Introduction to Biochemistry

MACROMOLECULES

Building Blocks

All large molecules (macromolecules) in our bodies are created from monomers. The building and deconstruction of these macromolecules are done by two processes.

Dehydration Synthesis

Simply put, we take small things and make one big thing.

Dehydration = removing water

Synthesis = put together

Hydrolysis

Simply put, we use water to break a big thing apart.

Hydro = water

lysis = break apart

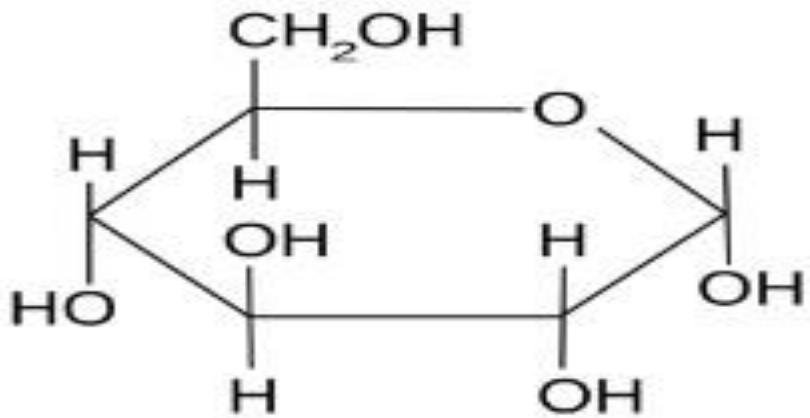
CARBOHYDRATES

Structure

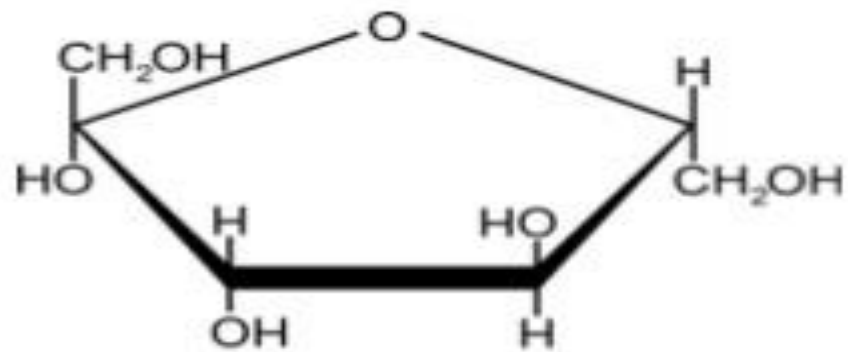
The building blocks of carbohydrates are **monosaccharides**.

All carbohydrates follow the generic formula of $C_nH_{2n}O_n$

Examples of monosaccharides include:



Glucose ($C_6H_{12}O_6$)

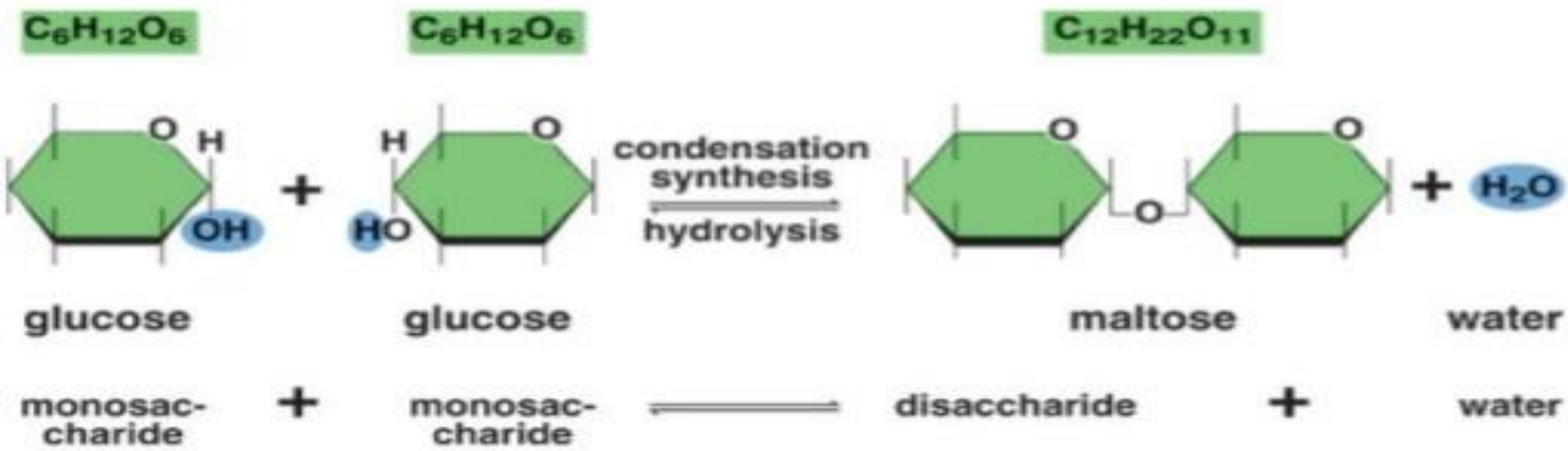


Fructose ($C_6H_{12}O_6$)

CARBOHYDRATES

Polymers

Disaccharides: When two monosaccharides are joined together in a dehydration synthesis reaction they form a disaccharide.



CARBOHYDRATES

Polymers

Examples of Disaccharides:

Maltose = Glucose + Glucose

Sucrose = Glucose + Fructose

Lactose = Glucose + Galactose

CARBOHYDRATES

Polymers

Polysaccharide: When very long chains of monosaccharides are arranged into a complex molecule we call this a polysaccharide.

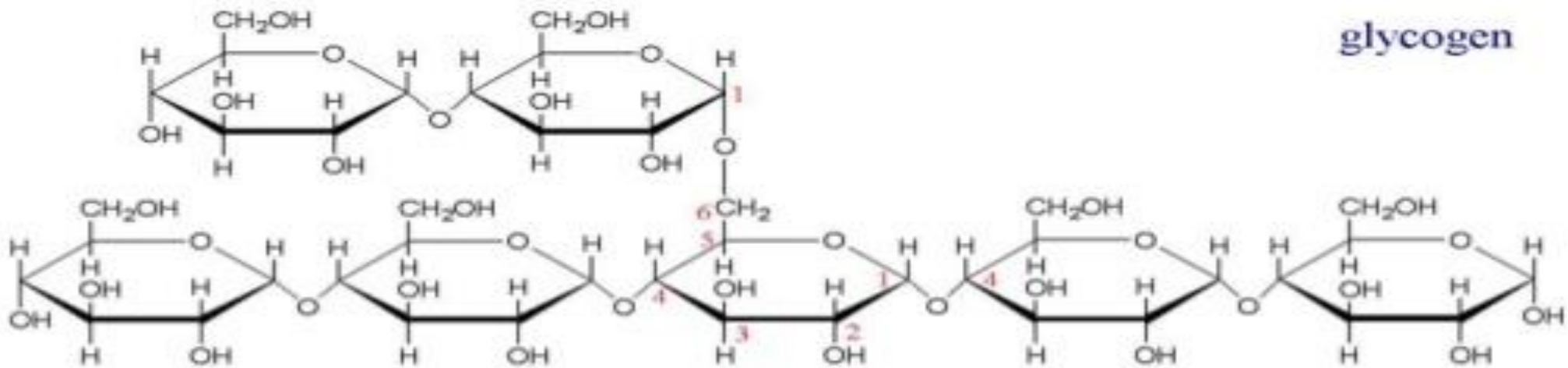
Polysaccharides have different structures and functions depending on the monomers that produce them.

CARBOHYDRATES

Polymers

Glycogen: Produced when very long chains of the monomer glucose are bonded together.

Function: Long term energy storage in animals.



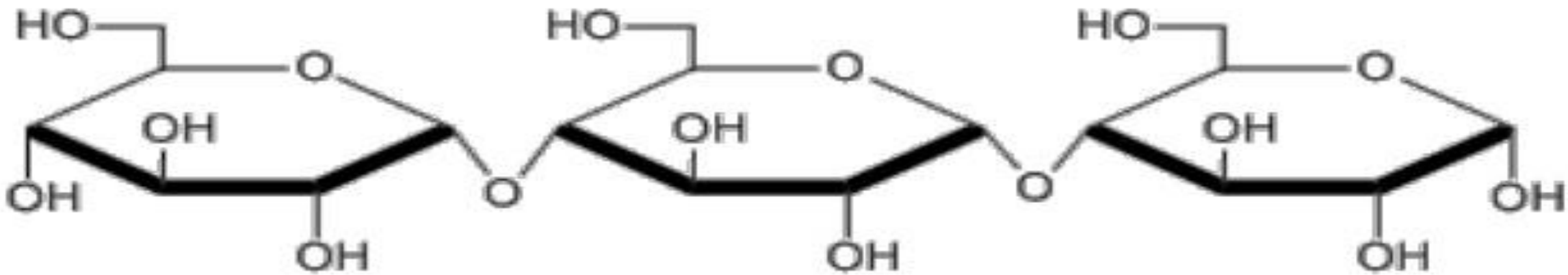
glycogen

CARBOHYDRATES

Polymers

Starch: Produced when very long chains of the monomer glucose are bonded together.

Function: Long term energy storage in plants.

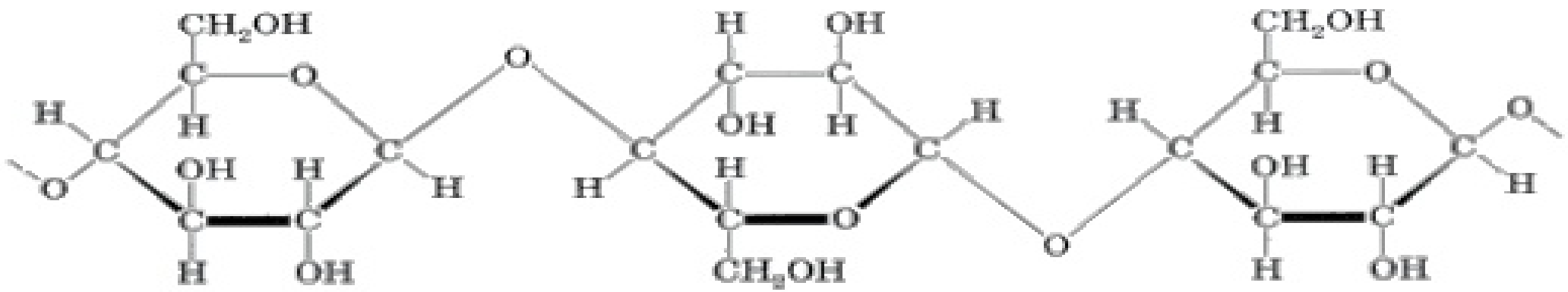


CARBOHYDRATES

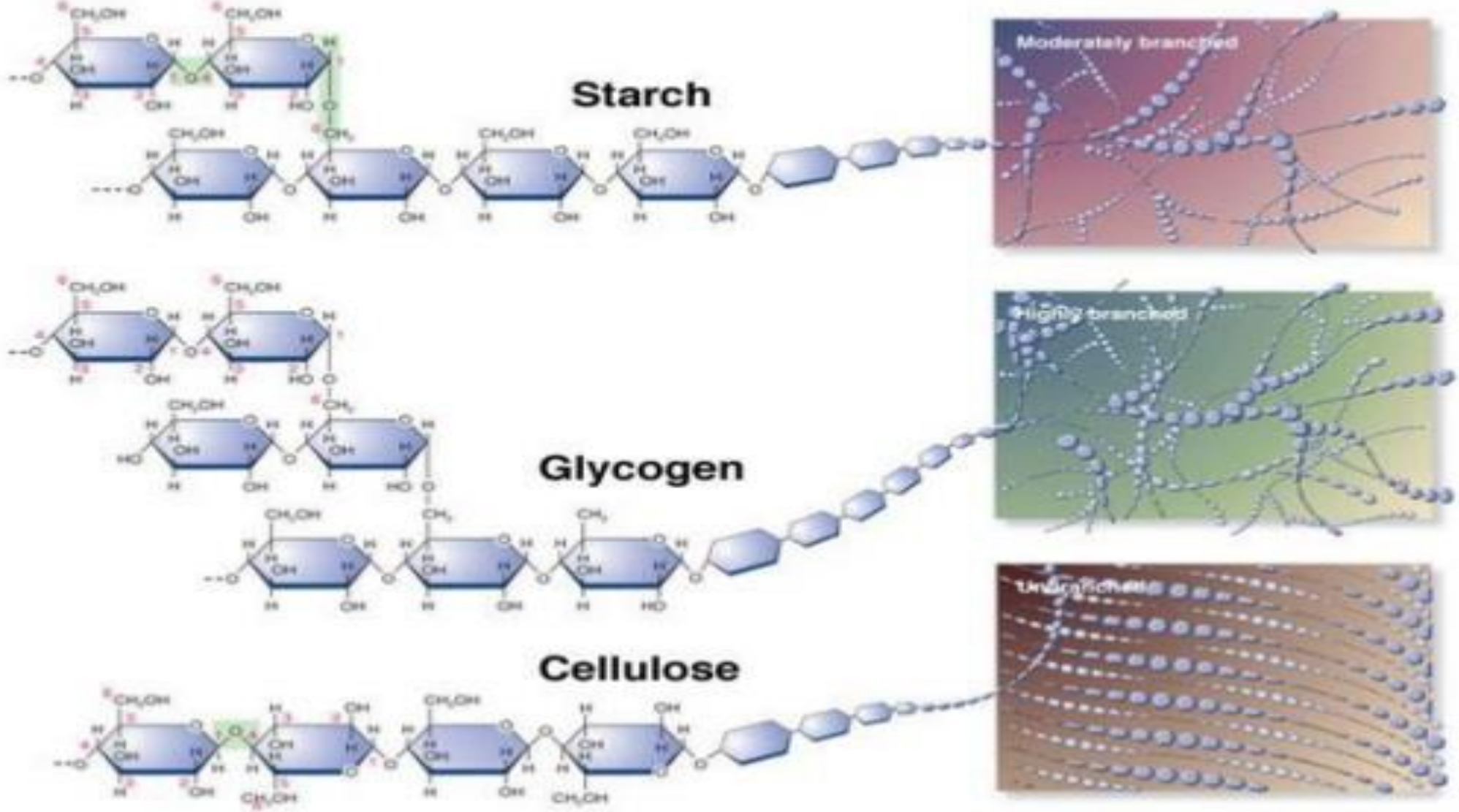
Polymers

Cellulose: Produced when very long chains of the monomer glucose are bonded together. The difference between starch and cellulose is the monomer glucose is reversed 180 degrees each time in cellulose.

Function: Structural compound found in plants.



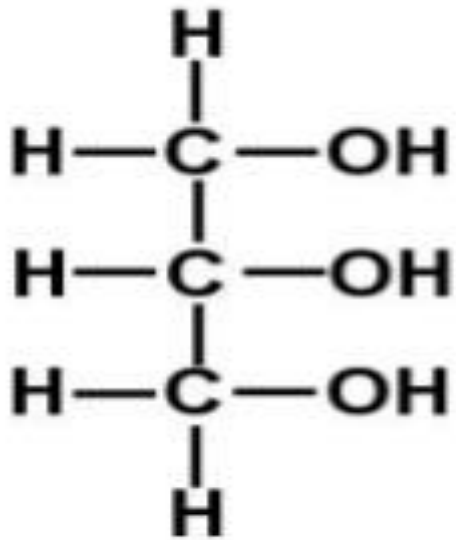
CARBOHYDRATES



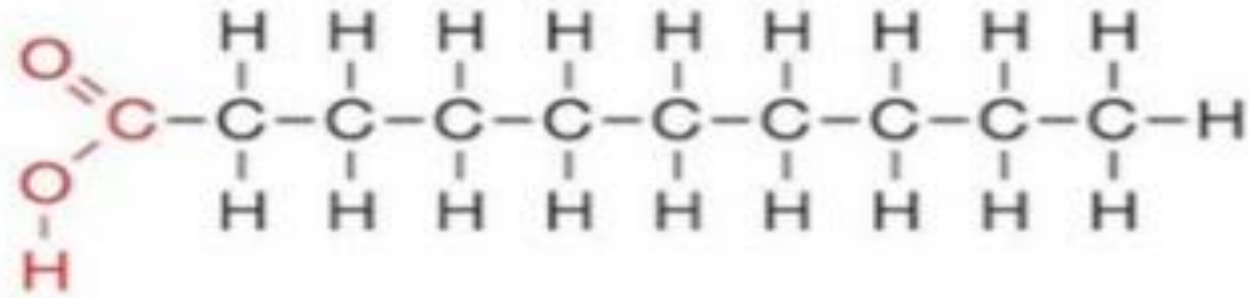
LIPIDS

Structure

All lipids are insoluble in water. The building blocks of lipids are **glycerol and fatty acids.**



Glycerol



fatty acid (saturated)

LIPIDS

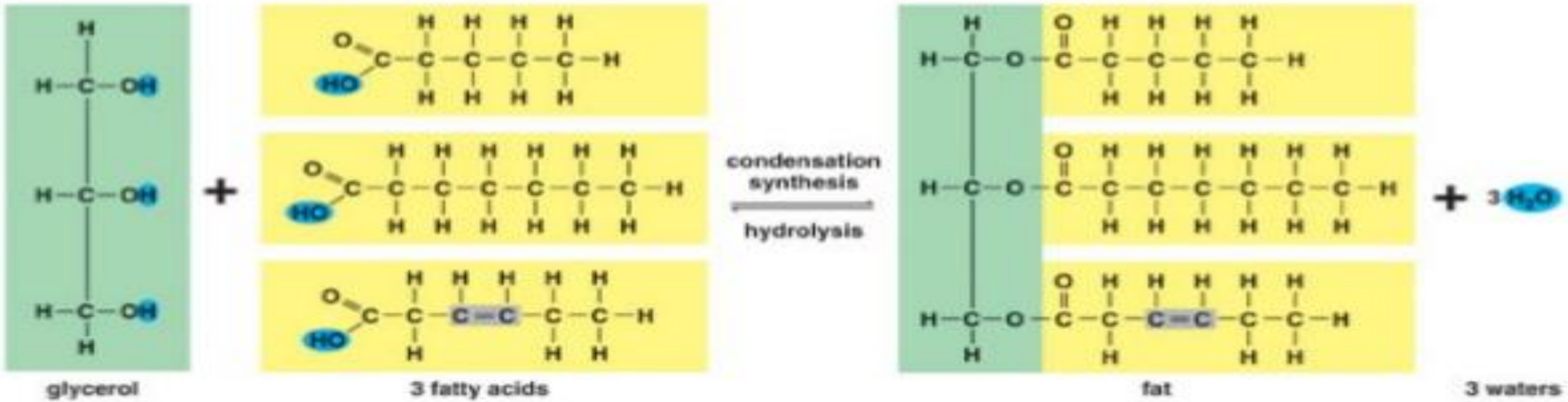
Function

- Long term energy stores
- Membrane formation
- Serve as hormones
- Provide insulation
- Protection of internal organs

LIPIDS

Polymers

Triglycerides: fats and oils that are formed by synthesizing a glycerol molecule with 3 fatty acids.



LIPIDS

Polymers

Triglycerides: the fatty acids (10-30 carbon chains) are what provide the variability in fats and oils.

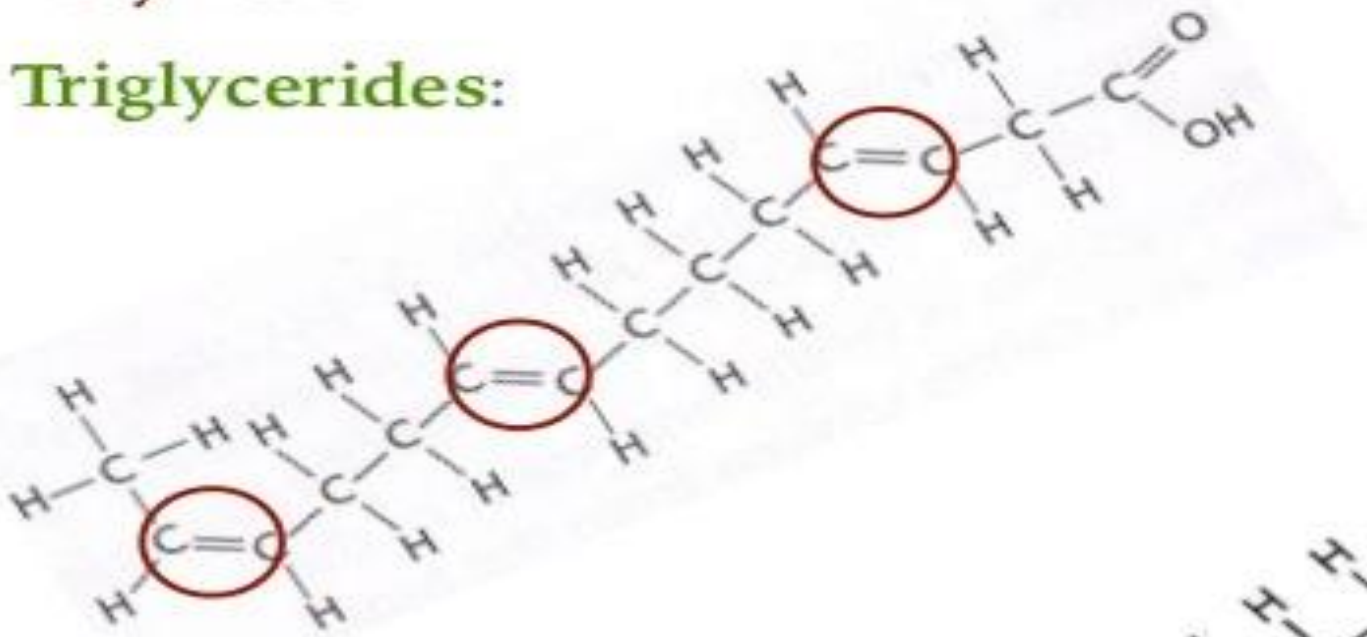
Saturated fatty acids: all the carbon atoms in the chain contain the maximum number of hydrogen atoms. Usually solid at room temperature

Unsaturated fatty acids: one or more double bonds between carbon atoms in the chain. Usually liquid at room temperature.

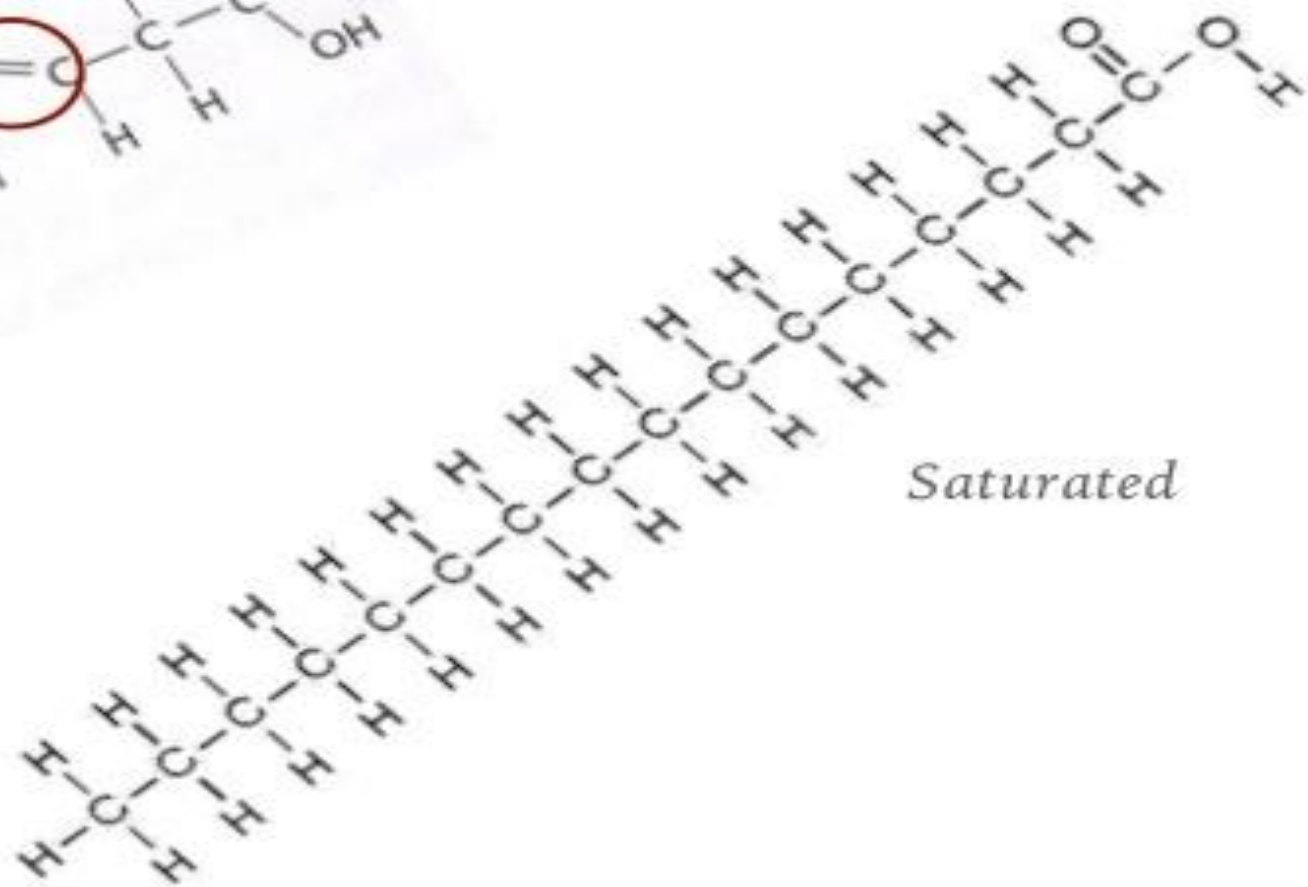
LIPIDS

Polymers

Triglycerides:



Unsaturated

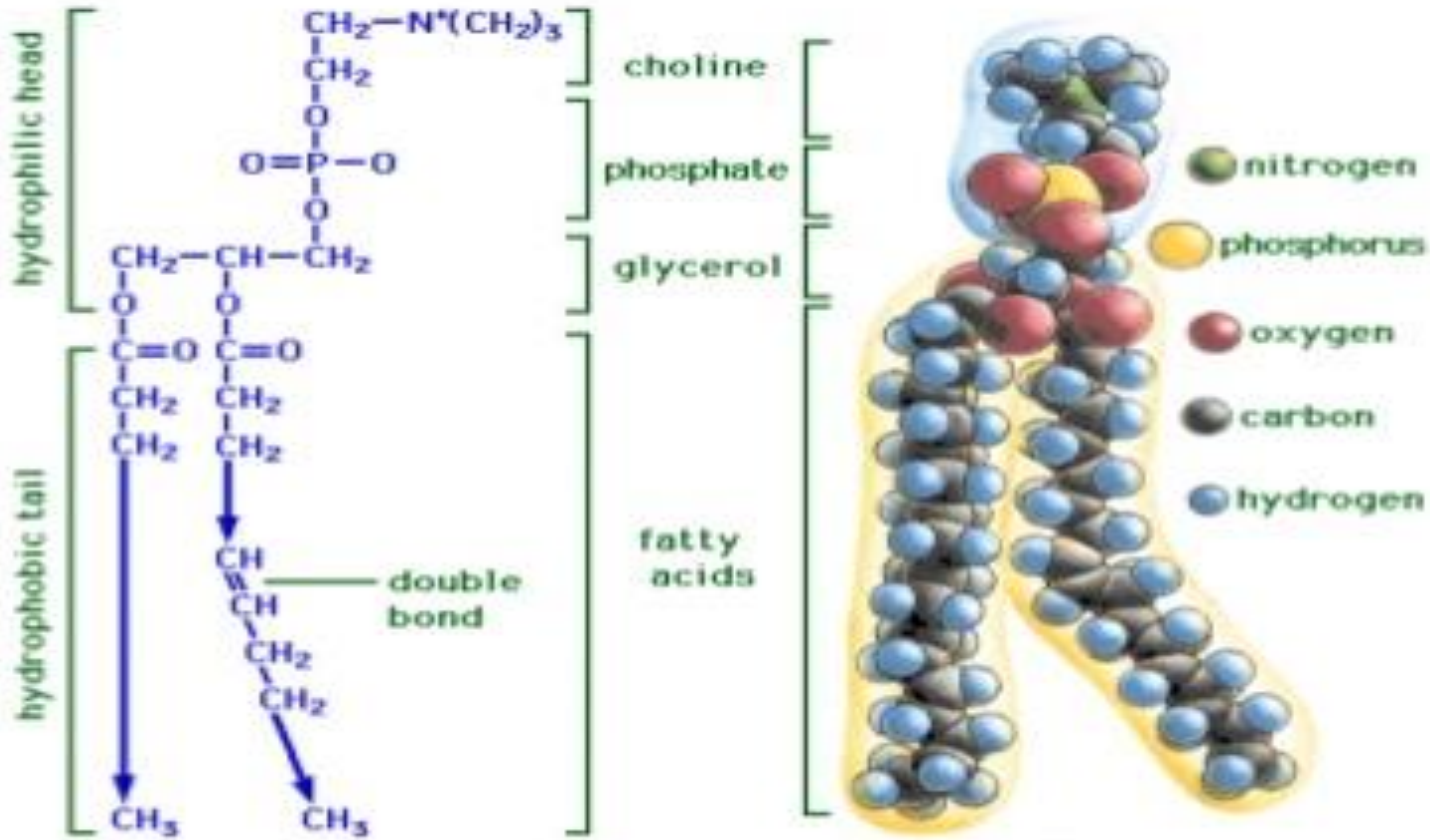


Saturated

LIPIDS

Polymers

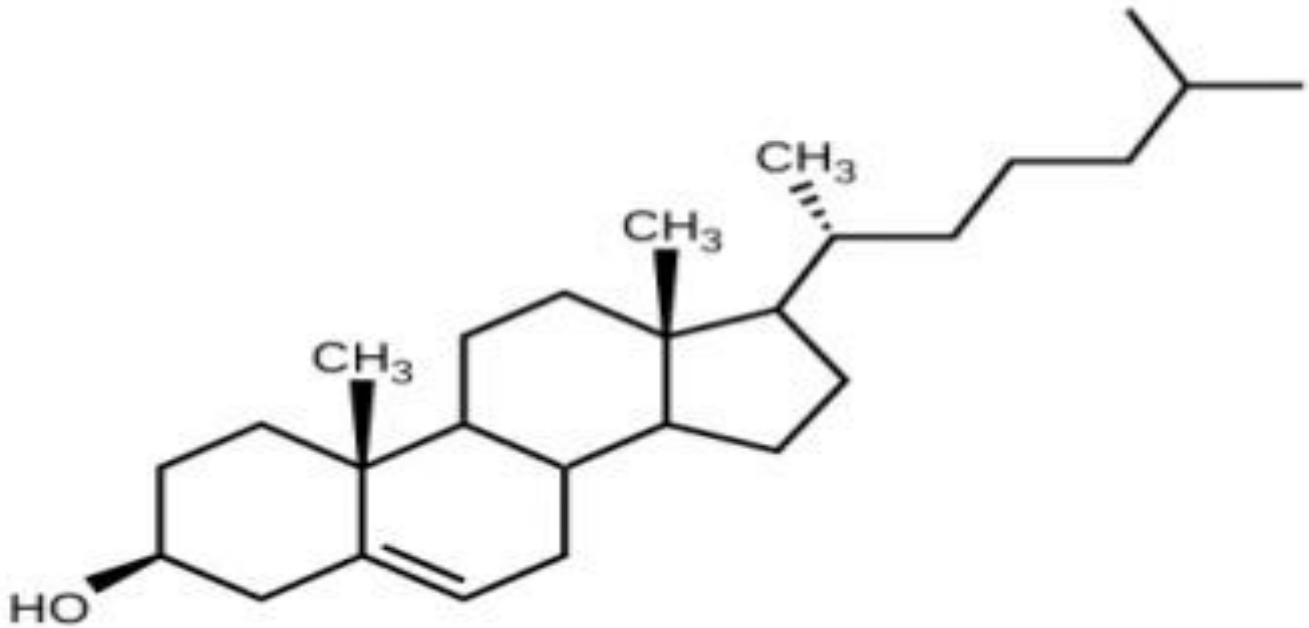
Phospholipids: A modified triglyceride. One fatty acid is removed and replaced with a phosphate group. This creates a polar molecule. One end hydrophilic (water loving) and the other is hydrophobic (water hating)



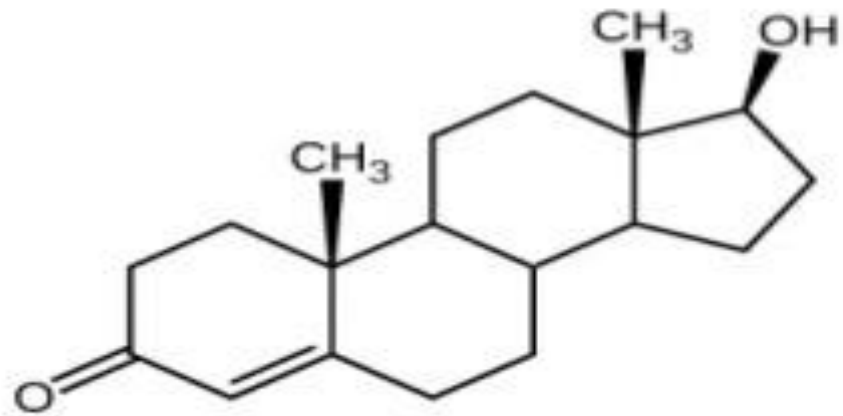
LIPIDS

Polymers

Cholesterol and Derivatives: found in many areas of the body such as cell membranes. Also include steroids and bile acid.



(a) Cholesterol



(b) Testosterone

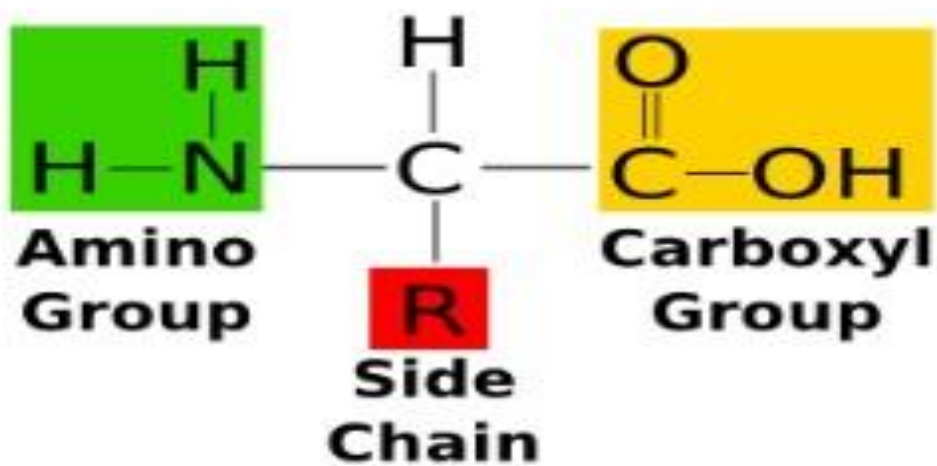
PROTEINS

Structure

The building blocks of proteins are **amino acids**. One end contains an amine group and one end contains a carboxyl group.

There are 20 amino acids, of which 9 can not be produced by your body.

The generic amino acid molecule looked like this:



PROTEINS

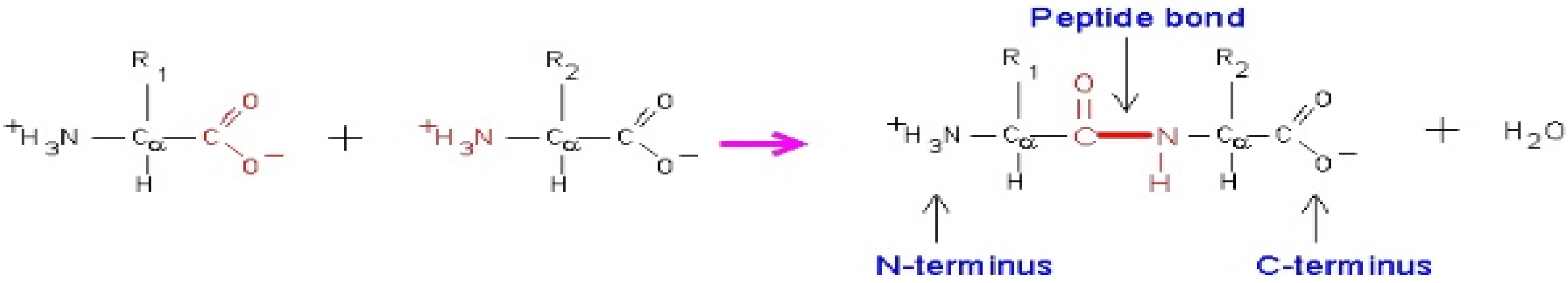
Function

- Structural Proteins
- Enzymes - speed reactions (end in ase)
- Antibodies
- Transport carriers
- Allow materials to cross cell membrane

PROTEINS

Polymers

Peptide chains: amino acids are bonded together via dehydration synthesis. The bond formed between amino acids are called peptide bonds.



PROTEINS

Polymers

Levels of Organization: The more amino acids that are added to the structure, the more complex it becomes. We group proteins structures into 4 classifications.

Primary: polypeptide chain.

Secondary: α helix and β sheets

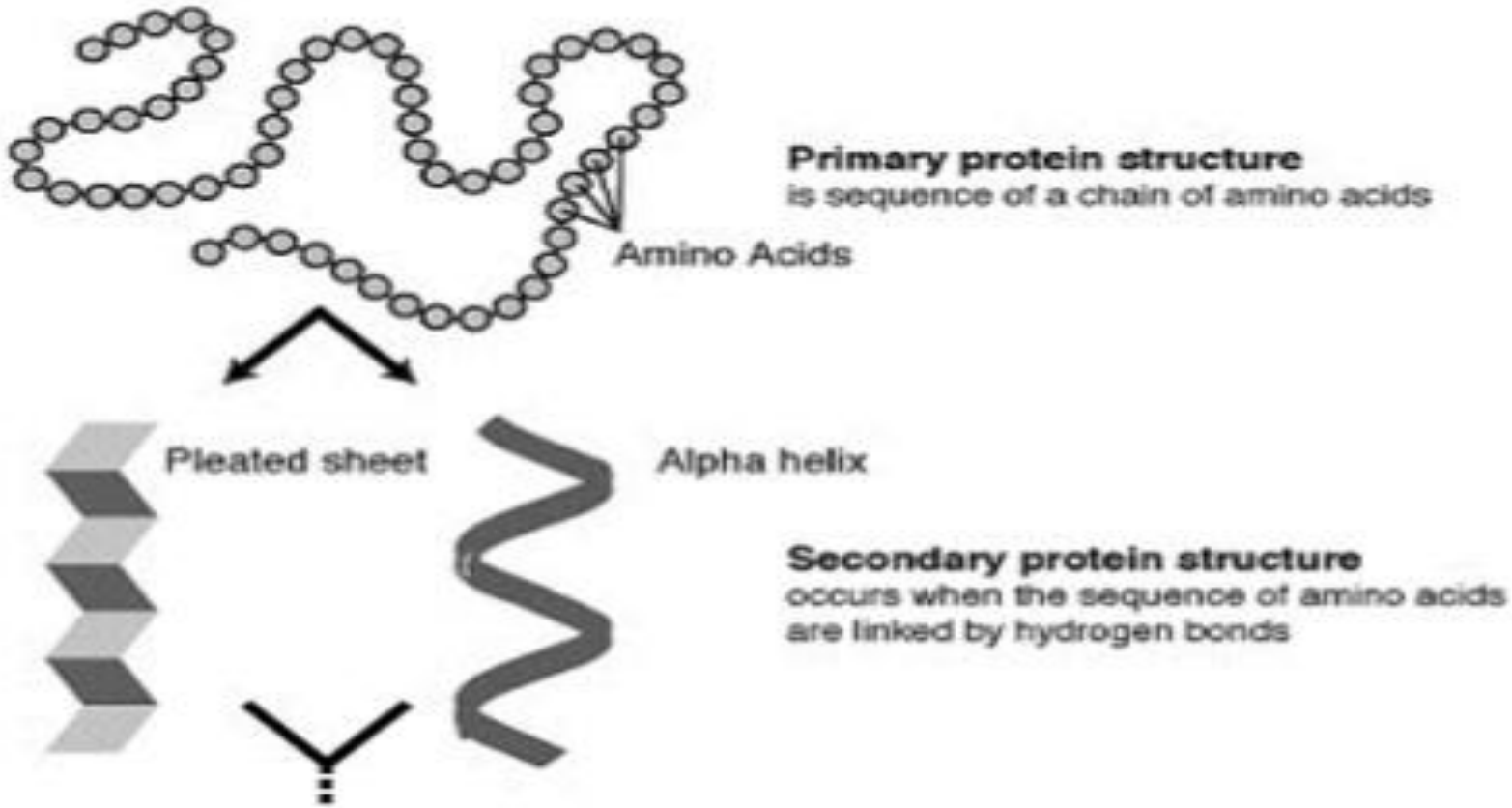
Tertiary: Globular Structures

Quaternary: Multiple polypeptide chains.

PROTEINS

Polymers

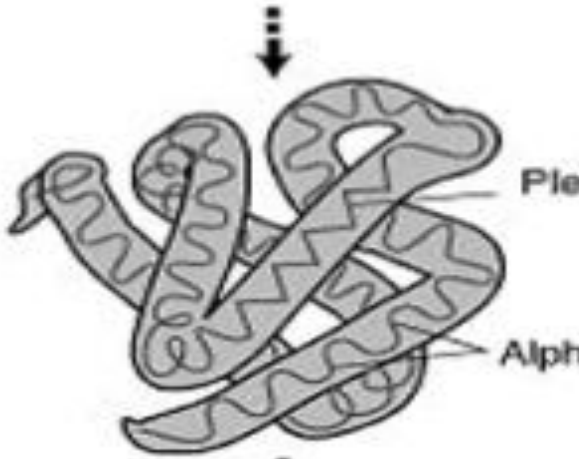
Levels of Organization:



PROTEINS

Polymers

Levels of Organization:



Tertiary protein structure
occurs when certain attractions are present between alpha helices and pleated sheets.

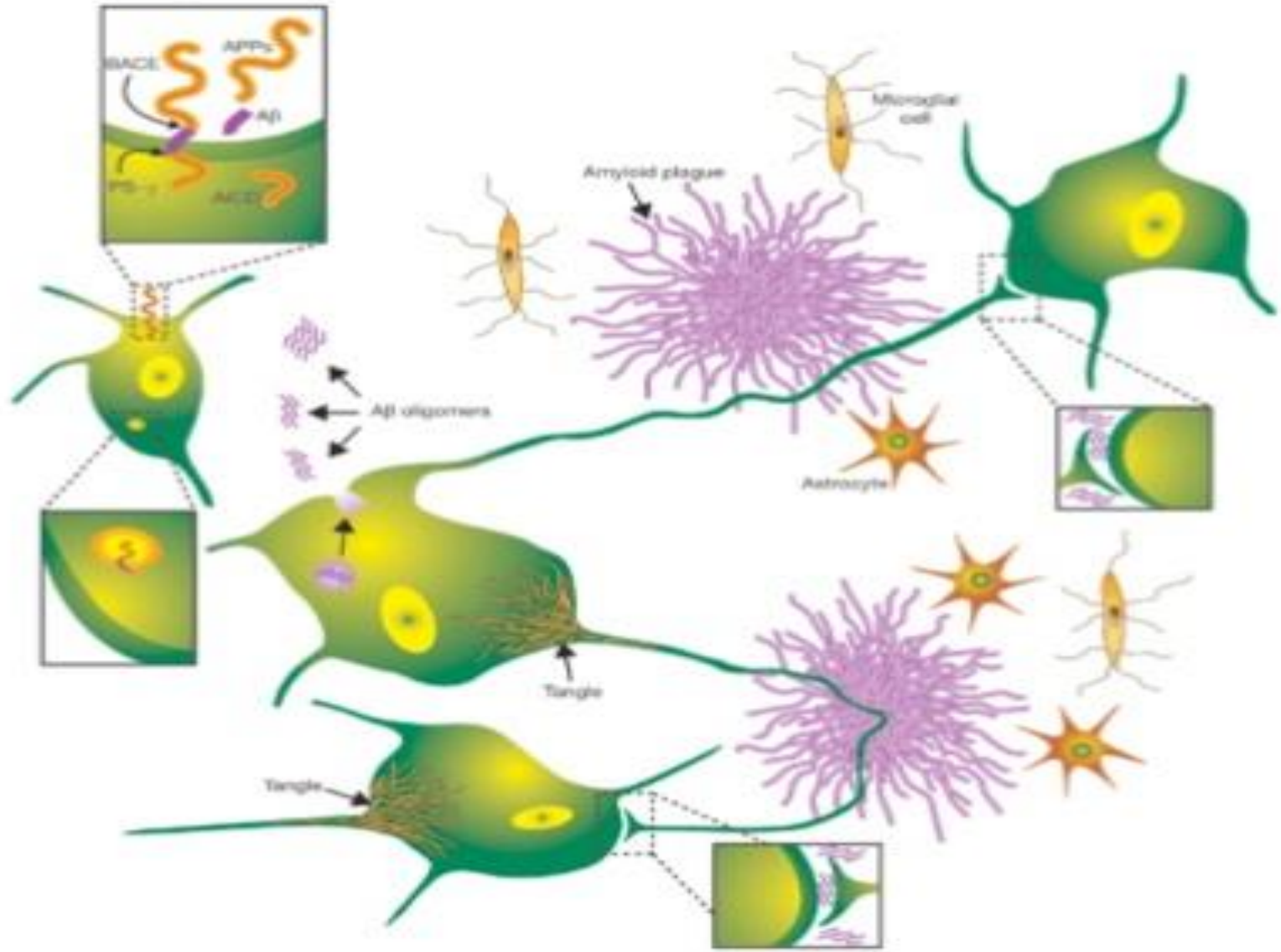
Quaternary protein structure
is a protein consisting of more than one amino acid chain.

PROTEINS – DISEASE

Alzheimer's

Amyloid plaque made of protein envelops axons

Tau changes shape and stick together causing tangles inside cell bodies.



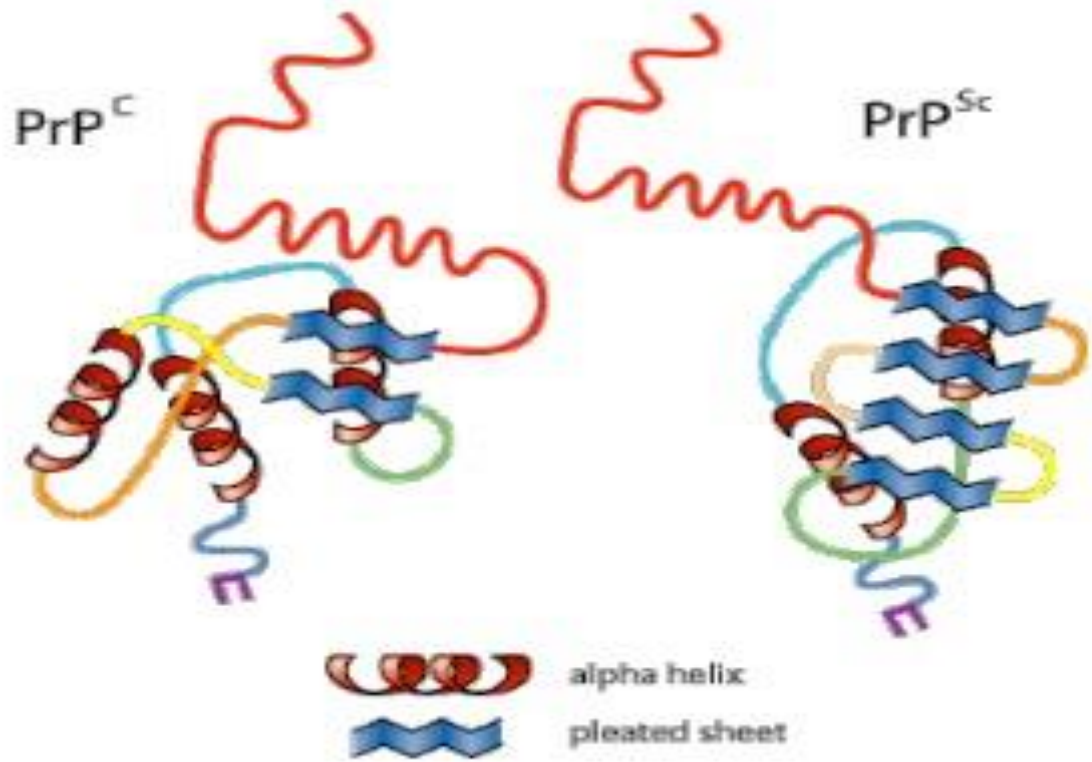
PROTEINS – DISEASE

Creutzfeld-Jacobs disease

Normally soluble prion proteins become insoluble

These proteins become insoluble in the presence of other insoluble prions

Insoluble prions damage brain tissue causing disease



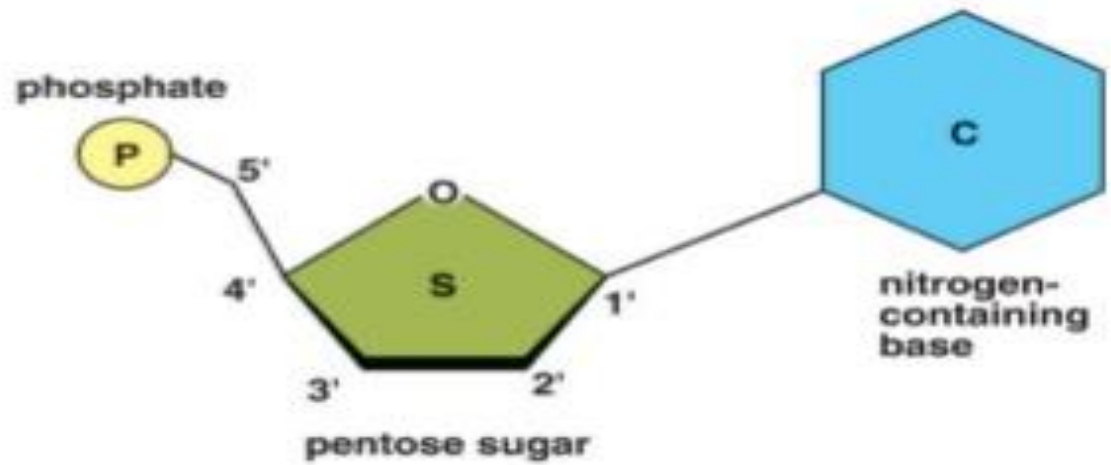
NUCLEIC ACIDS

Structure

The building blocks of nucleic acids are **nucleotides**.

Nucleotides consist of a phosphate group, a 5 sided sugar, and a nitrogenous base.

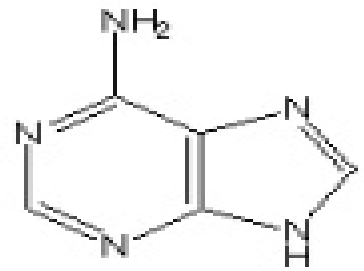
The generic nucleotide molecule looked like this:



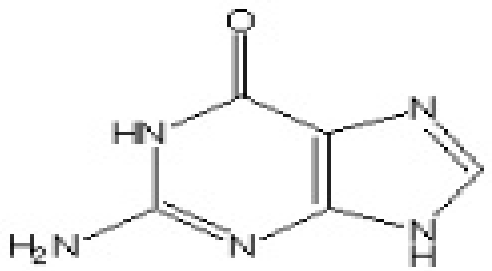
NUCLEIC ACIDS

Structure

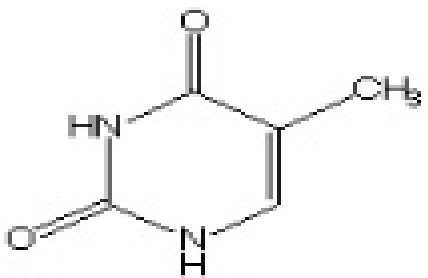
There are 5 nitrogenous bases that are used to create the polymers DNA and RNA.



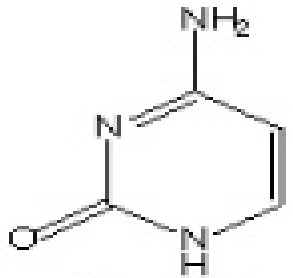
adenine



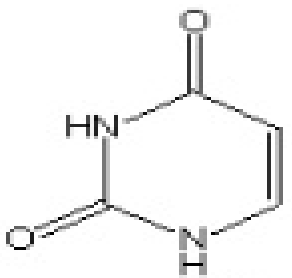
guanine



thymine



cytosine



uracil

NUCLEIC ACIDS

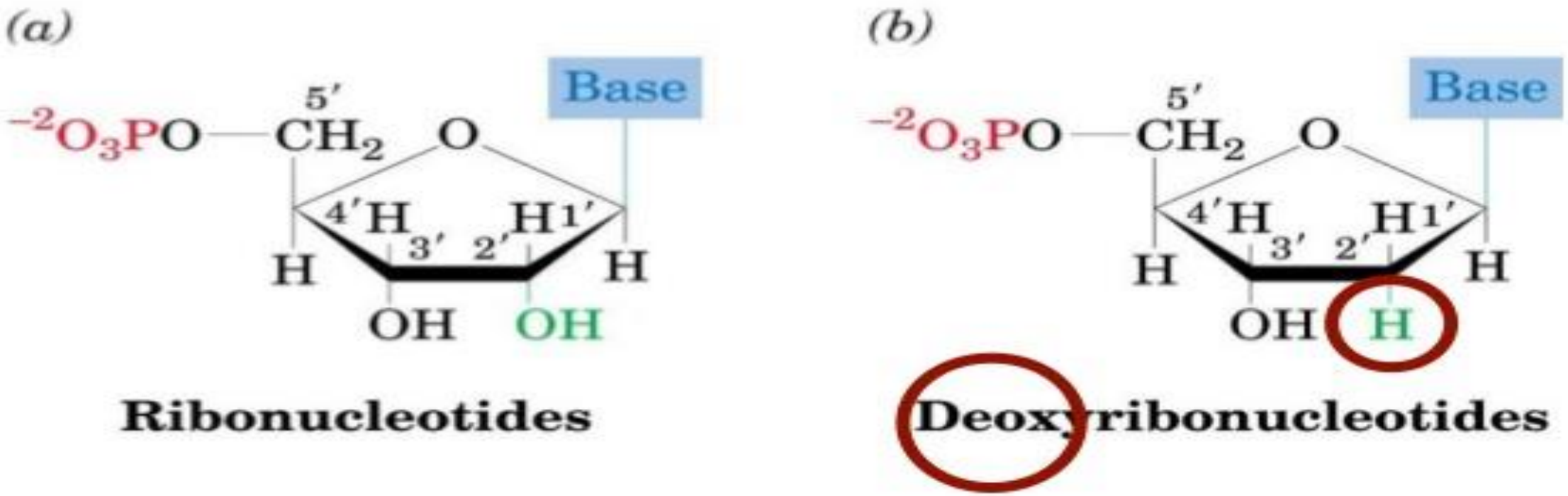
Function

- Energy
- Storage and transfer of genetic information

NUCLEIC ACIDS

Polymers

DNA and RNA:



NUCLEIC ACIDS

Polymers

DNA and RNA:

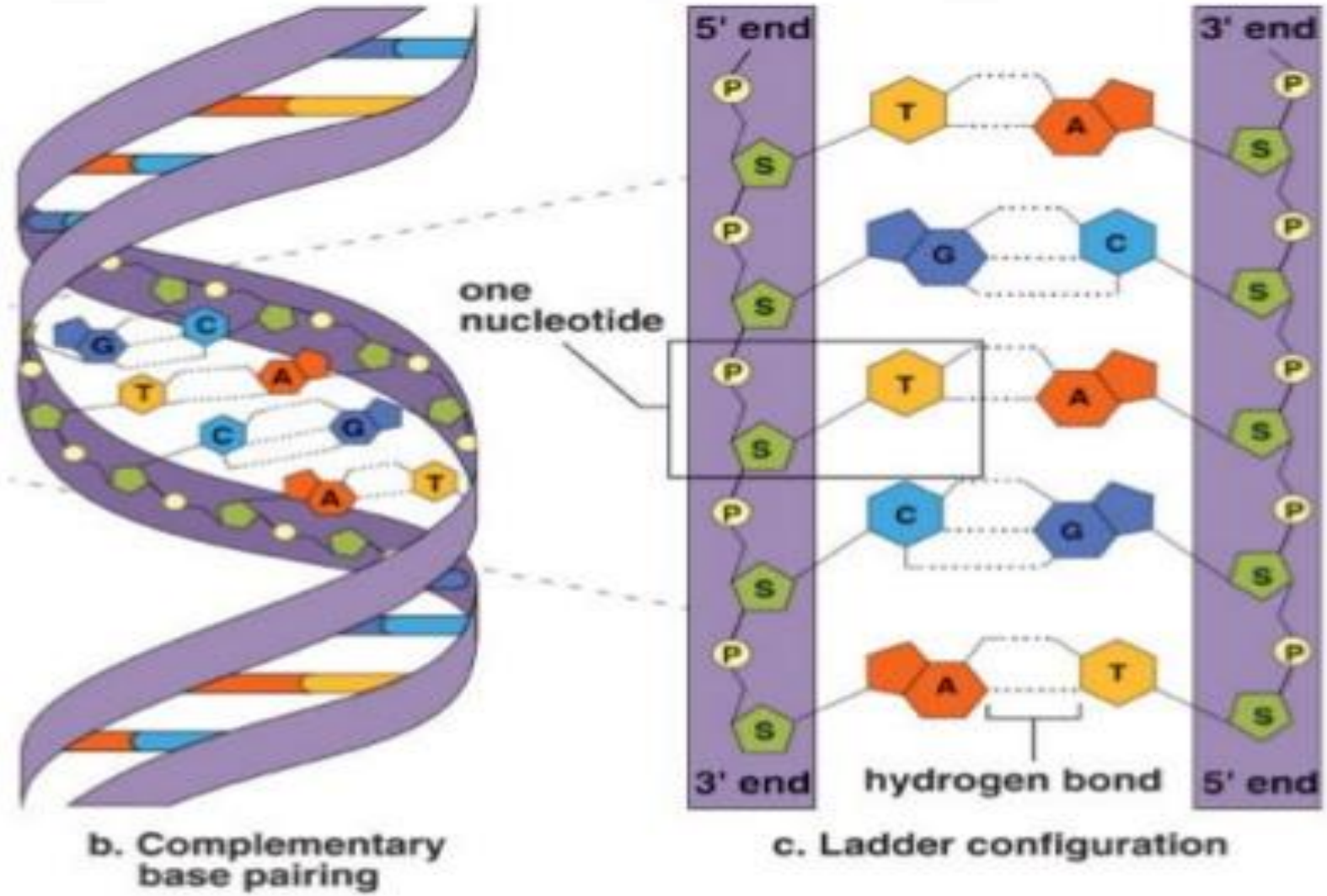
Table 2.3 DNA Structure Compared to RNA Structure

	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

NUCLEIC ACIDS

Polymers

DNA:



NUCLEIC ACIDS

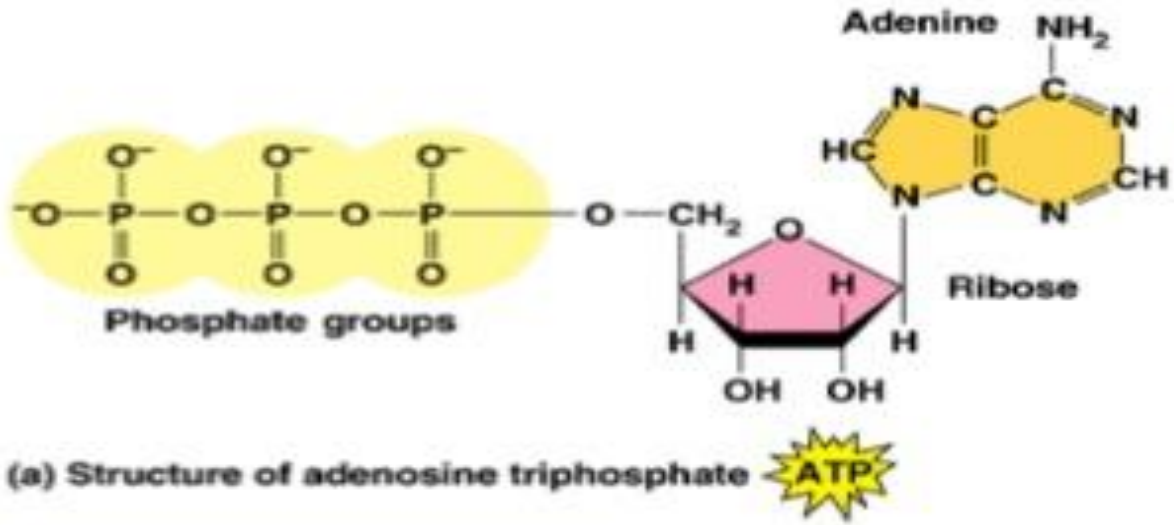
Special Nucleotide: ATP

Adenosine triphosphate (ATP) contains the nucleic acid adenine. It has 3 high energy phosphates attached.

ATP is the energy currency for the cell. When phosphates are removed, energy is released that allow for reactions to occur in the cell.

NUCLEIC ACIDS

Special Nucleotide: ATP



(a) Structure of adenosine triphosphate

Adenosine triphosphate (ATP)

Inorganic phosphate

Adenosine diphosphate (ADP)

(b) Hydrolysis of ATP