L 3/ CELL CHEMISTRY

Assist.Prof.Dr.Hams Hussain Hashim

BIOLOGY \ 1st Stage

Cells are composed of water, inorganic ions, and carbon-containing (organic) molecules.

Water is essential for life►

Water (H2O) is the most abundant molecule in living organisms, usually making up about 60–70% of the total body weight.

FUNCTIONS OF WATER IN THE BODY

.Water is the primary building block of cells■ ▪

.It regulates our internal body temperature by sweating and respiration■ ▪

The carbohydrates and proteins that our bodies use as food are metabolized■ ▪
.and transported by water in the bloodstream

.It assists in flushing waste mainly through urination■ ▪

.Acts as a shock absorber for brain, spinal cord, and fetus■ ▪

.Forms saliva■ ▪

.Lubricates joints■ ▪

ACIDS AND BASES►

Acids are molecules that dissociate in water, releasing hydrogen ions►▪ .(H+)

Bases are molecules that either take up hydrogen ions (H+) or release►▪ .hydroxide ions (OH-)

pH scale **The pH scale is used to indicate the acidity and basicity►▪ (alkalinity) of a solution.** The pH scale ranges from **0** to **14**, with **0** being the most **acidic** and **14** being the most **basic**. A solution at **pH 7** (**neutral pH**) has equal amounts of hydrogen ions (H+) and hydroxide ions (OH−). An acidic pH has more H+ than OH− and a basic pH has more OH− than .+H

Buffers **A buffer is a substance that helps minimize the change in the** ▪ ◄ **pH of a solution when acids or bases are added.** This is important because, most of the chemical processes that occur in living organisms are highly .sensitive to pH, and drastic changes in pH can cause some serious trouble

Organic Compounds ▪ ◄

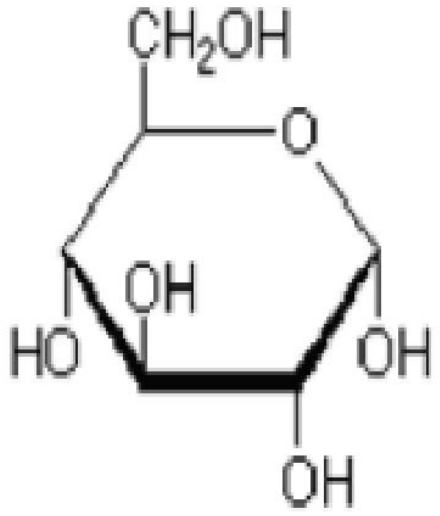
The chemical compounds of living things are known as **organic** ▪ **compounds** because of their association with organisms and because they are carbon-containing compounds. Among the numerous types of organic compounds, four major groups are found in all living things: **carbohydrates, .lipids, proteins, and nucleic acids**

CARBOHYDRATES .1▶

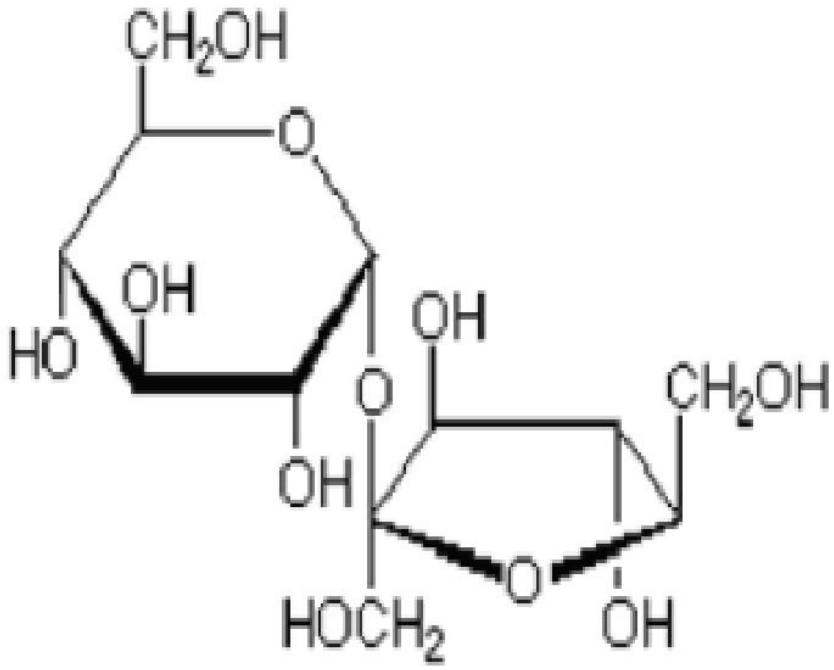
Almost all organisms use carbohydrates as **sources of energy**. In addition, some .carbohydrates serve **as structural materials**

- Carbohydrates are molecules composed of carbon, hydrogen, and oxygen; the ratio of hydrogen atoms to oxygen and carbon atoms is 2:1. The basic building blocks of carbohydrate molecules are the monosaccharides. The most important monosaccharide is **glucose** (the major nutrients of cells), **fructose,** .and **galactose**

- Two monosaccharides can form a covalent bond between them to form a disaccharide sugar. Three important disaccharides are also found in living things: **maltose, sucrose**, and **lactose**



glucose (a monosaccharide)



sucrose (a disaccharide)

When many monosaccharide molecules are joined together with covalent bonds, we have **a polysaccharide**. Among the most important polysaccharides is **starch**, which is composed of hundreds or thousands of glucose units linked to one another. Starch serves as a storage form for .carbohydrates in **plants**

Glycogen is also composed of thousands of glucose units, but the units are bonded in a different pattern than in starch. **Glycogen** is the form in which **glucose is stored**

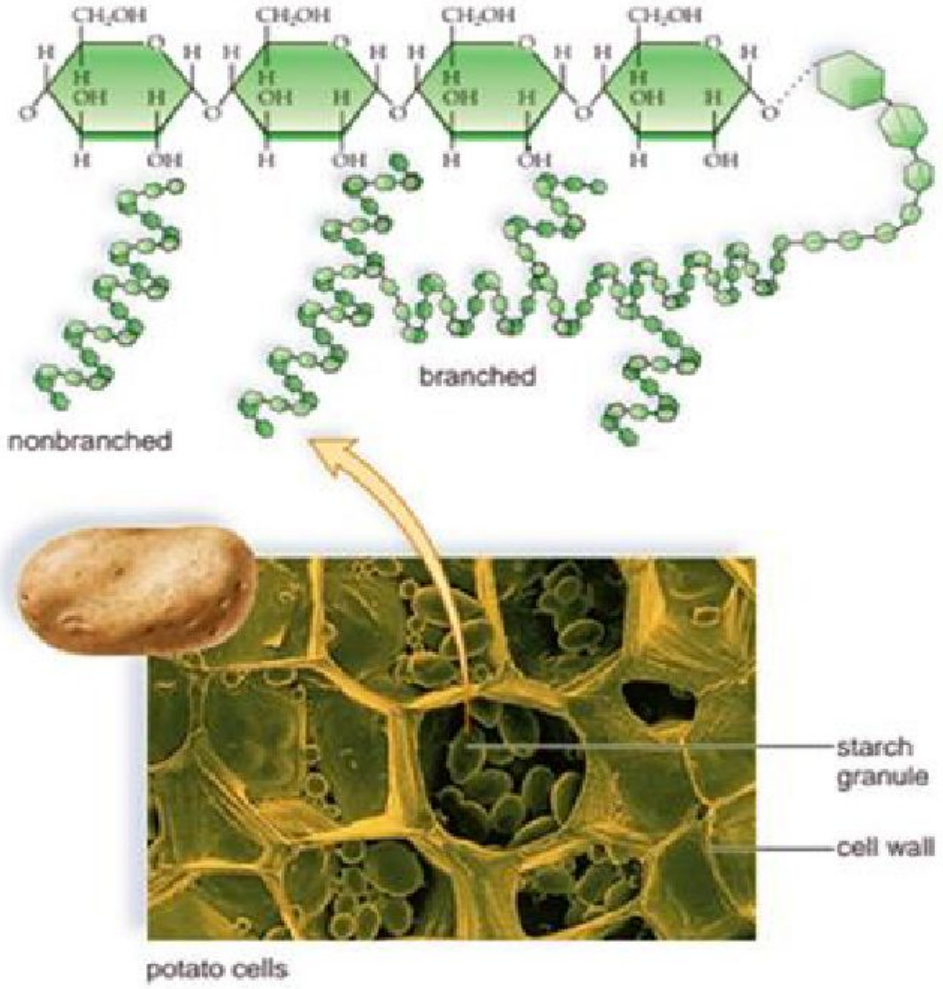


Figure 2.13 Starch is a plant complex carbohydrate.

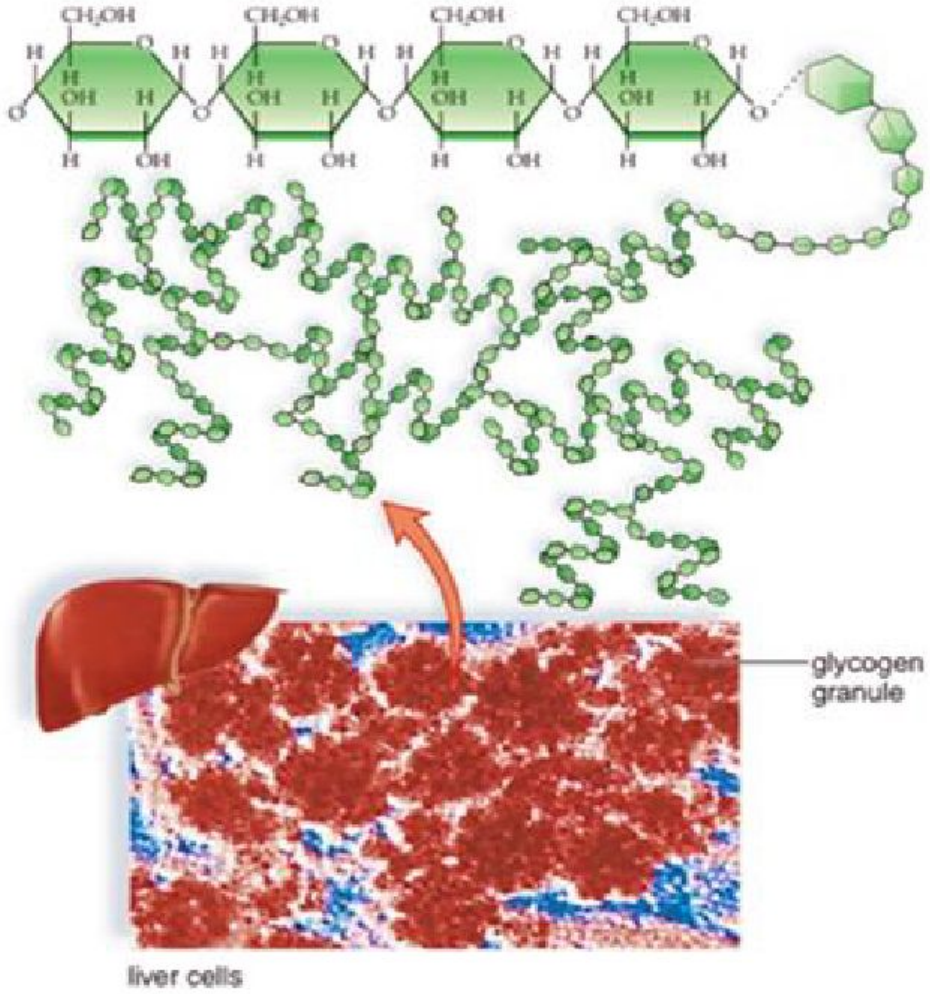


Figure 2.14 Glycogen is an animal complex carbohydrate.

:LIPIDS .2►

Lipids are large molecules that do not dissolve in water. They are▪ organic molecules composed of carbon, hydrogen, and oxygen atoms. The ratio of hydrogen atoms to oxygen atoms is much higher in lipids :than in carbohydrates. There are three major groups of lipids

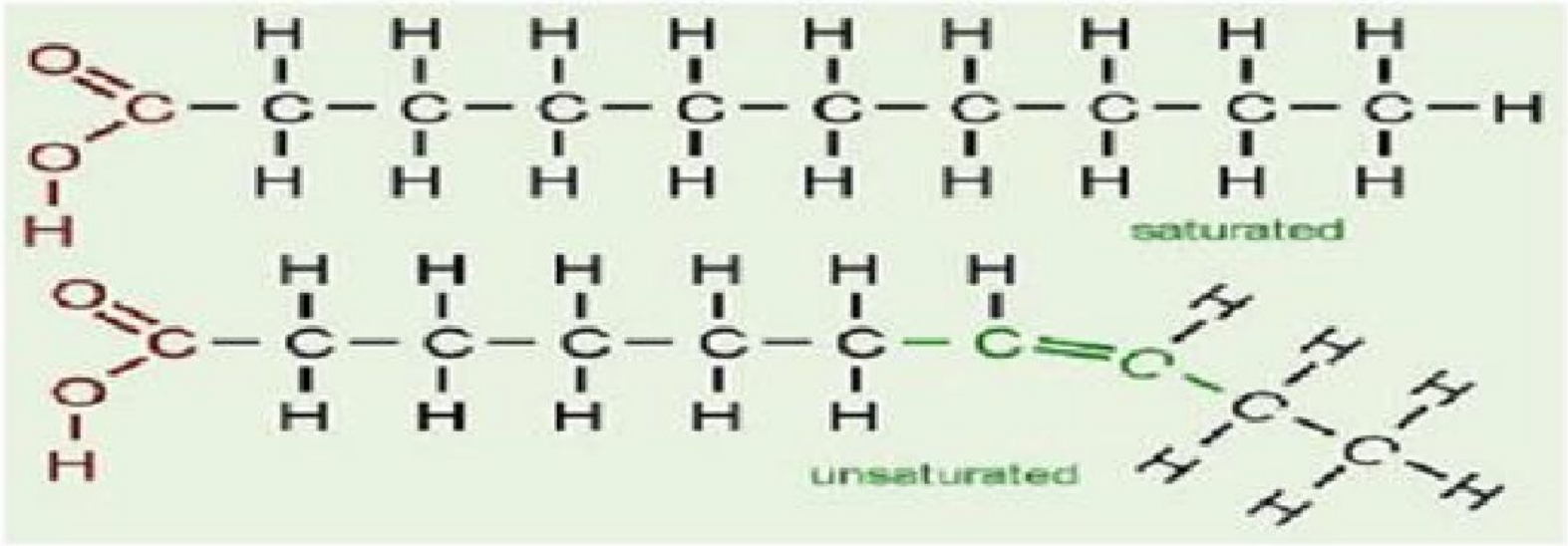
Fats and Oils►▪

Fats and oils form when one glycerol molecule reacts with three ▪ fatty acid molecules. A fatty acid is a carbon–hydrogen chain that ends with the acidic group —COOH. Fatty acids are either **saturated** or .**unsaturated**

Saturated fatty acids have no double bonds►▪ between the carbon atoms. The chain is saturated with all the hydrogens it can hold, and they are **solid** .at room temperature

Unsaturated fatty acids have double bonds in►▪ the carbon chain wherever the number of hydrogens is less than two per carbon , and they are **liquid** at .room temperature

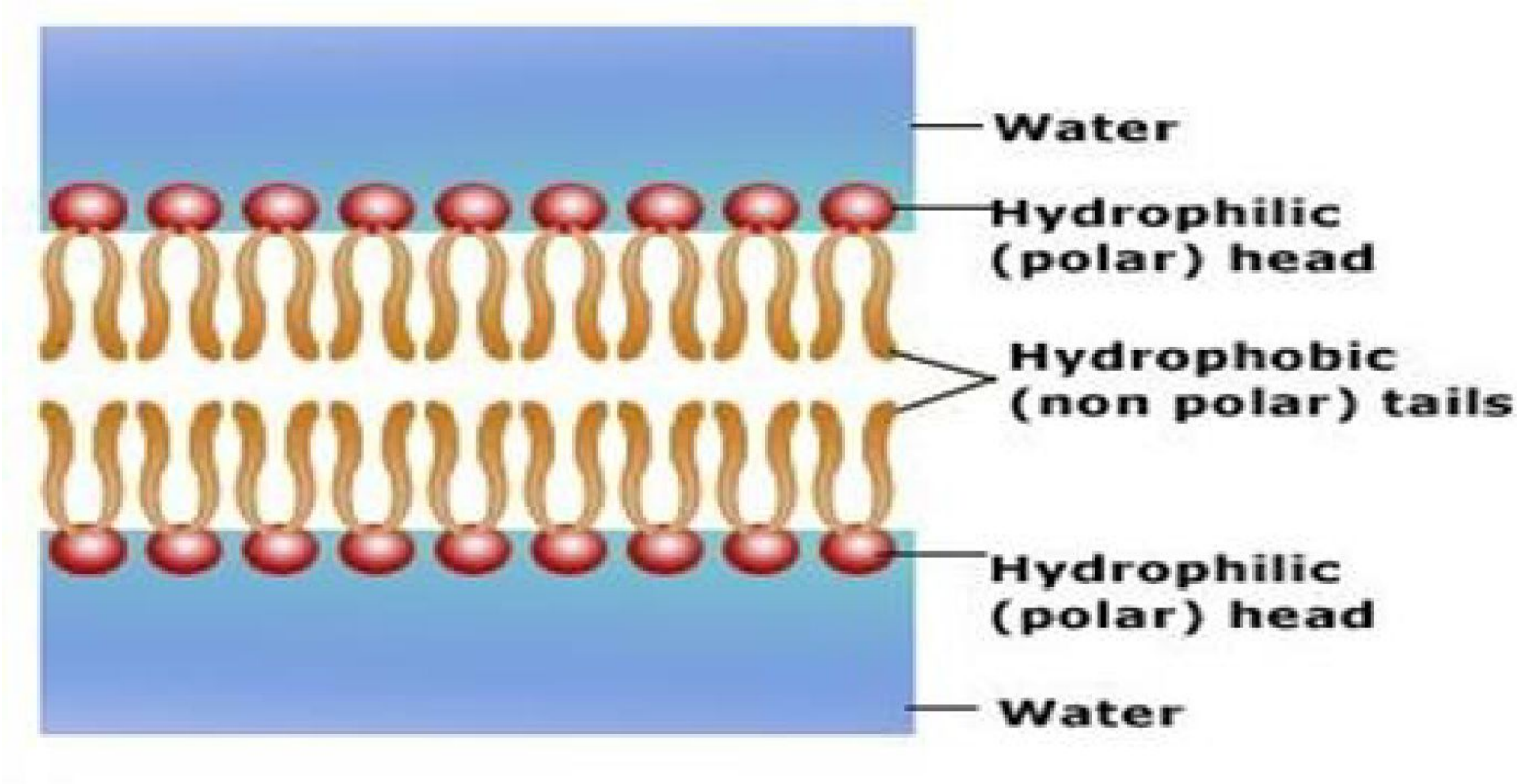
- **Saturated Lipids** : *Solid fats, animals*



3. **Unsaturated Lipids:** *Oils, plants*

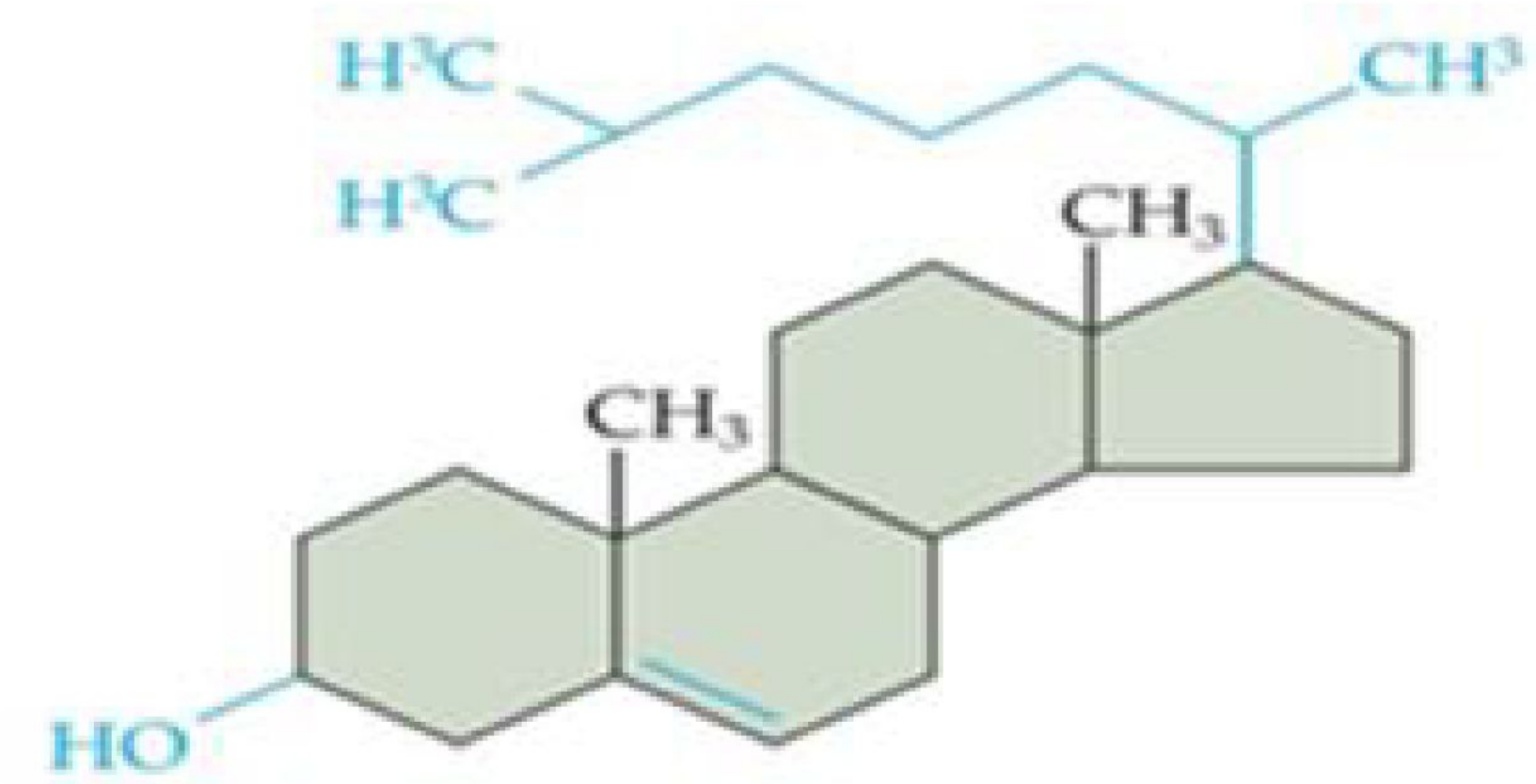
PHOSPHOLIPIDS ▶

The phospholipid molecule is similar to a fat except that the third fatty acid is replaced by a phosphate group. The phosphate end of the molecule will dissolve in water and is said to be **hydrophilic** (“likes water”). The fatty acid end of the molecule repels water and is called **hydrophobic** (“fears water”). Phospholipids are a major component of the .membranes surrounding the cells of all organisms


Water
Hydrophilic
(polar) head
Hydrophobic
(non polar) tails
Hydrophilic
(polar) head
Water

STEROIDS►

- Unlike the phospholipids and fats, steroids have a ring structure, they are grouped with lipid because they are also hydrophobic. Examples of steroids - .cholesterol, vitamin D, cortisone, estrogen



a. Cholesterol

:The roles of lipids►▪

.Provide an important form of energy storage-1▪

.Lipids are the major components of cell membrane-2▪

Lipid play roles in cell signaling both as steroid hormones and as -3▪
a message molecule that convey signals from cell surface receptors
.to targets within the cell

PROTEINS-3

Proteins, among the most complex of all organic compounds, are composed of amino acids. There are 20 kinds of amino acids. One protein differs from another by the number and arrangement of the 20 different amino acids. The primary structure of a protein is a long chain made of many amino acids. The long chain of amino acids twists and folds on itself to produce the final shape of a protein

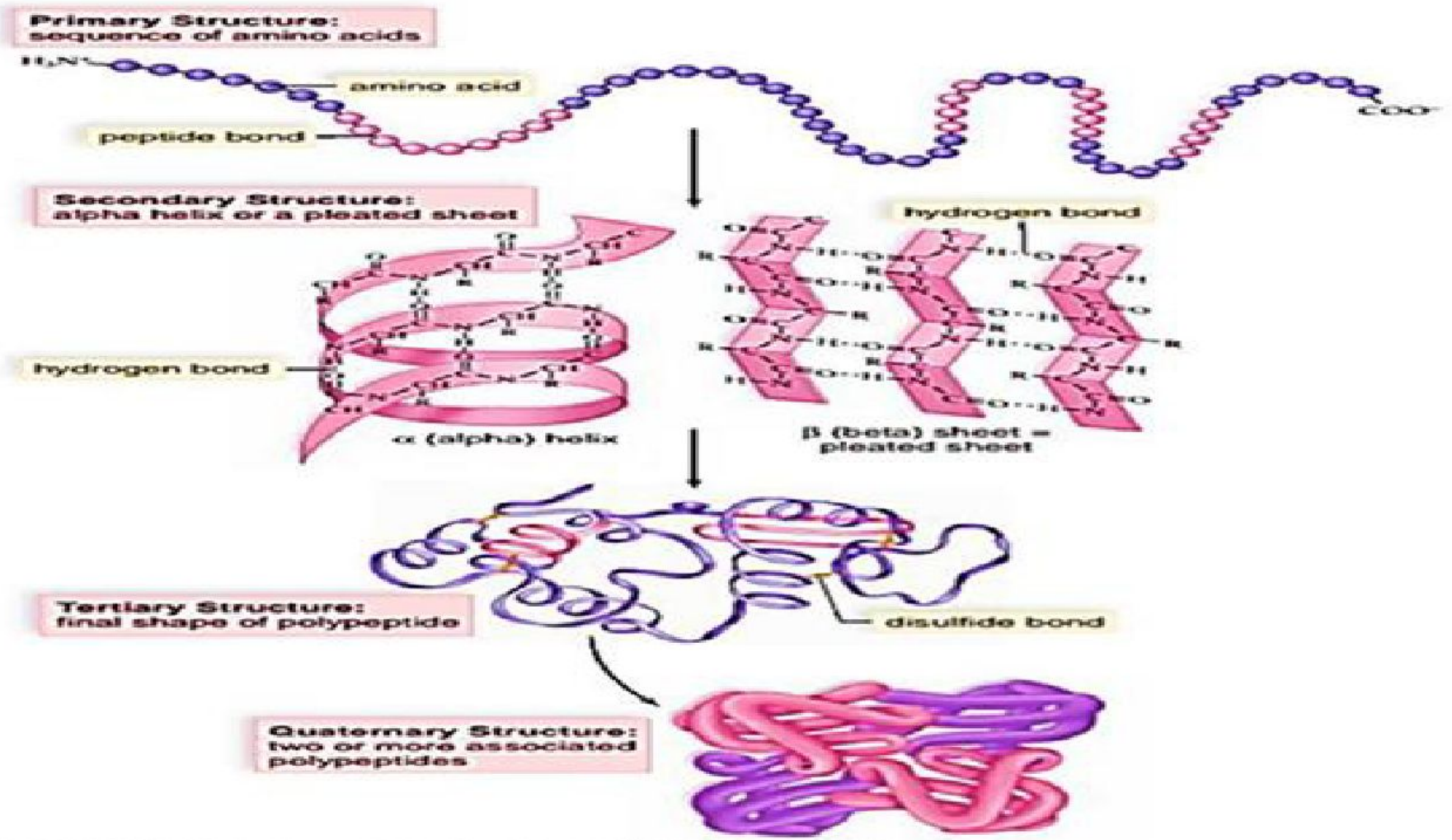


Figure 2.23 Levels of protein structure.

:The roles of proteins include►

Collagen and **keratin** are **structural proteins**. Collagen holds the tissues together **.1** throughout the body and strengthens ligaments and tendons. Keratin is a protein that toughens .and waterproofs the skin

.The proteins **actin** and **myosin** permit our **muscles** to contract **.2**

.**Enzymes** are a special class of proteins that assist other chemicals to react with eachother **.3**

.Many **hormones** that regulate body functions are proteins **.4**

Hemoglobin is a blood protein that transports oxygen and carbon dioxide throughout the **.5** .body

.**Antibodies** are proteins in the blood and body fluids that help to fight infections **.6**

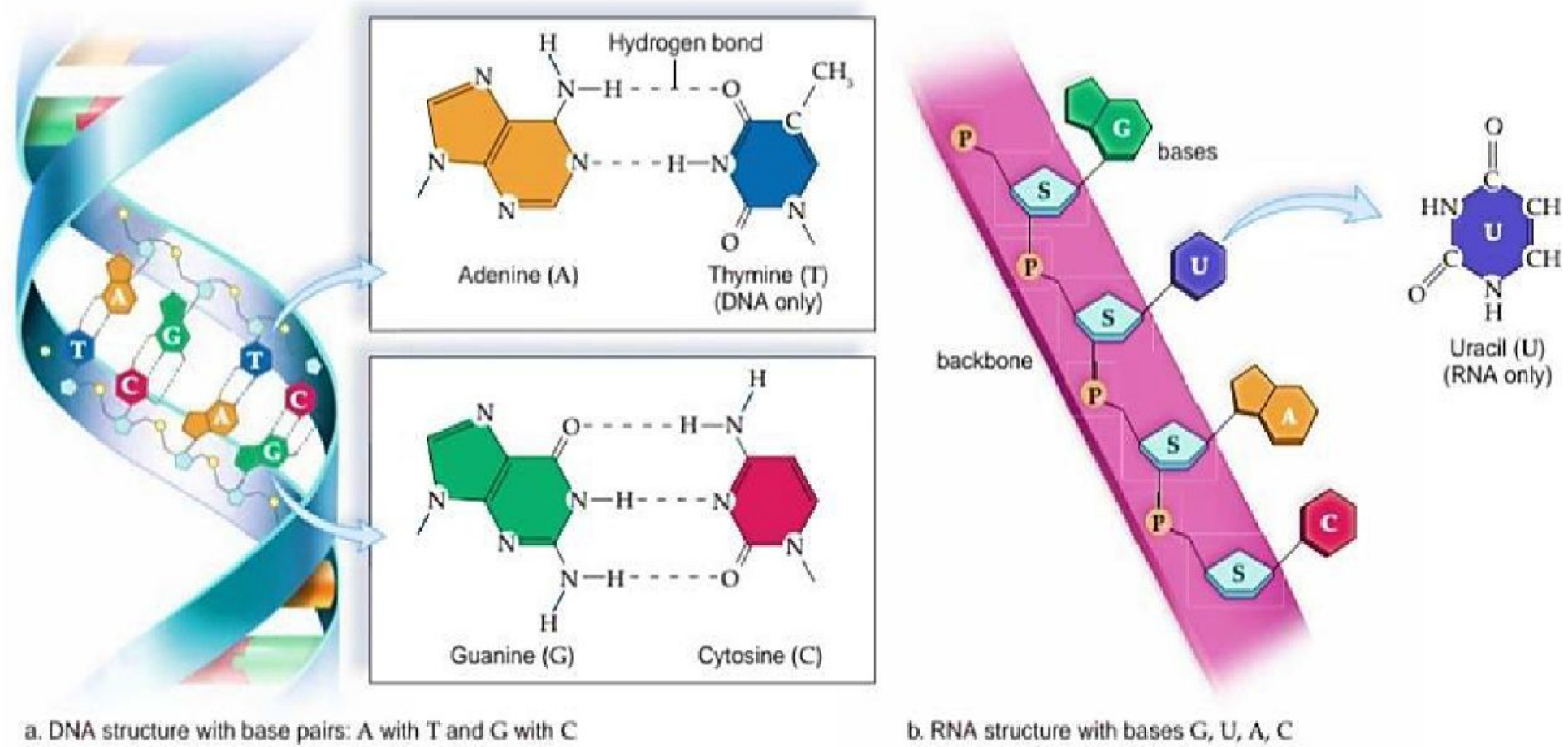
:NUCLEIC ACIDS .4►

Nucleic acids contain carbon, hydrogen, oxygen, nitrogen and phosphorus. They are composed of **nucleotides**. A nucleotide consists of **a nitrogen-containing base, a sugar .and a phosphate group**

There are two kinds of nucleic acids: **DNA (deoxyribonucleic acid)** and **RNA .(ribonucleic acid)**

In DNA, the bases are adenine A, thymine T, guanine G and cytosine C. The sugar is deoxyribose. In RNA the bases are the same except thymine T is replaced by uracil U. .The sugar in RNA is ribose

In DNA, there are two chains of nucleotides held together by hydrogen bonds. The chains are coiled into a helix. An adenine in one chain is always across from a thymine in the other chain. Guanine is always across from cytosine. Genes are segments of DNA. RNA .molecules are single- stranded .RNA functions in synthesis of proteins



a. DNA structure with base pairs: A with T and G with C

b. RNA structure with bases G, U, A, C

Figure 2.24 **The structure of DNA and RNA.**

a. In DNA, adenine and thymine are a complementary base pair. Note the hydrogen bonds that join them (like the "steps" in a spiral staircase). Likewise, guanine and cytosine can pair. **b.** RNA has uracil instead of thymine, so complementary base pairing isn't possible.

SUMMARY

Water is the most abundant molecule in living organisms. Water serves a number - .of essential functions in the body

pH is determined by the hydrogen ion concentration [H+]. Acids increase H+ but - ▪ .decrease the pH of water, and bases decrease H+ but increase the pH of water

A buffer is a substance that helps minimizing the change in the pH of a solution - ▪ .when acids or bases are added

:Organic Compounds - ▪

Four major groups of organic compounds are found in all living things: ▪ .carbohydrates, lipids, proteins, and nucleic acids

Carbohydrates-1 ▪

The basic building blocks of carbohydrate molecules are the • ▪
.monosaccharides

.The most important monosaccharide are glucose, fructose, and galactose • ▪

.Important disaccharides are maltose, sucrose, and lactose • ▪

.The most important polysaccharides are Starch and Glycogen • ▪

Almost all organisms use carbohydrates as sources of energy. In addition, • ▪
.some carbohydrates serve as structural materials

Lipids-2 ▪

Lipids are large molecules that do not dissolve in water. Three important • ▪
.lipids in the body are fats, phospholipids and steroids

The roles of lipids • ▪

.Provide an important form of energy storage-1 ▪

.Lipids are the major components of cell membrane-2 ▪

.Lipid play roles in cell signaling-3 ▪

Proteins-3 ▪

Proteins are very large complex molecules composed of subunits called amino • ▪
.acids

:The roles of proteins include • ▪

.Structural component of the cells and tissues .1 ▪

.Permit our muscles to contract .2 ▪

.Enzymes .3 ▪

Hormones .4 ▪

.Transport .5 ▪

.Defense against infections .6 ▪

Nucleic acids -4

.Nucleic acids are molecules made up of repeating units of nucleotides

A nucleotide consists of a nitrogen-containing base, a sugar and a phosphate group.

.There are two kinds of nucleic acids: DNA and RNA

.Genes are segments of DNA.\\ RNA functions in synthesis of proteins


THANK
YOU
4
LISTENING