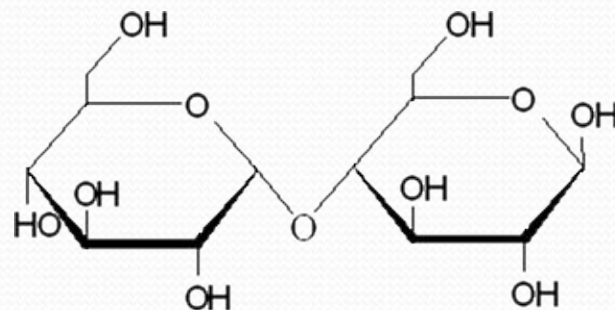
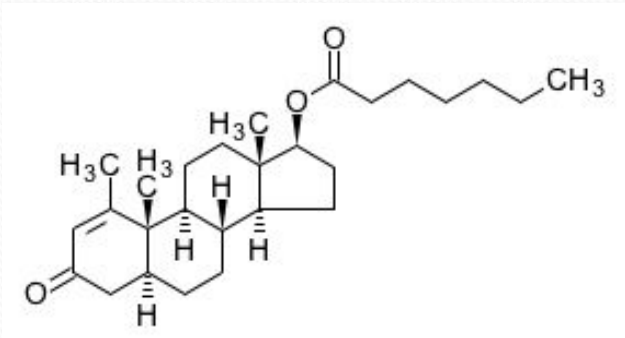
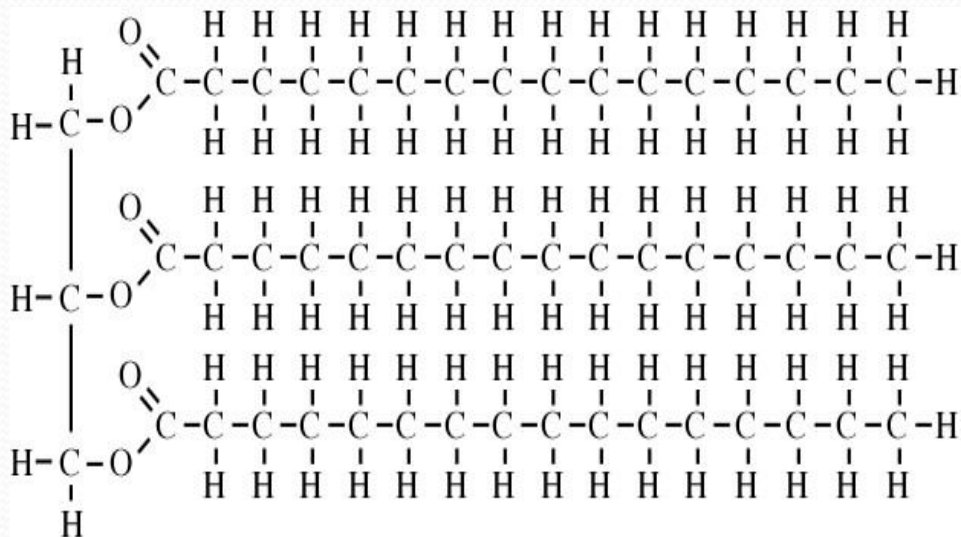
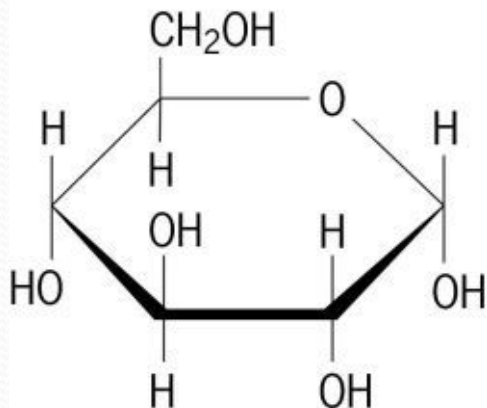


Biological Molecules

Carbohydrates, Proteins, Lipids, and Nucleic Acids

Organic Molecules



Glucose, triglyceride/fat. Steroid (cholesterol), disaccharide

Organic Molecules

- Proteins, Carbohydrates, Lipids etc are **macromolecules**
- Many molecules joined together

- **Monomer**
- Simple molecules

- **Polymer**
- Large molecules formed by combining monomers

Organic Molecules

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Polymer

carbohydrate (e.g., starch)

protein

nucleic acid

Monomer

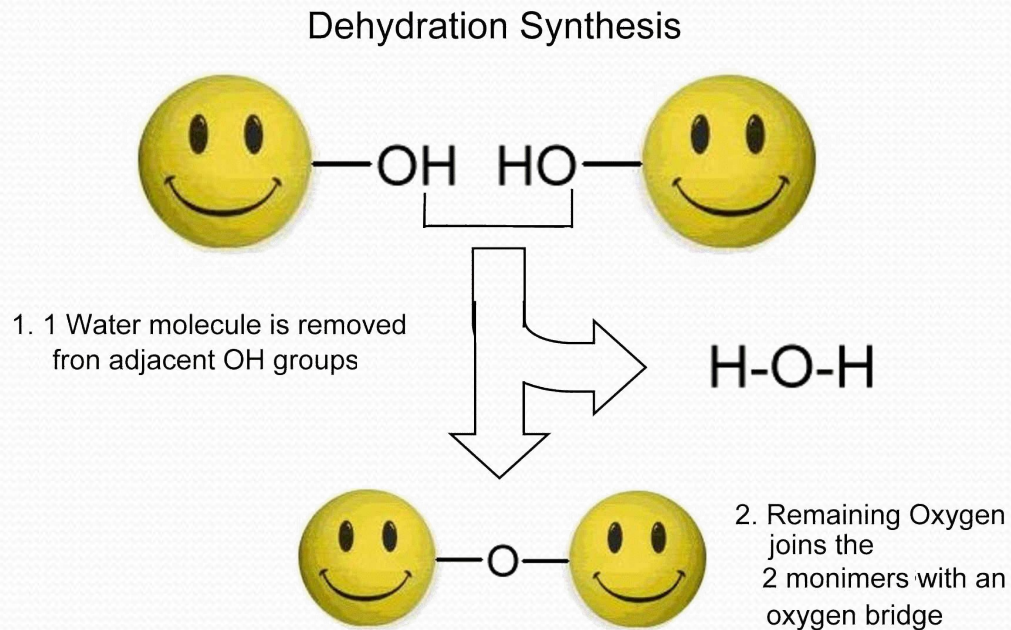
monosaccharide

amino acid

nucleotide

Polymer Formation

- Making big molecules from small molecules
- Requires **water!**
- **Dehydration Synthesis**
- Water is produced as monomers are combined together

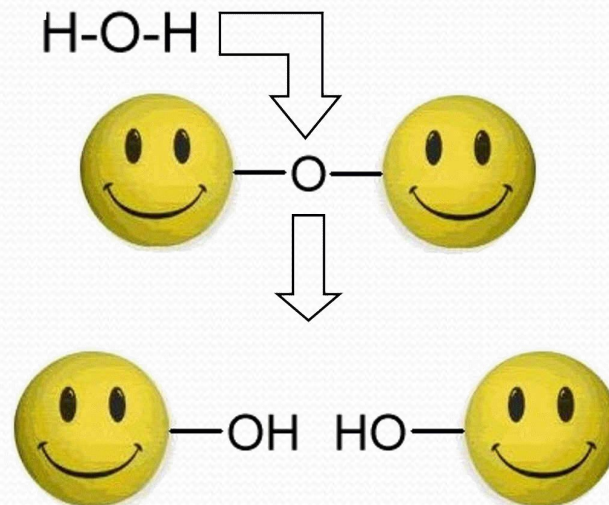


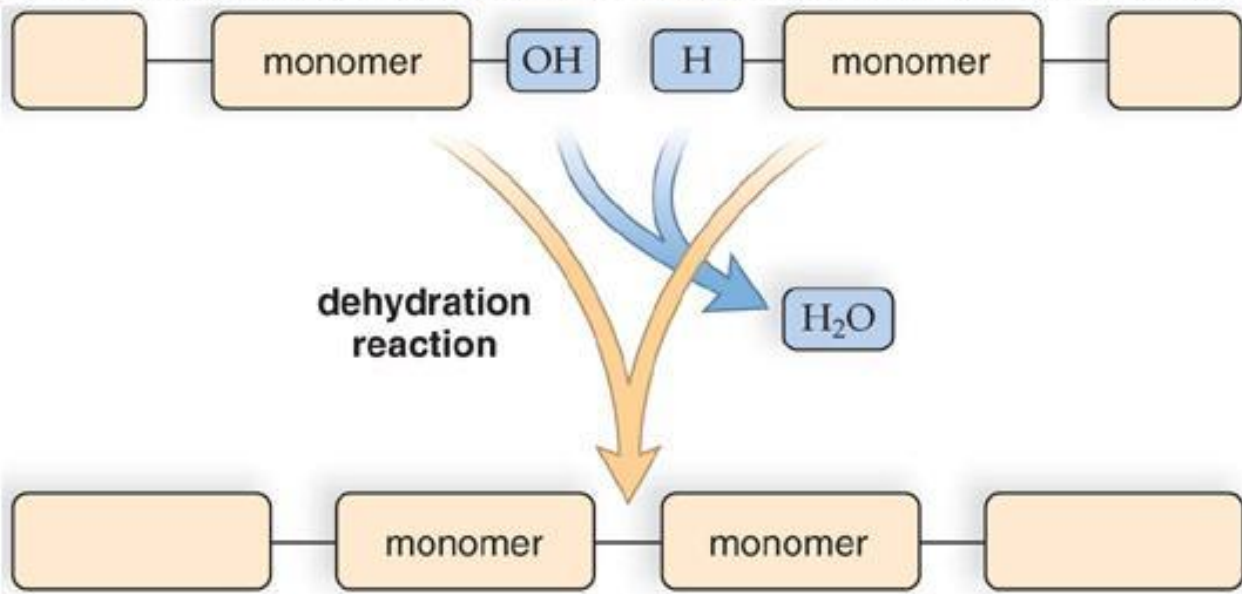
Polymer Breakdown

- Breaking big molecules into small molecules
- Requires **water!**
- **Hydrolysis**
- Water breaks up the bonds in another molecule
- Requires enzymes (helping molecules)

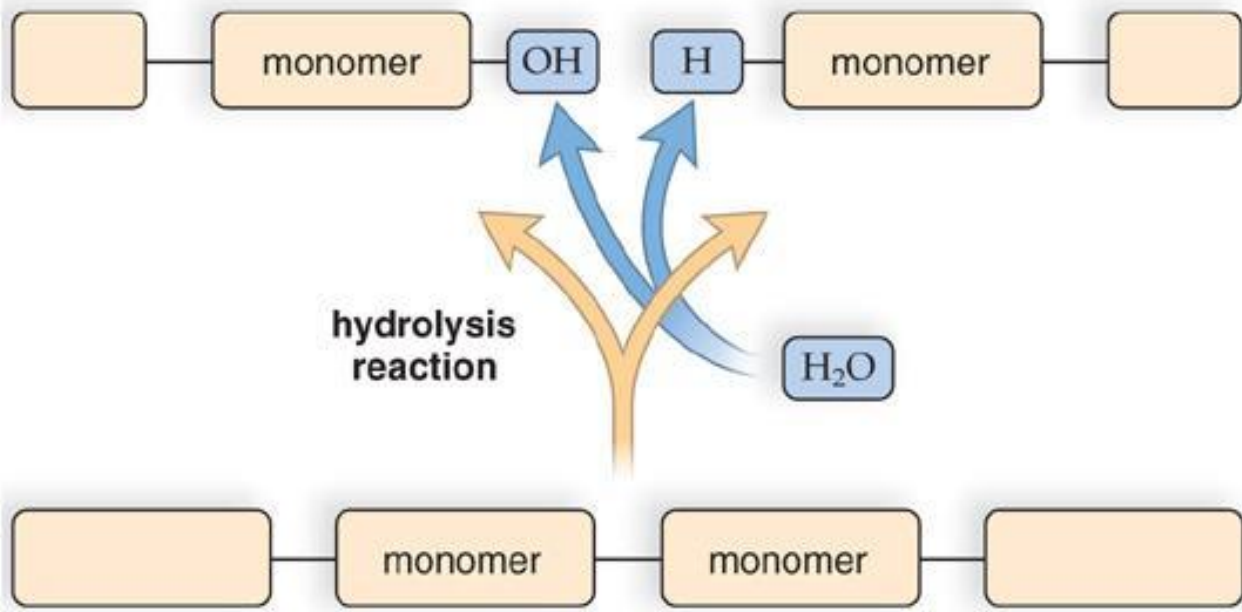
1. Water molecule is inserted
into oxygen bridge, breaking bond.

Hydrolysis





a.



b.

Carbohydrates

Sugars (glucose, sucrose, starch)

Functions

1. Short term energy supply

- Glucose produces ATP energy

2. Short term energy storage

- Gycogen is stored in the liver and muscles

3. Structure

- Plant cell walls, insect exoskeletons

4. Cell Membrane markers

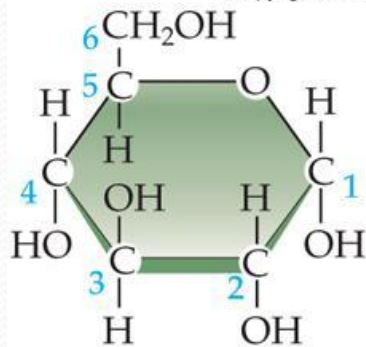
- Cell “identity tags”

All carbs have the formula $C_n(H_2O)_n$

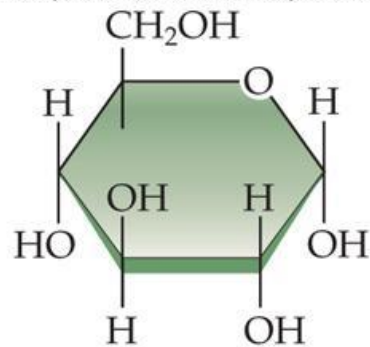
Monosaccharides

- Monosaccharides have 3-7 carbon atoms
- Ex) Glucose, ribose, galactose, fructose
- Only **one unit molecule**
- **Pentose** = 5 carbons
- **Hexose** = 6 carbons
- “**ose**” = carbohydrate

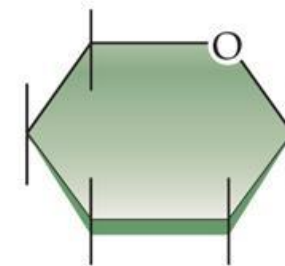
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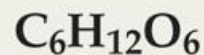
a.



b.



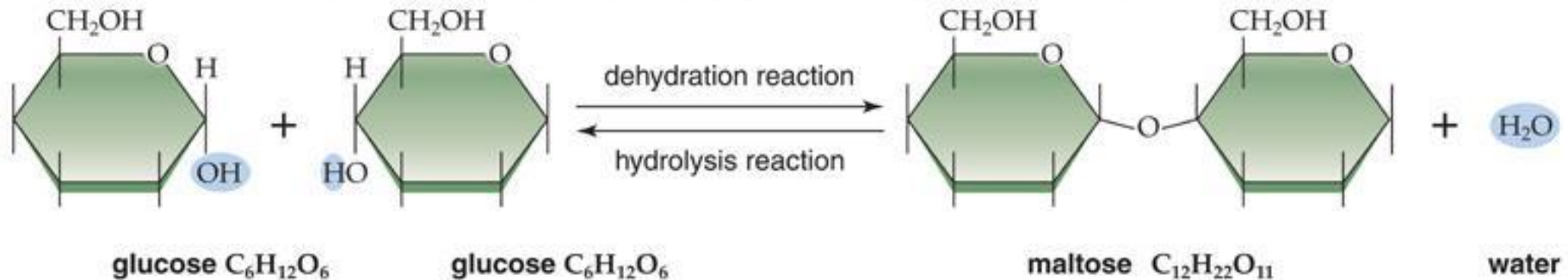
c.



Disaccharides

- Two molecules together
- Ex) Maltose, lactose
- Formed from dehydration synthesis

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monosaccharide + monosaccharide $\xrightleftharpoons[\text{hydrolysis reaction}]{\text{dehydration reaction}}$ disaccharide + water

Polysaccharides

- Many molecules together
- Repeating glucose subunits
- Examples:

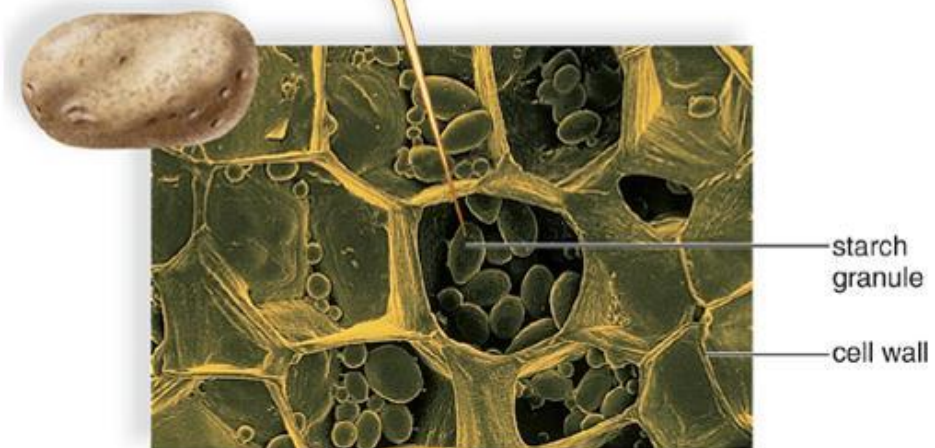
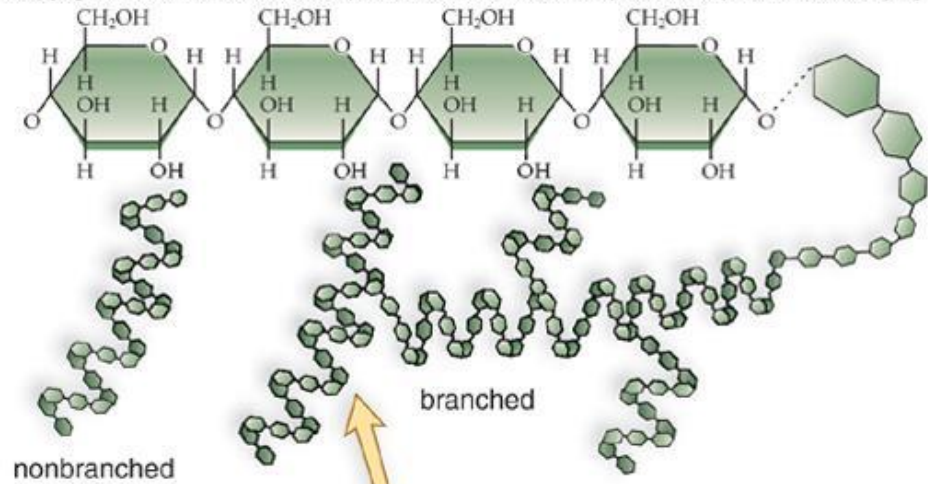
1. Starch

- Glucose storage in plants
- Straight chains with little branching

2. Glycogen

- Glucose storage in animals
- Many side chains

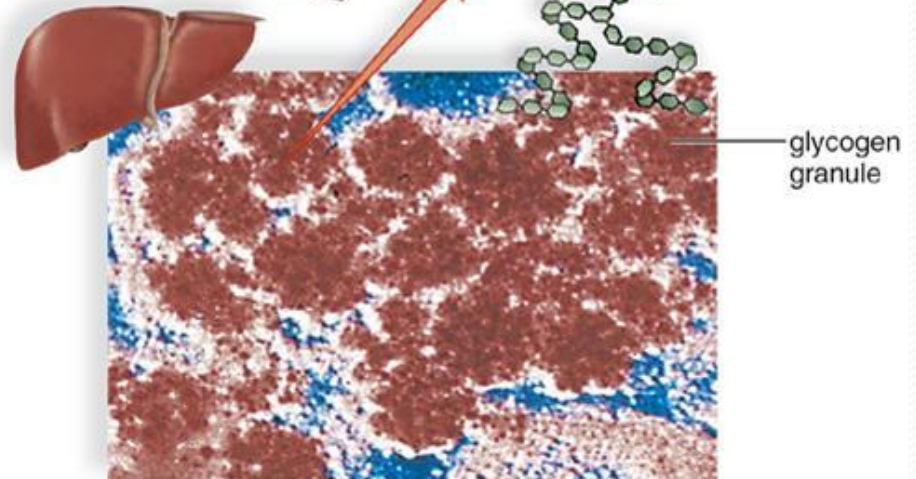
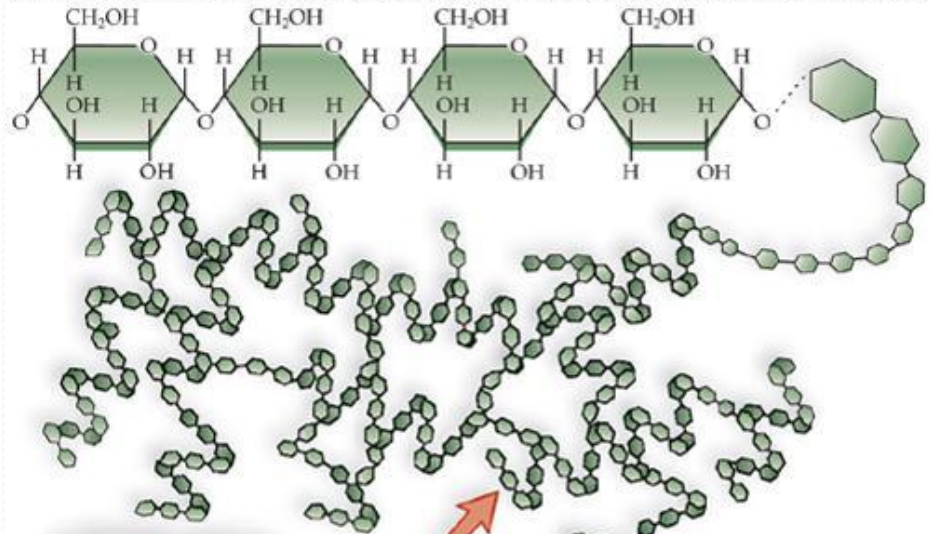
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potato cells

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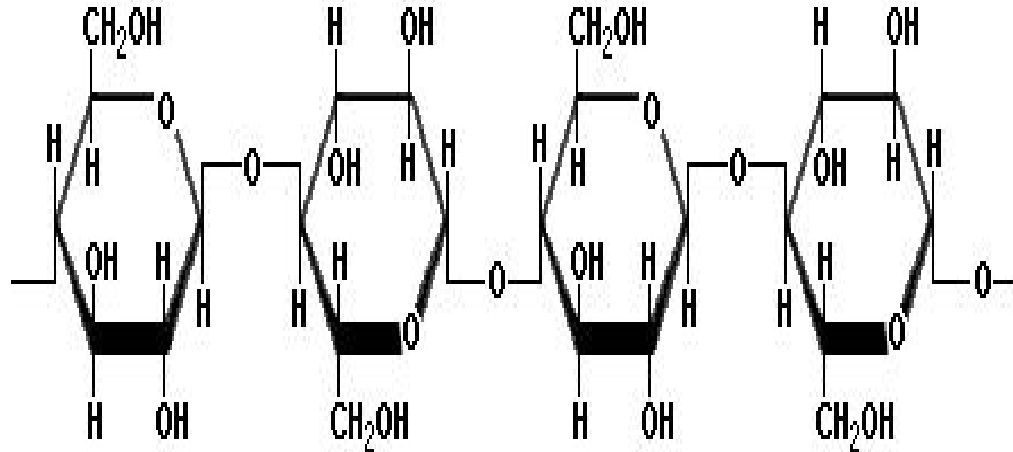
liver cells

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Polysaccharides

3. Cellulose

- In plant cell walls
- No branching – alternating oxygen positions for more structure
- Cannot be digested - fiber



Lipids

Fats, Oils, and Waxes

Functions

1. Long term energy storage

- Pack energy into a small space

2. Insulation and Padding

- Protects organs

3. Structure

- Cell membranes

4. Chemical Messengers

- Steroids

All lipids **do not** dissolve in water = hydrophobic

Types

1. Fatty Acids

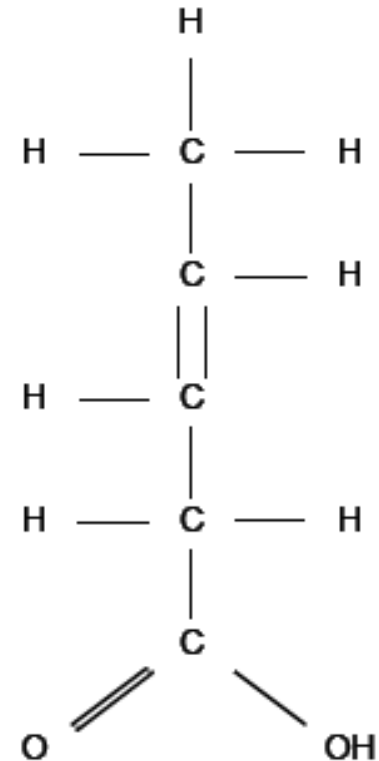
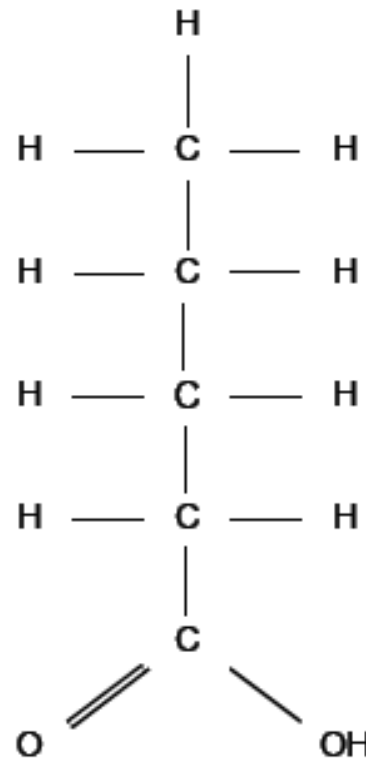
• Chain of carbons ending in COOH

• Saturated Fatty Acids

- Solid at room temperature
- Bad for health

• Unsaturated Fatty Acids

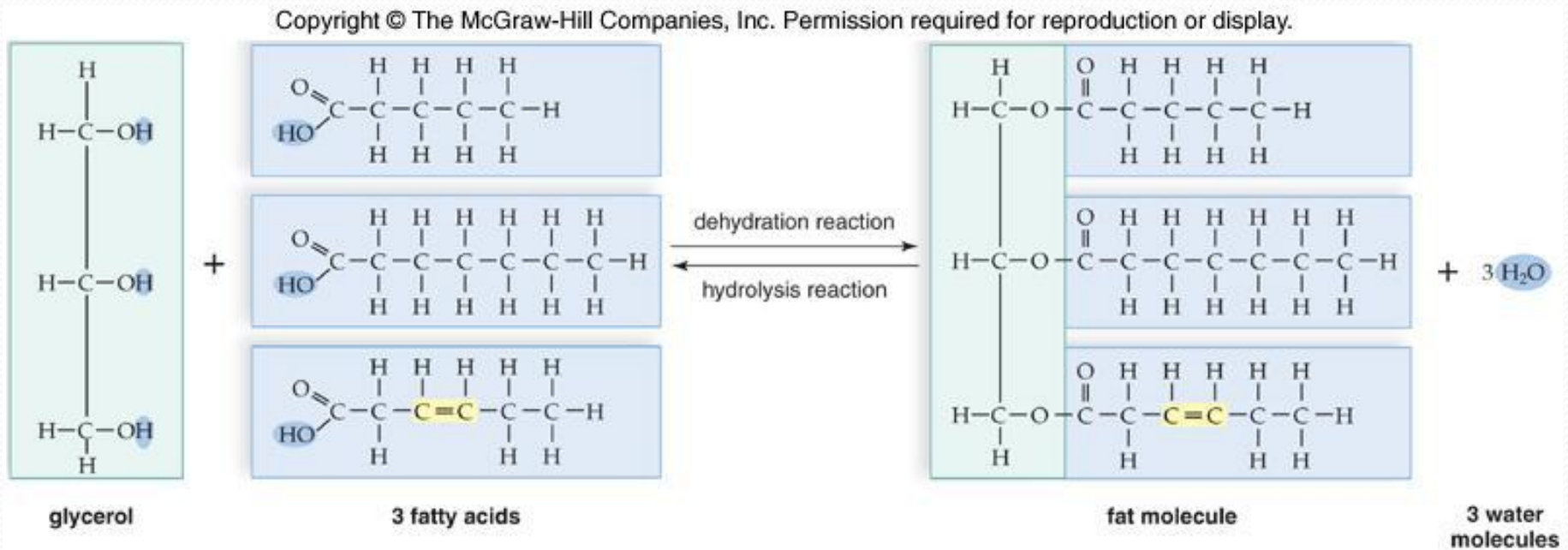
- Contain double bonds
- Liquid at room temperature



Types

2. Triclycerides

- .Neutral Fats
- .Glycerol + 3 Fatty Acids
- .Can be saturated or unsaturated

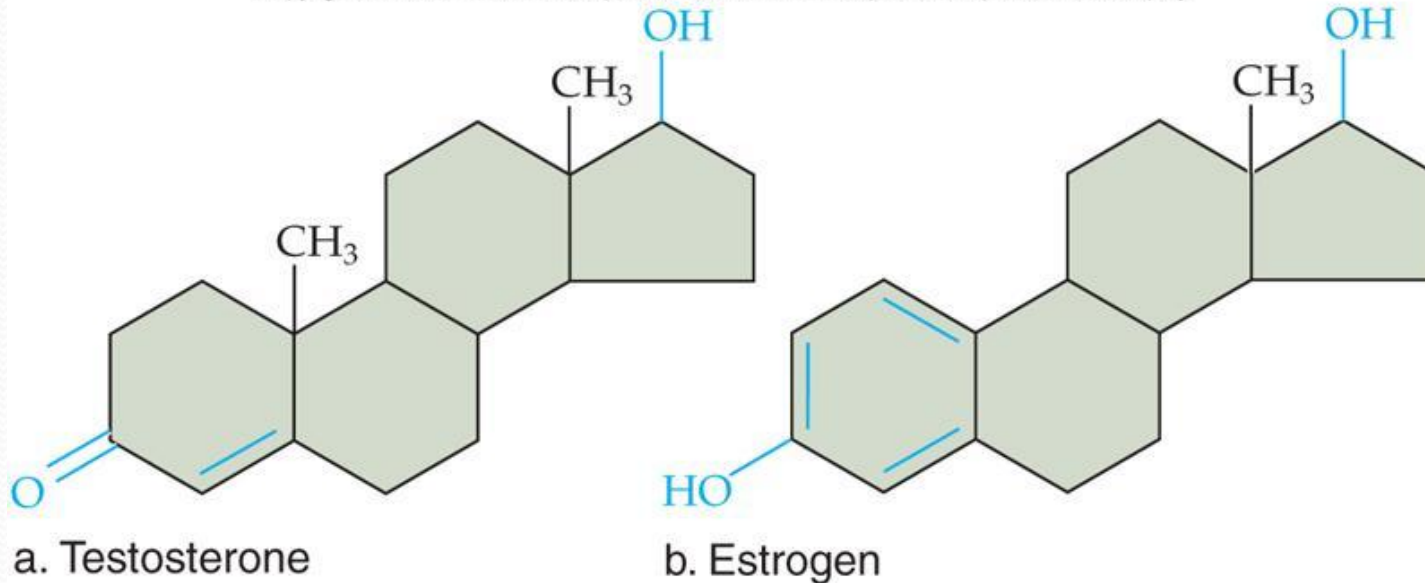


Types

4. Steroids

- Ringed structures made from cholesterol
- Chemical messengers and form hormones
- Ex) Cholesterol, Testosterone, Estrogen

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Proteins

Functions

1. Structure

- Keratin and collagen

2. Movement

- Actin and myosin

3. Enzymes

- Speed up chemical reactions

4. Transport

- Hemoglobin to carry oxygen in blood, proteins across cell membrane

Functions

5. Antibodies

- Fight disease

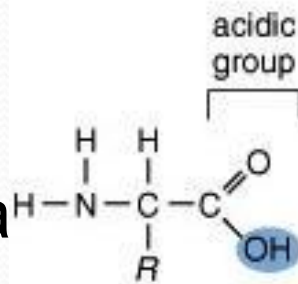
6. Hormones

- Maintain cell function – insulin

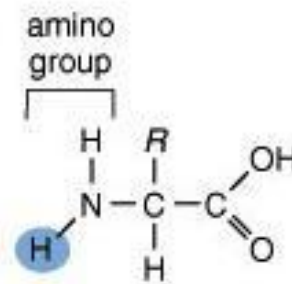
Structure of Proteins

- Made of **Amino Acids**
- Amine (NH_3); Acid (COOH)

• 20 different a



+

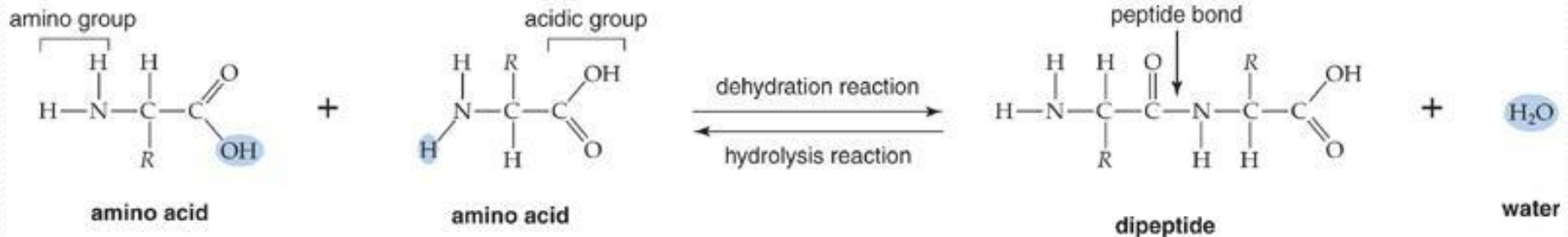


groups

Structure of Proteins

- Amino acids undergo dehydration synthesis to form
- **Dipeptides** (2 amino acids)
- **Polypeptides** (~3-20 amino acids)
- **Proteins** (many amino acids)
- **Peptide bond** is formed (**polar**)

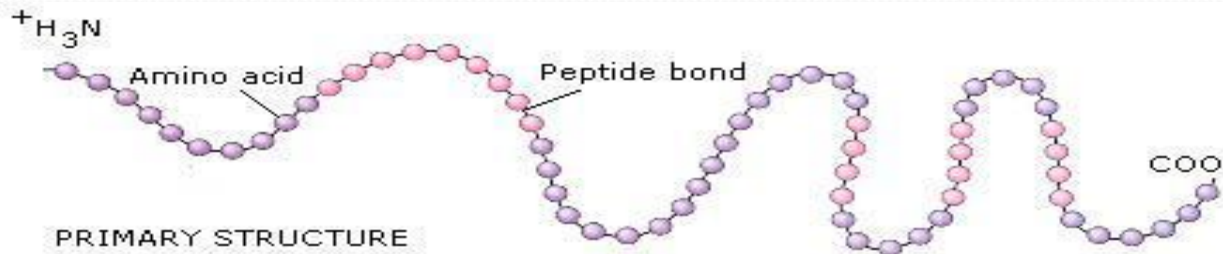
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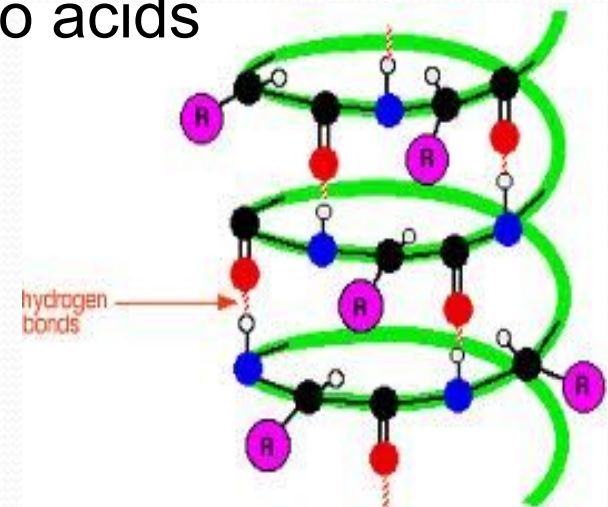
Structure of Proteins (4 Levels)

1. Primary Structure

- Linear sequence of amino acids



- **Hydrogen bonding** between amino acids
- Causes folding
- **Alpha helix** and **beta sheets**



Structure of Proteins (4 Levels)

3. Tertiary Structure

- 3D arrangement of amino acid chain
- Caused by covalent, ionic, and hydrogen bonding between R groups
- Precise shape = specific function

4. Quaternary Structure

- More than one polypeptide chain grouped together

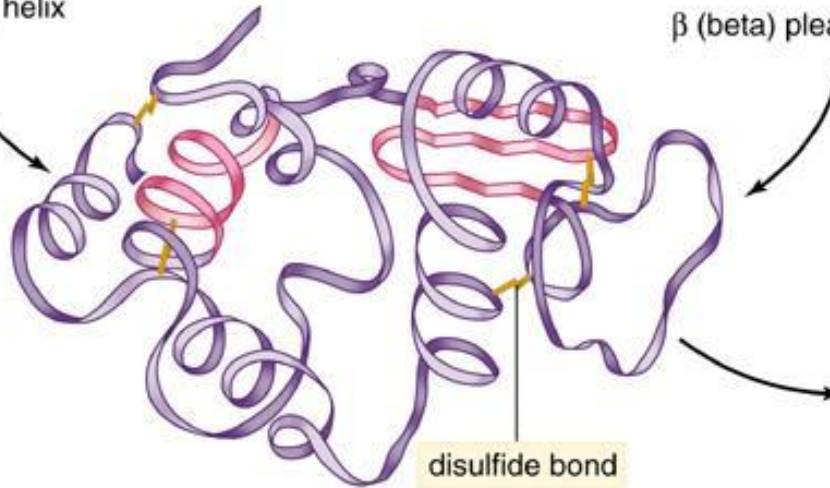
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α (alpha) helix

β (beta) pleated sheet

Tertiary Structure

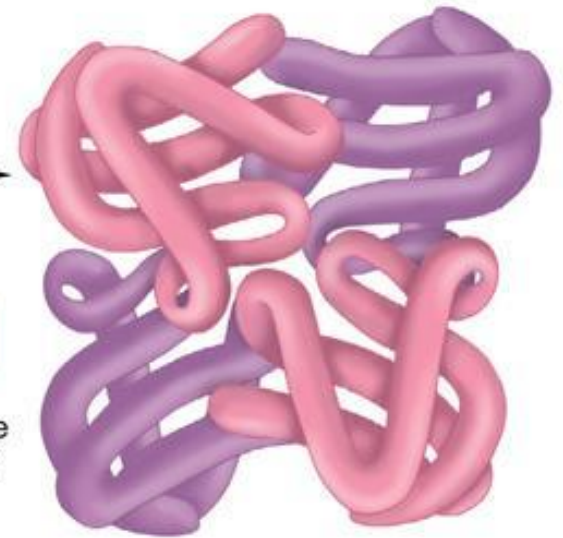
Due in part to covalent bonding between *R* groups the polypeptide folds and twists, giving it a characteristic globular shape.



disulfide bond

Quaternary Structure

This level of structure occurs when two or more polypeptides join to form a single protein.



Denaturing Proteins

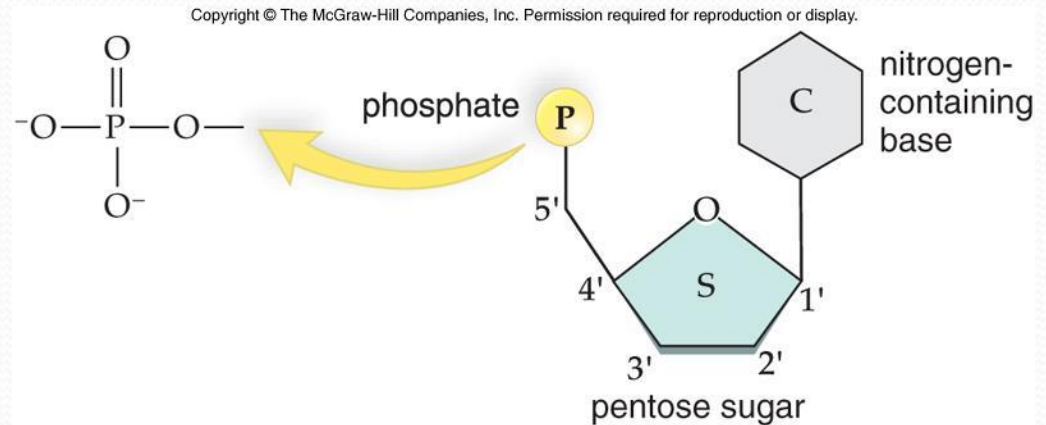
- Cause protein to lose shape = not function
- pH, temperature, chemicals and heavy metals disrupt bonds
- Ex) Heating an egg, adding vinegar to milk

Nucleic Acids

DNA and RNA

DNA

- Deoxyribonucleic acid
- Stores genetic information
- Codes for the order of amino acids in proteins
- Made of nucleotides
- 5 carbon sugar (deoxyribose)
- Phosphate
- Nitrogenous bases
 - Adenine (A)
 - Thymine (T)
 - Cytosine (C)
 - Guanine (G)



Nucleotide structure

DNA Structure

- The sugar and phosphate bond to form a backbone
- Bases stick out and hydrogen bond with a second strand – antiparallel
- Strands wind around in a double helix

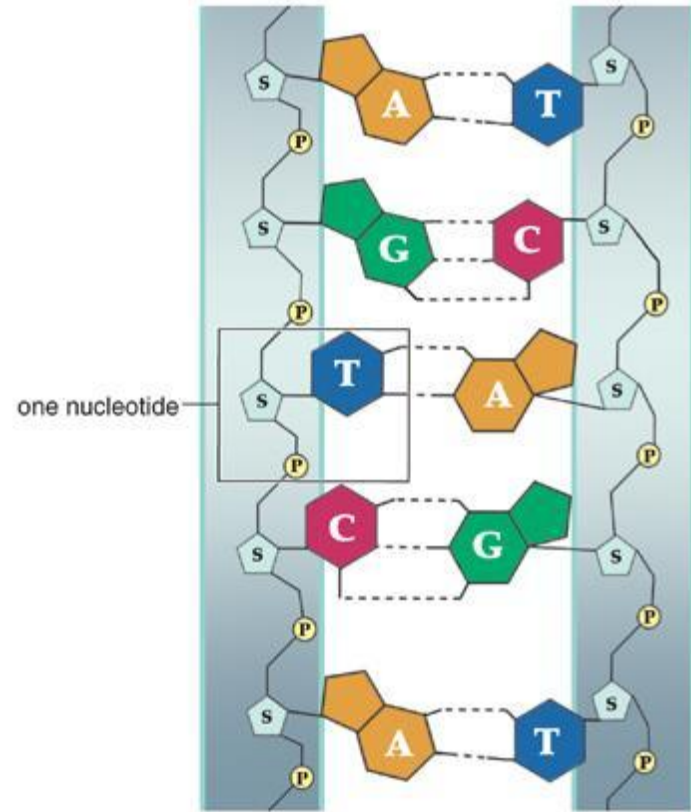
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a.



b.



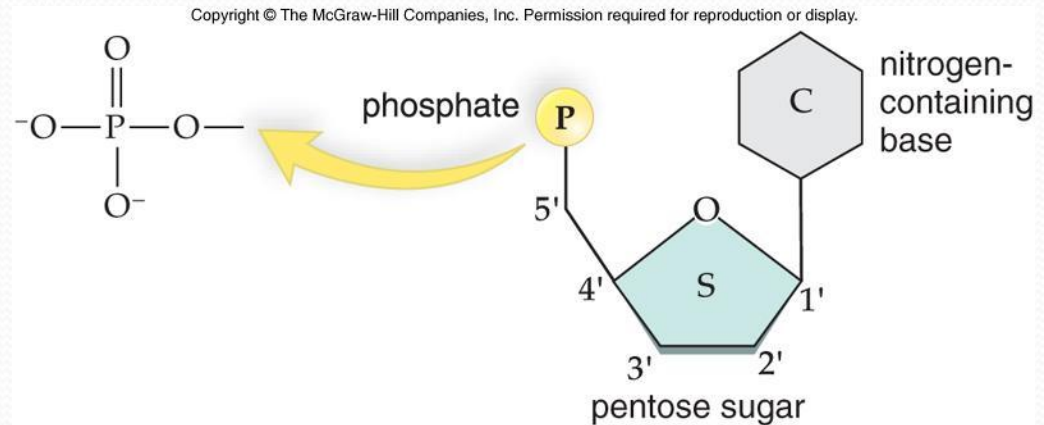
one nucleotide

c.

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RNA

- Ribonucleic acid
- Helps in protein synthesis
- Made of nucleotides
- 5 carbon sugar (ribose)
- Phosphate
- Nitrogenous bases
- Adenine (A)
- Uracil (U)
- Cytosine (C)
- Guanine (G)
- Single stranded



Nucleotide structure

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TABLE 2.1 **DNA Structure Compared to RNA Structure**

	DNA	RNA
Sugar	Deoxyribose	Ribose
Bases	Adenine, guanine, thymine, cytosine	Adenine, guanine, uracil, cytosine
Strands	Double stranded with base pairing	Single stranded
Helix	Yes	No

ATP

- Adenosine Triphosphate
- Molecule of ENERGY
- Energy is released during hydrolysis

