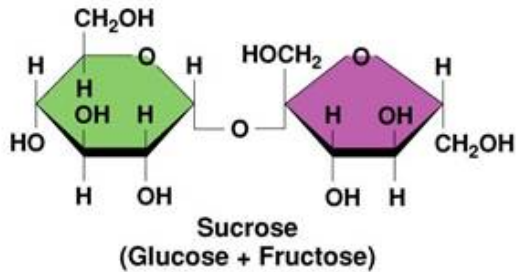


Two amino acids are shown at the top. In condensation, the amino acids are combined into a dipeptide. In hydrolysis, the dipeptide is split into two amino acids again.

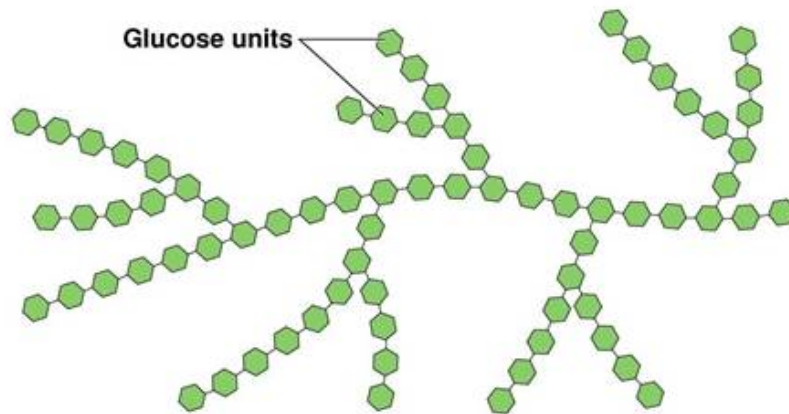
CARBOHYDRATE Classification:



(a) Monosaccharides



(b) Disaccharides

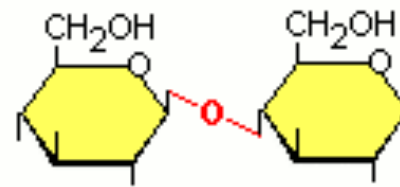


(c) Polysaccharide

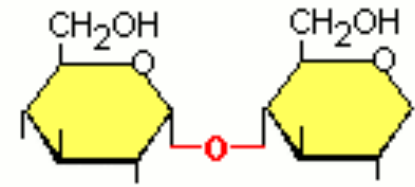
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Can you digest it or not?

- Beta glycosidic bonds are difficult for our bodies to break
- Fiber consists of polysaccharides with beta glycosidic bonds
- We can't digest fiber as a result



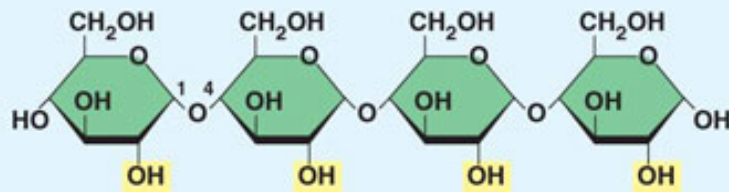
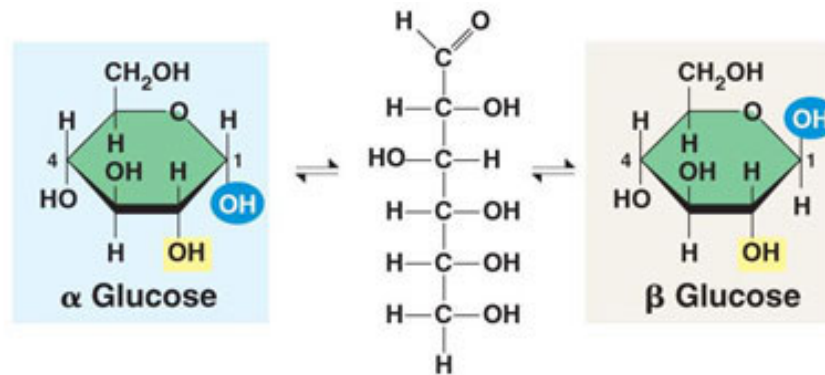
beta (1 → 4) bond
cellulose



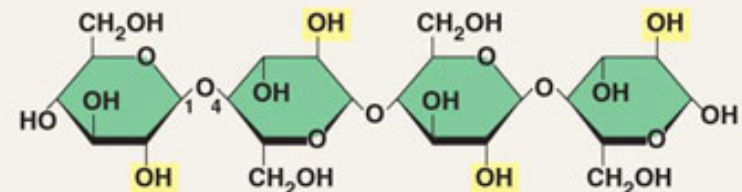
alpha (1 → 4) bond
starch, glycogen

Polysaccharides (starch vs. cellulose)

(a) α and β glucose ring structures

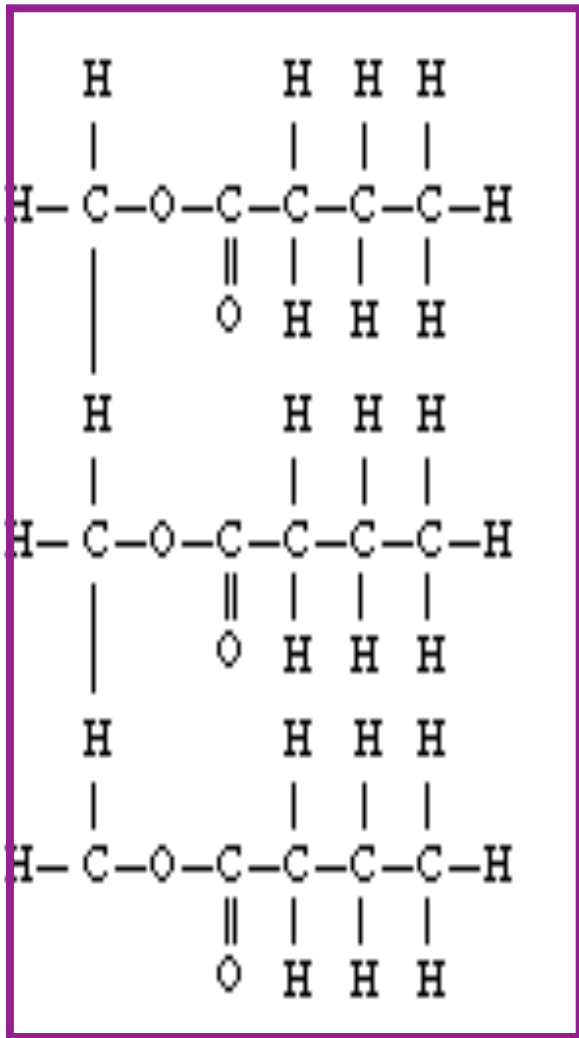


(b) Starch: 1-4 linkage of α glucose monomers
digestable in animals by amylase

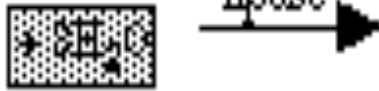


(c) Cellulose: 1-4 linkage of β glucose monomers
not digestable in animals (requires cellulase)

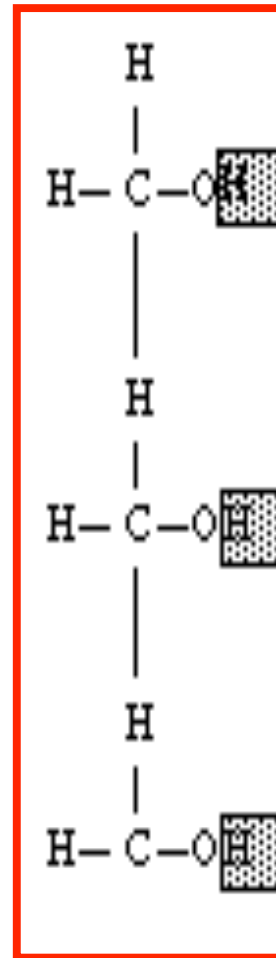
Lipid (polymer)



Tributyrin (a lipid)

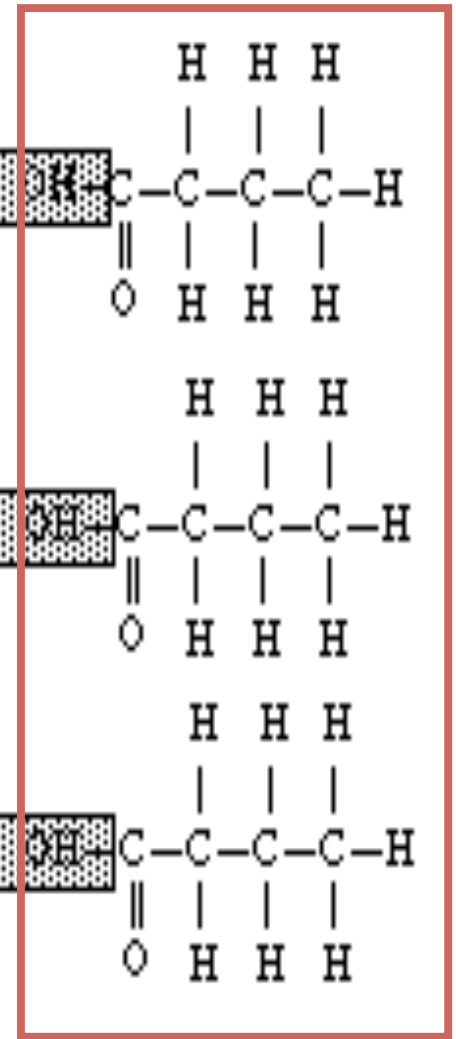


Glycerol
(monomer)



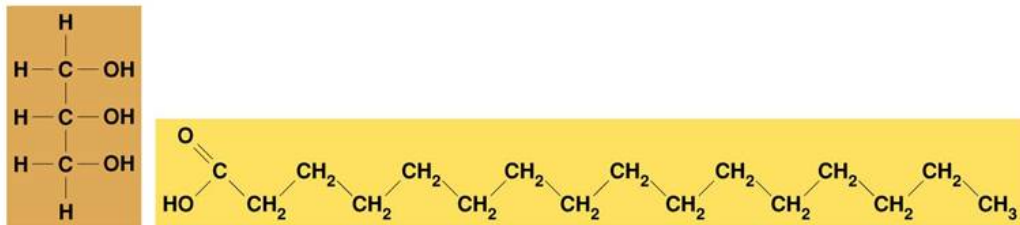
Glycerol

3 Fatty acids
(monomers)

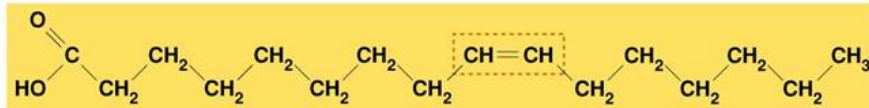


3 molecules of
butyric acid

Lipid Structure

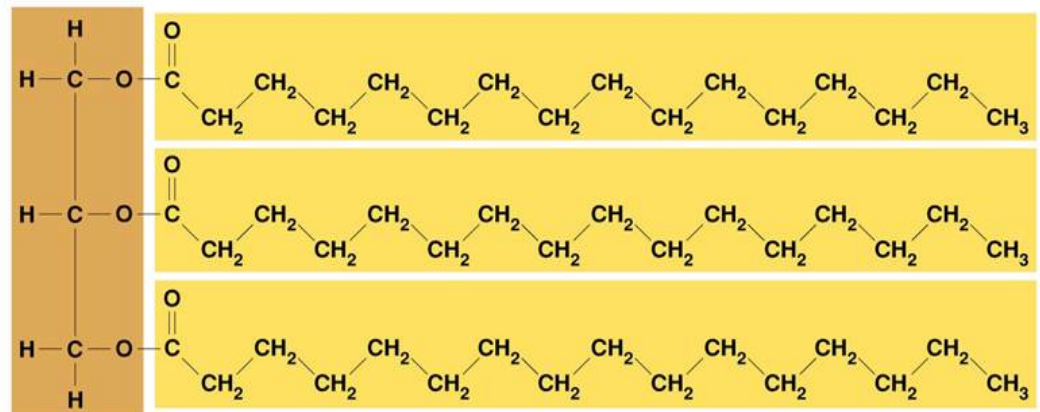


(a) Glycerol (b) Saturated fatty acid



(c) Unsaturated fatty acid

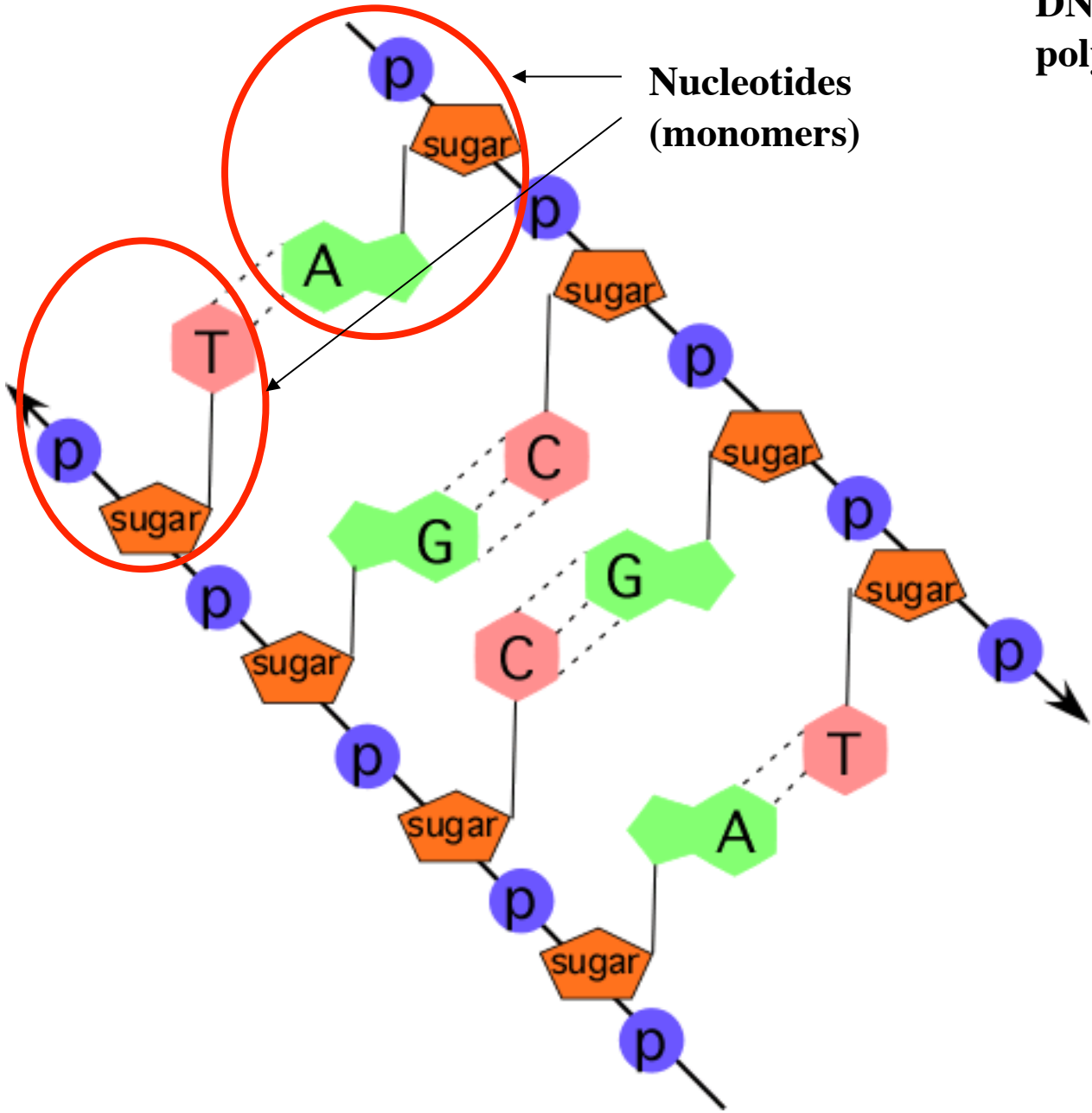
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(d) Triglyceride

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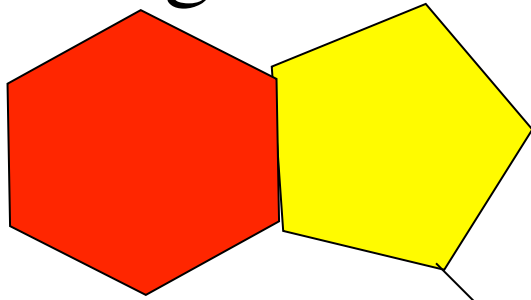
DNA (Nucleic Acid polymer)



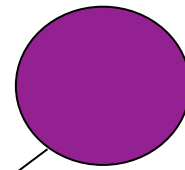
**Nucleotides
(monomers)**

Nucleotide

Nitrogen base



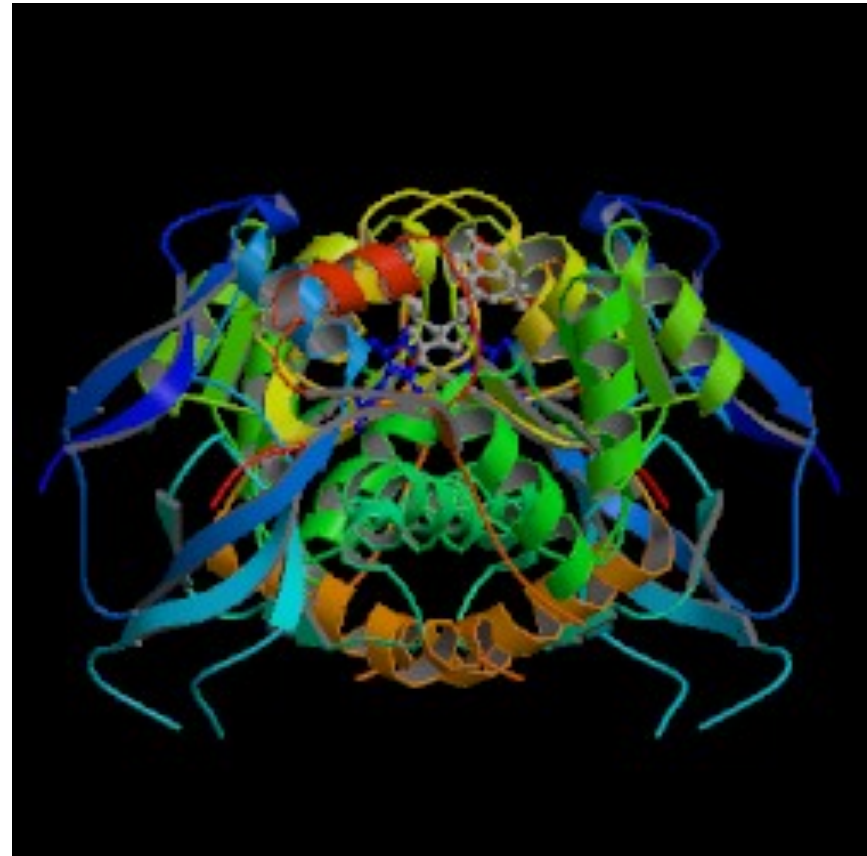
Phosphate group



Five carbon sugar

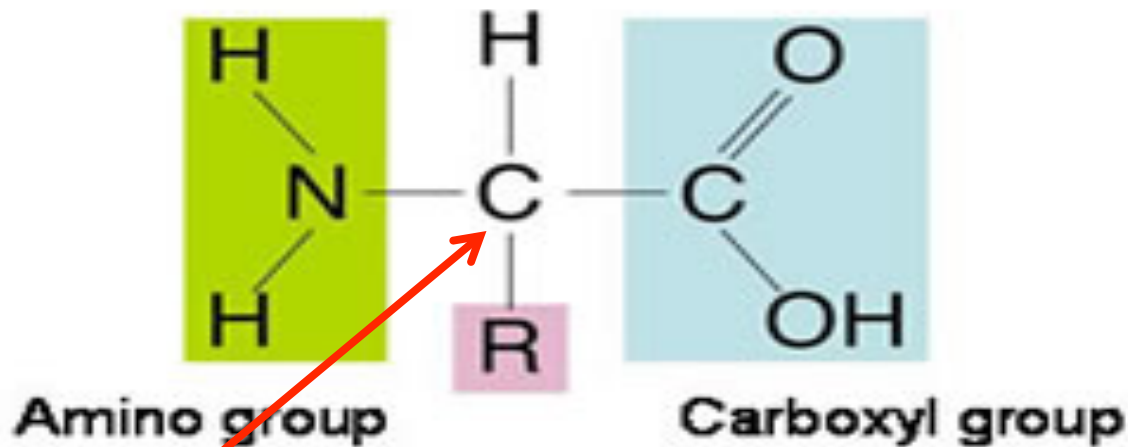
Protein Structure

- 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

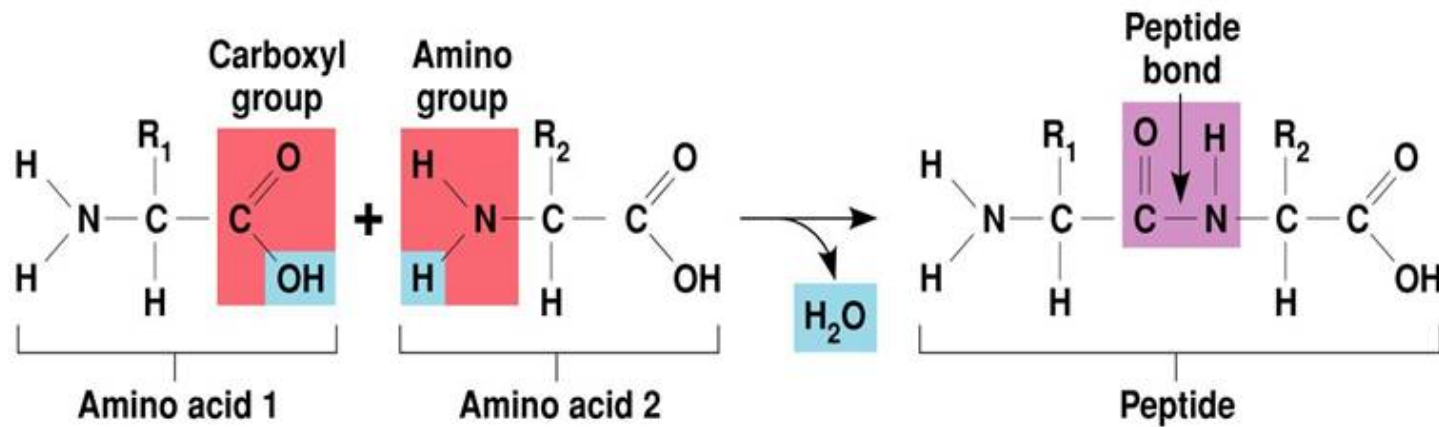
Structure of an Amino Acid



Alpha carbon

General structure

Formation of a Peptide Bond



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Four Levels of Protein Structure

- **Primary**- arrangement of amino acids in a polypeptide chain
- **Secondary** – formation of amino acid chain into a helix or sheet
- **Tertiary** – folding of whole polypeptide chain into a 3-D protein (due to interactions between R-groups)
- **Quaternary** – (not all proteins have this) attractions between more than one polypeptide chain resulting in a larger functional protein

