

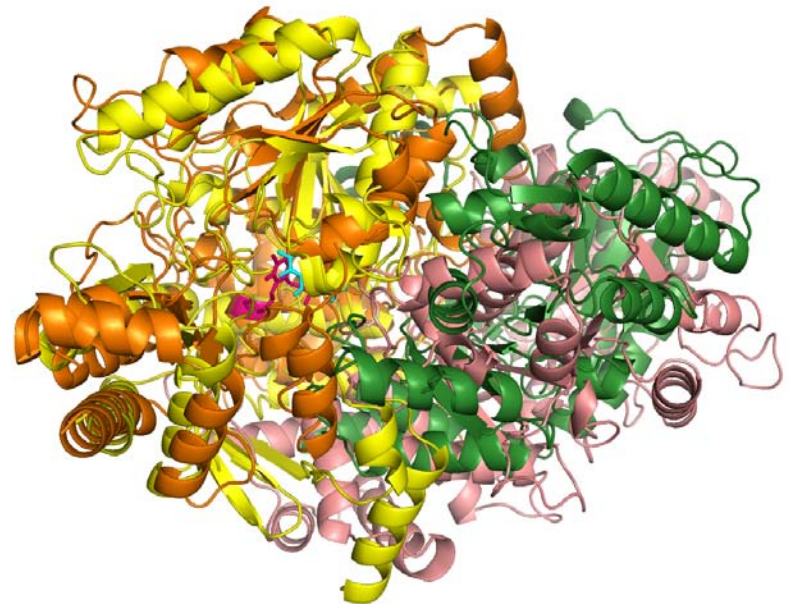
# The Structure and Function of Biomolecules



The student is expected to:

**TEKS**

**9A compare the structures and functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids**



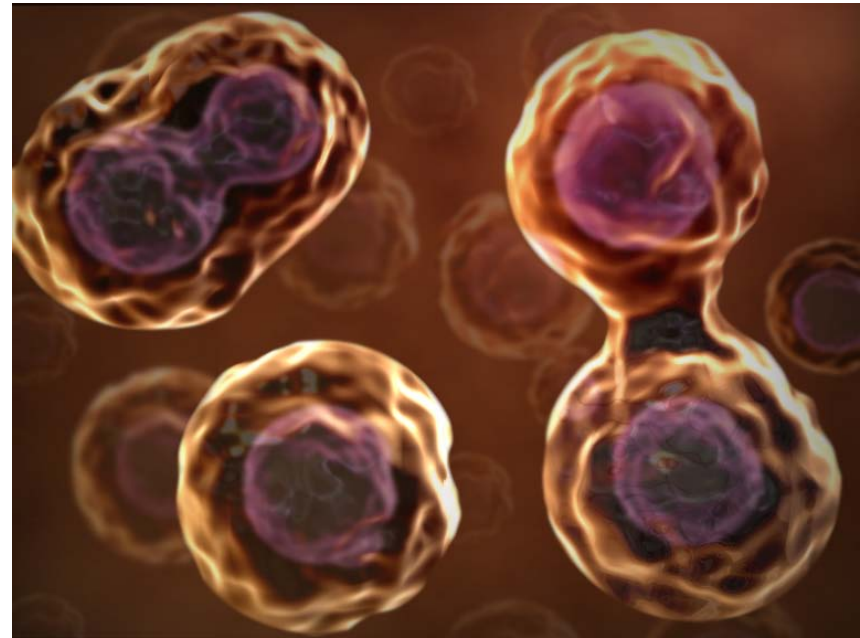
## KEY CONCEPT

**Carbon-based molecules are the foundation of life.**



# Humans use food for:

1. Energy
2. Growth of new cells and the repair of existing cells, tissues, organs, etc.



# What is Food made up of?

- Six chemical elements: C, H, O, N, P, S
- Salts Na, Mg, Cl, K, Ca
- Three trace elements: Fe, Cu, Zn

% of elements in the human body

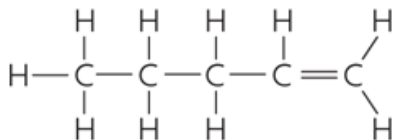


■ Oxygen    ■ Carbon    ■ Hydrogen    ■ Nitrogen    ■ Calcium  
■ Phosphorous    ■ Potassium    ■ Sodium    ■ Other

# Carbon atoms have unique bonding properties.

- Carbon forms covalent bonds with up to four other atoms, including other carbon atoms.
- Carbon-based molecules have three general types of structures.
  - straight chain
  - branched chain
  - ring

Straight chain

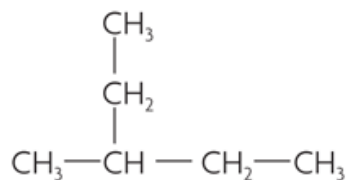


A simplified structure can also be shown as:



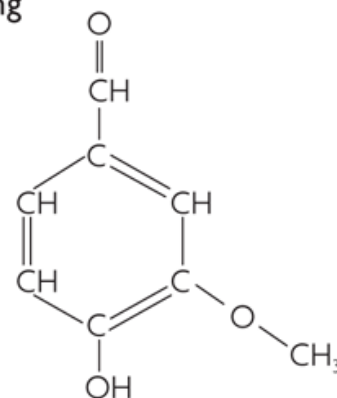
Pentene

Branched chain



Hexane

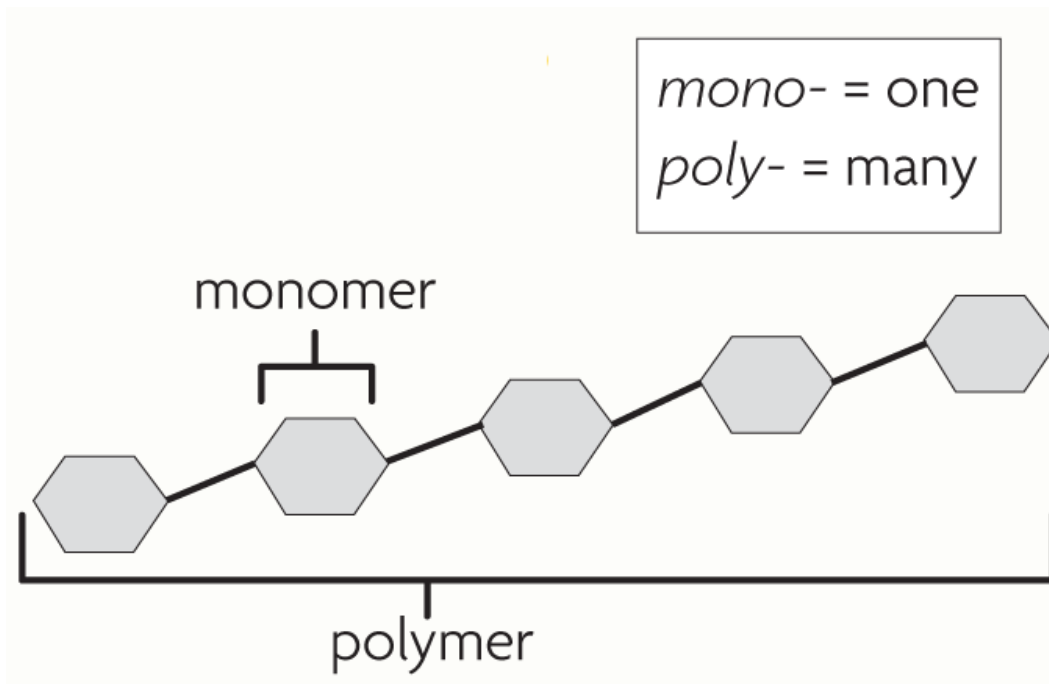
Ring



Vanillin

# Many carbon-based molecules are made of many small subunits bonded together.

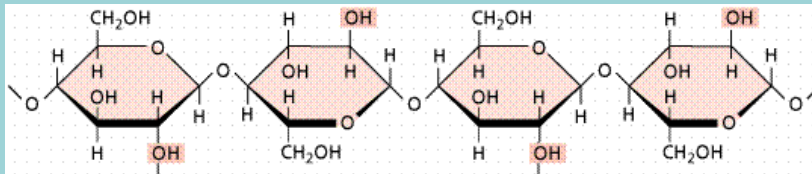
- Monomers are the individual subunits.
- Polymers are made of many monomers.



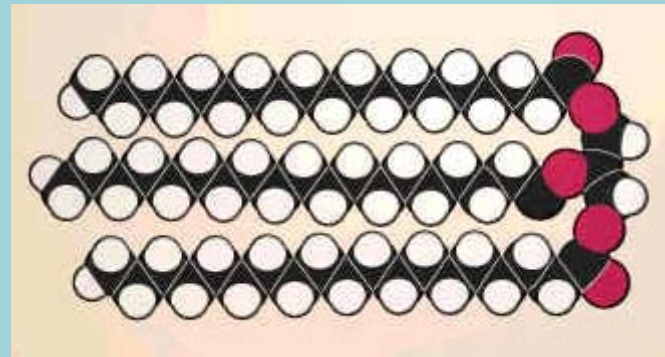


# Four main types of carbon-based molecules are found in living things.

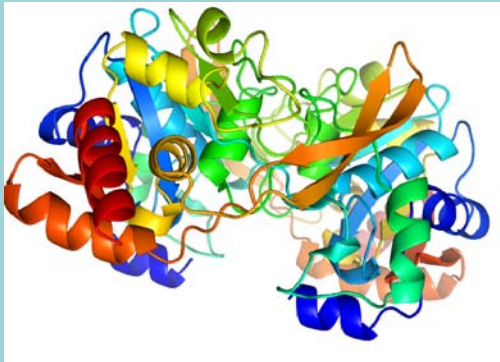
## 1. Carbohydrates



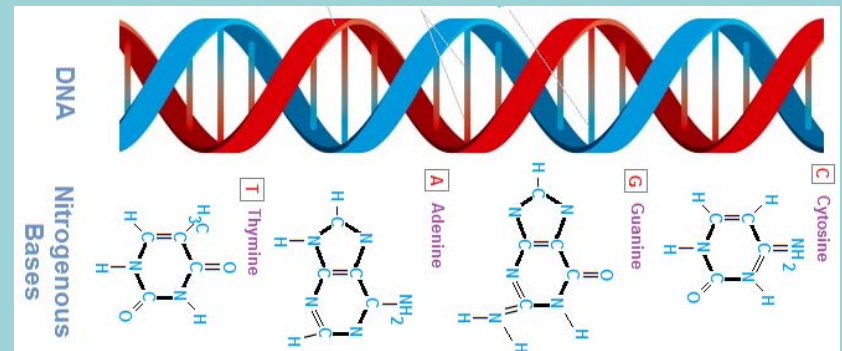
## 2. Lipids



## 3. Proteins



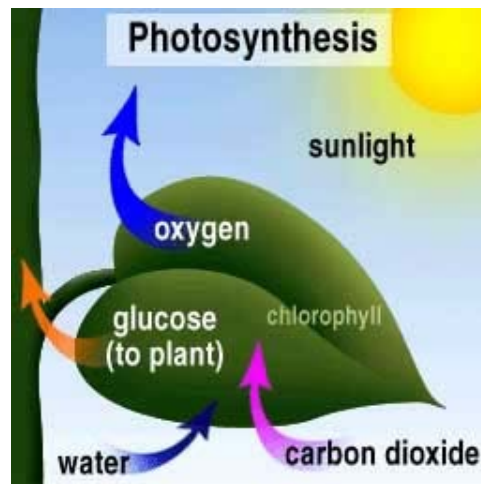
## 4. Nucleic Acids





# Types of Carbohydrates

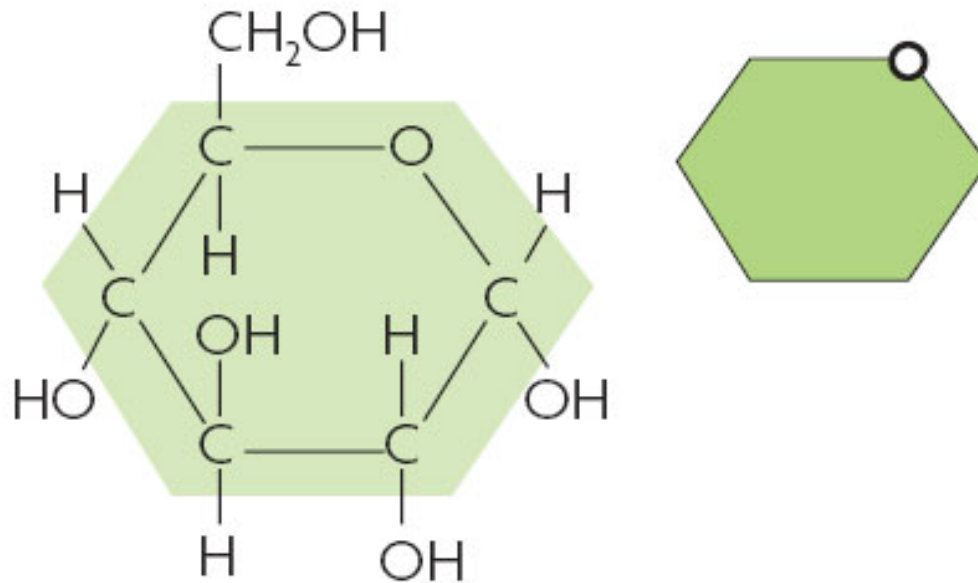
- Carbohydrates include sugars and starches.
- Monosaccharides are simple sugars.
- Polysaccharides include starches, cellulose, and glycogen.



Glucose is a carbohydrate!

# Structure of Carbohydrates

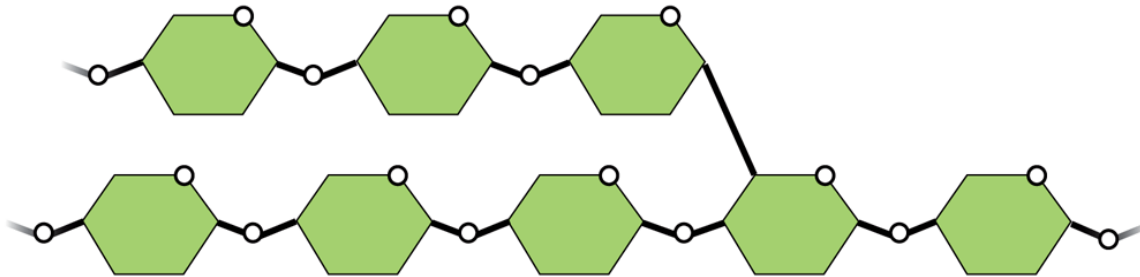
Carbohydrates are made of carbon, hydrogen, and oxygen.



Glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) can be ring shaped and is often shown as a simplified hexagon.

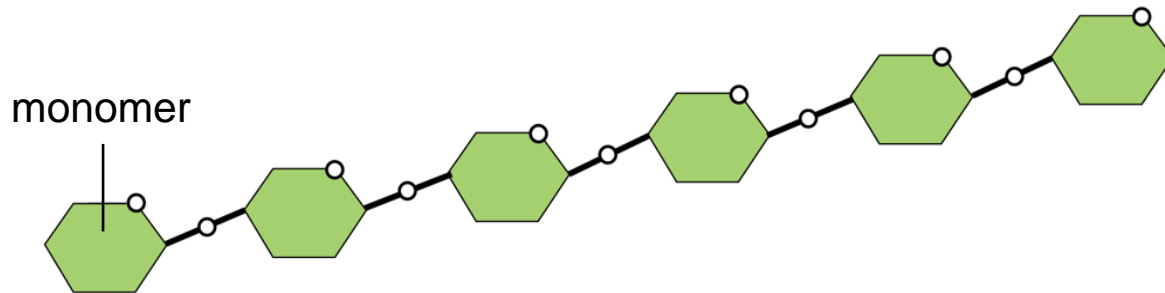
# Structure of Carbohydrates

Polymer (starch)



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

Polymer (cellulose)



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

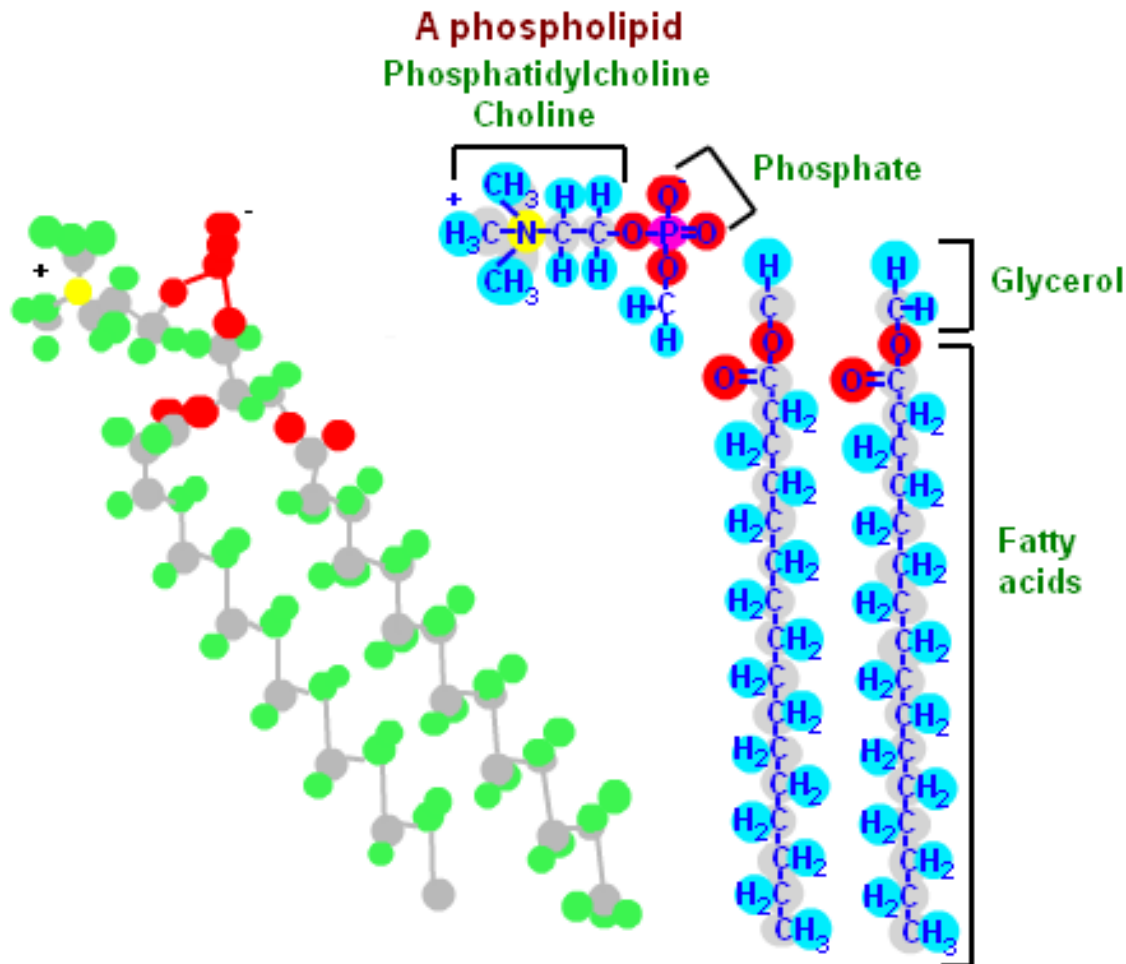
# Functions of Carbohydrates

- Carbohydrates can be broken down to provide energy for cells.
- Some carbohydrates are part of cell structure.
- Carbohydrates are also used for short-term energy storage.



# Structure of Lipids

- Lipids are made of the elements carbon, hydrogen, oxygen and phosphorus.



# Structure of Lipids

- Lipids are nonpolar molecules that include fats, oils, and cholesterol.
  - Many contain carbon chains called fatty acids.
  - Fats and oils contain fatty acids bonded to glycerol.

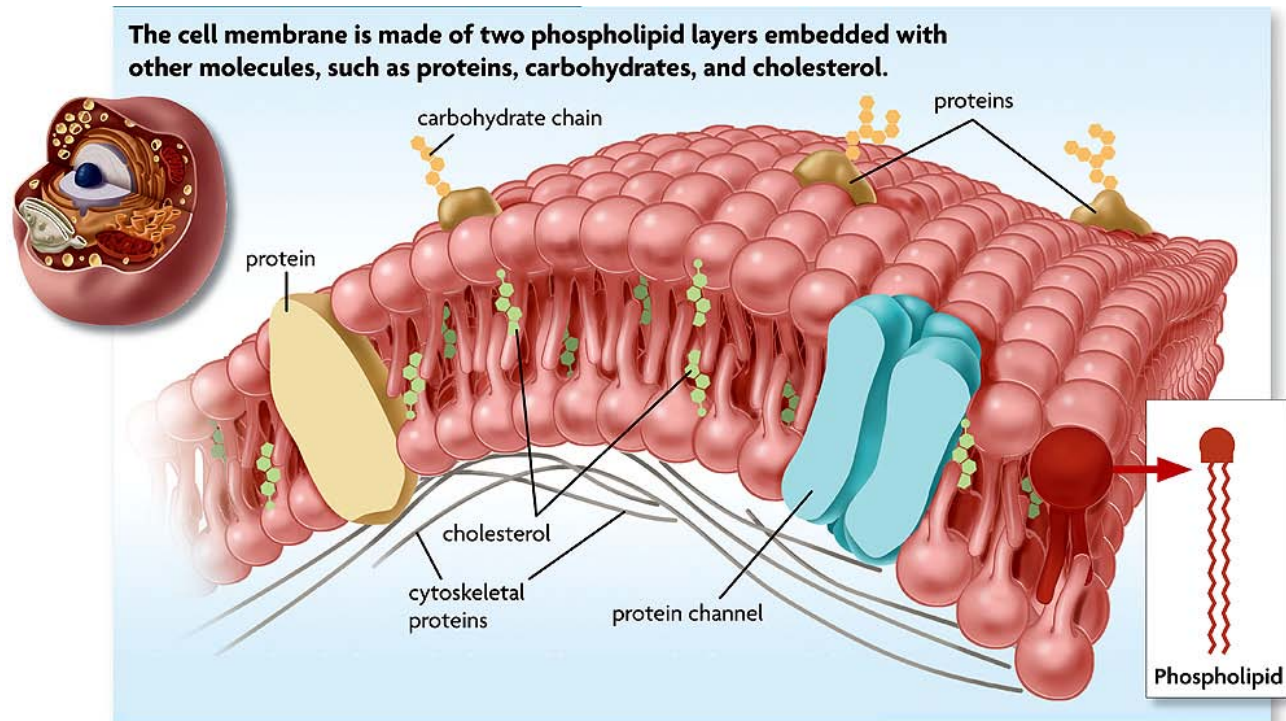
Triglyceride





# Lipids have several different functions.

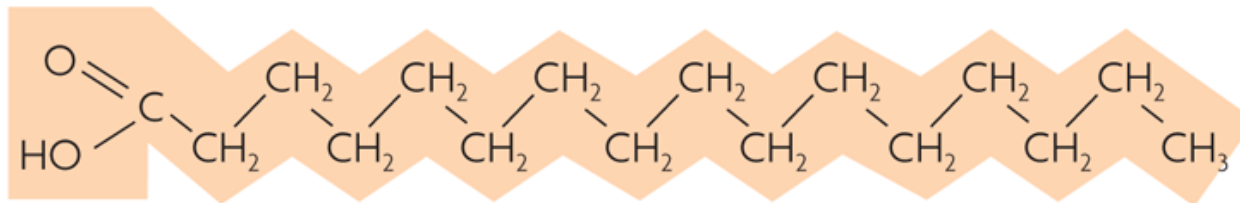
- broken down as a source of energy
- Store large amounts of energy long term
- make up cell membranes and other biological membranes
- used to make hormones



# Types of Lipids

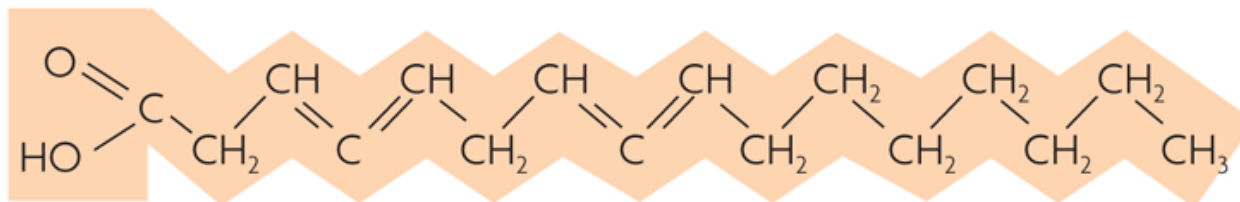
- Fats and oils have different types of fatty acids.
  - saturated fatty acids
  - unsaturated fatty acids

Saturated fatty acid



Saturated fats contain fatty acids in which all carbon–carbon bonds are single bonds.

Unsaturated fatty acid



Unsaturated fats have fatty acids with at least one carbon–carbon double bond.

# Examples of Lipids

- Phospholipids make up all cell membranes.

Phospholipid

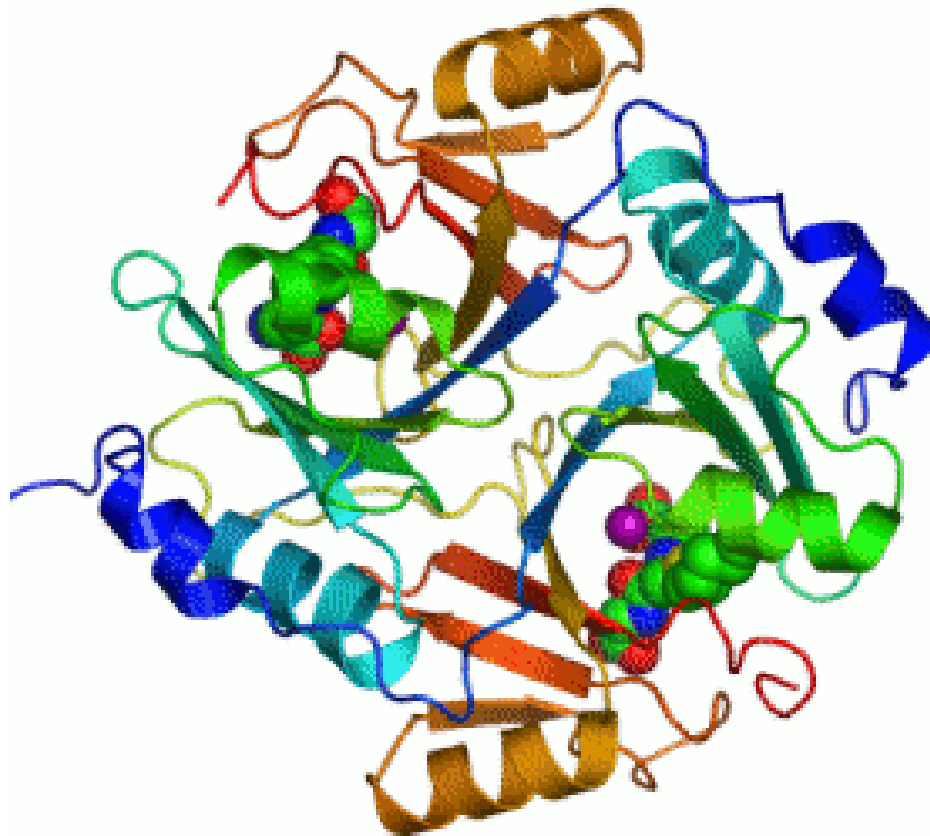


- Fats
- Oils
- Waxes
- Cholesterol



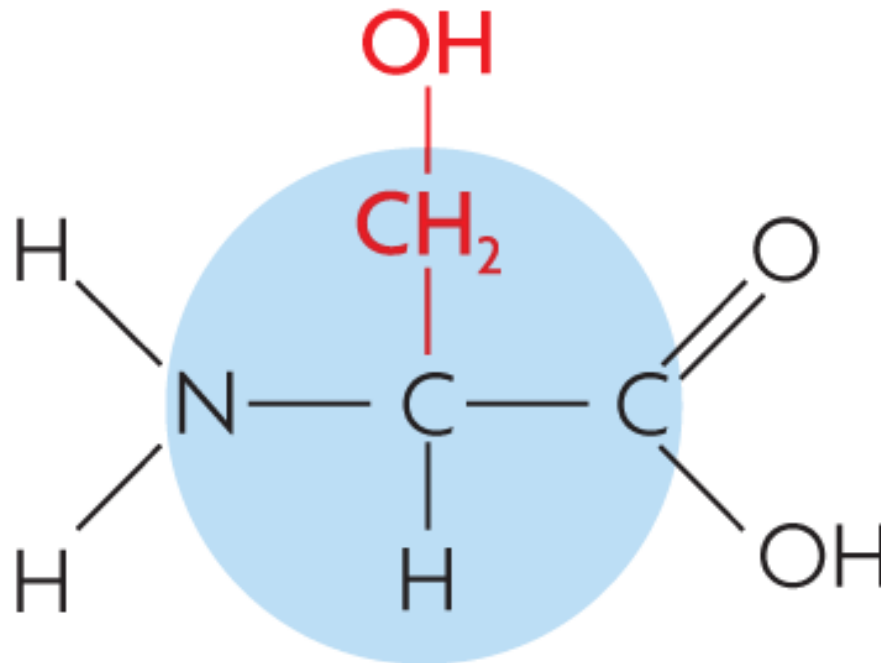
# Structure of Proteins

- Proteins are made of the elements carbon, hydrogen, oxygen, nitrogen and sulfur.



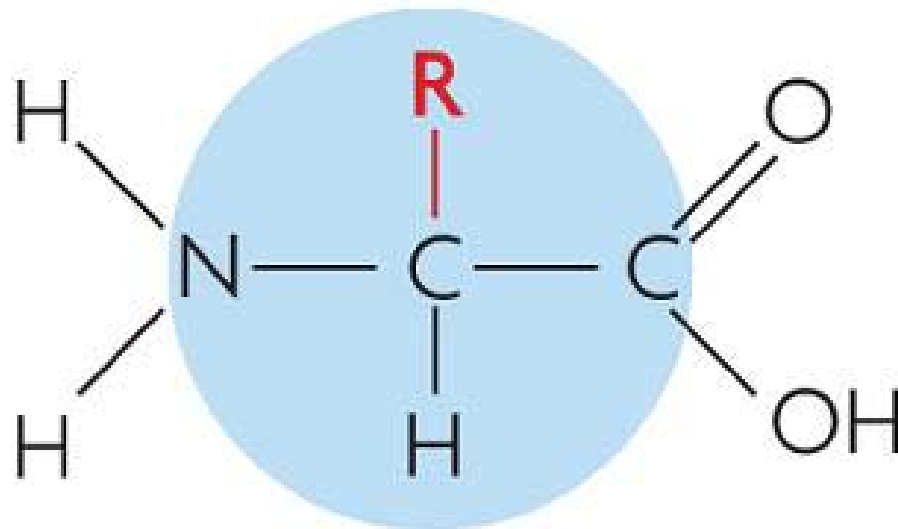
# Structure of Proteins

- Proteins are polymers of amino acid monomers.
  - Twenty different amino acids are used to build proteins in organisms.



# Structure of Proteins

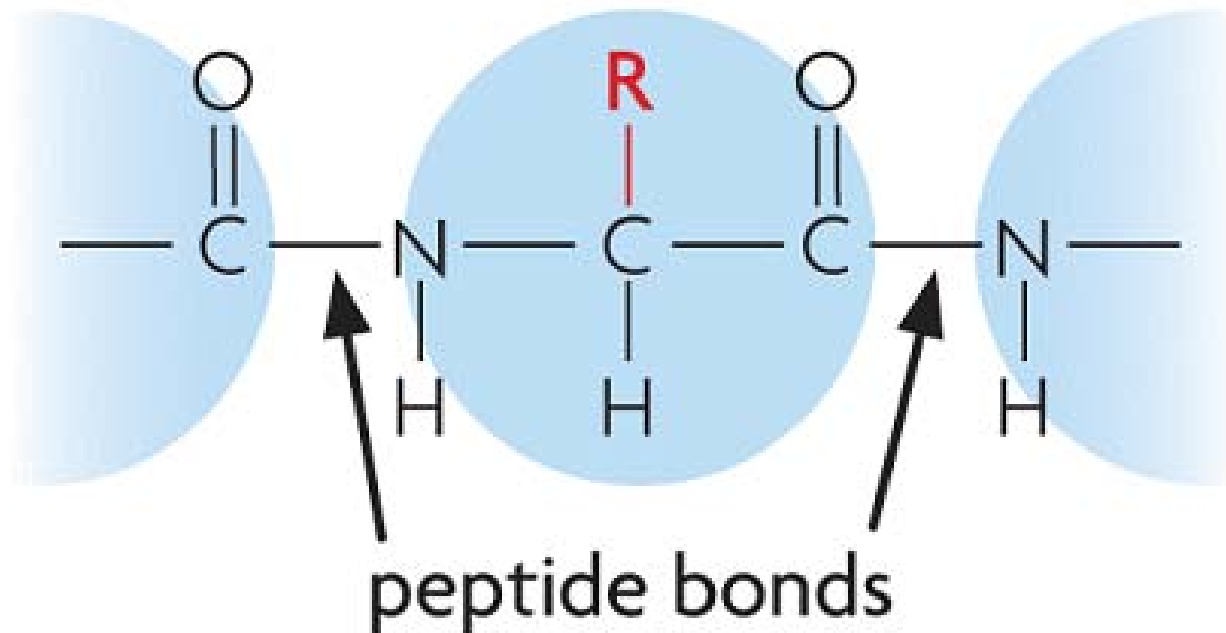
- Proteins are polymers of amino acid monomers.
  - Twenty different amino acids are used to build proteins in organisms.
  - Amino acids differ in side groups, or R groups.





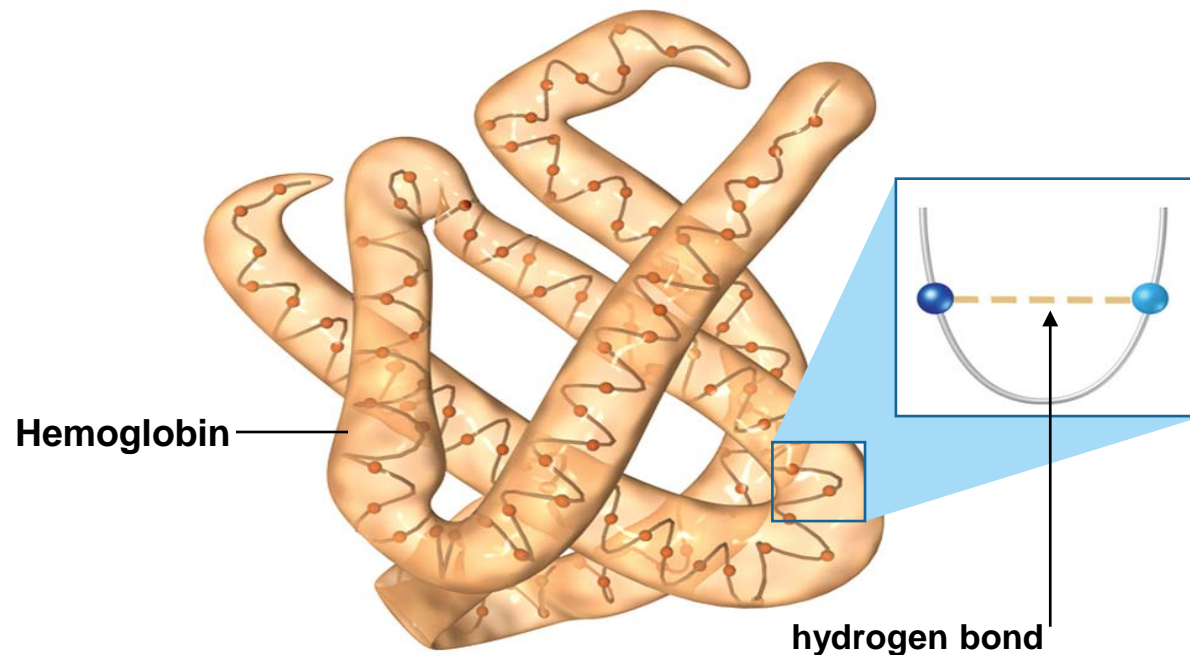
# Structure of Proteins

- Proteins are polymers of amino acid monomers.
  - Twenty different amino acids are used to build proteins in organisms.
  - Amino acids differ in side groups, or R groups.
  - Amino acids are linked by peptide bonds.



# Structure of Proteins

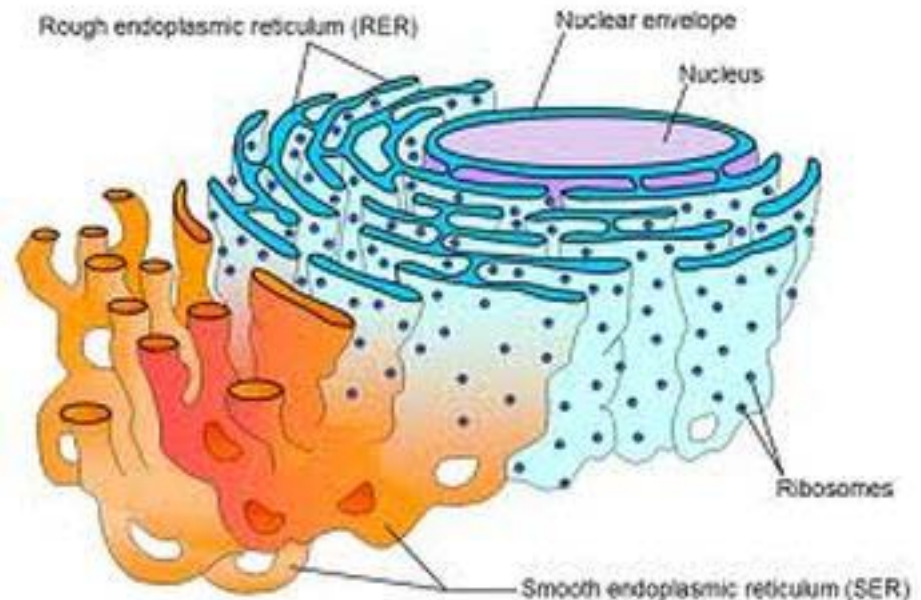
- Proteins differ in the number and order of amino acids.
  - Amino acids interact to give a protein its shape.



- Incorrect amino acids change a protein's structure and function.

# Function of Proteins

- regulate cell and body processes
- build cell structures
- building blocks of structures in organisms
- proteins called enzymes regulate chemical reactions in cells



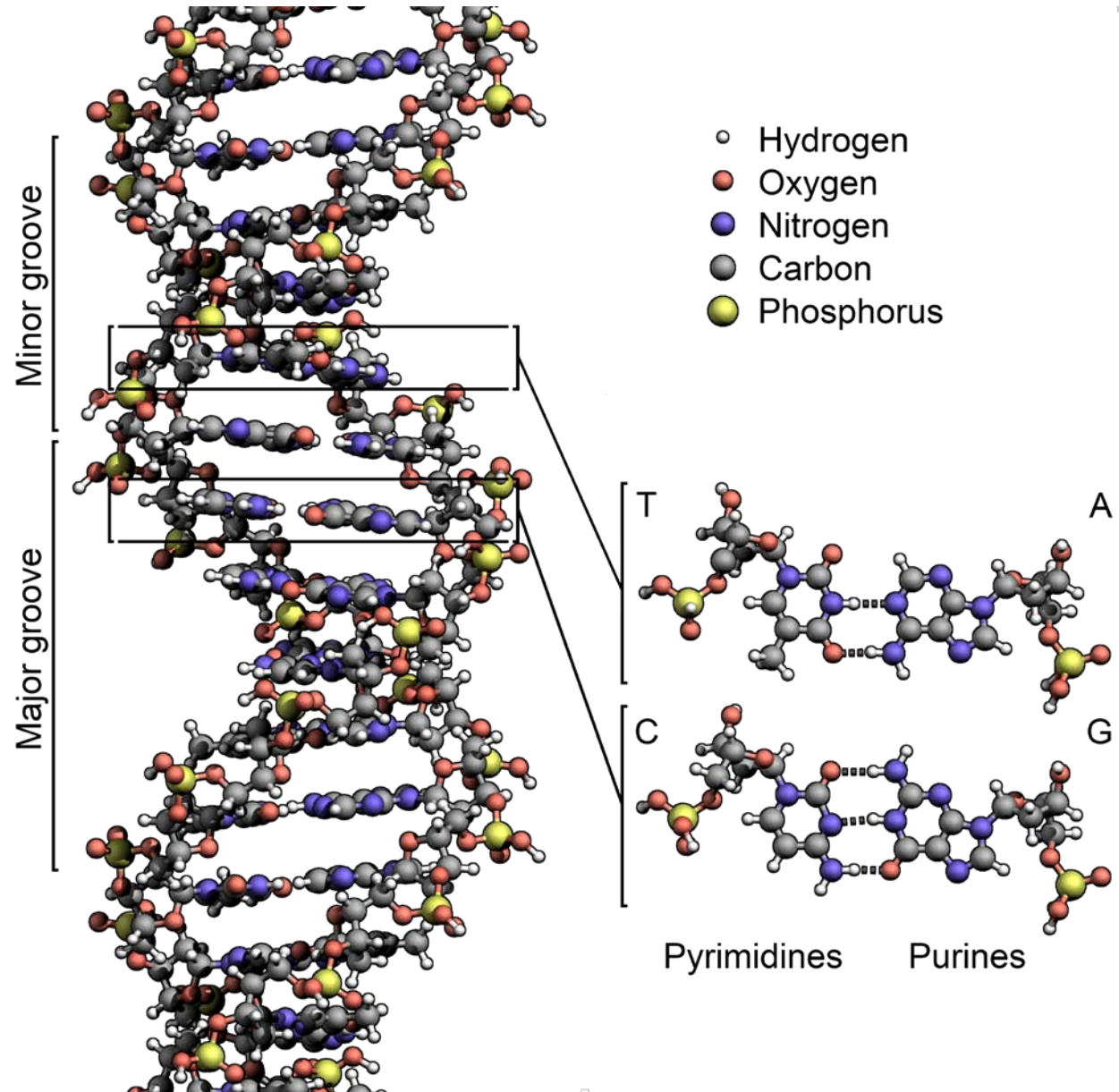
# Examples of Proteins

- enzymes
- skin
- hair
- connective tissues
- hemoglobin
- fibers in muscle tissue
- hormones



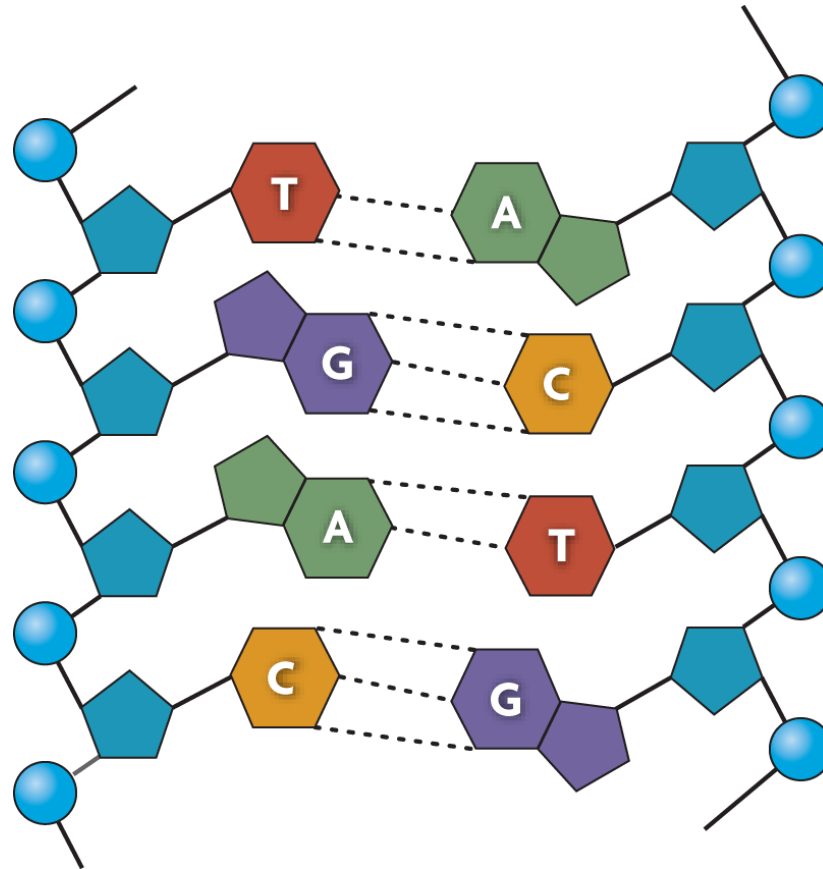
# Structure of Nucleic Acids

Nucleic acids are made of the elements carbon, hydrogen, oxygen, nitrogen and phosphorus.



# Structure of Nucleic Acids

- Nucleic acids are polymers of monomers called nucleotides.



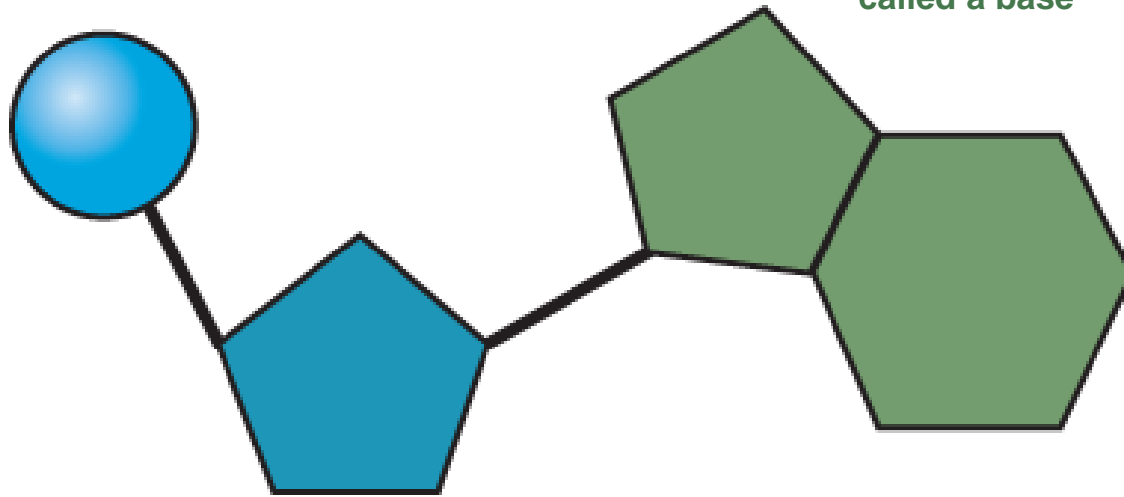


# Structure of Nucleic Acids

- Nucleic acids are polymers of monomers called nucleotides.
  - Nucleotides are made of a sugar, phosphate group, and a nitrogen base.

A phosphate group

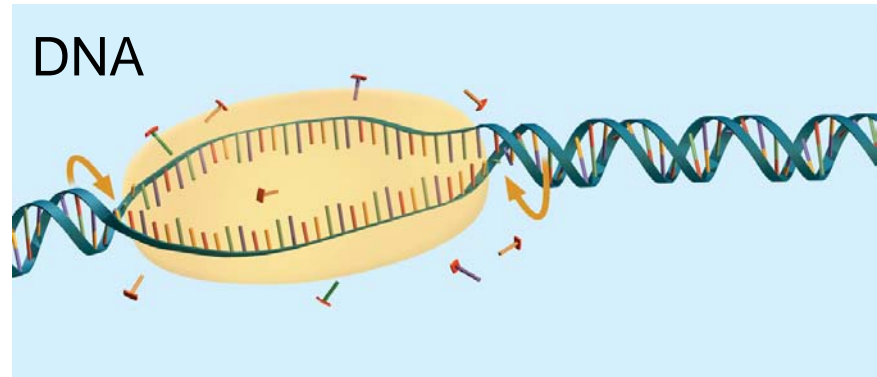
nitrogen-containing molecule,  
called a base



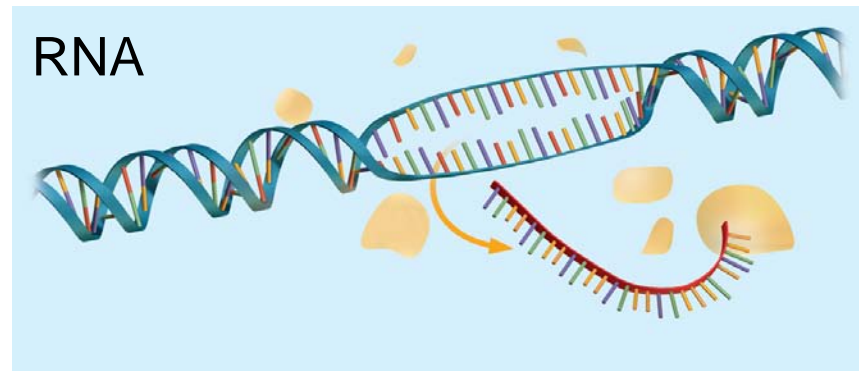
deoxyribose (sugar)

# Types and Functions of Nucleic Acids

- DNA stores genetic information.



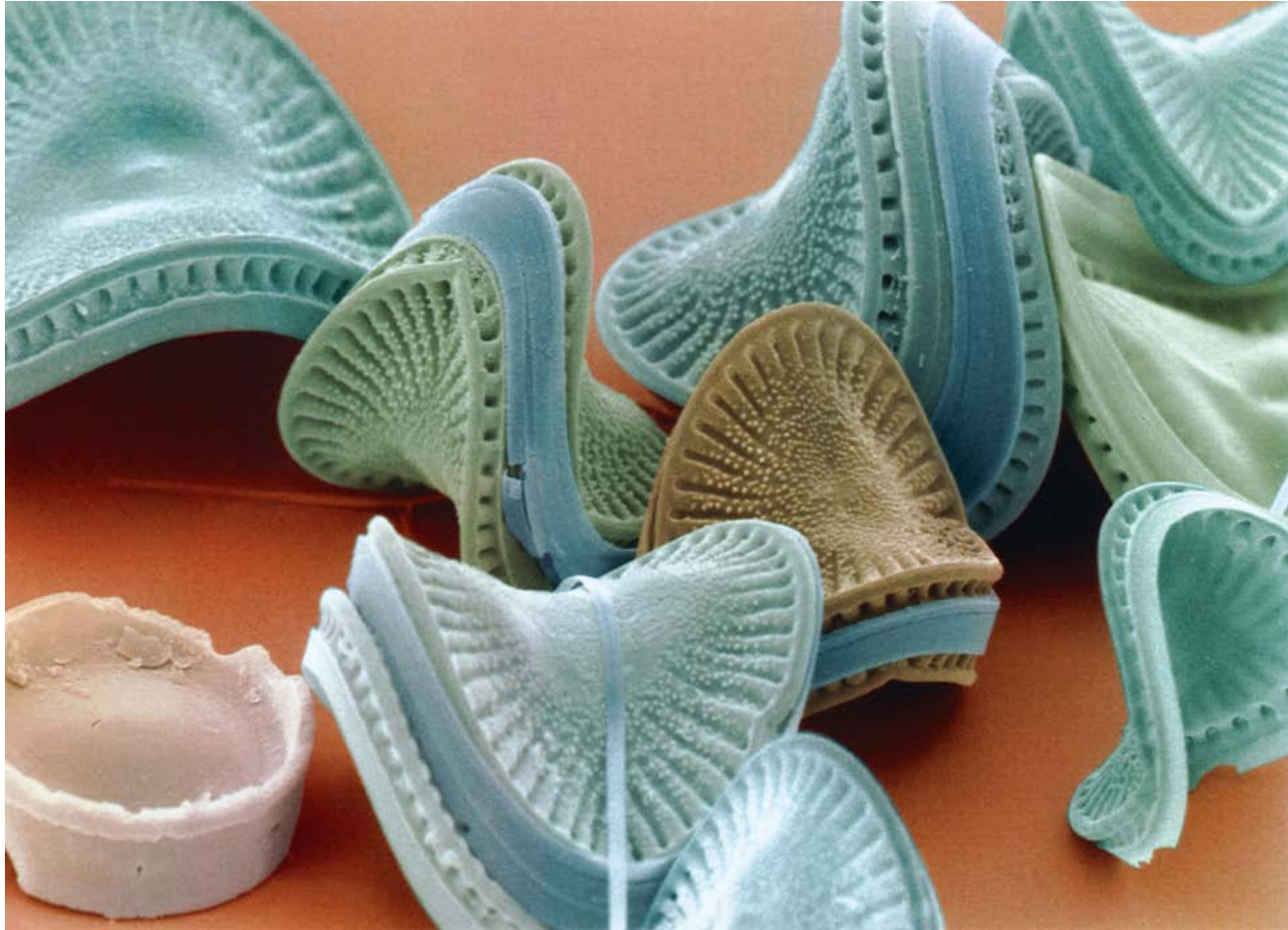
- RNA builds proteins.



**Nucleic acids are NOT used for energy!**

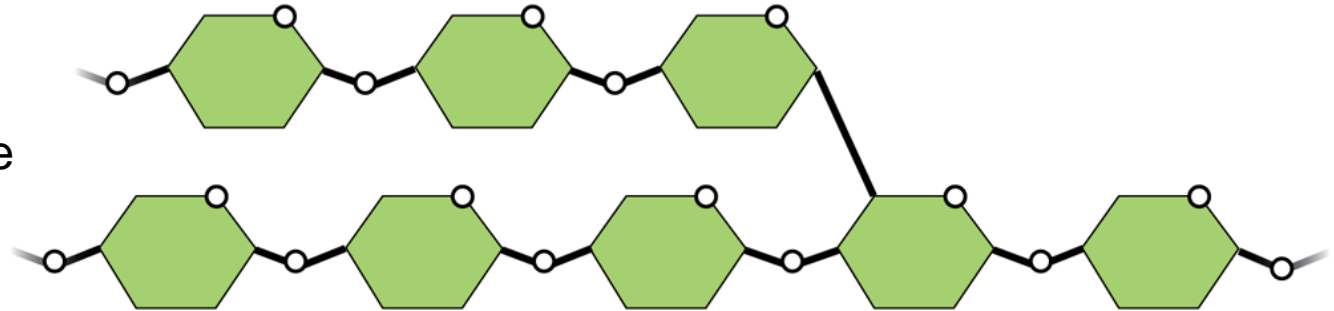
## KEY CONCEPT

**All cells need chemical energy.**

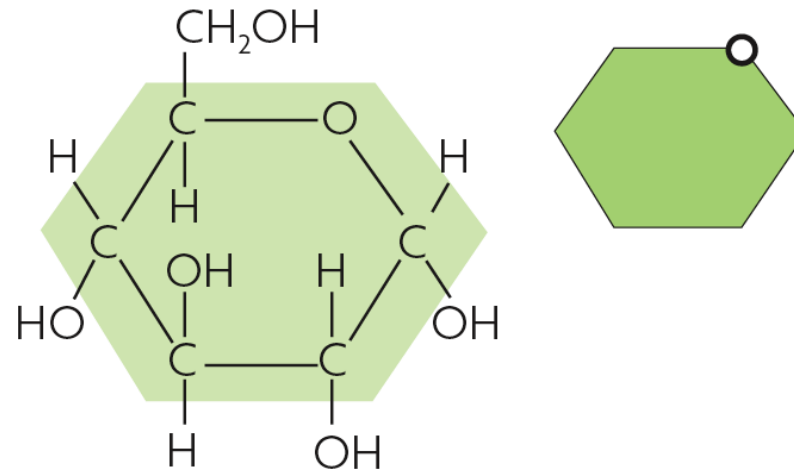


# Molecules in food store chemical energy in their bonds.

Starch molecule



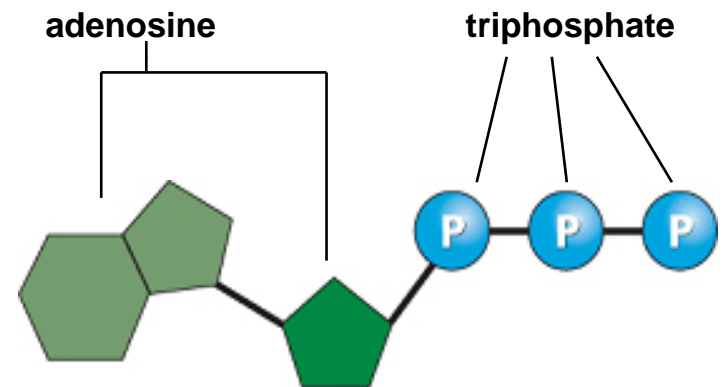
Glucose molecule



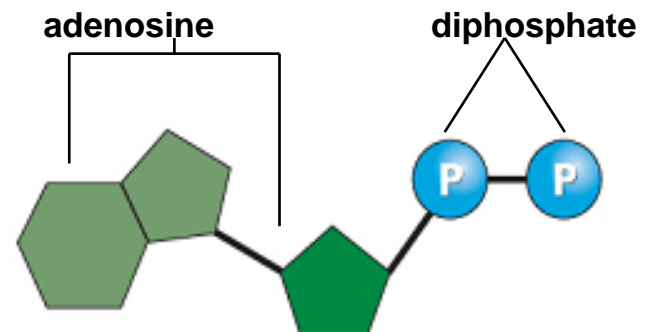
# Organisms break down carbon-based molecules to produce ATP.

- Carbohydrates are the molecules most commonly broken down to make ATP.
  - not stored in large amounts
  - up to 36 ATP from one glucose molecule

tri=3

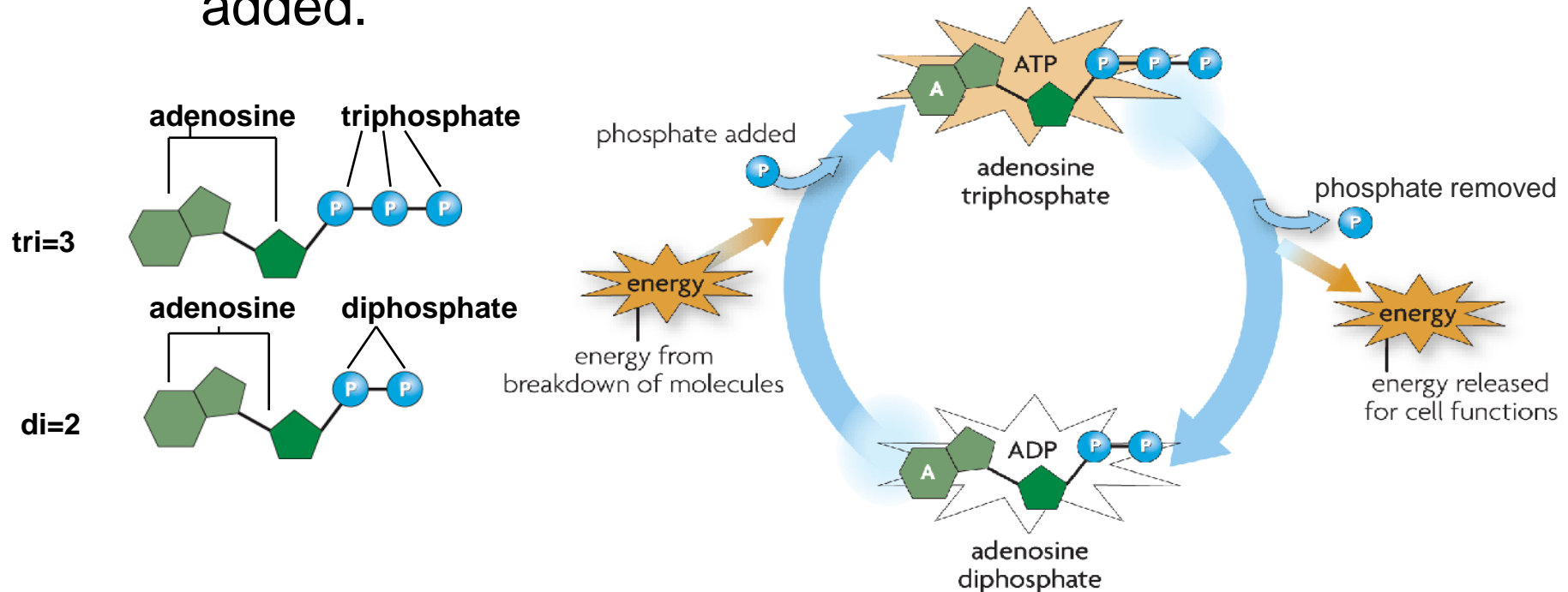


di=2



# The chemical energy used for most cell processes is carried by ATP.

- ATP transfers energy from the breakdown of food molecules to cell functions.
  - Energy is released when a phosphate group is removed.
  - ADP is changed into ATP when a phosphate group is added.





# Fats give you the most energy NOT carbohydrates and proteins!

- Fats store the most energy.
  - 80 percent of the energy in your body
  - about 146 ATP from a triglyceride
- Proteins are least likely to be broken down to make ATP.
  - amino acids are not usually needed for energy
  - about the same amount of energy as a carbohydrate

MOLECULE	ENERGY
Carbohydrate	4 calories per mg
Lipid	9 calories per mg
Protein	4 calories per mg