

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Introduction to Biochemistry

BIOC 201

(2026-2)

Dr. Hanna Alhoraibi

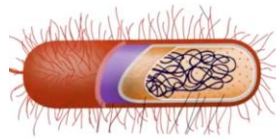
This lecture aims to introduce:

- Biochemistry
- Organization of life
- The four major groups of biological molecules present in living systems.
- The relationship between monomers and polymers.

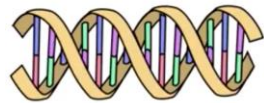
What is biochemistry?

Biochemistry

Big



biology



biochemistry



chemistry

small

Function → وظيفة
Structure → تركيب

What is biochemistry?

- Definition: The study of the molecules of living systems.
- The goal of biochemistry is to understand: the structure and the function of biological molecules.
- What are these molecules?

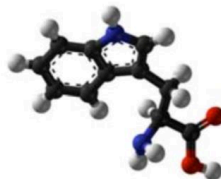
location
the chemical that happens
between it and the other

جزيئات كبيرة
عظيمة

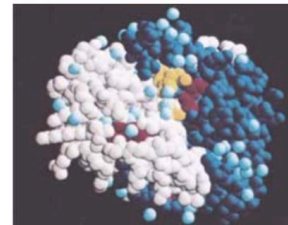
— **Macromolecules** (proteins, nucleic acids, lipids, and complex carbohydrates)

جزيئات صغيرة

— **Micromolecules** (amino acids, fatty acids, sugars and nucleotides)



Tryptophan



Molecules of Life

Proteins



Carbohydrates



Nucleic acids



Lipids



What is **bio**chemistry?



life

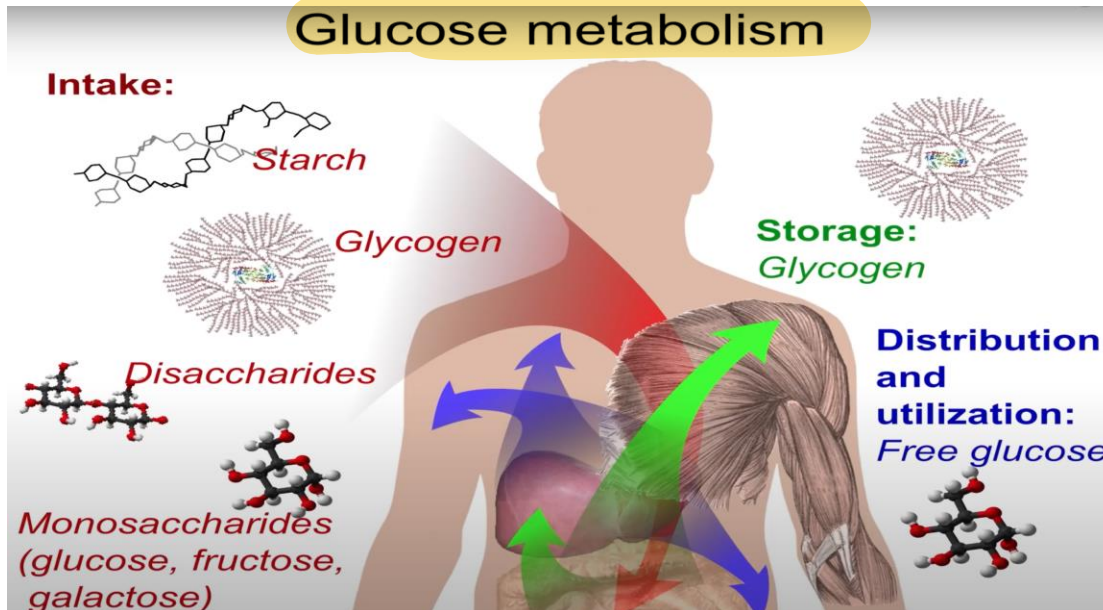
- Biochemistry is also the chemistry of life
- Life can be understood by knowing which molecules comprise living systems, their locations in cells, their structures, their interactions, and their functions.

Why study biochemistry?

- **Understanding is essential to all life sciences as it deals with common knowledge like:**
 - Genetics, cell biology, molecular biology
 - Microbiology, pathology
 - Pharmacology
 - Physiology and Immunology

Why study biochemistry?

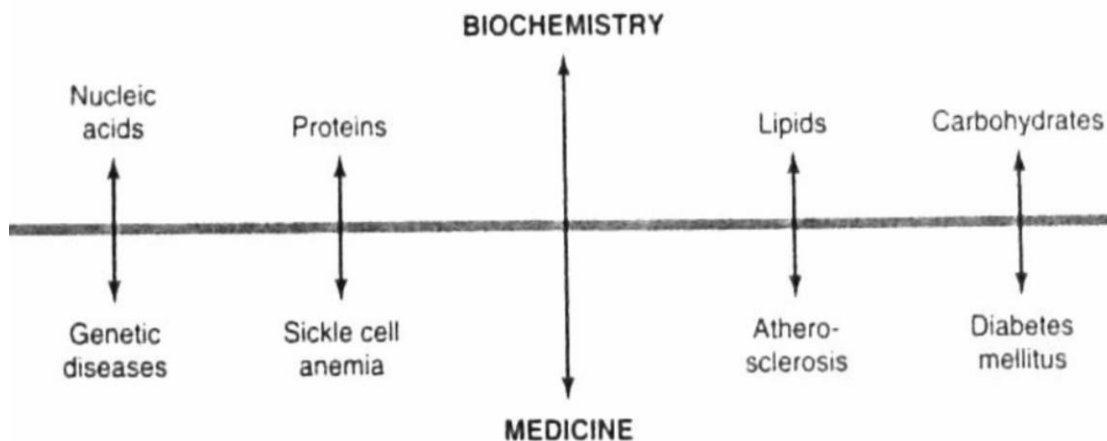
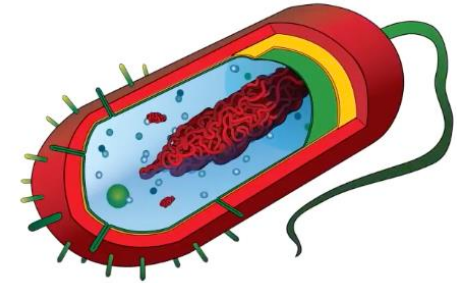
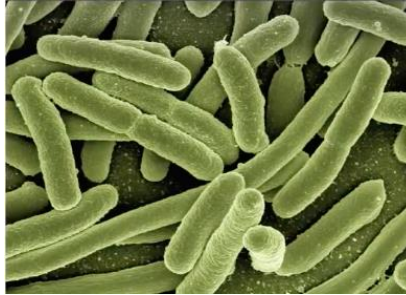
- Nutrition (metabolism of food: chemical process of molecules to get energy)



Nutrition Facts		
Serving Size 2/3 cup (55g)		
Servings Per Container About 8		
Amount Per Serving		
Calories 230	Calories from Fat 40	
	% Daily Value*	
Total Fat 8g		12%
Saturated Fat 1g		5%
Trans Fat 0g		
Cholesterol 0mg		0%
Sodium 160mg		7%
Total Carbohydrate 37g		12%
Dietary Fiber 4g		16%
Sugars 1g		
Protein 3g		
Vitamin A		10%
Vitamin C		8%
Calcium		20%
Iron		45%
* Percent Daily Values are based on a 2,000 calorie diet. Your daily value may be higher or lower depending on your calorie needs.		
	Calories:	2,000 2,500
Total Fat	Less than	65g 80g
Sat Fat	Less than	20g 25g
Cholesterol	Less than	300mg 300mg
Sodium	Less than	2,400mg 2,400mg
Total Carbohydrate		300g 375g
Dietary Fiber		25g 30g

Why study biochemistry?

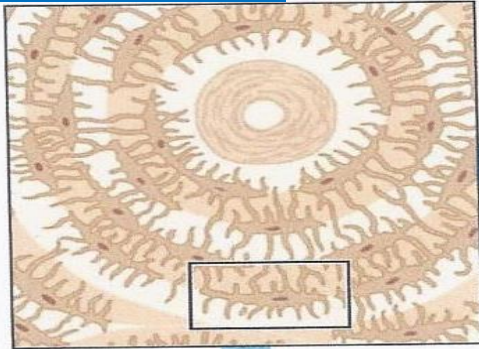
– medicine



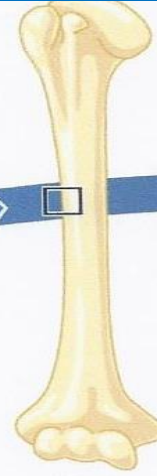
organ

organism

tissue



Bone tissue

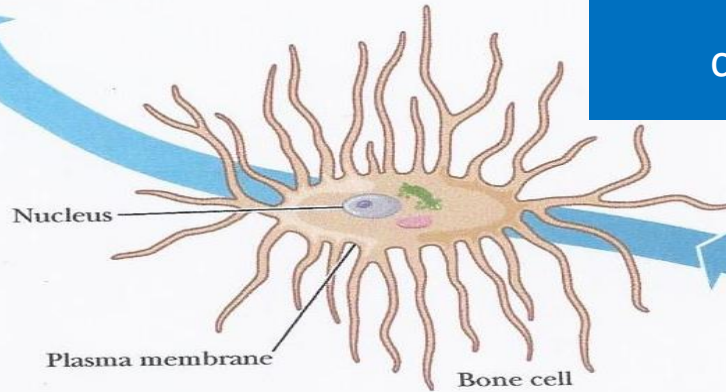


Bone

Skeletal system of human being

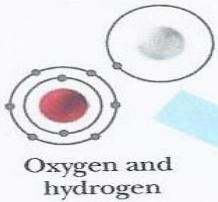


cell



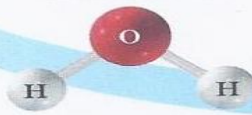
Bone cell

elements



Oxygen and hydrogen

Micro-molecule



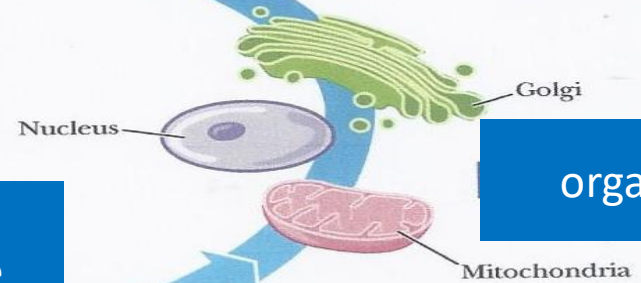
Water

Macro-molecule

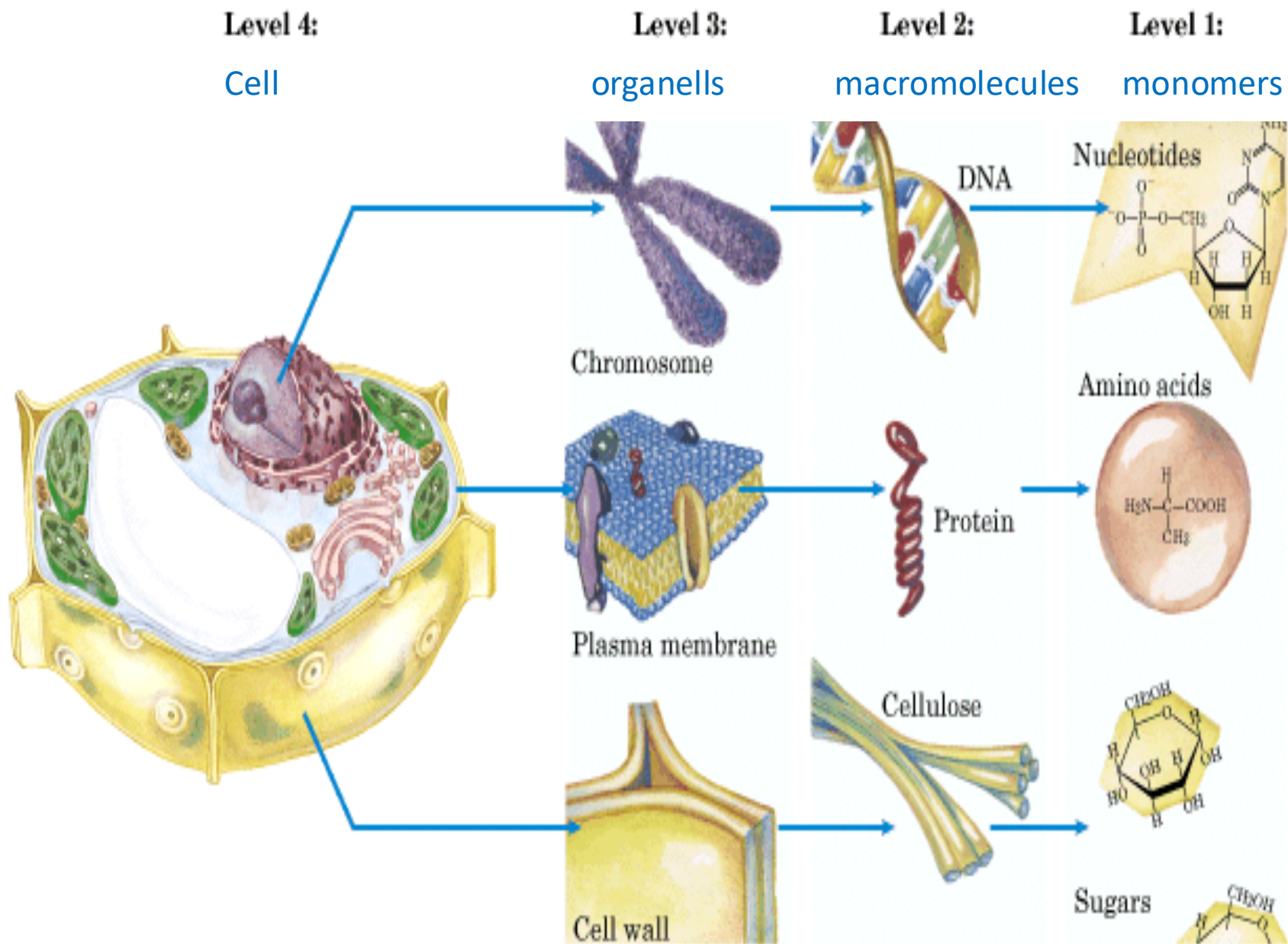


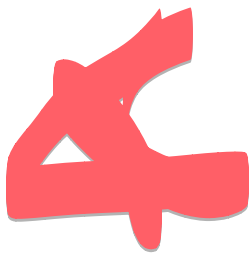
Protein

organel



Mitochondria





Elements of Life

Living matter consists of a relatively small number of elements

الأكثر شيوعاً

- Most abundant elements, essential for all organisms: C, N, O, P, S, H

C
Carbon

H
Hydrogen

N
Nitrogen

O
Oxygen

P
Phosphorous

S
Sulfur

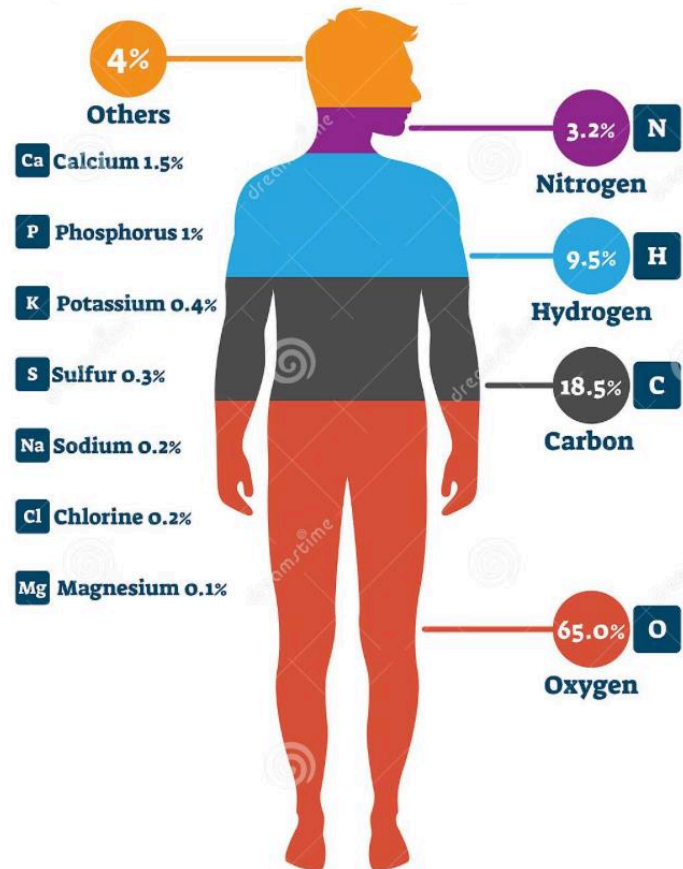
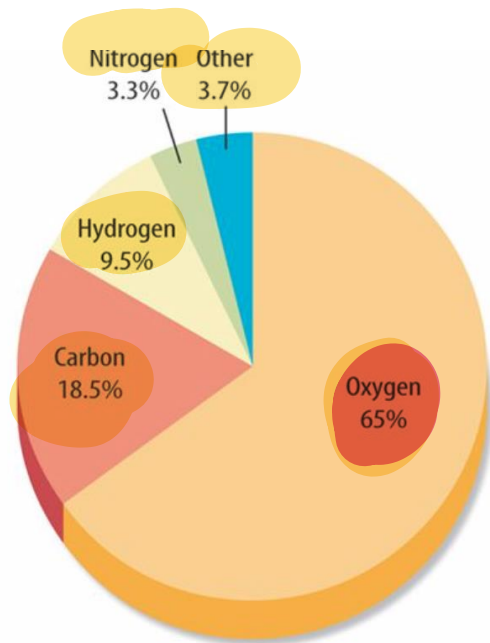
كمية قليلة

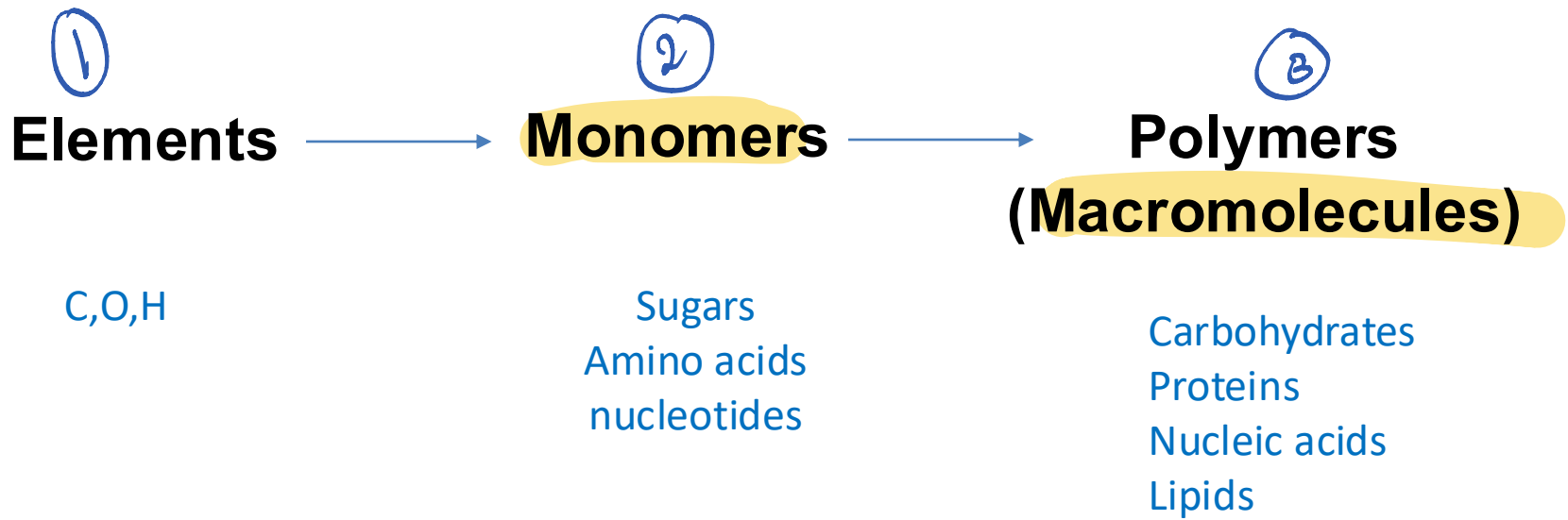
- Less abundant elements, essential for all organisms : Na, Mg, Cl, K, Ca
- Trace levels elements, essential for all organism: Mn, Fe, Co, Cu, Zn

كمية بسيطة جداً

Na → Sodium, Mg → Magnesium, Cl → Chlorine, K → Potassium, Ca → calcium
Mn → Manganese, Fe → Iron, Co → Cobalt, Cu → copper, Zn → Zinc

Human body





Monomers: building blocks

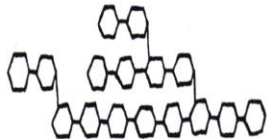
Polymers: long molecules consist of small subunits (monomers)

Four major macromolecules

Proteins



Carbohydrates



Nucleic acids



Lipids

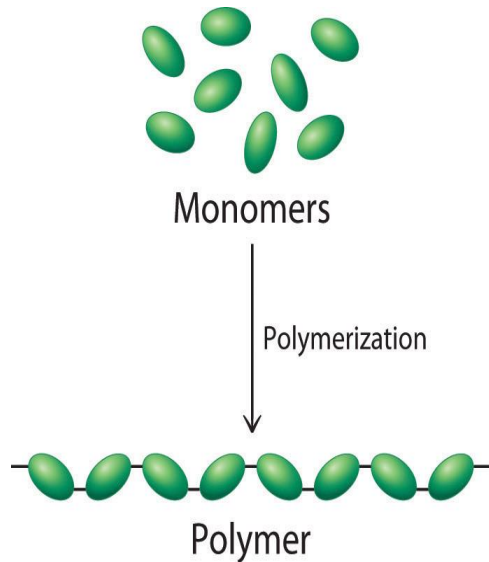


Chemical composition of a normal man (weight 65 kg)

Constituent	Percent (%)	Weight (kg)
① Water	61.6	40
② Protein	17.0	11
③ Lipid	13.8	9
④ Carbohydrate	1.5	1
⑤ Minerals	6.1	4

1. Carbohydrates

Carbohydrates are polymers of sugars (monosaccharides).



monosaccharide



(carbohydrate)

1. Carbohydrates

These molecules are important for:

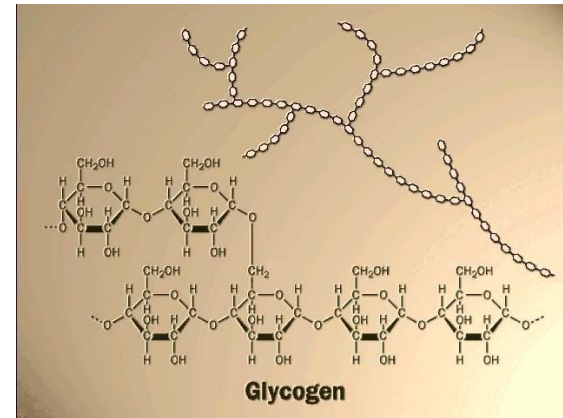
1. Energy storage (starch and glycogen)
2. Building biological structure (cellulose).

Starch
↓
Plants

glycogen
↙ ↘
humans animals

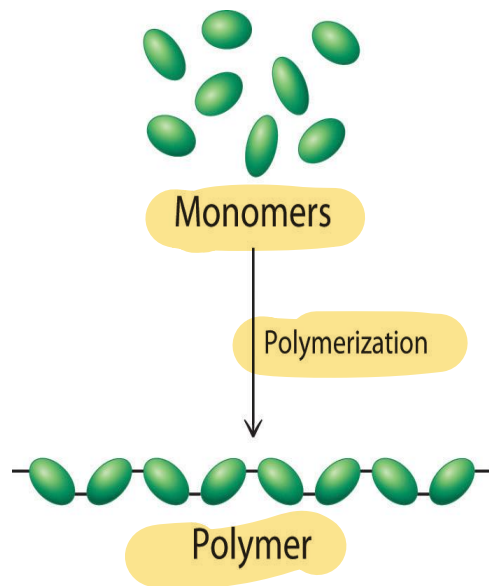


sugars

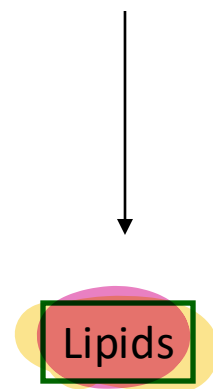


Carbohydrates

2. Lipids



Hydrocarbon chains (nonpolar)



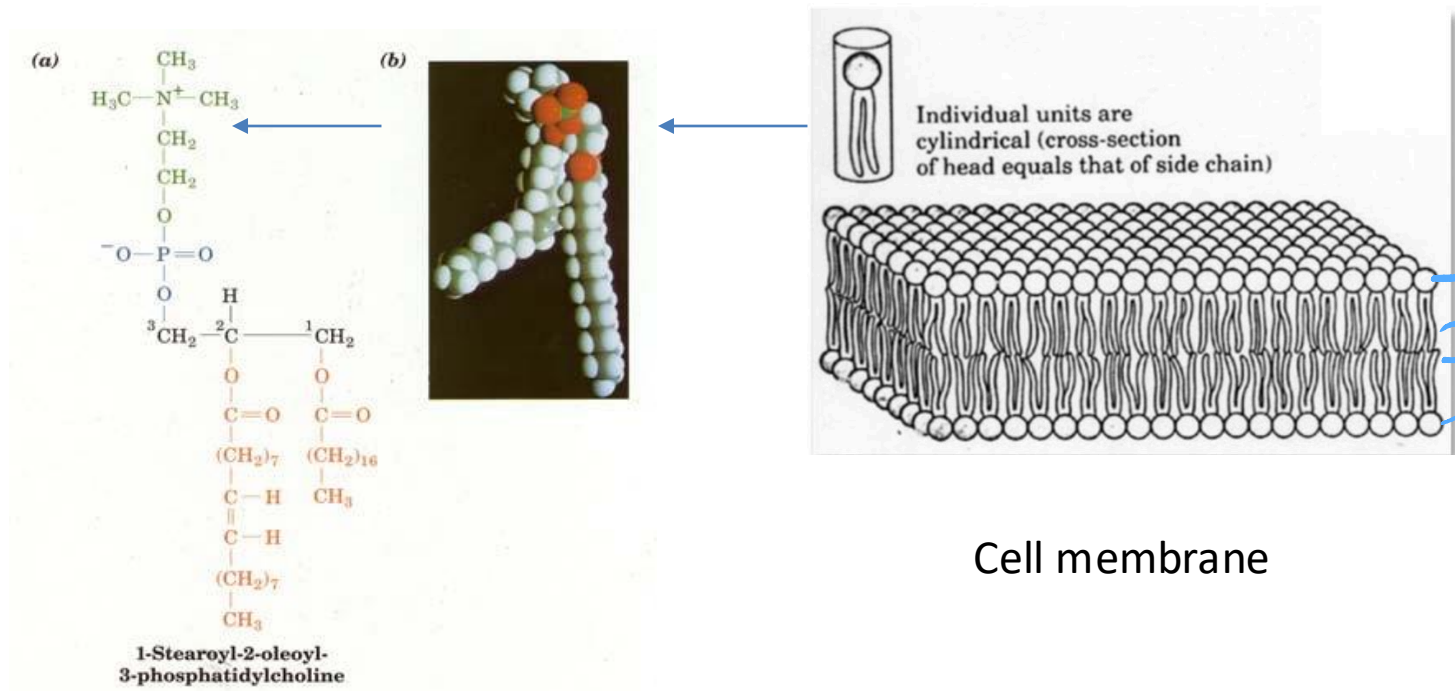
A diagram showing the formation of lipids. A vertical arrow points down from the text "Hydrocarbon chains (nonpolar)" to a pink oval containing the word "Lipids". The pink oval is enclosed in a green rectangular box.

Lipids

2. Lipids

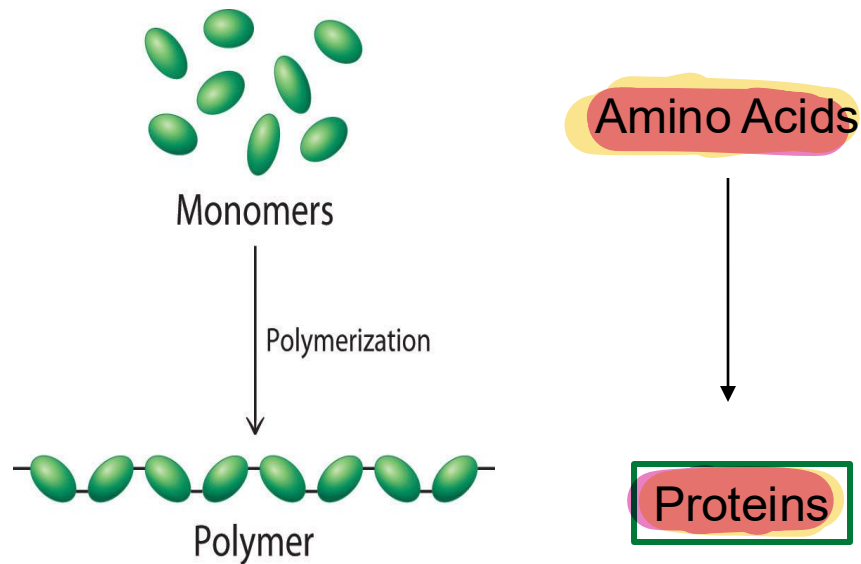
- These molecules are important as:

1. Energy storage (fats). *الغذاء الخلوي*
2. Structural molecule: (cell membranes).



3. Proteins

Proteins are polymers of amino acids.



3. Proteins

after water

- **Proteins:** These molecules are the most abundant macromolecules in cells (~20% by weight).

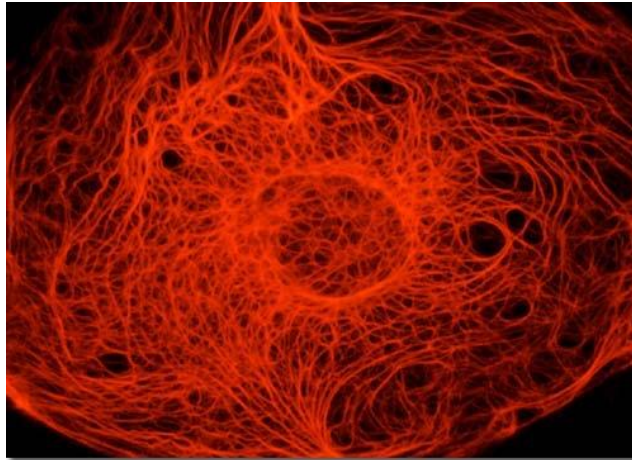
- **Functions**

1. Structural Proteins (collagen)
2. Biological Catalysts (Enzymes)
3. Signaling (some hormones)
4. Immune function (antibodies, antibodies receptors)



3. Proteins

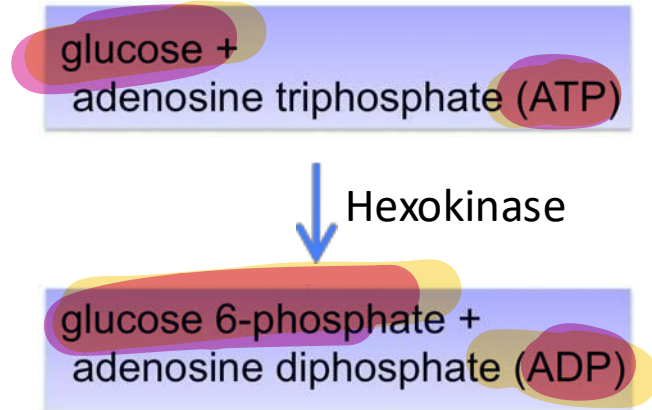
- Structural Proteins: support



Intermediate filaments in a mammalian cell

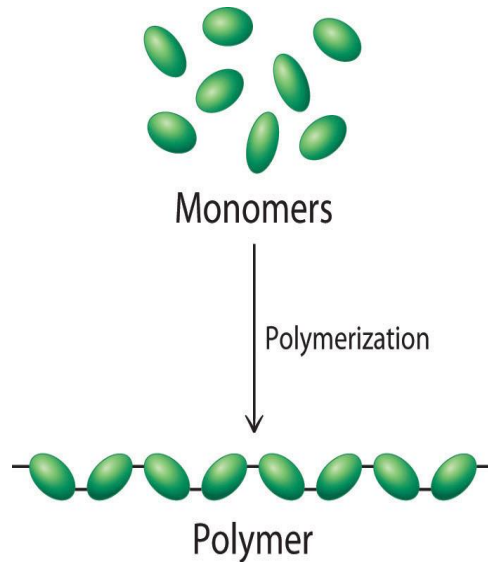
3. Proteins

- Proteins: Biological Catalysts (Enzymes)

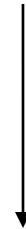


4. Nucleic acids

Nucleic acids are polymers of nucleotides.



Nucleotides



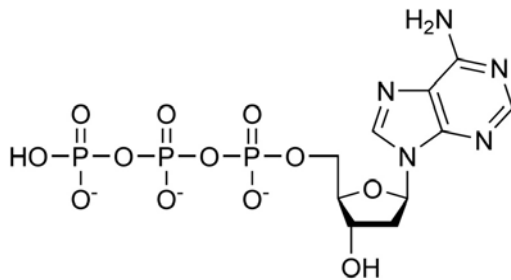
Nucleic acids (DNA & RNA)

4. Nucleic acids

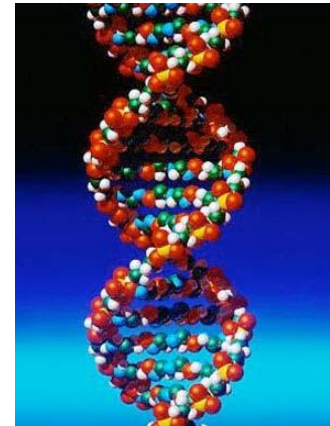
ذات الخيانت
الوراثية

للنفسيات

- Nucleic Acids (**DNA** and **RNA**).
- These molecules are important in:
 1. The storage and transfer of genetic information
 2. The synthesis of proteins.



nucleotides



nucleic acids

Macromolecule

Carbohydrates

Lipids

Proteins

Nucleic acids

Monomer

Monosaccharide

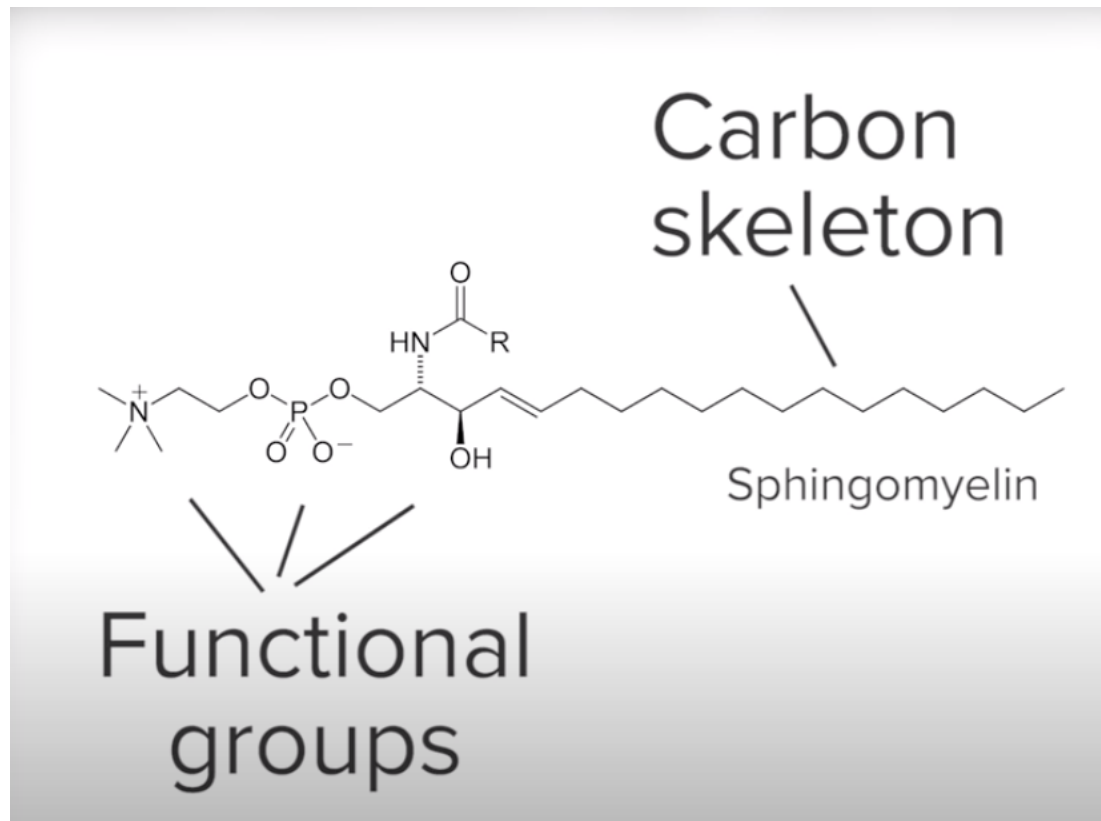
Not always polymers;
Hydrocarbon chains

Amino acids

Nucleotides

The skeleton of macromolecule

Biomolecules are compounds of carbons with a variety of functional groups

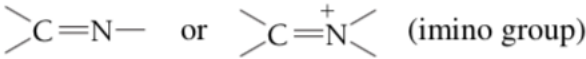
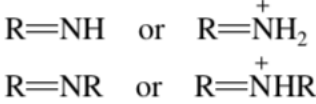


Common functional groups

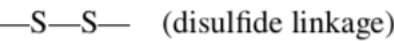
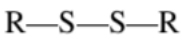
Different classes of biological molecules are characterized by different types of **functional groups**

Compound Name	Structure ^a	Functional Group or Linkage
Amine ^b	RNH_2 or RNH_3^+ R_2NH or R_2NH_2^+ R_3N or R_3NH^+	$\text{—N} \begin{smallmatrix} \diagup \\ \diagdown \end{smallmatrix}$ or $\text{—}\overset{+}{\text{N}}\text{—}$ (amino group)
Alcohol	ROH	—OH (hydroxyl group)
Thiol	RSH	—SH (sulfhydryl group)
Ether	ROR	—O— (ether linkage)
Aldehyde	$\begin{array}{c} \text{O} \\ \\ \text{R—C—H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{—C—} \end{array}$ (carbonyl group)
Ketone	$\begin{array}{c} \text{O} \\ \\ \text{R—C—R} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{—C—} \end{array}$ (carbonyl group)
Carboxylic acid ^b	$\begin{array}{c} \text{O} \\ \\ \text{R—C—OH} \end{array}$ or	$\begin{array}{c} \text{O} \\ \\ \text{—C—OH} \end{array}$ (carboxyl group) or
	$\begin{array}{c} \text{O} \\ \\ \text{R—C—O}^- \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{—C—O}^- \end{array}$ (carboxylate group)
Ester	$\begin{array}{c} \text{O} \\ \\ \text{R—C—OR} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{—C—O—} \end{array}$ (ester linkage) $\begin{array}{c} \text{O} \\ \\ \text{R—C—} \end{array}$ (acyl group) ^c
Thioester	$\begin{array}{c} \text{O} \\ \\ \text{R—C—SR} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{—C—S—} \end{array}$ (thioester linkage) $\begin{array}{c} \text{O} \\ \\ \text{R—C—} \end{array}$ (acyl group) ^c
Amide	$\begin{array}{c} \text{O} \\ \\ \text{R—C—NH}_2 \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{—C—N} \begin{smallmatrix} \diagup \\ \diagdown \end{smallmatrix} \end{array}$ (amido group) $\begin{array}{c} \text{O} \\ \\ \text{R—C—} \end{array}$ (acyl group) ^c
	$\begin{array}{c} \text{O} \\ \\ \text{R—C—NHR} \end{array}$	
	$\begin{array}{c} \text{O} \\ \\ \text{R—C—NR}_2 \end{array}$	

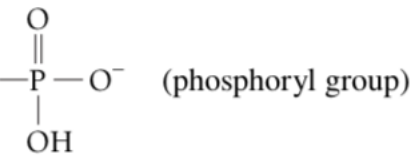
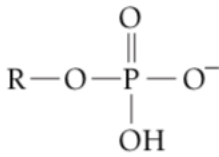
Imine (Schiff base)^b



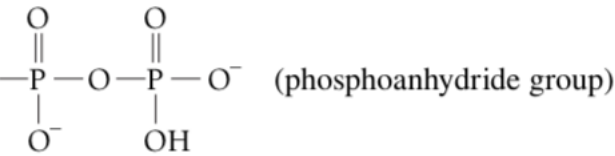
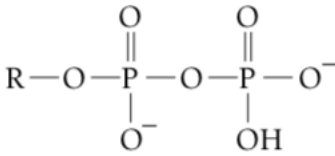
Disulfide



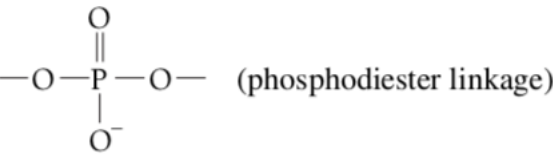
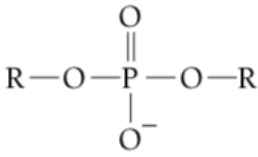
Phosphate ester^b



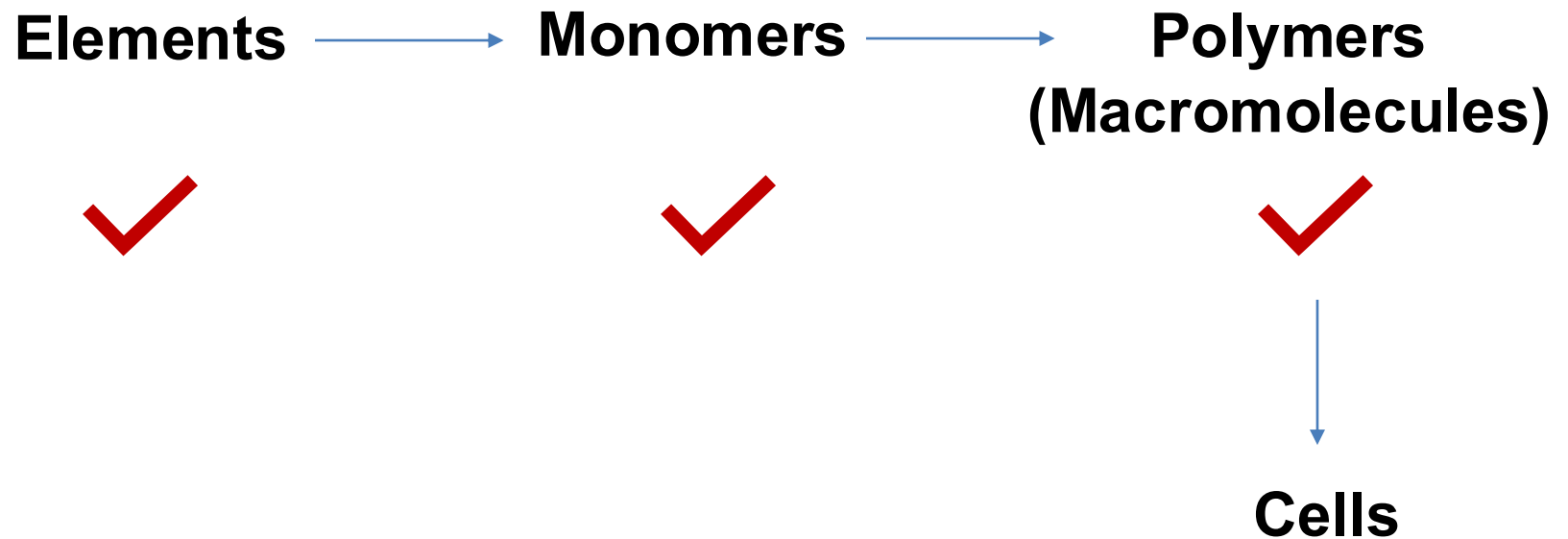
Diphosphate ester^b



Phosphate diester^b



^bR represents any carbon-containing group. In a molecule with more than one R group, the groups may be the same or different.

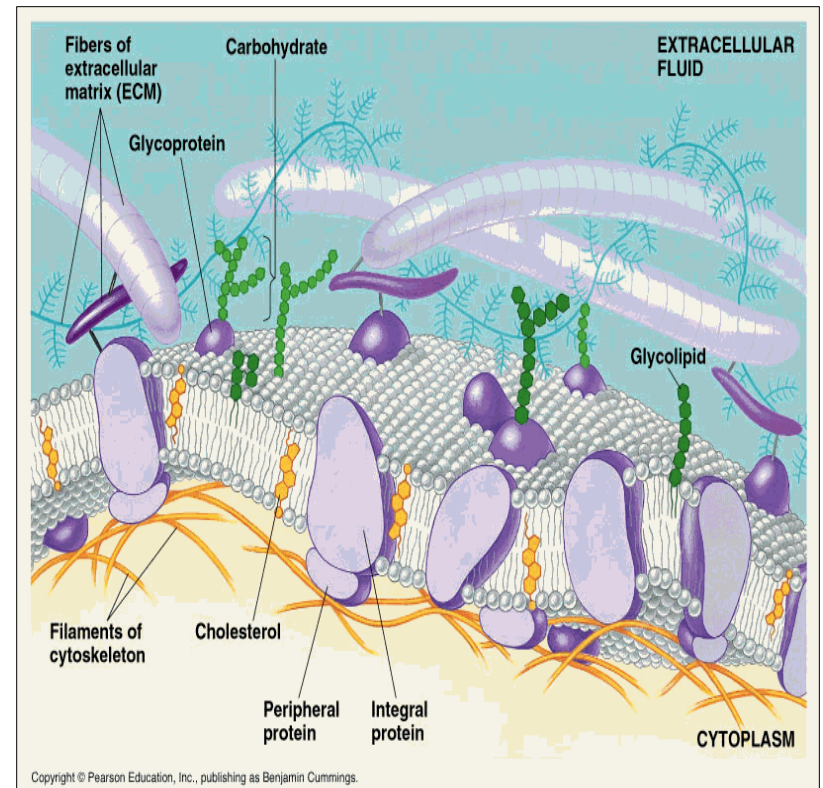


Biochemistry of cells

- **Cells** are smallest living unit of an organism.
- Complex living organism originate from simple elements. **Carbon, hydrogen, oxygen, sulfur, and nitrogen** combine to make up many different kind of biomolecules such as **carbohydrates, fatty acids, amino acids** which combine to make proteins.
- **Phosphorus** is the most ingredients for making **DNA** and **RNA**. A collection of interacting molecules, becomes a **cell** the basic unit of life.

Biochemistry and organization of cells

- Macromolecules recognize and interact with one another in specific ways to perform essential cellular functions (e.g. membranes are complexes of lipids, carbohydrates and proteins).
- Macromolecules have three dimensions and shapes! Much of biochemistry relies on this fact.



REFERENCES

1. Murray, R., Bender, D., Botham, K., Kennelly, P., Rodwell, V., Weil., P. (2012) Harper's illustrated biochemistry, 29th edition. Publisher: McGraw Hill Lange.
2. Nelson, D. and Cox, M. (2008) Lehninger principles of biochemistry, 5th edition. Publisher: W.H. Freeman and company, New York.
3. Harvey, R. and Ferrier, D. (2011) Lippincott's illustrated reviews: biochemistry, 5th edition. Publisher: Lippincott Williams & Wilkins.

4. Moorthy, K. (2008) Fundamentals of Biochemical Calculations, 2nd edition. Publisher: CRC Press.

4. Moorthy, K. (2008) Fundamentals of Biochemical Calculations, 2nd edition. Publisher: CRC Press.