شرح وتلخيص التفاعلات الكيميائية في – منهج انسباير

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1	شرح وتلخيص التفاعلات الكيميائية – الدرس الثاني من الوحدة السادسة
2	أسئلة على درس الذرات والعناصر والمركبات _ بريدج

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End of Term 1 Exam Coverage

Grade 9 Advanced – Biology

Academic Year 2026-2027

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Q1 : Module 6: Chemistry in Biology

Lesson 2: Chemical Reactions

BIO.3.1.02.022 Identify examples of chemical reactions that support main functions of living organisms where reactants and products rearrange to form ATP, ADP and inorganic phosphate.

(Page 11)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 13 (Chemical Reaction vs. Physical Change) · Page 11):

A chemical reaction is the process by which atoms or groups of atoms in substances are reorganized into different substances. Chemical bonds are broken and new bonds are formed. Starting substances are called reactants (left side of the arrow), and new substances formed are called products (right side of the arrow). In Figure 13, rusting is a chemical reaction because iron and oxygen react to form a new substance called iron oxide (rust). In living cells, ATP breaks down into ADP and inorganic phosphate (Pi) to release energy, and ADP + Pi recombine to form ATP.

Key Ideas from the Student Book:

- A chemical reaction breaks old chemical bonds and forms new chemical bonds.
- Reactants are written on the left side of the reaction arrow; products are written on the right side.
- Matter cannot be created or destroyed (Law of Conservation of Mass): both sides have the same number of atoms.
- Figure 13 shows rust (iron oxide) on a chain, which is a chemical reaction, unlike boiling water which is a physical change.

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Term / Example	Meaning	Type of Change
Reactants	Starting substances before the reaction (left side)	Input of chemical reaction
Products	New substances formed during the reaction (right side)	Output of chemical reaction
Rusting (Iron + Oxygen -> Iron Oxide)	Atoms rearrange to form a new orange-brown substance	Chemical reaction (Chemical change)
ATP <-> ADP + Inorganic Phosphate (Pi)	Cells store and release energy by rearranging phosphate bonds	Biological chemical reaction
Melting Ice / Boiling Water	Changes state from solid to liquid to gas without making a new substance	Physical change only

Remember:

✓ Reactants (starting substances) -> Products (new substances formed).

✓ Rusting (iron + oxygen -> iron oxide) and ATP <-> ADP + Pi are chemical reactions.

✓ Melting ice and boiling water are physical changes, not chemical reactions.

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Figure 13 After a chemical change, such as rusting, a new substance is formed. During a physical change, such as water boiling, the chemical makeup of the water is not altered.

The Change Matrix: Physical vs. Chemical

Physical Change	Chemical Reaction
Alters a substance's appearance, but not its core composition.	Atoms are reorganized into completely different substances. Bonds are broken and formed. Clues include heat, light, or a new state.
	
Example: Water boiling in a beaker.	Example: Oxygen reacting with iron to form rust (Iron Oxide, Fe_2O_3).

Questions :

Question 1: In Figure 13, why is rusting classified as a chemical reaction?

(A) Iron and oxygen form a new substance called iron oxide	(B) Iron only changes its physical shape without new bonds
(C) Water changes state from liquid to water vapor	(D) Atoms are destroyed during the rusting process

Question 2: What is the definition of a chemical reaction?

(A) A change in shape without forming new substances	(B) A process that reorganizes atoms into different substances
(C) The freezing of liquid water into solid ice	(D) The destruction of atoms to create new matter

Question 3: What are reactants in a chemical reaction?

(A) The starting substances in a chemical reaction	(B) The new substances formed at the end
(C) Substances that never change their bonds	(D) Heat and light released by physical changes

Question 4: What are products in a chemical reaction?

(A) The starting substances before a reaction begins	(B) The arrows used in a chemical equation
(C) The substances formed during a chemical reaction	(D) Unchanged mixtures of water and sand

Question 5: Where are reactants written in a chemical equation?

(A) On the left side of the arrow	(B) On the right side of the arrow
(C) Above the reaction arrow only	(D) Underneath the product formulas

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Question 6: Where are products written in a chemical equation?

(A) On the left side of the arrow	(B) On the right side of the arrow
(C) Before the plus sign on the left	(D) Inside parentheses before reactants

Question 7: What new substance is formed when iron and oxygen react?

(A) Carbon dioxide gas	(B) Glucose sugar
(C) Sodium chloride	(D) Iron oxide (rust)

Question 8: Which of the following is a physical change, NOT a chemical reaction?

(A) Iron rusting in moist air	(B) Cells breaking down glucose for energy
(C) Boiling liquid water into steam	(D) Combining ADP and phosphate to make ATP

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Q2 : Module 6: Chemistry in Biology

Lesson 2: Chemical Reactions

BIO.3.1.02.022 Identify examples of chemical reactions that support main functions of living organisms where reactants and products rearrange to form ATP, ADP and inorganic phosphate.

(Page 13)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 14 (Activation Energy Graph) · Page 13):

Most chemical reactions require energy to begin. Activation energy is the minimum amount of energy needed for reactants to form products in a chemical reaction. For example, a candle will not burn until a flame provides the activation energy. In Figure 14, reactants X and Y must absorb activation energy (the peak of the curve) before they can combine to form product XY. In this graph, the energy of the product XY is lower than the energy of the reactants X + Y, so energy is released (exothermic reaction).

Key Ideas from the Student Book:

- Activation energy is the minimum energy required to start a chemical reaction.
- In Figure 14, reactants X and Y must overcome the activation energy barrier to form product XY.
- Exothermic reactions release energy (products have lower energy than reactants).
- Endothermic reactions absorb energy (products have higher energy than reactants).

Concept in Figure 14	Description
Activation Energy	The minimum amount of energy needed for reactants to form products (height of the hill)
Reactants (X + Y)	Starting molecules on the left of the graph before absorbing activation energy
Product (XY)	Final molecule on the right of the graph after the reaction completes
Exothermic Reaction	Releases heat energy; products have LOWER energy than reactants (like Figure 14)
Endothermic Reaction	Absorbs heat energy; products have HIGHER energy than reactants

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Remember:

✓ Activation energy = minimum energy needed to start a chemical reaction.

✓ Exothermic = releases heat energy (Product energy < Reactant energy, as in Figure 14).

✓ Endothermic = absorbs heat energy (Product energy > Reactant energy).

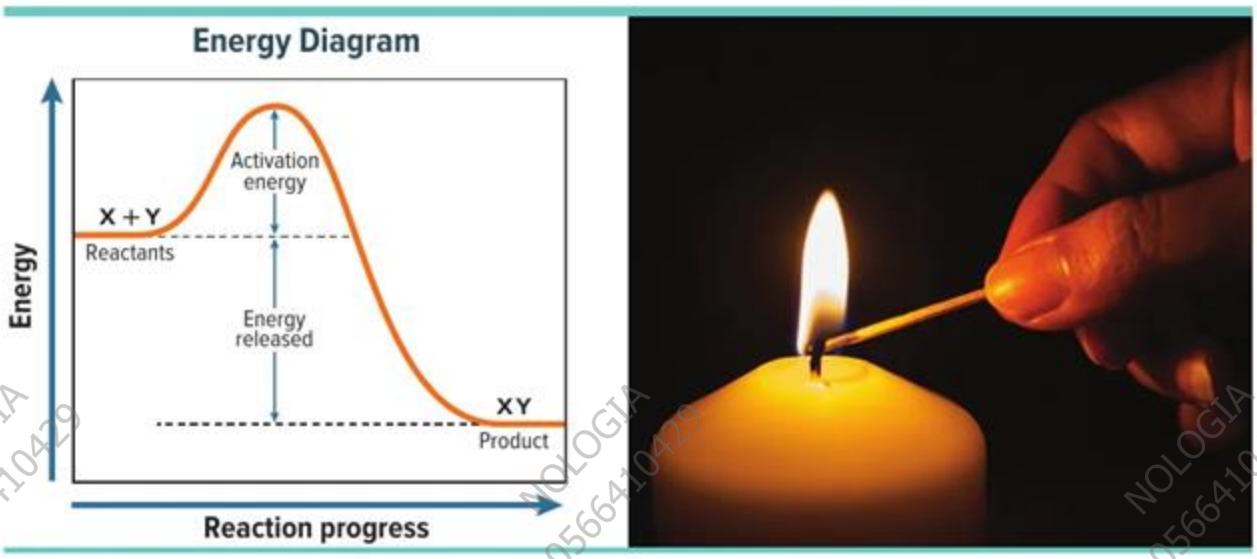
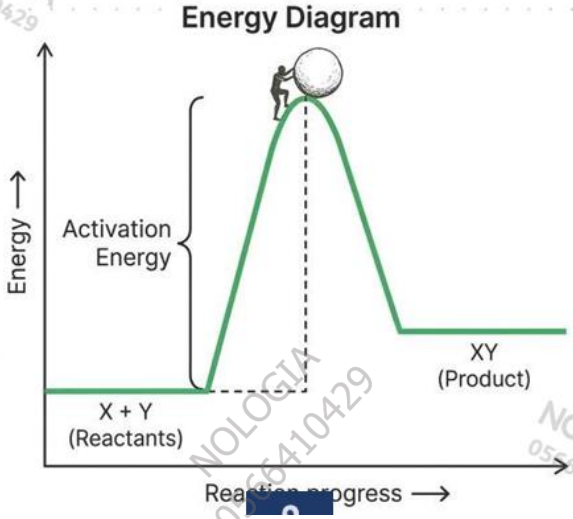


Figure 14 The flame of the match provides activation energy—the amount of energy needed to begin a reaction. The reaction gives off energy in the form of heat and light.

The Energy Requirement

Activation Energy
The minimum amount of energy needed for reactants to form products.





The Candle Metaphor: A candle won't burn until you light the wick. The flame provides the activation energy. Once the reaction begins, it sustains itself.

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Questions :

Question 1: According to Figure 14, what is required for reactants X and Y to form product XY?

(A) Activation energy	(B) Freezing temperatures
(C) Loss of all atoms	(D) A physical mixture

Question 2: What is the definition of activation energy?

(A) The total mass of products at the end of a reaction	(B) The minimum amount of energy needed for reactants to form products
(C) The energy stored only inside frozen water molecules	(D) The number of protons inside a carbon nucleus

Question 3: In Figure 14, what are the reactants shown on the left of the graph?

(A) X + Y	(B) XY only
(C) ATP + water	(D) Iron oxide

Question 4: In Figure 14, what is the product shown on the right of the graph?

(A) X only	(B) Y only
(C) XY	(D) X - Y

Question 5: What does the peak (top of the hill) in Figure 14 represent?

(A) The mass of the final products	(B) The freezing point of the solution
(C) A reaction that needs no energy	(D) The activation energy required to start the reaction

Question 6: What is an endothermic reaction?

(A) A chemical reaction that absorbs energy in the form of heat	(B) A chemical reaction that releases heat to the surroundings
(C) A reaction where products have lower energy than reactants	(D) A reaction that requires zero activation energy

Question 7: Which type of reaction is shown in the energy graph of Figure 14?

(A) Endothermic reaction because energy is absorbed	(B) Exothermic reaction because energy is released
(C) Physical change with no bond breaking	(D) Nuclear reaction inside a star

Question 8: In an endothermic reaction, which has higher energy?

(A) The reactants have higher energy than the products	(B) Neither reactants nor products contain energy
(C) Both have exactly the same energy level	(D) The products have higher energy than the reactants

Question 9: In an exothermic reaction, which has higher energy?

(A) The reactants have higher energy than the products	(B) The products have higher energy than the reactants
(C) The products have infinite energy	(D) The reactants have zero energy

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Q3 : Module 6: Chemistry in Biology

Lesson 2: Chemical Reactions

BIO.3.1.02.021 Identify examples of reactions catalyzed by enzymes that occur in living systems, describing their importance in living organism and explaining why an enzyme deficiency results in the inability to perform a specific function in life.

(Page 15)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 17 (Effect of Enzyme on Activation Energy) · Page 15):

A catalyst is a substance that lowers the activation energy needed to start a chemical reaction without being used up or increasing the amount of product. Enzymes are biological catalysts (mostly proteins) that speed up chemical reactions in living organisms. Figure 17 compares a reaction with and without an enzyme: the red curve (With enzyme) has a much LOWER activation energy hill than the blue curve (Without enzyme), so products form much faster. If a person has an enzyme deficiency (lack of a specific enzyme), the reaction cannot occur fast enough to support that life function.

Key Ideas from the Student Book:

- A catalyst lowers activation energy and is NOT used up in the reaction.
- Enzymes are biological catalysts made of protein (such as amylase in saliva).
- In Figure 17, the enzyme lowers the activation energy peak so the reaction happens faster.
- Each enzyme catalyzes only one specific reaction; an enzyme deficiency prevents that specific function from occurring.

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Term / Enzyme	Function in Living Organisms
Catalyst	Substance that lowers activation energy and speeds up a chemical reaction without being used up
Enzyme	Biological catalyst (protein) that speeds up specific reactions in cells
Blue Curve (Without Enzyme)	Higher activation energy barrier -> slow chemical reaction
Red Curve (With Enzyme)	Lower activation energy barrier -> fast chemical reaction
Amylase (in saliva)	Breaks down amylose (starch) into simpler sugars; deficiency stops starch digestion

Remember:

✓ Enzymes are biological catalysts (proteins) that speed up reactions by LOWERING activation energy.

✓ Enzymes are NOT used up in a reaction and do NOT change the amount of product made.

✓ An enzyme deficiency stops the specific reaction that enzyme catalyzes.

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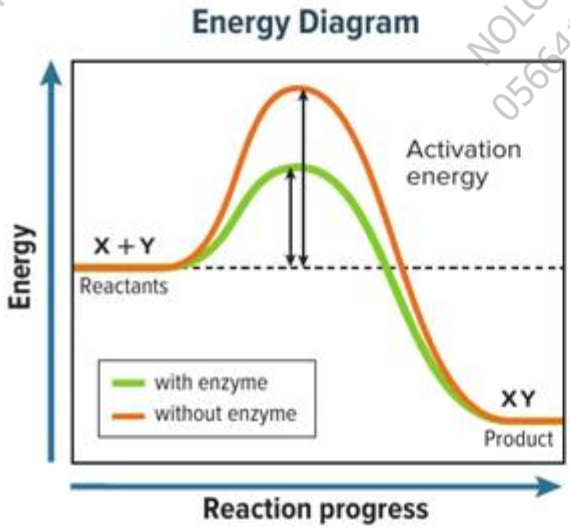
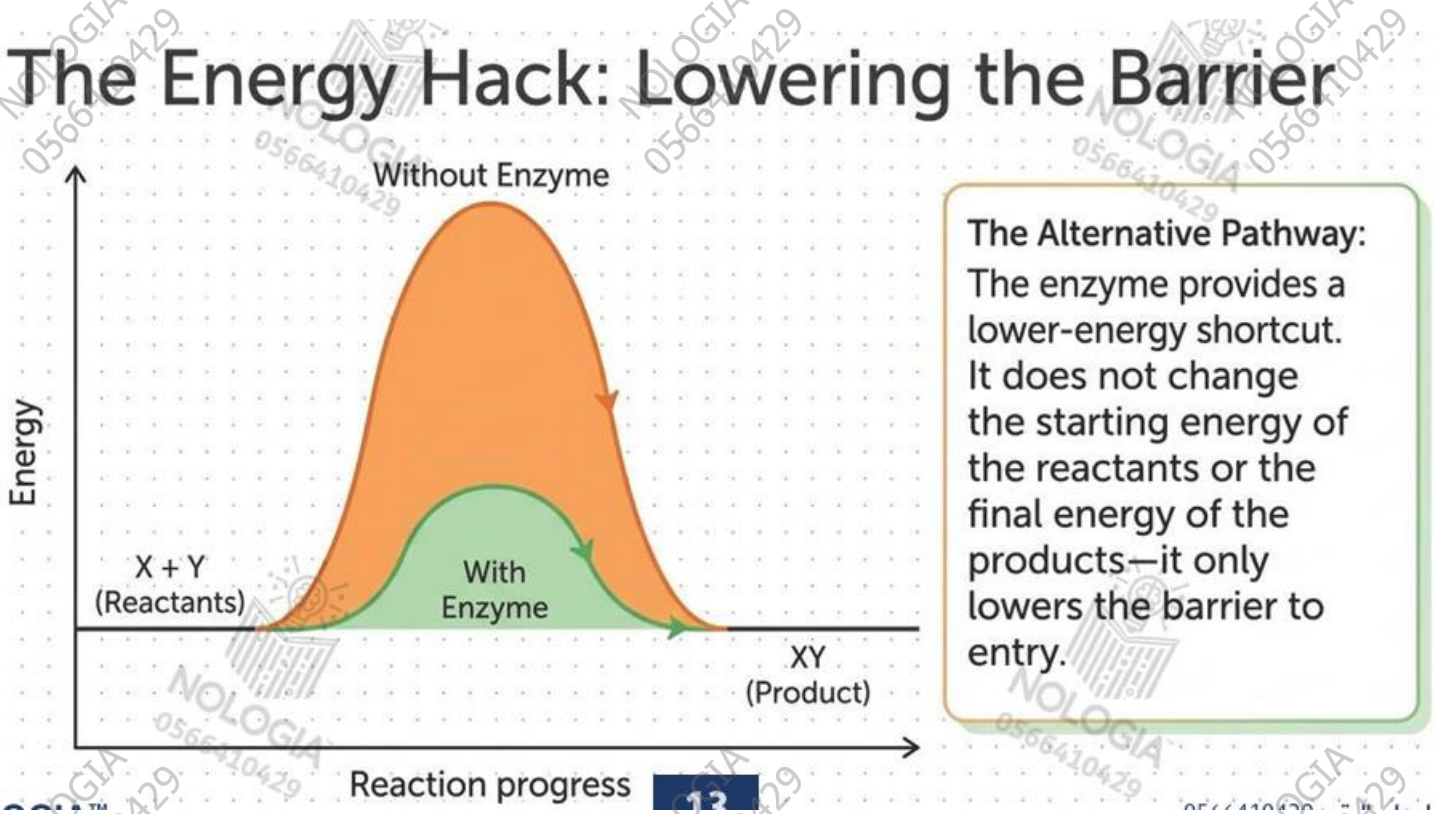


Figure 17 When an enzyme acts as a biological catalyst, the reaction occurs at a rate that is useful to cells.

Compare *the activation energy of the reaction without an enzyme to the activation energy of the reaction with an enzyme.*



Questions :

Question 1: In Figure 17, how does an enzyme affect a chemical reaction?

(A) It lowers the activation energy	(B) It raises the activation energy
(C) It stops the formation of products	(D) It is used up as a reactant

Question 2: What is the definition of a catalyst?

(A) A substance that slows down all chemical reactions	(B) A substance that lowers activation energy to speed up a reaction
(C) A product formed only during freezing	(D) A lipid that stores long-term energy

Question 3: What are enzymes?

(A) Biological catalysts made of proteins	(B) Simple sugars stored in plant cell walls
(C) Inorganic salts dissolved in ocean water	(D) Fatty acid tails in the cell membrane

Question 4: In Figure 17, which curve shows the reaction WITH an enzyme?

(A) The higher blue curve with higher activation energy	(B) A flat line with zero reactants
(C) The lower red curve with lower activation energy	(D) A vertical line showing no products

Question 5: In Figure 17, which curve shows the reaction WITHOUT an enzyme?

(A) The higher blue curve with higher activation energy	(B) The lower red curve with lower activation energy
(C) The bottom axis of the graph	(D) The product line on the right

Question 6: Does a catalyst increase the total amount of product made?

(A) Yes, it doubles the mass of products	(B) No, it only makes the reaction happen faster
(C) Yes, it turns into extra product molecules	(D) No, it stops any product from forming

Question 7: Does a catalyst get used up during a chemical reaction?

(A) Yes, it is destroyed after one reaction	(B) Yes, it becomes part of the product
(C) Yes, it evaporates as a gas	(D) No, it is not used up and can be used again

Question 8: Which enzyme in human saliva breaks down starch (amylose)?

(A) Hemoglobin	(B) Keratin
(C) Amylase	(D) Cellulose

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Q4 : Module 6: Chemistry in Biology

Lesson 2: Chemical Reactions

BIO.3.1.02.021 Identify examples of reactions catalyzed by enzymes that occur in living systems, describing their importance in living organism and explaining why an enzyme deficiency results in the inability to perform a specific function in life.

(Page 16)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 18 (How an Enzyme Works: Substrate & Active Site) · Page 16):

Figure 18 illustrates how an enzyme works. A substrate is a reactant that binds to an enzyme. An active site is the specific location on an enzyme where a substrate binds. The active site and the substrate have complementary shapes (like puzzle pieces or a lock and key). When the substrate binds to the active site, they form an enzyme-substrate complex. The active site changes shape slightly to help break old bonds and form new bonds, releasing the products. The enzyme is unchanged and ready to bind another substrate. Factors such as pH and temperature affect enzyme shape and activity.

Key Ideas from the Student Book:

- A substrate is a reactant that binds to an enzyme.
- The active site is the specific place on an enzyme where the substrate fits by complementary shape.
- Step 1: Substrates bind to the active site -> Step 2: Enzyme-substrate complex forms -> Step 3: Substrates convert to products and are released.
- Extreme pH or high temperature changes the shape of the active site so the substrate can no longer bind.

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Part / Step in Figure 18	Definition & Role
Substrate	The reactant that binds to a specific enzyme
Active Site	The specific pocket/location on an enzyme where the substrate binds
Enzyme-Substrate Complex	Temporary structure formed when the substrate binds to the active site
Products	New substances released from the enzyme after chemical bonds rearrange
pH & Temperature	Extreme temperature or pH changes the shape of the active site and reduces enzyme activity

Remember:

✓ Substrate = reactant that binds to an enzyme; Active site = specific place where the substrate binds.

✓ Sequence: Enzyme + Substrates -> Enzyme-Substrate Complex -> Enzyme + Products.

✓ Only substrates with the matching (complementary) shape fit into the active site.

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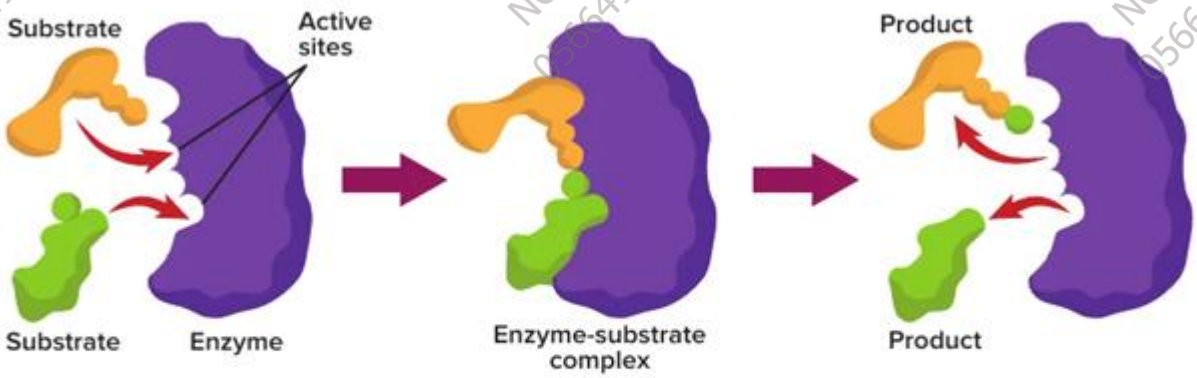
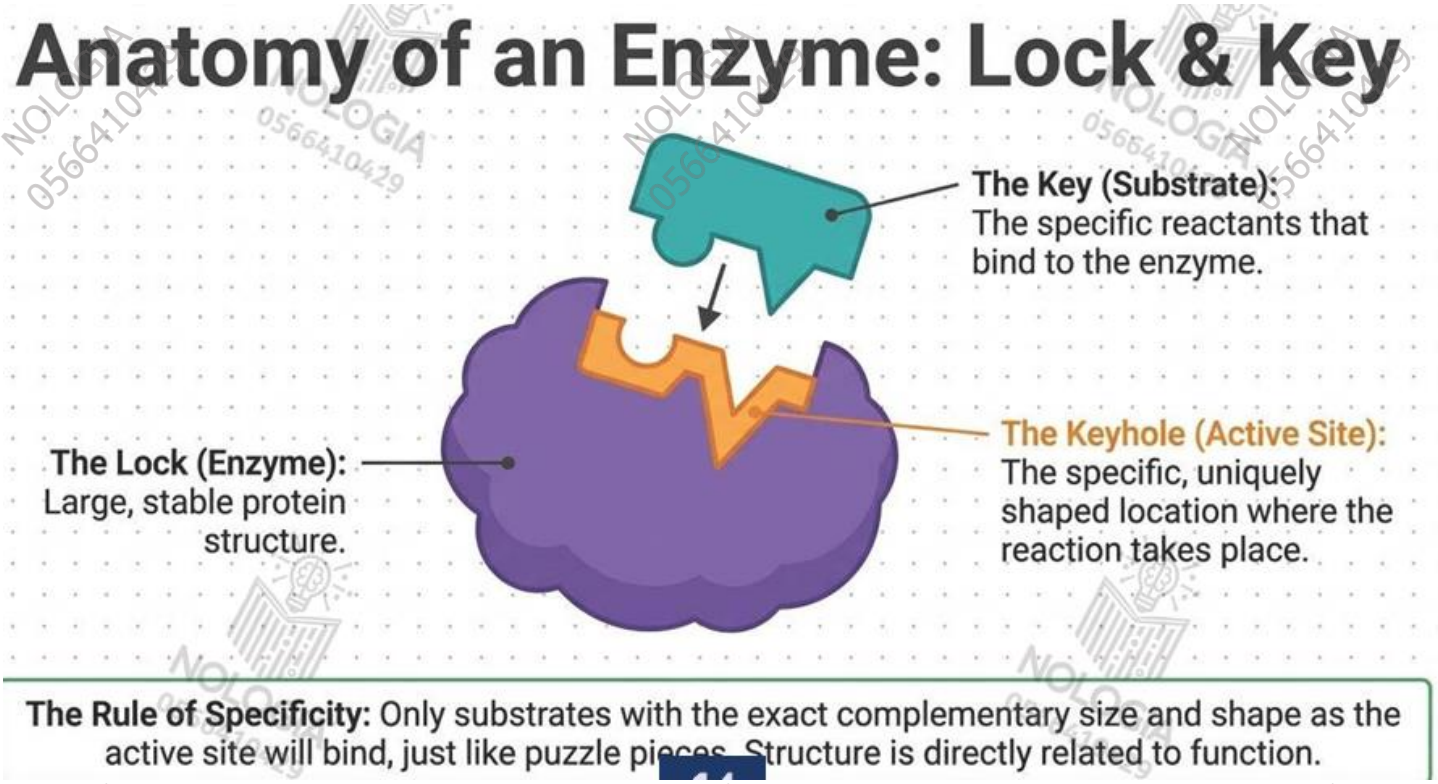


Figure 18 Substrates interact with enzymes at specific places called active sites. Only substrates with a specific shape can bind to the active site of an enzyme. Once the substrates bind, the active site changes shape and forms the enzyme-substrate complex. The substrates react to form products. The products are then released.



Questions :

Question 1: In Figure 18, what is the specific location on an enzyme where the substrate binds?

(A) Active site	(B) Product wall
(C) Cell nucleus	(D) Lipid tail

Question 2: What is the definition of a substrate?

(A) A product that destroys the cell membrane	(B) A reactant that binds to an enzyme
(C) An organelle that stores water in plants	(D) A microscope used to view atoms

Question 3: What is the definition of an active site?

(A) The specific location on an enzyme where a substrate binds	(B) The outer cell wall of a plant cell
(C) The final product released at the end	(D) The center of an atom containing protons

Question 4: Why can only a specific substrate bind to an enzyme active site?

(A) All substrates have the exact same shape	(B) Enzymes are made of liquid water
(C) The active site and substrate have complementary shapes	(D) Products push the substrate away from the cell

Question 5: What structure forms when a substrate binds to the active site?

(A) A phospholipid bilayer	(B) A cellulose cell wall
(C) A hydrogen bond network	(D) The enzyme-substrate complex

Question 6: What happens to the active site right after the substrate binds?

(A) It dissolves completely in water	(B) It changes shape slightly to fit the substrate tightly
(C) It turns into a carbohydrate ring	(D) It freezes into a solid crystal

Question 7: How does the enzyme-substrate complex help chemical reactions occur?

(A) It helps chemical bonds break and new bonds form	(B) It increases the activation energy needed
(C) It prevents reactants from touching each other	(D) It destroys all atoms in the substrate

Question 8: What is released from the enzyme at the end of the reaction in Figure 18?

(A) New enzymes	(B) Unchanged substrates
(C) Products	(D) Activation energy

Question 9: What happens to the enzyme after it releases the products?

(A) It is destroyed and cannot be used again	(B) It remains unchanged and can bind another substrate
(C) It leaves the cell as waste material	(D) It turns into glucose sugar

Question 10: What is the correct order of steps in Figure 18?

(A) Substrates bind -> Enzyme-substrate complex -> Products released	(B) Products bind -> Substrates released -> Enzyme destroyed
(C) Enzyme melts -> Products bind -> Complex freezes	(D) Active site disappears -> Substrates form -> Enzyme breaks

Q5 : Module 6: Chemistry in Biology

Lesson 3: Water and Its Solutions

BIO.3.1.02.020 Identify the solubility as the ability of a solute to dissolve in a solvent and explain the properties of water that make it the universal solvent.

(Page 18)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 19 (Polarity of the Water Molecule) · Page 18):

A water molecule (H2O) is formed by covalent bonds linking one oxygen atom and two hydrogen atoms. Because oxygen attracts electrons more strongly than hydrogen, the shared electrons spend more time near the oxygen nucleus than the hydrogen nuclei. This unequal sharing of electrons and the bent shape of the water molecule make water a polar molecule. As shown in Figure 19, the oxygen end has a slightly negative charge, and the two hydrogen ends have a slightly positive charge.

Key Ideas from the Student Book:

- Polar molecules have an unequal distribution of charges (oppositely charged regions).
- In a water molecule (H2O), covalent bonds share electrons unequally between oxygen and hydrogen.
- The oxygen end is slightly negative, and the two hydrogen ends are slightly positive.
- Solubility is the ability of a solute to dissolve in a solvent; water is the universal solvent because of its polarity.

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Part of Water Molecule (H2O)	Charge / Property	Reason
Oxygen end (1 O atom)	Slightly negative (-)	Electrons spend more time near the oxygen nucleus
Hydrogen ends (2 H atoms)	Slightly positive (+)	Electrons spend less time near the hydrogen nuclei
Molecular Shape	Bent shape (like a magnet with poles)	Unequal distribution of electrons
Polar Molecule	Molecule with oppositely charged regions	Makes water able to dissolve other polar and ionic solutes

Remember:

✓ Water (H2O) is a POLAR molecule due to unequal sharing of electrons and its bent shape.

✓ Oxygen end = slightly negative (-); Hydrogen ends = slightly positive (+).

✓ Polarity allows water to dissolve many solutes, making water the universal solvent.

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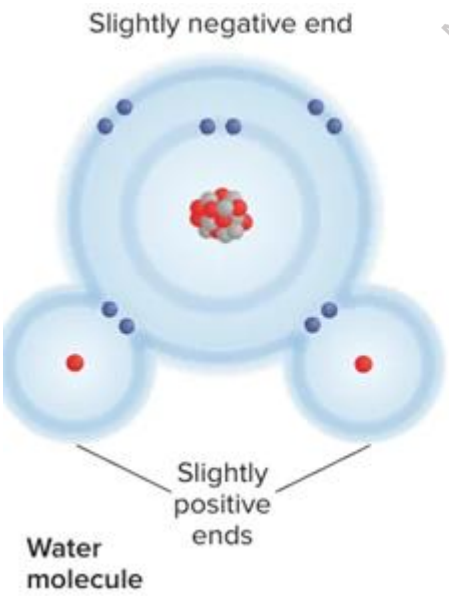
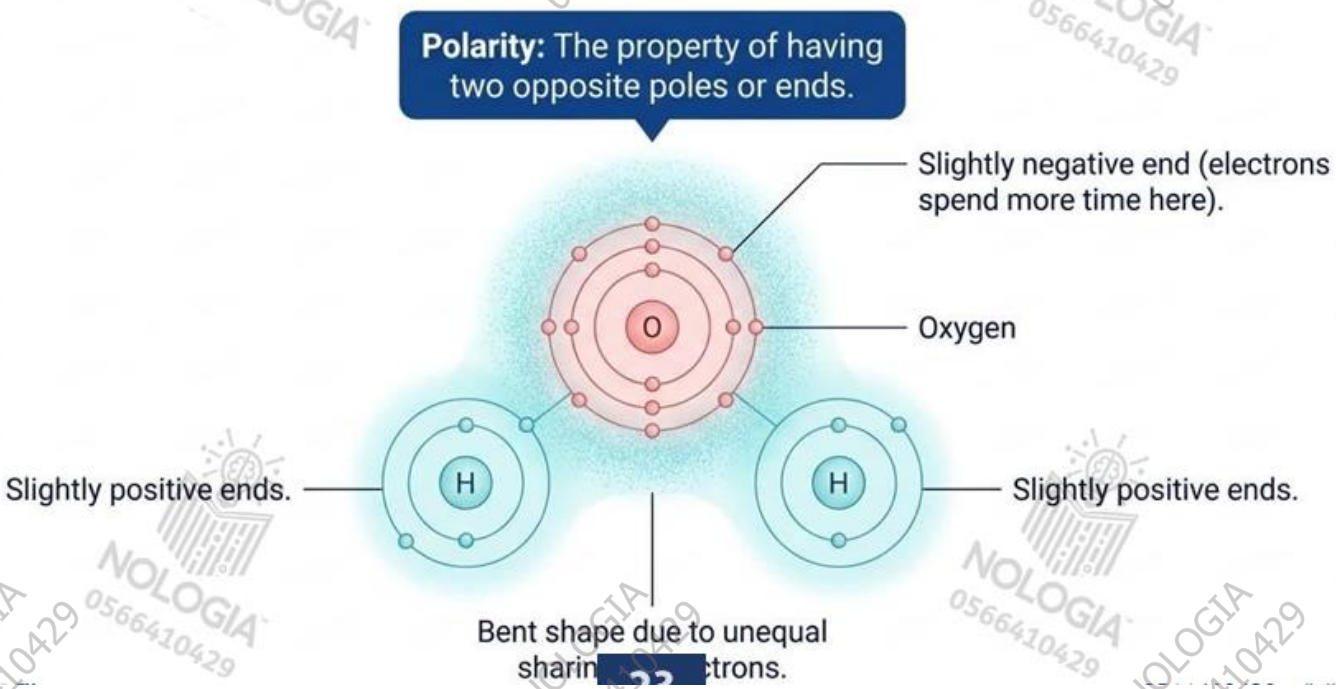


Figure 19 Water molecules have a bent shape, and electrons are not shared equally between hydrogen and oxygen. This results in a molecule with oppositely charged regions.

The Foundation: Molecular Polarity

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Questions :

Question 1: According to Figure 19, why is a water molecule polar?

(A) Unequal sharing of electrons gives it opposite partial charges	(B) It contains only positively charged oxygen atoms
(C) It transfers protons completely to form a metal	(D) It has a straight nonpolar carbon chain

Question 2: What is the definition of a polar molecule?

(A) A molecule with no electrons or protons	(B) A molecule that has an unequal distribution of charges
(C) A molecule found only at the North and South Poles	(D) A molecule that cannot dissolve in any liquid

Question 3: In Figure 19, what charge does the oxygen end of a water molecule have?

(A) Slightly negative	(B) Slightly positive
(C) Completely neutral	(D) Strongly positive

Question 4: In Figure 19, what charge do the two hydrogen ends of a water molecule have?

(A) Slightly negative	(B) Slightly positive
(C) Completely neutral	(D) Strongly negative

Question 5: Why is the oxygen end of a water molecule slightly negative?

(A) Oxygen has no protons in its nucleus	(B) Shared electrons spend more time near hydrogen
(C) Shared electrons spend more time near the oxygen nucleus	(D) Hydrogen destroys the oxygen electrons

Question 6: What type of bond holds the oxygen and hydrogen atoms together inside one water molecule?

(A) Ionic bond	(B) Peptide bond
(C) Metallic bond	(D) Covalent bond

Question 7: What is the shape of a water molecule shown in Figure 19?

(A) Bent shape	(B) Flat square shape
(C) Hexagonal ring shape	(D) Long straight chain

Question 8: How many hydrogen atoms and oxygen atoms are in one water molecule (H2O)?

(A) One hydrogen atom and two oxygen atoms	(B) Two hydrogen atoms and one oxygen atom
(C) Two carbon atoms and one oxygen atom	(D) Three hydrogen atoms and three oxygen atoms

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Q6 : Module 6: Chemistry in Biology

Lesson 3: Water and Its Solutions

BIO.3.1.02.020 Identify the solubility as the ability of a solute to dissolve in a solvent and explain the properties of water that make it the universal solvent.

(Page 19)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 21 (Van der Waals Forces in Water) · Page 19):

Because molecules have moving electrons, they can develop oppositely charged regions. Van der Waals forces are weak electrostatic attractions between oppositely charged regions of nearby molecules (named after Dutch physicist Johannes van der Waals). Although weaker than covalent or ionic bonds, van der Waals forces between water molecules are strong enough to hold a water droplet together and allow a water strider insect to walk on the surface of water (surface tension), as shown in Figure 21.

Key Ideas from the Student Book:

- Van der Waals forces are weak attractive forces between oppositely charged regions of molecules.
- They are weaker than covalent bonds and ionic bonds.
- In Figure 21, van der Waals forces between water molecules hold water droplets together.
- In Figure 21, these forces also create surface tension that holds a water strider on the water surface.

Feature / Force	Description & Biological Importance
Van der Waals Forces	Weak electrostatic attractions between oppositely charged regions of molecules
Strength	Weaker than covalent and ionic bonds, but strong when many molecules act together
Figure 21 (Left): Water Droplet	Van der Waals forces pull water molecules together into a round droplet
Figure 21 (Right): Water Strider	Surface tension from attractions between water molecules supports the insect on water

Remember:

✓ Van der Waals forces = weak attractions between oppositely charged regions of nearby molecules.

✓ They are weaker than covalent or ionic bonds.

✓ In Figure 21, they hold water droplets together and allow a water strider to stand on water.

Intermolecular Forces: The "Molecular Velcro"

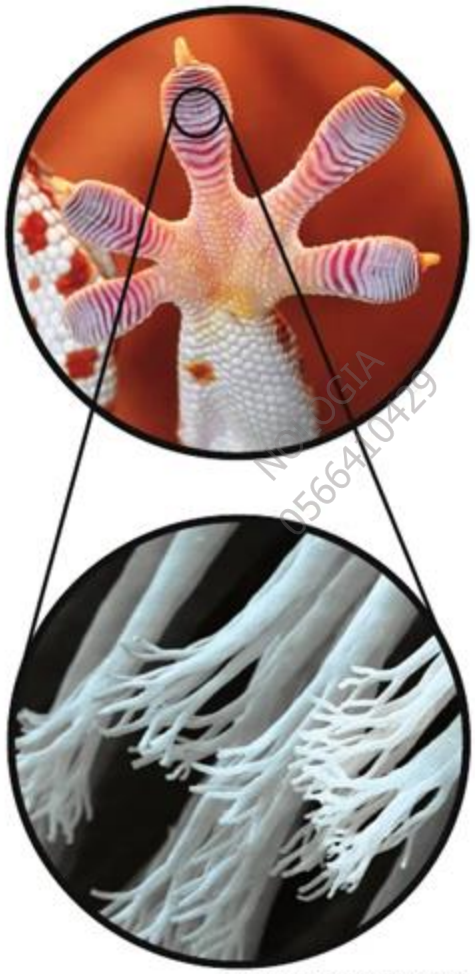
NOLOGIA Study Series • 02 Forces

Van der Waals Forces

- Weak electrostatic attractions between opposite charges of different molecules.
- Weaker than covalent or ionic bonds.
- Ideal for short-term biological interactions.
- Strength depends on molecule size, shape, and ability to attract electrons.

The Gecko Metaphor: Geckos climb smooth surfaces because of van der Waals forces between hairlike structures on their toes and the surface.





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Figure 20 Scientists have determined that geckos can climb smooth surfaces because of van der Waals forces between the hairlike structures on their toes and the surface they are climbing.

Questions :

Question 1: In Figure 21, what holds the water droplet together and supports the water strider?

(A) Van der Waals forces between water molecules	(B) Ionic bonds between sodium and chlorine
(C) Peptide bonds between amino acids	(D) Nonpolar tails of phospholipids

Question 2: What are van der Waals forces?

(A) Strong covalent bonds inside a single atom	(B) Weak attractions between oppositely charged regions of molecules
(C) Forces that push identical charges together	(D) Chemical reactions that destroy water molecules

Question 3: How strong are van der Waals forces compared to covalent and ionic bonds?

(A) They are weaker than covalent and ionic bonds	(B) They are much stronger than covalent bonds
(C) They are stronger than ionic bonds only	(D) They have the exact same strength as covalent bonds

Question 4: Where do van der Waals forces occur?

(A) Inside the nucleus of a single proton	(B) Only between two positive hydrogen nuclei
(C) Between oppositely charged regions of nearby molecules	(D) Only inside dry table salt crystals

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Question 5: In Figure 21, why does liquid water form round droplets?

(A) Water molecules repel each other strongly	(B) Air pressure freezes the water into ice
(C) Gravity destroys the covalent bonds in water	(D) Attractive forces pull the water molecules toward each other

Question 6: In Figure 21, what allows the water strider insect to walk on water without sinking?

(A) The insect is heavier than liquid water	(B) Surface tension caused by attractions between water molecules
(C) The water is frozen into solid ice	(D) Ionic bonds between the insect and oxygen gas

Question 7: What is cohesion in water?

(A) The attraction among water molecules for each other	(B) The attraction of water molecules to glass
(C) The breakdown of water into hydrogen gas	(D) The dissolving of oil in pure water

Question 8: What property of water is created by cohesion at the surface of a pond?

(A) Acidity	(B) Buffering
(C) Surface tension	(D) Radioactivity

Question 9: What is adhesion in water?

(A) The attraction of water molecules only to each other	(B) The attraction of water molecules to other substances
(C) The repulsion between water and plant stems	(D) The evaporation of water into steam

Q7 : Module 6: Chemistry in Biology

Lesson 3: Water and Its Solutions

BIO.3.1.02.020 Identify the solubility as the ability of a solute to dissolve in a solvent and explain the properties of water that make it the universal solvent.

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Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 23 (Visualizing Hydrogen Bonding) · Page 21):

A hydrogen bond is a weak electrostatic interaction between a slightly positive hydrogen atom of one molecule and a slightly negative oxygen, nitrogen, or fluorine atom of another molecule. Figure 23 shows how hydrogen bonds give water unique life-supporting properties: (1) Universal Solvent: water dissolves ionic and polar solutes; (2) Adhesion: water sticks to plant cell walls and rises in narrow tubes (capillary action); (3) Cohesion: water molecules stick together, creating surface tension; (4) Ice Floats: in solid ice, hydrogen bonds lock water molecules at fixed distances that are farther apart than in liquid water, making ice LESS dense than liquid water.

Key Ideas from the Student Book:

- A hydrogen bond forms between a slightly positive H atom and a slightly negative O, N, or F atom on another molecule.
- In Figure 23, liquid water molecules are closer together, while solid ice molecules are held farther apart in a crystal lattice.
- Because water molecules in ice are farther apart, solid ice is LESS dense than liquid water and floats.
- Floating ice insulates the liquid water below, allowing fish and aquatic life to survive winter.

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Property in Figure 23	Role of Hydrogen Bonds	Importance to Living Things
Hydrogen Bond	Weak attraction between H (+) of one water molecule and O (-) of another	Holds liquid water and ice structures together
Ice vs. Liquid Water	Water molecules in ice are spaced farther apart than in liquid water	Ice is less dense than liquid water, so ice floats and insulates ponds
Universal Solvent	Water surrounds and separates ions and polar molecules	Dissolves nutrients and minerals inside cells and blood
Adhesion	Water forms hydrogen bonds with other polar surfaces (like glass or xylem)	Allows capillary action so water moves up plant stems
Cohesion	Water molecules attract each other via hydrogen bonds	Creates surface tension so droplets form and insects walk on water

Remember:

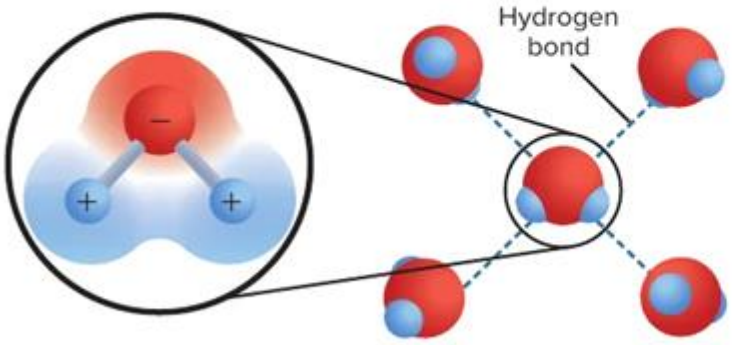
✓ Hydrogen bond = weak attraction between H (+) of one molecule and O, N, or F (-) of another molecule.

✓ Ice is LESS dense than liquid water because hydrogen bonds hold molecules farther apart in ice.

✓ Cohesion = water sticks to water (surface tension); Adhesion = water sticks to other surfaces (capillary action).

Figure 23 Visualizing Hydrogen Bonding

Hydrogen Bonding



A water molecule is made up of one oxygen atom and two hydrogen atoms. A water molecule is polar in nature. Its bent shape results in a slightly positive charge on the hydrogen atoms and a slightly negative charge on the oxygen atom. As a result, it forms hydrogen bonds. Water is called the universal solvent because many substances dissolve in it.

Diagnostic Matrix: Bonds vs. Forces

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Covalent Bonds	Hydrogen Bonds	Van der Waals Forces
Within a molecule (atoms sharing electrons)	Between specific polar molecules (H + O/N/F)	Between any molecules with slightly charged regions
Very Strong ("Molecular Knot")	Moderate (Strongest intermolecular force)	Weak ("Molecular Velcro")
Linking Hydrogen and Oxygen to form H_2O	Connecting two different H_2O molecules	A gecko climbing a wall

Properties of Water: Cohesion & Adhesion

NOLOGIA Study Series • 04 Synthesis

Cohesion (Water + Water)

Mechanism: Molecules are attracted to each other due to hydrogen bonds.

Result: Creates surface tension.



Adhesion (Water + Other)

Mechanism: Water forms hydrogen bonds with molecules on other surfaces.

Result: Capillary action.



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Questions :

Question 1: According to Figure 23, why does solid ice float on liquid water?

(A) Ice is less dense because hydrogen bonds hold water molecules farther apart	(B) Ice is more dense because water molecules pack tightly together
(C) Ice loses all of its oxygen atoms when it freezes	(D) Ice is a nonpolar oil that repels liquid water

Question 2: What is a hydrogen bond?

(A) A strong covalent bond between two carbon atoms	(B) A weak interaction between a hydrogen atom and an oxygen, nitrogen, or fluorine atom
(C) An ionic bond between sodium and chlorine ions	(D) A peptide bond between two amino acids

Question 3: In Figure 23, how are water molecules arranged in solid ice compared to liquid water?

(A) They are held at fixed distances farther apart than in liquid water	(B) They are packed much closer together than in liquid water
(C) They have no hydrogen bonds between them	(D) They are broken into separate hydrogen and oxygen gases

Question 4: How does the density of solid ice compare to the density of liquid water?

(A) Solid ice is twice as dense as liquid water	(B) Solid ice and liquid water have the exact same density
(C) Solid ice is less dense than liquid water	(D) Solid ice is heavier per liter than liquid water

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Question 5: How does floating ice help aquatic organisms survive in winter?

(A) The ice sinks to the bottom and crushes the fish	(B) The ice boils the water at the bottom of the pond
(C) The ice removes all oxygen from the pond	(D) The ice layer insulates the liquid water beneath it so it does not freeze solid

Question 6: In Figure 23, which property allows water to dissolve many substances?

(A) Universal solvent	(B) Nonpolar repulsion
(C) Low specific heat	(D) Covalent insolubility

Question 7: In Figure 23, which property causes water to climb up a narrow glass tube or plant stem?

(A) Evaporation	(B) Adhesion (capillary action)
(C) Freezing	(D) Buffering

Question 8: In Figure 23, which property causes water molecules to stick to each other to form droplets?

(A) Adhesion	(B) Hydrolysis
(C) Cohesion	(D) Acidification

Question 9: Which three electronegative atoms can form a hydrogen bond with hydrogen?

(A) Carbon, Iron, or Sodium	(B) Helium, Neon, or Argon
(C) Gold, Silver, or Copper	(D) Oxygen (O), Nitrogen (N), or Fluorine (F)

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Q8 : Module 6: Chemistry in Biology

Lesson 3: Water and Its Solutions

BIO.3.1.02.018 Distinguish between homogeneous mixtures (solutions) and heterogeneous mixtures.

(Page 22)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 24 (Homogeneous Solution: Solvent & Solute) · Page 22):

A mixture is a combination of two or more substances in which each substance retains its individual characteristics and properties. There are two main types of mixtures: (1) Homogeneous Mixture (Solution): has a uniform composition throughout (you cannot see separate parts). A solution contains a solvent (substance in which another substance is dissolved, such as water in Figure 24) and a solute (substance that is dissolved, such as the powdered drink mix in Figure 24). (2) Heterogeneous Mixture: components remain distinct and you can tell them apart, such as a salad, a suspension (sand and water where particles settle out), or a colloid (milk or blood where particles do not settle out).

Key Ideas from the Student Book:

- A homogeneous mixture is also called a solution and has a uniform composition throughout.
- In a solution, the solvent dissolves the solute (in Figure 24, water is the solvent and powdered drink mix is the solute).
- In a heterogeneous mixture, components remain distinct.
- A suspension is a heterogeneous mixture whose particles settle out over time (like sand and water), while a colloid has particles that do not settle out (like milk or blood).

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Term / Mixture Type	Definition	Examples
Mixture	Combination of 2+ substances where each keeps its own properties	Salt water, salad, air, blood
Homogeneous Mixture (Solution)	Uniform composition throughout; parts are evenly mixed at the molecular level	Drink mix in water (Figure 24), salt water, tea, saliva
Solvent	The substance in which another substance is dissolved	Water (in Figure 24)
Solute	The substance that is dissolved in the solvent	Powdered drink mix (in Figure 24), salt, sugar
Heterogeneous Mixture	Components remain distinct (not uniform throughout)	Salad, Suspension (sand + water; settles), Colloid (milk, blood; does not settle)

Remember:

✓ Homogeneous mixture = Solution (uniform throughout) = Solvent (dissolves, e.g. water) + Solute (gets dissolved, e.g. drink mix/salt).

✓ Heterogeneous mixture = NOT uniform (distinct parts): Suspension (particles settle, e.g. sand + water) & Colloid (particles do not settle, e.g. blood/milk).

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Figure 24 The drink mix forms a homogeneous mixture in water. The particles of the solute (drink mix) are dissolved and spread throughout the solvent (water).

MIXTURES
A combination where each substance retains its individual characteristics.

Homogeneous Mixtures
Uniform composition throughout.

Heterogeneous Mixtures
Components remain distinct.

Solutions

Suspensions & Colloids

Homogeneous Mixtures: Solutions



Solvent	Solute
The substance in which another substance is dissolved (e.g., Water - the "Universal Solvent" due to its polarity).	The substance that is dissolved (e.g., Powder drink mix, salt).

Biological Example: Saliva is a solution containing water, proteins, and salts that begins digestion.

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Questions :

Question 1: In Figure 24, what are the solvent and the solute in the glass?

(A) Water is the solvent and powdered drink mix is the solute	(B) Powdered drink mix is the solvent and water is the solute
(C) Both water and drink mix are insoluble suspensions	(D) The glass is the solute and air is the solvent

Question 2: What is the definition of a mixture?

(A) A pure element made of only one kind of atom	(B) A combination of two or more substances that keep their individual properties
(C) A chemical reaction that destroys starting atoms	(D) A single molecule of pure distilled water

Question 3: What is a homogeneous mixture?

(A) A mixture that has a uniform composition throughout	(B) A mixture where sand settles at the bottom
(C) A mixture with visible separate layers like oil and water	(D) A solid rock mixed with large pebbles

Question 4: What is another name for a homogeneous mixture?

(A) A suspension	(B) A colloid
(C) A solution	(D) A precipitate

Question 5: What is the definition of a solvent?

(A) A solid particle that settles at the bottom of a cup	(B) The substance that is dissolved in a liquid
(C) A gas that cannot mix with water	(D) A substance in which another substance is dissolved

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Question 6: What is the definition of a solute?

(A) The liquid that does the dissolving	(B) The substance that is dissolved in the solvent
(C) An insoluble rock at the bottom of a river	(D) A filter paper used to trap sand

Question 7: In salt water, which substance is the solute and which is the solvent?

(A) Salt is the solute and water is the solvent	(B) Water is the solute and salt is the solvent
(C) Both salt and water are solvents	(D) Neither salt nor water is a solute

Question 8: What is a heterogeneous mixture?

(A) A solution with a completely uniform composition	(B) Pure liquid water with nothing dissolved in it
(C) A mixture in which the components remain distinct (not uniform)	(D) A compound formed by covalent bonds

Question 9: What is a suspension?

(A) A heterogeneous mixture in which particles settle out over time	(B) A homogeneous solution that never separates
(C) A pure element found on the periodic table	(D) A gas dissolved evenly in another gas

Question 10: What is a colloid?

(A) A suspension where heavy rocks sink immediately	(B) A pure chemical compound like carbon dioxide
(C) A heterogeneous mixture in which the particles do not settle out	(D) An empty container with no matter inside

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Q9 : Module 6: Chemistry in Biology

Lesson 4: The Building Blocks of Life

BIO.3.1.02.023 Use acid-base indicators or pH test strips to classify solutions as acidic, basic, or neutral.

(Page 24)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 28 (The pH Scale & Buffers) · Page 24):

Acids are substances that release hydrogen ions (H+) when dissolved in water (more H+ than OH-). Bases are substances that release hydroxide ions (OH-) when dissolved in water (more OH- than H+). The pH scale (Figure 28) measures the concentration of H+ ions from 0 to 14: Neutral solutions have pH = 7.0 (equal H+ and OH-, such as pure water). Acidic solutions have pH below 7 (0 to <7; lower pH = stronger acid, e.g., battery acid, stomach acid, lemon juice). Basic solutions have pH above 7 (>7 to 14; higher pH = stronger base, e.g., baking soda, ammonia, bleach, oven cleaner). Buffers are mixtures that react with acids or bases to keep cell pH within a safe range (6.5 to 7.5).

Key Ideas from the Student Book:

- Acids release hydrogen ions (H+) in water and have a pH less than 7.
- Bases release hydroxide ions (OH-) in water and have a pH greater than 7.
- Pure water is neutral with a pH of 7.0 (equal H+ and OH- concentrations).
- Buffers are mixtures that react with acids or bases to keep the pH of cells between 6.5 and 7.5.

Solution Type	pH Range	Ion Concentration	Examples in Figure 28
Acidic Solution	Below 7 (0 to < 7)	More H+ ions than OH- ions	Battery acid (0), Stomach acid (1.5), Lemon juice (2), Vinegar, Tomatoes, Coffee
Neutral Solution	Exactly 7.0	Equal numbers of H+ and OH- ions	Pure water (7.0), Milk / Blood (~6.5-7.4)
Basic (Alkaline) Solution	Above 7 (> 7 to 14)	More OH- ions than H+ ions	Seawater (8), Baking soda (9), Ammonia (11.5), Bleach (12.5), Oven cleaner (13.5), NaOH (14)
Buffers	Keeps pH 6.5 - 7.5	Absorbs excess H+ or OH- ions	Buffers in human blood and cells

Remember:

✓ Acid = releases H+ ions, pH < 7 (closer to 0 = stronger acid).

✓ Base = releases OH- ions, pH > 7 (closer to 14 = stronger base).

✓ Neutral = pH 7 (pure water); Buffers keep cell pH stable (6.5 to 7.5).



Figure 28 The pH scale is used to indicate the relative strength of acids and bases.

Questions :

Question 1: According to Figure 28, which pH value represents a strongly acidic solution?

(A) pH 2 (such as lemon juice or stomach acid)	(B) pH 7 (such as pure water)
(C) pH 9 (such as baking soda)	(D) pH 13 (such as bleach or oven cleaner)

Question 2: What is the definition of an acid?

(A) A substance that releases hydroxide ions (OH-) in water	(B) A substance that releases hydrogen ions (H+) when dissolved in water
(C) A substance with a pH of 14	(D) A nonpolar lipid that repels water

Question 3: What is the definition of a base?

(A) A substance that releases hydroxide ions (OH-) when dissolved in water	(B) A substance that releases only hydrogen ions (H+) in water
(C) A substance with a pH below 7	(D) Pure distilled water with pH 7

Question 4: What does the pH scale measure?

(A) The temperature of boiling water	(B) The mass of sugar in a cup
(C) The concentration of hydrogen ions (H+) in a solution	(D) The speed of light in water

Question 5: What is the pH range of acidic solutions?

(A) Below 7 (from 0 to less than 7)	(B) Exactly 7.0 only
(C) Above 7 (from 7 to 14)	(D) From 14 to 20

Question 6: What is the pH range of basic (alkaline) solutions?

(A) From 0 to 3	(B) From 4 to 6
(C) Exactly 7.0	(D) Above 7 (greater than 7 to 14)

Question 7: What is the pH of a neutral solution such as pure water?

(A) 0.0	(B) 7.0
(C) 10.0	(D) 14.0

Question 8: In Figure 28, which of the following is an acidic substance?

(A) Baking soda	(B) Household ammonia
(C) Stomach acid (or lemon juice)	(D) Oven cleaner

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Question 9: What is the definition of a buffer?

(A) A mixture that can react with acids or bases to keep the pH within a particular range	(B) An enzyme that breaks down starch in saliva
(C) A strong acid that lowers cell pH to zero	(D) A lipid layer that blocks water from entering cells

Question 10: Which solution is a stronger base: pH 8 or pH 13?

(A) A solution with pH 8	(B) A solution with pH 13
(C) Neither is a base	(D) Both have the same basicity

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Q10 : Module 6: Chemistry in Biology

Lesson 4: The Building Blocks of Life

BIO.3.1.02.019 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids.

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Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 29 (Carbon Chains: Straight, Branched, and Ring Molecules) · Page 25):

Almost all biological molecules contain the element carbon (C). Organic chemistry is the study of organic compounds (compounds containing carbon). Because a carbon atom has 4 electrons in its outermost energy level, it can form 4 covalent bonds with other atoms (such as H, O, N, P, S, or other C atoms). As shown in Figure 29, carbon atoms can bond together to form straight chains, branched chains, or rings. Carbon, hydrogen, and oxygen from sugar molecules (formed during photosynthesis) combine with nitrogen (N) and sometimes sulfur (S) to form amino acids and other large macromolecules.

Key Ideas from the Student Book:

- Carbon is a component of almost all biological molecules.
- A carbon atom has 4 electrons in its outermost shell and forms 4 covalent bonds.
- In Figure 29, carbon chains form three main shapes: straight chains, branched chains, and rings.
- Carbon, hydrogen, and oxygen from sugar molecules combine with nitrogen (N) to form amino acids.

Carbon Property / Structure	Key Fact
Valence Electrons in Carbon	4 electrons in the outer energy level -> forms 4 covalent bonds
Figure 29 Carbon Shapes	Straight chains, Branched chains, and Rings
Sugars (Carbohydrates)	Contain Carbon (C), Hydrogen (H), and Oxygen (O) in a 1:2:1 ratio $(CH_2O)_n$
Forming Amino Acids from Sugars	Carbon, hydrogen, and oxygen from sugar molecules combine with Nitrogen (N) (and sometimes Sulfur) to form amino acids
Polymers & Monomers	Macromolecules are polymers built from repeating smaller units called monomers

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Remember:

✓ Carbon has 4 outer electrons -> forms 4 covalent bonds.

✓ Figure 29 carbon shapes: Straight chains, Branched chains, and Rings.

✓ C, H, and O from sugars + Nitrogen (N) -> Amino acids (monomers of proteins).

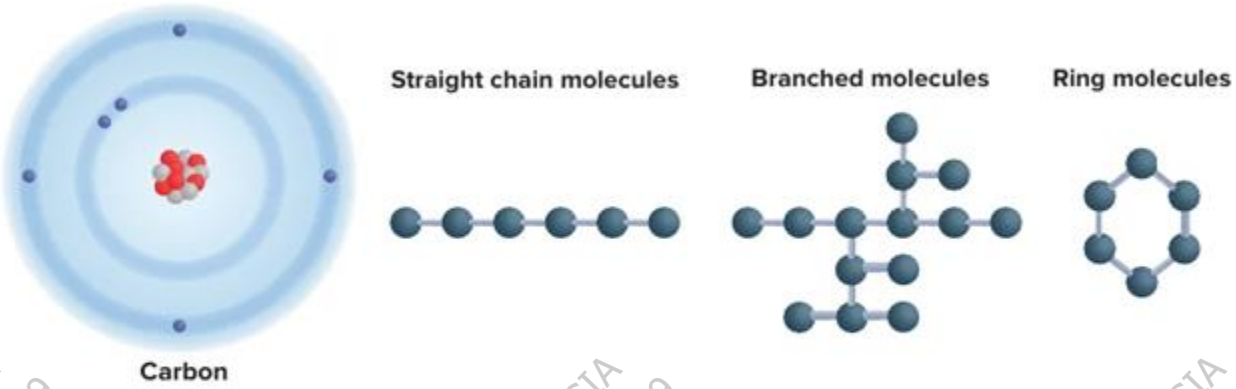
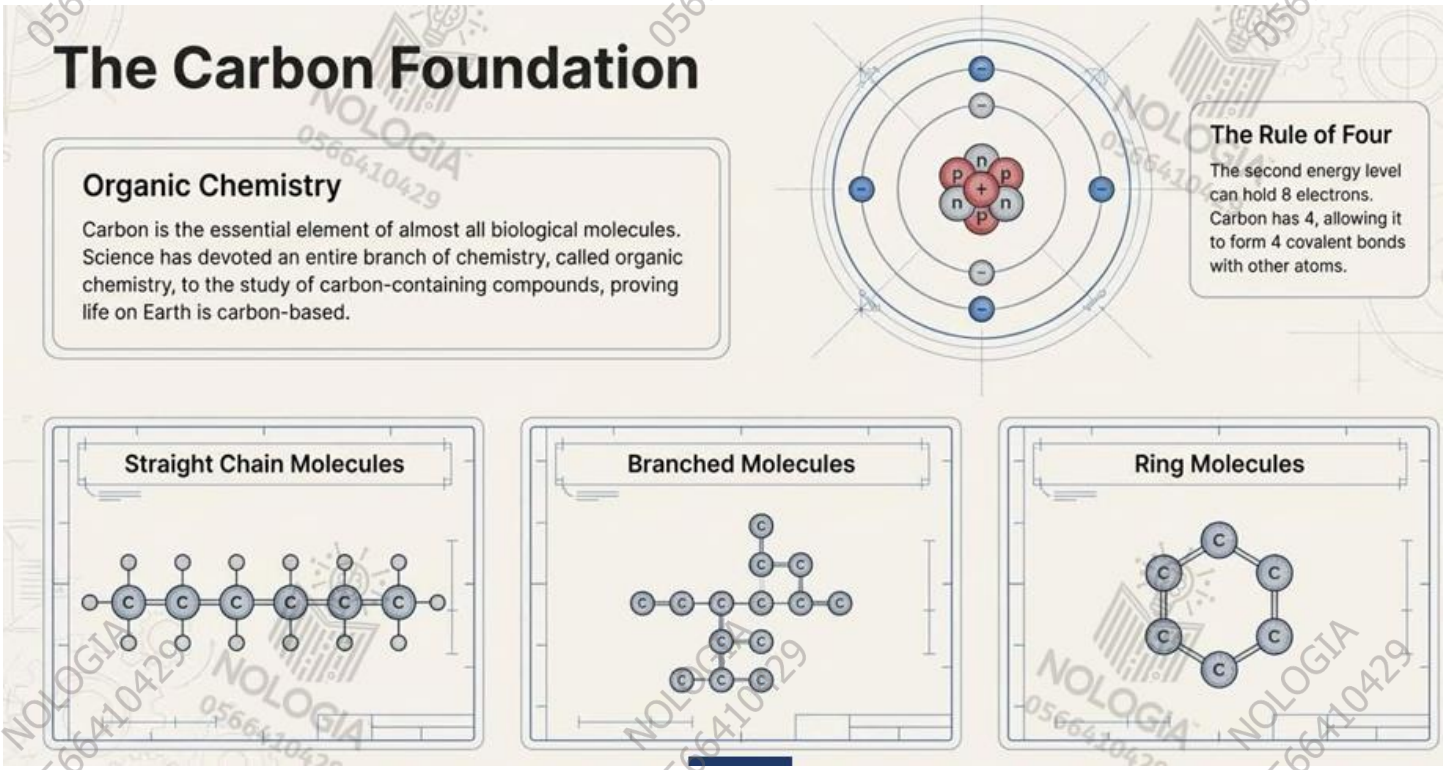


Figure 29 Life is based on carbon compounds. The half-filled outer energy level of carbon, shown in the image on the left, allows for the formation of straight chain, branched, and ring molecules.



Questions :

Question 1: According to Figure 29, which three shapes can carbon chains form?

(A) Straight chains, branched chains, and rings	(B) Ionic cubes, metal sheets, and gases
(C) Single protons, neutrons, and electrons	(D) Water droplets, ice crystals, and steam

Question 2: Which element is the backbone of almost all biological molecules?

(A) Iron	(B) Carbon
(C) Sodium	(D) Helium

Question 3: How many electrons does a carbon atom have in its outermost energy level?

(A) One electron	(B) Two electrons
(C) Four electrons	(D) Eight electrons

Question 4: How many covalent bonds can one carbon atom form with other atoms?

(A) One covalent bond	(B) Two covalent bonds
(C) Three covalent bonds	(D) Four covalent bonds

Question 5: What is an organic compound?

(A) A compound that contains carbon atoms	(B) A compound made only of sodium and chlorine
(C) Pure liquid water with no carbon	(D) A metal wire made of pure copper

Question 6: What are macromolecules?

(A) Single atoms of hydrogen gas	(B) Large molecules formed by joining smaller organic molecules together
(C) Tiny water droplets in a cloud	(D) Simple ions like Na+ and Cl-

Question 7: What is the definition of a polymer?

(A) A large molecule formed from smaller repeating units called monomers	(B) A single atom with no chemical bonds
(C) A substance that lowers activation energy	(D) A solution with a pH of 7

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Q11 : Module 6: Chemistry in Biology

Lesson 4: The Building Blocks of Life

BIO.3.1.02.024 Explain that the hydrocarbon backbones of the sugars formed during photosynthesis are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules used, for example, to form new cells.

(Page 28)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 32 (Lipids: Saturated Fats, Unsaturated Fats, and Phospholipids) · Page 28):

Lipids are molecules made mostly of carbon and hydrogen (hydrocarbon chains) that make up fats, oils, and waxes. Their primary functions are to store energy and form biological barriers (cell membranes). As shown in Figure 32: (1) Saturated fats (like stearic acid) have ONLY single bonds between carbon atoms, so their tails are full of hydrogen atoms and straight (solid at room temperature). (2) Unsaturated fats (like oleic acid) have at least one DOUBLE bond (C=C) between carbon atoms, causing a bend in the tail (liquid at room temperature). (3) Phospholipids have a hydrophilic (polar) phosphate head and two hydrophobic (nonpolar) fatty acid tails, forming the structure of cell membranes.

Key Ideas from the Student Book:

- Lipids are made mostly of carbon and hydrogen and do NOT dissolve in water.
- Saturated fats (like stearic acid in Figure 32) have only single bonds between carbon atoms.
- Unsaturated fats (like oleic acid in Figure 32) have at least one double bond between carbon atoms.
- A phospholipid has a polar (hydrophilic) head and two nonpolar (hydrophobic) tails, forming cell membranes.

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Lipid Type in Figure 32	Bond Structure	Key Property & Function
Saturated Fat (e.g., Stearic acid)	Only SINGLE bonds (C-C) between carbon atoms	Straight chains; full of H atoms; solid at room temperature
Unsaturated Fat (e.g., Oleic acid)	One or more DOUBLE bonds (C=C) between carbon atoms	Bent chain at the double bond; liquid oil at room temperature
Polyunsaturated Fat	More than one double bond in the tail	Can accommodate even more hydrogen atoms
Phospholipid	1 polar phosphate head + 2 nonpolar fatty acid tails	Forms the bilayer of plasma membranes around cells

Remember:

✓ Saturated fat (Stearic acid) = ONLY single C-C bonds; Unsaturated fat (Oleic acid) = has C=C DOUBLE bond(s).

✓ Phospholipid = 1 polar head (attracted to water) + 2 nonpolar tails (repelled by water) -> builds cell membranes.

✓ Main functions of lipids: store energy and form water-repelling barriers (membranes, waxes).

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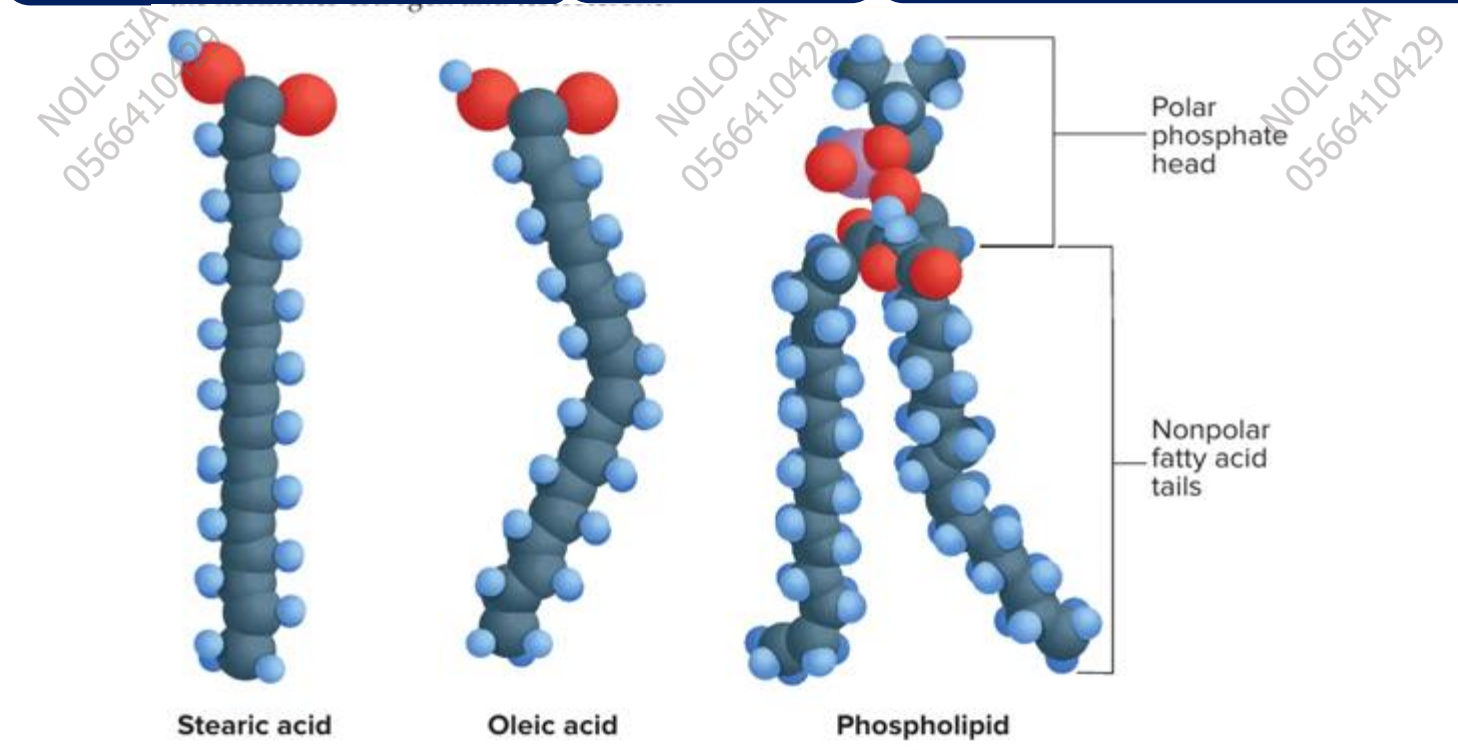
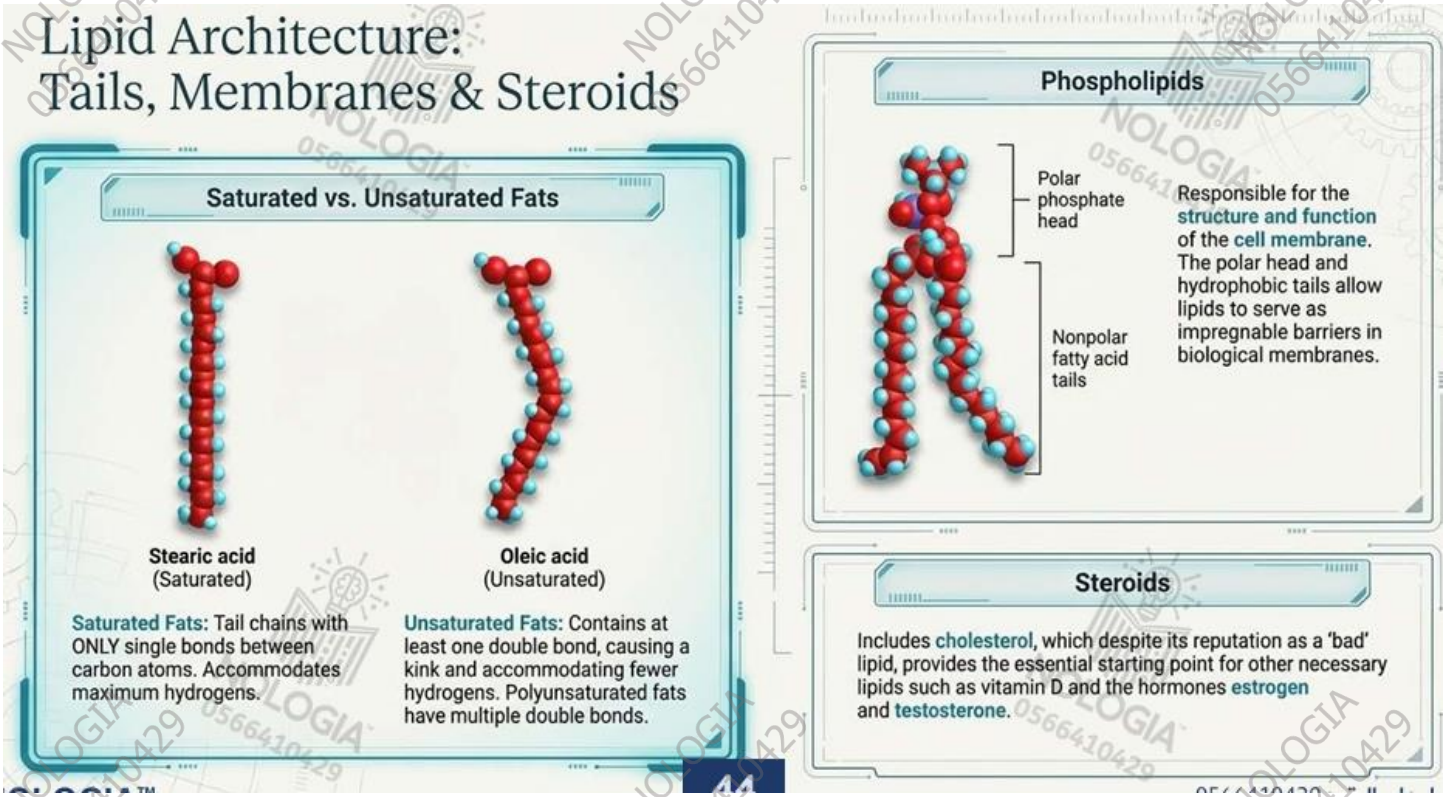


Figure 32 Stearic acid has no double bonds between carbon atoms; oleic acid has one double bond. Phospholipids have a polar head and two nonpolar tails.



احصل على الشرح كاملاً بـ 149 درهم فقط

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Questions :

Question 1: In Figure 32, how does unsaturated oleic acid differ from saturated stearic acid?

(A) Oleic acid has a double bond between carbon atoms	(B) Oleic acid has only single bonds between carbon atoms
(C) Oleic acid contains no carbon or hydrogen atoms	(D) Oleic acid is made of amino acid monomers

Question 2: What are lipids made mostly of?

(A) Sodium and chlorine ions	(B) Carbon and hydrogen atoms
(C) Pure nitrogen and sulfur	(D) Iron and oxygen atoms

Question 3: What are the two main functions of lipids in living organisms?

(A) Storing energy and forming biological barriers (membranes)	(B) Storing genetic code and making ribosomes
(C) Speeding up reactions as enzymes	(D) Dissolving salts as a universal solvent

Question 4: What is a saturated fat?

(A) A lipid with many double and triple bonds	(B) A carbohydrate ring made of glucose
(C) A lipid with only single bonds between carbon atoms in its tails	(D) A protein dissolved in water

Question 5: What is an unsaturated fat?

(A) A lipid with only single bonds between carbons	(B) A nucleic acid found in the nucleus
(C) A simple sugar found in fruit	(D) A lipid with at least one double bond between carbon atoms in its tail

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Question 6: What is a fat with more than one double bond in its tail called?

(A) A monosaccharide	(B) A saturated fat
(C) A polyunsaturated fat	(D) A polypeptide

Question 7: What are the two main parts of a phospholipid in Figure 32?

(A) One polar head and two nonpolar fatty acid tails	(B) Three sugar rings and one nitrogen base
(C) Twenty amino acids and one peptide bond	(D) Two oxygen atoms and one hydrogen atom

Question 8: Which cell structure is formed primarily by phospholipids?

(A) The ribosome	(B) The chromosome
(C) The plasma membrane (cell membrane)	(D) The cellulose cell wall

Question 9: What are triglycerides?

(A) Lipids made of three fatty acids bonded to one glycerol molecule	(B) Proteins made of three amino acids
(C) Sugars made of three glucose rings	(D) Nucleic acids with three DNA strands

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Q12 : Module 6: Chemistry in Biology

Lesson 4: The Building Blocks of Life

BIO.3.1.02.024 Explain that the hydrocarbon backbones of the sugars formed during photosynthesis are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules used, for example, to form new cells.

(Page 29)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Get It? (What are the primary functions of proteins?) · Page 29):

A protein is a compound made of small carbon compounds called amino acids. Amino acids are made of carbon, nitrogen, oxygen, hydrogen, and sometimes sulfur. Every amino acid has a central carbon atom bonded to four groups: a hydrogen atom (-H), an amino group (-NH2), a carboxyl group (-COOH), and a variable group (-R) that makes each of the 20 amino acids different. Peptide bonds join amino acids together into chains to make proteins. Answer to Get It? (Page 29): The primary functions of proteins are to transport substances, speed up chemical reactions (as enzymes), provide structural support, communicate signals between cells, and control cell growth.

Key Ideas from the Student Book:

- Proteins are polymers made of monomers called amino acids joined by peptide bonds.
- Amino acids contain carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur.
- There are 20 different amino acids, which differ only in their variable group (-R).
- Get It? (Page 29): The primary functions of proteins are transporting substances, speeding up reactions (enzymes), structural support, cell communication, and controlling cell growth.

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Protein Feature / Question	Key Scientific Summary
Get It? Primary Functions of Proteins	1. Transport substances (e.g., hemoglobin) 2. Speed up chemical reactions (enzymes) 3. Provide structural support (collagen, keratin) 4. Communicate signals (hormones/receptors) 5. Control cell growth
Monomers of Proteins	Amino acids (20 different variable R groups)
Elements in Amino Acids	Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), and sometimes Sulfur (S)
4 Groups on Central Carbon	Hydrogen (-H), Amino group (-NH2), Carboxyl group (-COOH), and Variable group (-R)
Peptide Bond	Covalent bond that joins amino acids together to form protein chains

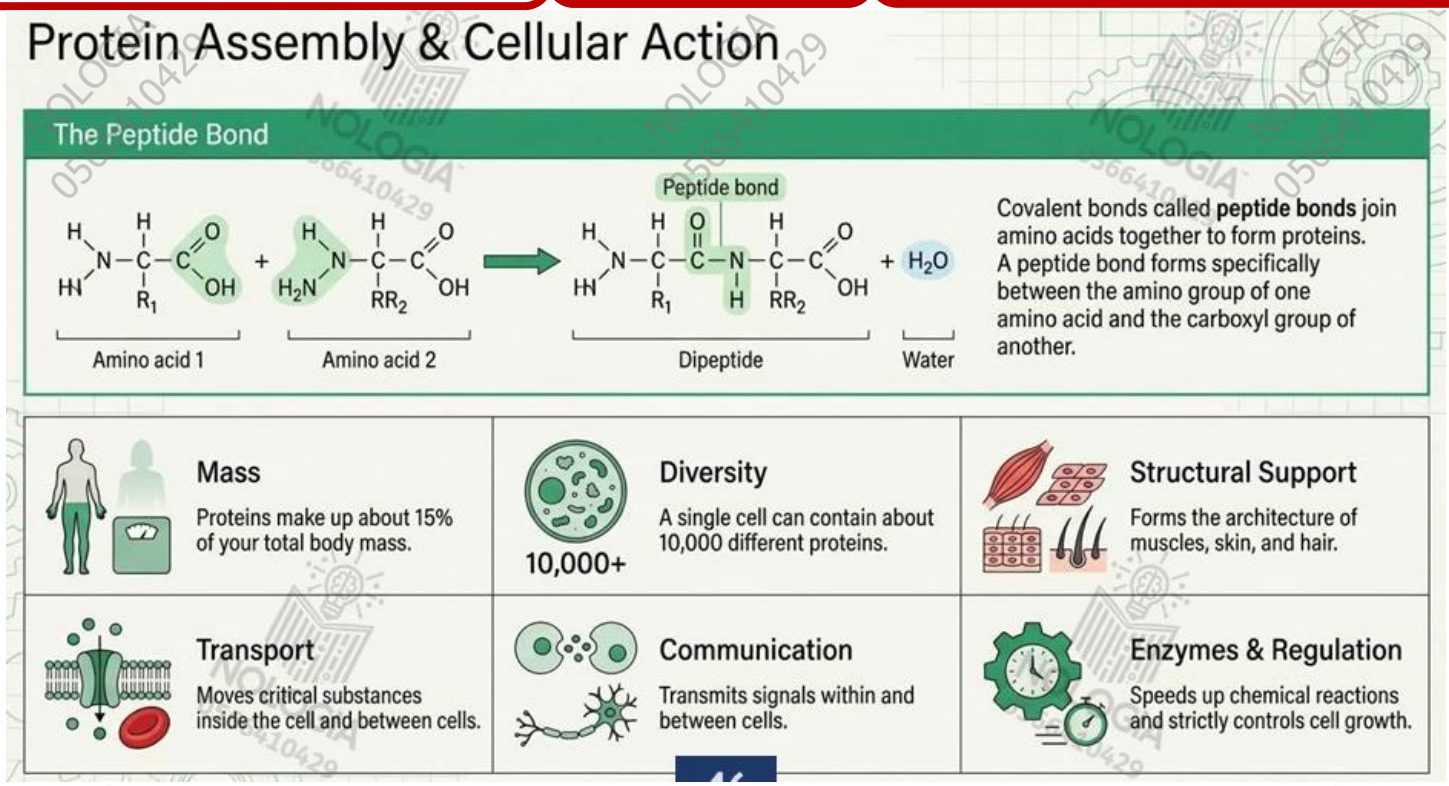
Remember:

✓ Monomers of proteins = Amino acids (joined by peptide bonds).

✓ Amino acid structure = Central Carbon + Amino group (-NH2) + Carboxyl group (-COOH) + H + Variable group (-R).

✓ Primary functions of proteins: transport substances, speed up reactions (enzymes), structural support, communication, and cell growth.

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Questions :

Question 1: What are the primary functions of proteins in living organisms?

(A) Transport substances, speed up reactions, provide structural support, and communicate signals	(B) Dissolve ionic salts as the universal solvent inside ponds
(C) Store all genetic information in a double helix	(D) Form the waxy waterproof cuticle on plant leaves

Question 2: What are the monomers (building blocks) of proteins?

(A) Fatty acids	(B) Amino acids
(C) Nucleotides	(D) Monosaccharides

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Question 3: Which elements make up amino acids?

(A) Carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur	(B) Only hydrogen and oxygen
(C) Sodium, chlorine, and iron only	(D) Calcium, potassium, and helium

Question 4: Which protein forms hair, fingernails, and waterproof scales?

(A) Sucrose	(B) Oleic acid
(C) Keratin	(D) Chitin

Question 5: What determines the specific function of a protein in a cell?

(A) Its three-dimensional (3D) shape and amino acid sequence	(B) The temperature of the outside air
(C) The amount of sand in the soil	(D) The number of fatty acid tails it has

Question 6: Which function of proteins is performed by enzymes like amylase?

(A) Storing hereditary DNA code	(B) Insulating the body with fat layers
(C) Dissolving salt in pure water	(D) Speeding up chemical reactions in cells

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Q13 : Module 6: Chemistry in Biology

Lesson 4: The Building Blocks of Life

BIO.3.1.02.024 Explain that the hydrocarbon backbones of the sugars formed during photosynthesis are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules used, for example, to form new cells.

(Page 31)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 35 (Nucleotide Structure & Nucleic Acids) · Page 31):

Nucleic acids are complex macromolecules that store and transmit genetic information. They are polymers made of smaller repeating subunits (monomers) called nucleotides. As shown in Figure 35a, every nucleotide consists of three units: (1) a phosphate group, (2) a five-carbon (pentose) sugar, and (3) a nitrogen-containing base (nitrogenous base). Nucleotides contain Carbon, Hydrogen, Oxygen, Nitrogen, and Phosphorus (C, H, O, N, P). The two main nucleic acids in living organisms are DNA (double helix; stores genetic info) and RNA (single strand; helps build proteins). ATP (adenosine triphosphate) is a nucleotide with three phosphate groups that stores chemical energy for cells.

Key Ideas from the Student Book:

- Nucleic acids store and transmit genetic information.
- The monomers of nucleic acids are nucleotides.
- In Figure 35a, each nucleotide has 3 parts: a phosphate group, a 5-carbon (pentose) sugar, and a nitrogenous base.
- Two types of nucleic acids: DNA (double helix) and RNA (single strand). ATP is an energy-carrying nucleotide with 3 phosphate groups.

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احصل على الشرح كاملاً بـ 149 درهم فقط

Component / Molecule	Key Structure & Role (Figure 35)
Nucleotide (Monomer)	3 parts: 1. Phosphate group 2. Five-carbon (pentose) sugar 3. Nitrogen-containing base
Elements in Nucleic Acids	Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), and Phosphorus (P)
DNA (Deoxyribonucleic Acid)	Double-stranded (double helix); sugar = deoxyribose; stores genetic information
RNA (Ribonucleic Acid)	Single-stranded; sugar = ribose; translates genetic code into proteins
ATP (Adenosine Triphosphate)	A nucleotide with 3 phosphate groups used as a storehouse of chemical energy in cells

Remember:

✓ Monomer of nucleic acids = Nucleotide.

✓ 3 parts of a nucleotide (Figure 35a): 1. Phosphate group + 2. Five-carbon (pentose) sugar + 3. Nitrogen-containing base.

✓ Function of nucleic acids (DNA & RNA) = store and transmit genetic information; ATP = nucleotide with 3 phosphates that stores cell energy.

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اضغط على الاسم لتحصل على مزيد من الملفات في تلغرام: NOLOGIA

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Figure 35 shows the basic structure of a nucleotide and nucleic acid. There are five major nucleotides, all of which have three units—a phosphate, a nitrogenous base, and a ribose sugar. In nucleic acids, the sugar of one nucleotide bonds to the phosphate of another. The nitrogenous base that sticks out from the chain is available for hydrogen bonding with other bases in other nucleic acids.

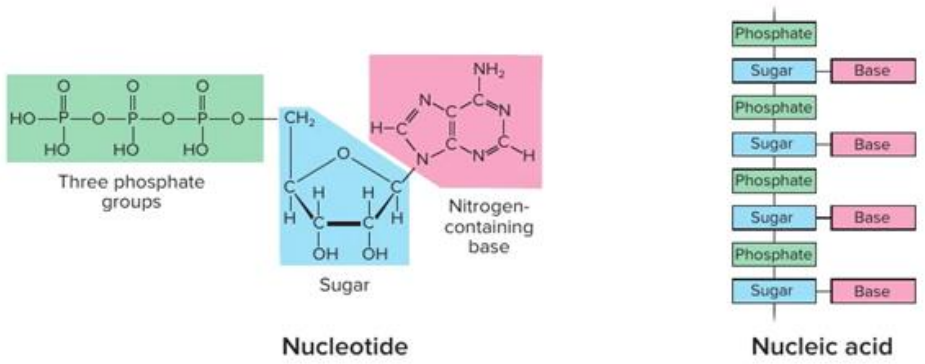
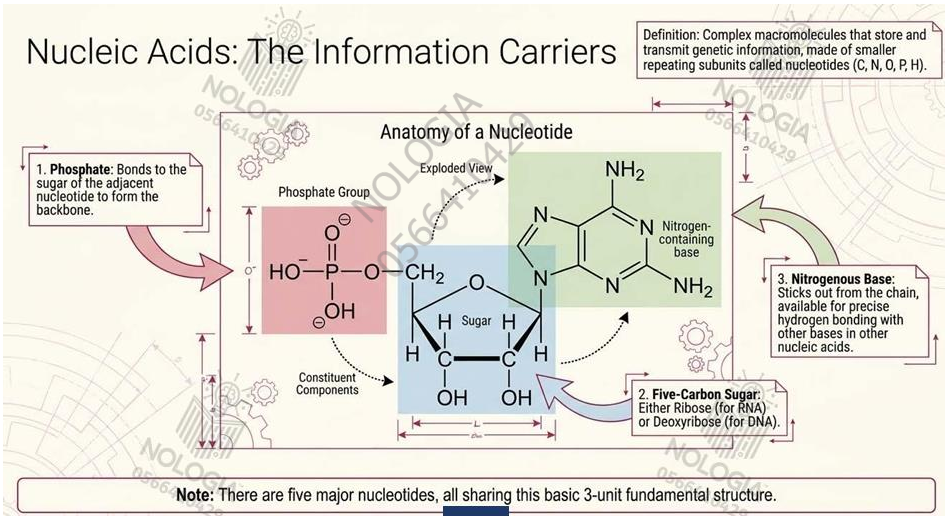
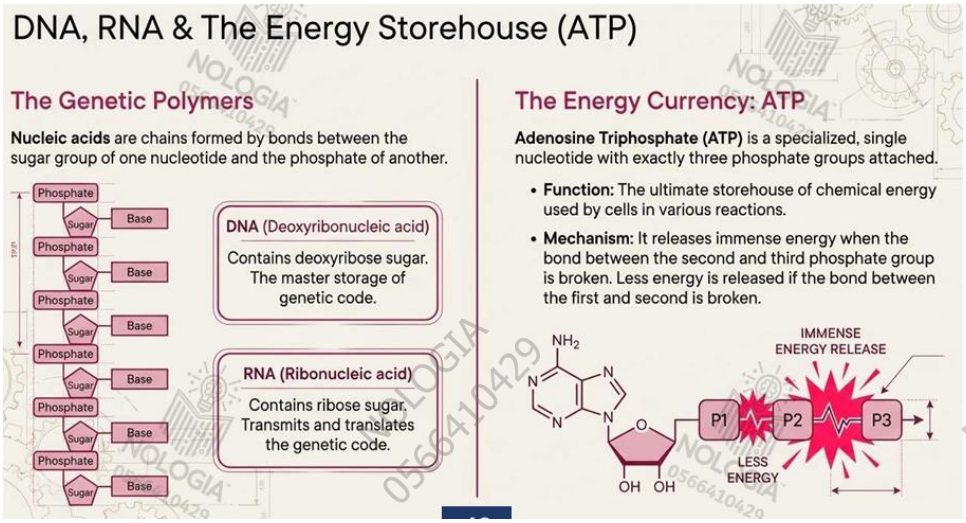


Figure 35 **Left:** DNA nucleotides contain the sugar deoxyribose. RNA nucleotides contain the sugar ribose. **Right:** Nucleotides are joined together by bonds between their sugar group and phosphate group.





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احصل على الشرح كاملاً بـ 149 درهم فقط

Questions :

Question 1: According to Figure 35, what are the three parts of a nucleotide?

(A) A phosphate group, a 5-carbon sugar, and a nitrogenous base	(B) An amino group, a carboxyl group, and an R group
(C) One glycerol molecule and three fatty acid tails	(D) Two hydrogen atoms and one oxygen atom

Question 2: What is the primary function of nucleic acids?

(A) To insulate the body against cold weather	(B) To store and transmit genetic information
(C) To form waterproof wax on plant leaves	(D) To dissolve salt crystals in water

Question 3: What are the repeating monomers that make up nucleic acids?

(A) Amino acids	(B) Monosaccharides
(C) Nucleotides	(D) Fatty acids

Question 4: Which five elements are found in nucleotides?

(A) Carbon, hydrogen, oxygen, nitrogen, and phosphorus (C, H, O, N, P)	(B) Iron, copper, gold, silver, and zinc
(C) Sodium, chlorine, calcium, and helium	(D) Carbon and hydrogen only

Question 5: In Figure 35b, how many strands make up a DNA molecule?

(A) One single straight strand	(B) Two strands twisted into a double helix (spiral)
(C) Four flat sheets	(D) Three branched lipid tails

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Question 6: How many strands usually make up an RNA molecule?

(A) A single strand of nucleotides	(B) Two strands in a double helix
(C) Six strands in a ring	(D) Zero strands

Question 7: Which five-carbon sugar is found in DNA nucleotides?

(A) Deoxyribose	(B) Ribose
(C) Sucrose	(D) Cellulose

Question 8: Which five-carbon sugar is found in RNA nucleotides?

(A) Deoxyribose	(B) Ribose
(C) Glycogen	(D) Starch

Question 9: In Figure 35a, which group is attached to the left side of the pentose sugar?

(A) A fatty acid tail	(B) A carboxyl group
(C) A cholesterol ring	(D) The phosphate group

Question 10: In Figure 35a, which group is attached to the right side of the pentose sugar?

(A) A glycerol molecule	(B) The nitrogenous base
(C) A peptide bond	(D) A sodium ion

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Q14 : Module 7: Cellular Structure and Function

Lesson 1: Cell Discovery and Theory

BIO.3.1.01.076 Assess the role of selected technologies in enhancing our understanding of cells and cellular processes.

(Page 37)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 1 (Robert Hooke's Microscope and Cork Cells) · Page 37):

A cell is the basic structural and functional unit of all living organisms. Because most cells are too small to see with the unaided eye, the invention of the microscope led to the discovery of cells. As shown in Figure 1, in 1665 English scientist Robert Hooke made a simple compound light microscope and looked at a thin piece of cork (dead oak bark). He saw small boxlike chambers that reminded him of the rooms (cellulae) where monks lived in a monastery, so he named them "cells." Later, Dutch scientist Anton van Leeuwenhoek designed a more powerful microscope and was the first person to observe living cells.

Key Ideas from the Student Book:

- A cell is the basic structural and functional unit of all living things.
- In 1665, Robert Hooke used a basic light microscope to observe dead cork (oak bark), shown in Figure 1.
- Hooke saw empty boxlike chambers and named them "cells" (from cellulae, meaning small rooms).
- Anton van Leeuwenhoek improved the microscope and was the first scientist to observe living cells.

Scientist / Term	Year & Discovery
Cell	The basic structural and functional unit of all living organisms
Robert Hooke (Figure 1)	1665: Used a basic compound light microscope to observe dead cork (oak bark) and coined the word "cell"
Cork (Oak Bark)	Dead plant tissue whose empty boxlike cell walls were drawn by Hooke in Figure 1
Anton van Leeuwenhoek	Late 1600s: Built a stronger simple microscope and was the first to observe LIVING cells (pond water/bacteria)

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اضغط على الاسم لتحصل على مزيد من الملفات في تلغرام: NOLOGIA

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Remember:

✓ Cell = basic structural and functional unit of all living organisms.

✓ Robert Hooke (1665, Figure 1) = observed dead cork (oak bark) with a light microscope and named "cells".

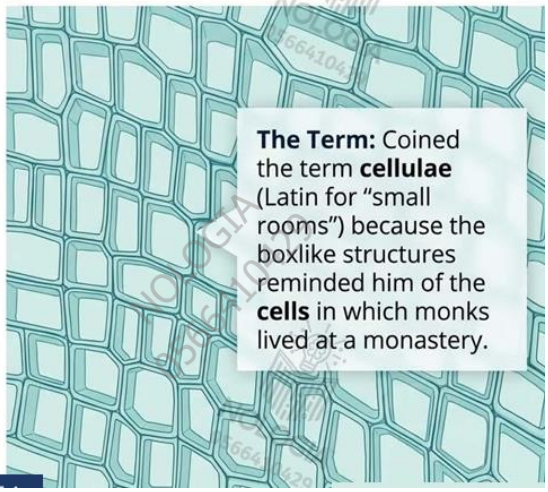
✓ Anton van Leeuwenhoek = first scientist to observe LIVING cells.

The NOLOGIA Lab Notebook



The Scientist: English scientist **Robert Hooke** (1665).

The Observation: Looked at dead **cells** of oak bark (cork).



The Term: Coined the term **cellulae** (Latin for "small rooms") because the boxlike structures reminded him of the **cells** in which monks lived at a monastery.

Light micrograph 100x



Figure 1 Robert Hooke used a basic light microscope to see what looked like empty chambers in a cork sample.

Infer *what you think Hooke would have seen if these were living cells.*

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Questions :

Question 1: In Figure 1, what did Robert Hooke observe when he discovered and named "cells"?

(A) Empty boxlike chambers in dead cork (oak bark)	(B) Living bacteria swimming in pond water
(C) Individual DNA atoms using an electron beam	(D) Chloroplasts making sugar inside green leaves

Question 2: What is the definition of a cell?

(A) A nonliving crystal of sodium chloride	(B) The basic structural and functional unit of all living organisms
(C) A single atom of carbon or hydrogen	(D) A glass lens inside a telescope

Question 3: Which scientist coined the word "cell" in 1665?

(A) Robert Hooke	(B) Anton van Leeuwenhoek
(C) Rudolf Virchow	(D) Johannes van der Waals

Question 4: What type of microscope did Robert Hooke use in Figure 1?

(A) A scanning tunneling microscope (STM)	(B) A transmission electron microscope (TEM)
(C) A basic compound light microscope	(D) A scanning electron microscope (SEM)

Question 5: What specimen did Robert Hooke examine in Figure 1?

(A) Human blood plasma	(B) Living pond algae
(C) Frog muscle tissue	(D) Cork (dead oak bark)

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Question 6: Why did Robert Hooke name the small chambers "cells"?

(A) They reminded him of the small rooms (cellulae) where monks lived	(B) They looked like round water droplets
(C) They were filled with green chlorophyll	(D) They were moving rapidly across the slide

Question 7: Which Dutch scientist was the first person to observe LIVING cells?

(A) Robert Hooke	(B) Isaac Newton
(C) Anton van Leeuwenhoek	(D) Robert Brown

Question 8: Why was Anton van Leeuwenhoek able to see living cells after Hooke?

(A) He used beams of electrons instead of light	(B) He used a computer probe to scan atoms
(C) He stained dead oak bark with ink	(D) He designed a microscope with a more powerful, higher-quality lens

Question 9: Why could scientists NOT discover cells before the 1600s?

(A) Living things did not have cells before 1665	(B) Most cells are too small to be seen with the unaided human eye
(C) Cells only exist inside dead oak trees	(D) Light did not exist before the 1600s

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Q15 : Module 7: Cellular Structure and Function

Lesson 1: Cell Discovery and Theory

BIO.3.1.01.075 Identify that all living things are composed of cells.

(Page 39)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Information from text + Get It? (The Cell Theory & Optical Microscopes) · Page 39):

In 1838, Matthias Schleiden concluded that all plants are made of cells. In 1839, Theodor Schwann concluded that all animals are made of cells. In 1855, Rudolf Virchow proposed that all cells come from existing cells. Together, their observations formed the Cell Theory, which has three principles: (1) All living organisms are composed of one or more cells. (2) Cells are the basic unit of structure and organization of all living organisms. (3) Cells arise only from previously existing cells, with cells passing copies of their genetic material on to their daughter cells. Answer to Get It? (Page 39): No, cells cannot appear spontaneously without genetic material from previous cells because all cells arise only from pre-existing cells. Optical (compound light) microscopes use visible light and a series of glass lenses; total magnification is found by multiplying the lens magnifications (e.g., 10x * 10x = 100x), up to ~1000x.

Key Ideas from the Student Book:

- Principle 1: All living organisms are composed of one or more cells.
- Principle 2: Cells are the basic unit of structure and organization of all living organisms.
- Principle 3: Cells arise only from previously existing cells, passing genetic material to daughter cells.
- Get It? (Page 39): Cells cannot appear spontaneously; they must come from pre-existing cells.
- Total magnification of a compound light microscope = ocular lens magnification x objective lens magnification.

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Scientist / Concept on Page 39	Contribution / Principle
Matthias Schleiden (1838)	Studied plant tissues and concluded that all plants are composed of cells
Theodor Schwann (1839)	Studied animal tissues and concluded that all animals are composed of cells
Rudolf Virchow (1855)	Proposed that all cells are produced from the division of existing cells
3 Principles of Cell Theory	1. All living things are made of 1+ cells 2. Cells are the basic unit of structure/organization 3. Cells arise only from pre-existing cells (passing on DNA)
Get It? (Page 39)	Can cells appear spontaneously? No, cells only come from previously existing cells
Optical (Light) Microscopes	Use visible light and lenses; Total Magnification = Objective lens x Ocular lens (e.g., 10x * 10x = 100x); max ~1000x

Remember:

✓ 3 Principles of Cell Theory: (1) All living things are made of cells; (2) Cells are the basic unit of life; (3) Cells come only from pre-existing cells.

✓ Schleiden = plants; Schwann = animals; Virchow = cells come from existing cells.

✓ Light Microscope Total Magnification = Lens 1 x Lens 2 (e.g., 10x * 10x = 100x).

The Cell Theory (Fundamental Ideas of Modern Biology)

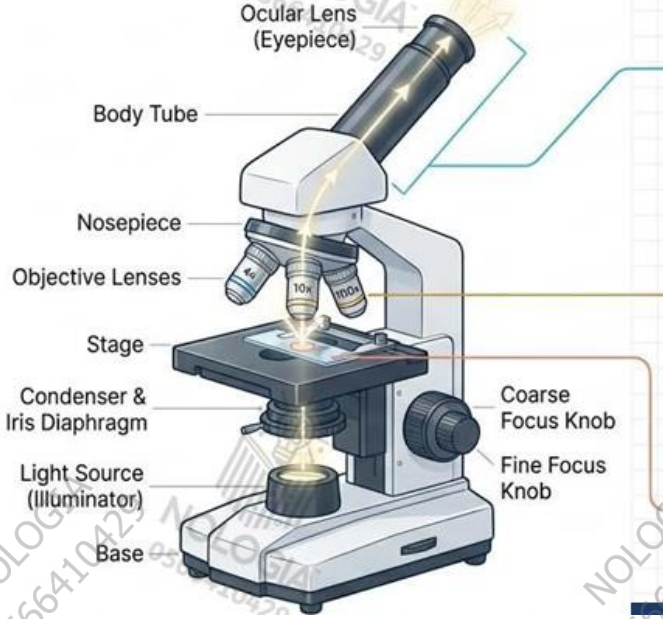
1. All **living organisms** are composed of **one** or more **cells.**

2. **Cells** are the basic unit of **structure** and **organization** of all living organisms.

3. Cells arise only from **previously existing** cells, with cells passing copies of their **genetic material** on to their **daughter cells.**

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Modern Microscope Technology: Optical



Mechanism:
Uses **visible light** and a series of **glass lenses** to magnify an object. (e.g., 10x objective lens × 10x ocular lens = 100x **magnification**).

Limitations:
Objects cause visible **light to scatter**, which **blurs images. Maximum magnification** without blurring is around 1000×.

Preparation:
Because cells are **tiny, thin, and translucent**, scientists must often **stain the cells** to make individual components visible.

Questions :

Question 1: Can cells appear spontaneously without genetic material from previous cells?

(A) No, cells arise only from previously existing cells	(B) Yes, cells form spontaneously from pure water
(C) Yes, cells appear from nonliving rocks and air	(D) No, because cells do not contain genetic material

Question 2: Which statement is one of the three principles of the cell theory?

(A) Only animals are composed of cells	(B) All living organisms are composed of one or more cells
(C) All cells contain a large central vacuole	(D) Cells can form from nonliving water and mud

Question 4: According to the cell theory, where do new cells come from?

(A) From sunlight and air	(B) From nonliving salt crystals
(C) Only from previously existing cells	(D) From empty cork chambers

Question 5: Which scientist concluded in 1839 that all animals are made of cells?

(A) Matthias Schleiden	(B) Theodor Schwann
(C) Rudolf Virchow	(D) Anton van Leeuwenhoek

Question 6: Which physician proposed in 1855 that all cells come from existing cells?

(A) Robert Hooke	(B) Matthias Schleiden
(C) Rudolf Virchow	(D) Theodor Schwann

Question 7: What do optical (compound light) microscopes use to magnify an image?

(A) Magnets and a beam of electrons	(B) A charged metal probe and a vacuum
(C) X-rays and radioactive isotopes	(D) Visible light and a series of glass lenses

Question 8: What is the maximum useful magnification of a standard compound light microscope?

(A) About 10x	(B) About 1000x
(C) About 500,000x	(D) About 10,000,000x

Question 9: Can a compound light microscope be used to view living cells?

(A) No, it requires a vacuum that kills all cells	(B) No, it can only view gold-coated dead cells
(C) Yes, living cells can be observed with a light microscope	(D) No, it can only view individual atoms

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Q16 : Module 7: Cellular Structure and Function

Lesson 1: Cell Discovery and Theory

BIO.3.1.01.076 Assess the role of selected technologies in enhancing our understanding of cells and cellular processes.

(Page 40)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 3 (Non-Optical Microscopes: TEM, SEM, and STM) · Page 40):

Non-optical (electron) microscopes use magnets to aim a beam of electrons at a cell to produce an image, magnifying up to 500,000x. There are three main types: (1) Transmission Electron Microscope (TEM): passes electrons through a thin slice of a DEAD specimen to produce a 2D black-and-white image of internal cell structures. (2) Scanning Electron Microscope (SEM): directs electrons over the surface of a DEAD specimen to produce a 3D black-and-white surface image. (3) Scanning Tunneling Microscope (STM, Figure 3): brings the charged tip of a probe extremely close to the specimen so electrons "tunnel" through the small gap, creating a 3D computer image of atoms and molecules (such as DNA in Figure 3). Unlike TEM and SEM, STM CAN be used with live specimens.

Key Ideas from the Student Book:

- Electron microscopes use magnets to aim a beam of electrons instead of visible light.
- TEM produces a 2D image of internal structures (up to 500,000x); SEM produces a 3D image of the surface. Both require DEAD specimens in a vacuum.
- In Figure 3, a Scanning Tunneling Microscope (STM) uses a charged probe tip to create 3D computer images of objects as small as atoms and DNA molecules.
- Unlike TEM and SEM, STM can be used with live specimens.

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Microscope Type	How It Works & Image Type	Can It View Live Specimens?
Compound Light Microscope	Uses visible light and glass lenses (up to ~1000x)	Yes (live or dead cells)
TEM (Transmission Electron)	Beam of electrons passes through thin slice -> 2D internal image (up to 500,000x)	No (specimen must be dead, sliced, and in a vacuum)
SEM (Scanning Electron)	Beam of electrons scans surface -> 3D surface image	No (specimen must be dead and in a vacuum)
STM (Scanning Tunneling, Figure 3)	Charged probe tip near specimen; electrons tunnel across gap -> 3D computer image of atoms/DNA	Yes (CAN be used with live specimens)

Remember:

✓ TEM = 2D internal view (dead specimen); SEM = 3D surface view (dead specimen).

✓ STM (Figure 3) = charged probe tip -> 3D computer image of atoms and DNA; CAN view live specimens.

✓ Electron microscopes use magnets and electron beams (up to 500,000x).

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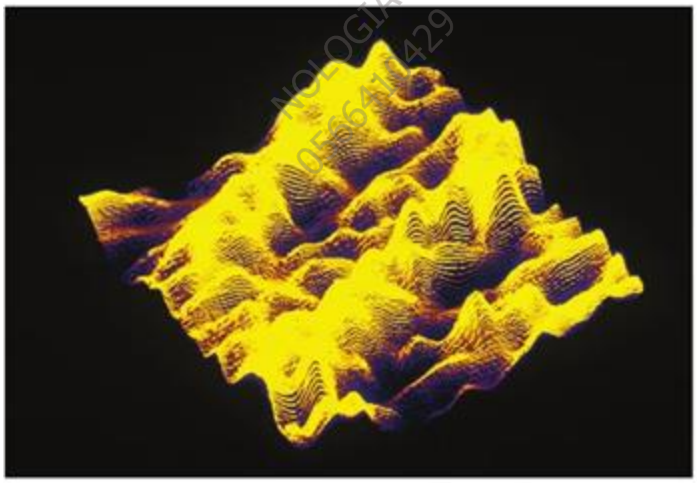
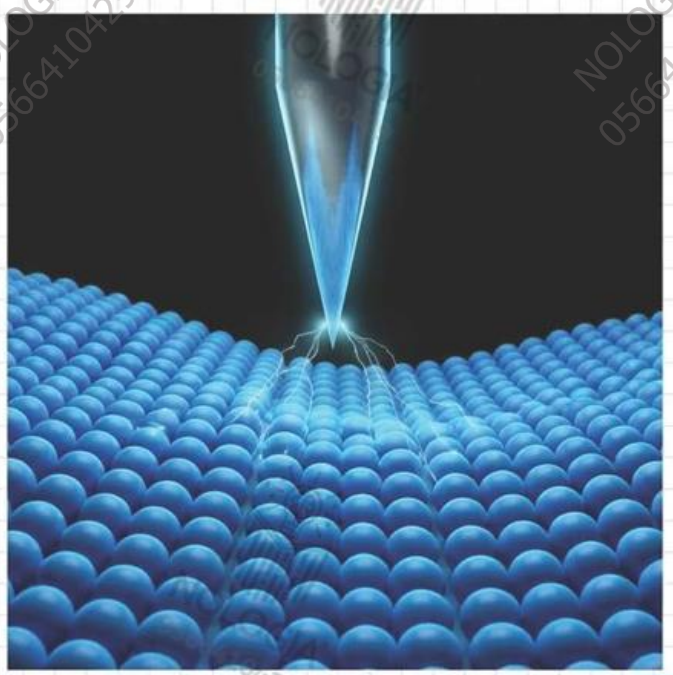


Figure 3 The scanning tunneling microscope (STM) provides images, such as this DNA molecule, in which cracks and depressions appear darker and raised areas appear lighter.

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Lab Notebook

The Atomic Level: STM & 3-D SIM



STM (Scanning Tunneling Microscope) [1981]

Mechanism: Brings a **charged probe** extremely close to the specimen; **electrons "tunnel"** through the small gap.

Capability: Creates **3D computer images** of objects as small as **individual atoms.**

Advantage: Unlike TEM and SEM, STM can be used **with live specimens.**

3-D SIM [2008]

Three-dimensional **structured illumination microscopy.**

Combines a **3D view, high resolution,** and **multiple colors.**

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Questions :

Question 1: In Figure 3, which microscope creates 3D computer images of DNA and atoms and can view live specimens?

(A) Scanning tunneling microscope (STM)	(B) Transmission electron microscope (TEM)
(C) Scanning electron microscope (SEM)	(D) Simple pocket magnifying glass

Question 2: What do electron microscopes use instead of visible light and glass lenses?

(A) Sound waves and water droplets	(B) Magnets and a beam of electrons
(C) Candles and plastic mirrors	(D) pH paper and chemical buffers

Question 3: Up to how many times can a transmission electron microscope (TEM) magnify an image?

(A) Up to 30x	(B) Up to 100x
(C) Up to 500,000x	(D) Up to 2x

Question 4: Why must specimens be dead when viewed in a TEM or SEM?

(A) Visible light kills all cells instantly	(B) Specimens must be placed in a vacuum and sliced or coated with metal
(C) Glass lenses crush the living cells	(D) Water boils inside a light microscope

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Question 5: How does a Scanning Tunneling Microscope (STM) work?

(A) It shines sunlight through two glass lenses	(B) It slices a dead cell into thin ribbons
(C) It brings a charged probe tip near the specimen so electrons tunnel across the gap	(D) It boils the specimen in acid

Question 6: Which electron microscope can be used to observe LIVE specimens?

(A) Transmission Electron Microscope (TEM)	(B) Scanning Tunneling Microscope (STM)
(C) Scanning Electron Microscope (SEM)	(D) Neither TEM, SEM, nor STM

Question 7: In Figure 3, what molecule is shown in the scanning tunneling electron micrograph?

(A) A DNA molecule	(B) A starch granule
(C) A water molecule	(D) A sodium ion

Question 8: What is a major limitation of both TEM and SEM?

(A) Their magnification is lower than a light microscope	(B) They cannot see structures smaller than a whole leaf
(C) Only nonliving (dead) cells and tissues can be observed	(D) They only work under bright sunlight

Question 9: What is an image produced by an electron microscope called?

(A) A pH scale	(B) A chromatogram
(C) An X-ray film	(D) An electron micrograph

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Q17 : Module 7: Cellular Structure and Function

Lesson 1: Cell Discovery and Theory

Compare the structure and function of plant and animal cells and that of eukaryote and prokaryote cell.

(Page 41)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 4 (Prokaryotic Cell vs. Eukaryotic Cell) · Page 41):

All cells share fundamental features: every cell has a plasma membrane (special boundary that encloses the cell and controls what enters and leaves), genetic material (DNA), cytoplasm, and ribosomes. Scientists group cells into two broad categories based on whether they have internal membrane-bound organelles (Figure 4): (1) Prokaryotic cells (such as bacteria) are smaller and simpler (1 to 100 times smaller) and DO NOT have a nucleus or other membrane-bound organelles. (2) Eukaryotic cells (such as plants, animals, fungi, protists, and yeast) are larger and HAVE a distinct nucleus (which houses DNA) and membrane-bound organelles (which carry out specialized functions).

Key Ideas from the Student Book:

- All cells have a plasma membrane, genetic material (DNA), cytoplasm, and ribosomes.
- Prokaryotic cells DO NOT have a nucleus or other membrane-bound organelles (e.g., bacteria).
- Eukaryotic cells HAVE a nucleus and membrane-bound organelles (e.g., plants, animals, fungi/yeast, algae).
- In Figure 4, prokaryotic cells are much smaller (1 to 100 times smaller) than eukaryotic cells.

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Feature	Prokaryotic Cell (Figure 4 Right)	Eukaryotic Cell (Figure 4 Left)
Definition	Simple cell WITHOUT a nucleus or membrane-bound organelles	Complex cell WITH a nucleus and membrane-bound organelles
Nucleus	Absent (No nucleus; DNA is free in cytoplasm)	Present (DNA is enclosed inside a distinct nucleus)
Membrane-bound Organelles	Absent (No mitochondria, chloroplasts, ER, or Golgi)	Present (Contains mitochondria, ER, Golgi, vacuoles, etc.)
Relative Size	Smaller (1 to 100 times smaller than eukaryotic cells)	Larger (1 to 100 times larger than prokaryotic cells)
Shared by BOTH Cells	Plasma membrane, Genetic material (DNA), Cytoplasm, and Ribosomes	Plasma membrane, Genetic material (DNA), Cytoplasm, and Ribosomes
Examples	Unicellular bacteria and archaea	Plants, animals, fungi (yeast), and algae (protists)

Remember:

✓ Prokaryote = NO nucleus, NO membrane-bound organelles, smaller (e.g., Bacteria).

✓ Eukaryote = HAS a nucleus, HAS membrane-bound organelles, larger (e.g., Plants, Animals, Yeast, Algae).

✓ Both Prokaryotes & Eukaryotes have: Plasma membrane + DNA + Cytoplasm + Ribosomes.

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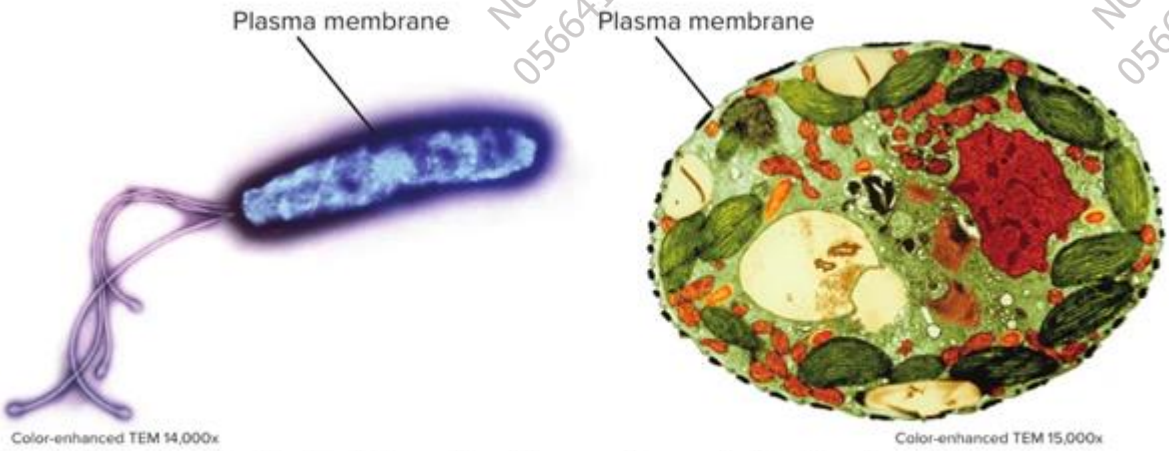
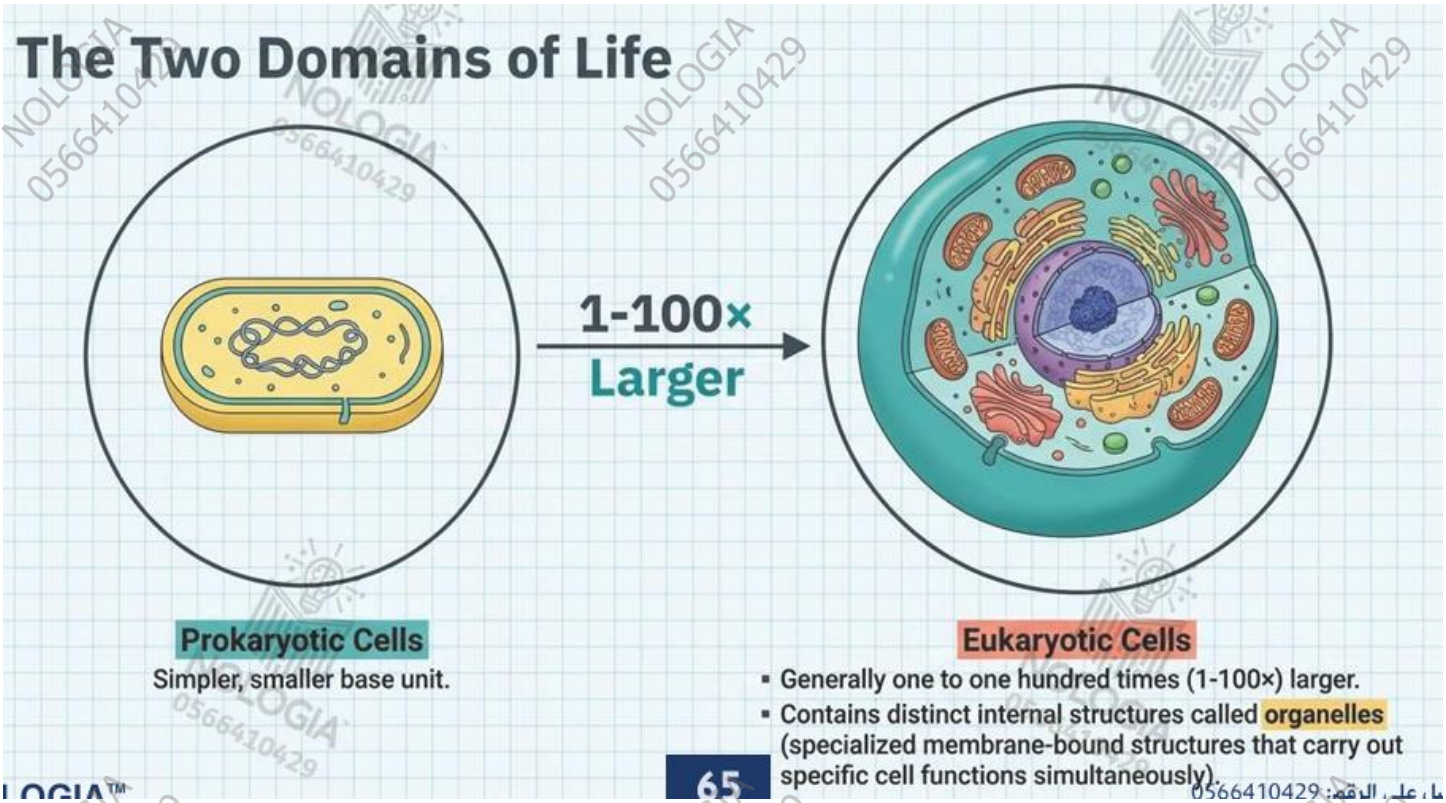


Figure 4 The prokaryotic cell on the left is smaller and appears less complex than the eukaryotic cell on the right. The prokaryotic cell has been enlarged for the purpose of comparing each cell's internal structures.



Questions :

Question 1: What is the definition of a prokaryotic cell?

(A) A cell with a large nucleus and many mitochondria	(B) A cell without a nucleus or other membrane-bound organelles
(C) A plant cell with chloroplasts and a central vacuole	(D) A multicellular animal tissue

Question 2: What is the definition of a eukaryotic cell?

(A) A cell that contains a nucleus and other membrane-bound organelles	(B) A bacterial cell with no internal membranes
(C) A virus particle with no plasma membrane	(D) A cell that contains no genetic material

Question 3: What is the definition of the plasma membrane?

(A) The organelle that captures sunlight in plants	(B) A rigid wall found only in dead cork
(C) A special boundary that helps control what enters and leaves the cell	(D) A protein fiber that moves chromosomes

Question 4: What are organelles?

(A) Simple ions dissolved in ocean water	(B) Glass lenses inside a light microscope
(C) Nonliving rocks in the environment	(D) Specialized internal structures that carry out specific cell functions

Question 5: What is the definition of the nucleus?

(A) The outer boundary of a bacterial cell	(B) A distinct central organelle that contains the cell's genetic material (DNA)
(C) A tail used by bacteria to swim in water	(D) A simple sugar produced during photosynthesis

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Question 6: How does the size of a prokaryotic cell compare to a eukaryotic cell in Figure 4?

(A) Prokaryotic cells are 100 times larger than eukaryotic cells	(B) Both cells are always the exact same size
(C) Prokaryotic cells are 1 to 100 times smaller than eukaryotic cells	(D) Prokaryotic cells are large enough to see without a microscope

Question 7: Which organism is a prokaryote?

(A) An oak tree	(B) A human
(C) A mushroom fungus	(D) A bacterium (such as E. coli)

Question 8: Which of the following organisms are eukaryotes?

(A) Bacteria and archaea only	(B) Plants, animals, fungi (yeast), and protists (algae)
(C) Viruses and prions only	(D) Nonliving salt crystals

Question 9: Where is the DNA located in a prokaryotic cell?

(A) Inside a double-membrane nucleus	(B) Free in the cytoplasm (not enclosed in a nucleus)
(C) Inside the Golgi apparatus	(D) Outside the cell wall

Question 10: Where is the DNA located in a eukaryotic cell?

(A) Outside the plasma membrane	(B) Inside the cell wall
(C) Inside the lysosomes	(D) Inside the nucleus

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Q18 : Module 7: Cellular Structure and Function

Lesson 2: The Plasma Membrane

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

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Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 5 (Structure of the Phospholipid Bilayer) · Page 43):

Most of the plasma membrane is made of phospholipids. A phospholipid is a lipid made of a glycerol backbone, two fatty acid chains (tails), and a phosphate group (head). As shown in Figure 5, the plasma membrane is a phospholipid bilayer, in which two layers of phospholipids are arranged tail-to-tail (like a sandwich). The phosphate group heads are polar (hydrophilic / attracted to water), so they face outward toward the watery environments inside and outside the cell. The two fatty acid tails are nonpolar (hydrophobic / repelled by water), so they face inward (toward each other) in the middle of the membrane away from water. This barrier keeps water-soluble substances from easily moving through the middle of the membrane.

Key Ideas from the Student Book:

- A phospholipid has 1 polar phosphate head and 2 nonpolar fatty acid tails attached to a glycerol backbone.
- The plasma membrane is a phospholipid bilayer: two layers of phospholipids arranged tail-to-tail (Figure 5).
- Polar heads are hydrophilic (attracted to water) and face the watery outside and inside of the cell.
- Nonpolar tails are hydrophobic (repelled by water) and point inward toward the middle of the bilayer.

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Part of Phospholipid Bilayer (Figure 5)	Polarity & Water Interaction	Position in Membrane
Phosphate Group Head	Polar (Hydrophilic = attracted to water)	Faces outward toward watery inside and outside of the cell
Two Fatty Acid Tails	Nonpolar (Hydrophobic = repelled by water)	Face inward (tail-to-tail) in the interior of the membrane
Phospholipid Bilayer	Double layer of phospholipids arranged tail-to-tail	Forms a barrier between the inside and outside of the cell

Remember:

✓ Phospholipid Bilayer (Figure 5) = two layers of phospholipids arranged tail-to-tail.

✓ Polar heads = hydrophilic (love water) -> face outside & inside.

✓ Nonpolar tails = hydrophobic (fear water) -> face inward (middle of sandwich).

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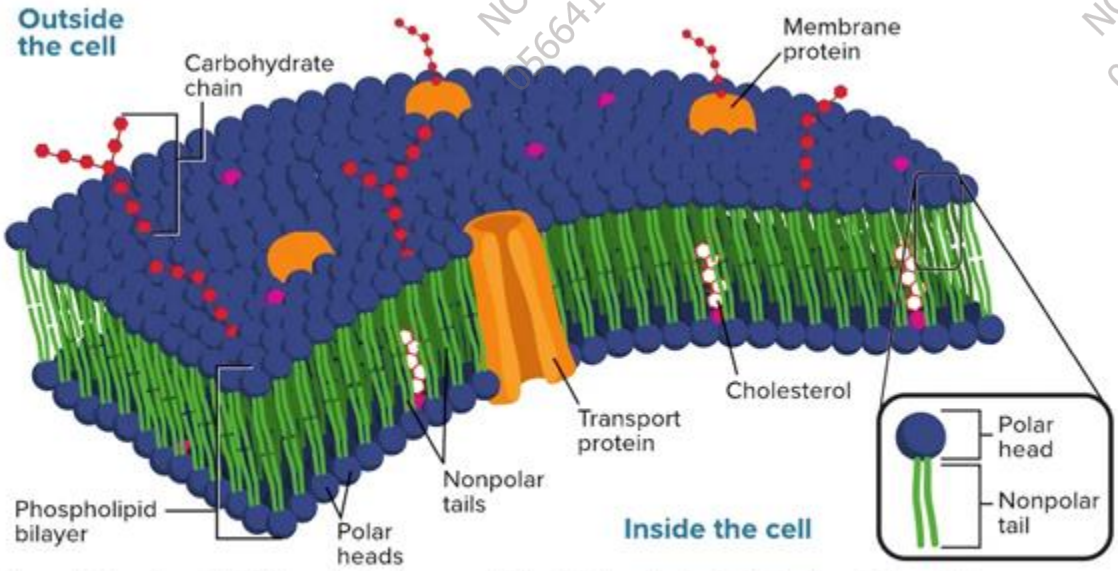
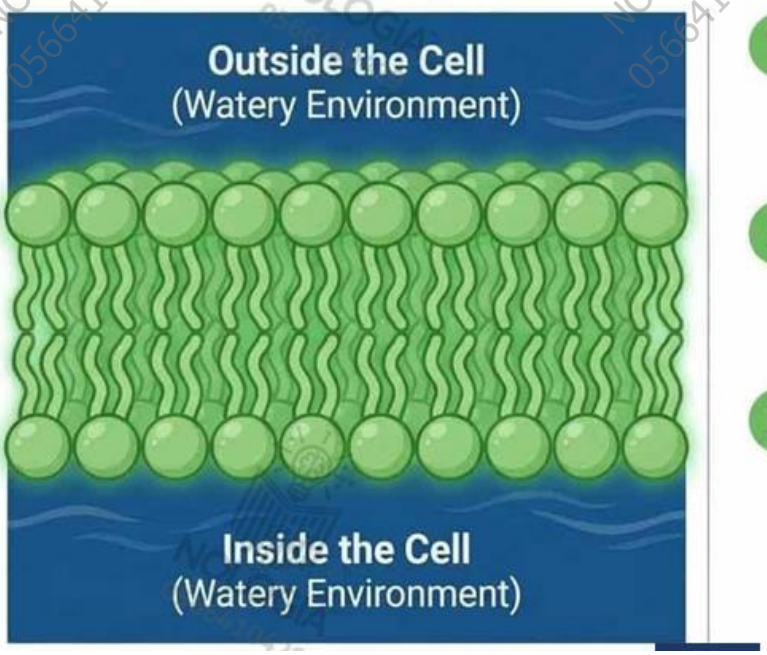


Figure 5 The phospholipid bilayer looks like a sandwich, with the polar heads facing the outside and the nonpolar tails facing the inside.



1 The Threat
Water exists both inside and outside the cell.

2 The Solution
Two layers of phospholipids arrange themselves tail-to-tail.

3 The "Sandwich" Effect
The polar heads form the "bread" (closest to water molecules).

The nonpolar tails form the "filling" (farthest away from water).

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Questions :

Question 1: In Figure 5, how are phospholipids arranged in the plasma membrane bilayer?

(A) Tail-to-tail, with polar heads facing water and nonpolar tails facing inward	(B) Head-to-head, with nonpolar tails facing the watery outside
(C) In a single flat layer of glucose rings	(D) In a rigid wall made only of amino acids

Question 2: What is the definition of a phospholipid bilayer?

(A) A single layer of sugar molecules around a plant cell	(B) Two layers of phospholipids arranged tail-to-tail that make up the plasma membrane
(C) A double helix of DNA inside the nucleus	(D) A stack of thylakoid disks inside a chloroplast

Question 3: What are the three chemical parts of a single phospholipid molecule?

(A) A glycerol backbone, two fatty acid chains, and a phosphate group	(B) A pentose sugar, a nitrogen base, and a peptide bond
(C) Three glucose rings and one iron atom	(D) An amino group, a carboxyl group, and sulfur

Question 4: In Figure 5, which part of the phospholipid is polar and hydrophilic?

(A) The two fatty acid tails	(B) The middle hydrocarbon interior
(C) The phosphate head	(D) The cholesterol ring

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Question 5: What does the word "hydrophilic" mean?

(A) Attracted to water (water-loving)	(B) Repelled by water (water-fearing)
(C) Able to make light energy	(D) Made of solid iron metal

Question 6: What does the word "hydrophobic" mean?

(A) Attracted to water (water-loving)	(B) Repelled by water (water-fearing)
(C) Dissolved easily in water	(D) Full of hydrogen bonds with water

Question 7: In Figure 5, why is one of the two fatty acid tails bent (kinked)?

(A) Because it is made of amino acids	(B) Because it contains no carbon atoms
(C) Because it is frozen into ice	(D) Because it contains an unsaturated carbon-carbon double bond

Question 8: How many layers of phospholipids make up the plasma membrane?

(A) One single layer	(B) Two layers (a bilayer)
(C) Four layers	(D) Ten layers

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Q19 : Module 7: Cellular Structure and Function

Lesson 2: The Plasma Membrane

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

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Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 6 (The Fluid Mosaic Model of the Plasma Membrane) · Page 45):

Moving with and among the phospholipids in the plasma membrane are proteins, cholesterol, and carbohydrates (Figure 6): (1) Receptor proteins on the outer surface transmit signals to the inside of the cell. (2) Proteins on the inner surface anchor the membrane to the internal support structure, giving the cell its shape. (3) Transport proteins span the entire membrane and create tunnels for needed substances or wastes to move through. (4) Cholesterol is nonpolar and positioned among the fatty acid tails; it prevents the fatty acid tails from sticking together, keeping the membrane fluid. (5) Carbohydrate chains attached to proteins define cell characteristics and help cells identify chemical signals (and help immune cells recognize foreign cells). Together, these moving components form a side-by-side pattern called the fluid mosaic model.

Key Ideas from the Student Book:

- The fluid mosaic model describes the plasma membrane as a flexible "sea" of phospholipids in which proteins, cholesterol, and carbohydrates float and move sideways.
- Transport proteins span the membrane to move substances and wastes across it.
- Receptor proteins on the outer surface transmit signals into the cell.
- Cholesterol among the phospholipids keeps fatty acid tails from sticking together, maintaining membrane fluidity.
- Carbohydrate chains on the outer surface act like ID tags to identify chemical signals and fight disease.

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Component in Figure 6	Location in Membrane	Function
Phospholipid Bilayer	Main double layer (polar heads outside, nonpolar tails inside)	Forms a flexible selective barrier around the cell
Transport Proteins	Span all the way through the bilayer	Create tunnels to move needed substances or wastes across the membrane
Receptor Proteins	Outer surface of the plasma membrane	Receive and transmit chemical signals to the inside of the cell
Cholesterol	Positioned among the nonpolar fatty acid tails	Prevents fatty acid tails from sticking together -> contributes to membrane fluidity
Carbohydrate Chains	Attached to proteins on the outer surface	Help cells identify chemical signals and distinguish normal cells from foreign cells
Fluid Mosaic Model	Whole plasma membrane	"Fluid" because phospholipids move sideways like a sea; "Mosaic" because proteins/carbohydrates make a pattern on the surface

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Remember:

✓ Fluid Mosaic Model (Figure 6): "Fluid" = phospholipids & cholesterol move sideways; "Mosaic" = pattern of proteins & carbohydrates.

✓ Transport proteins = tunnels across membrane; Receptor proteins = transmit signals.

✓ Cholesterol = prevents fatty acid tails from sticking together; Carbohydrate chains = cell identification (ID tags).

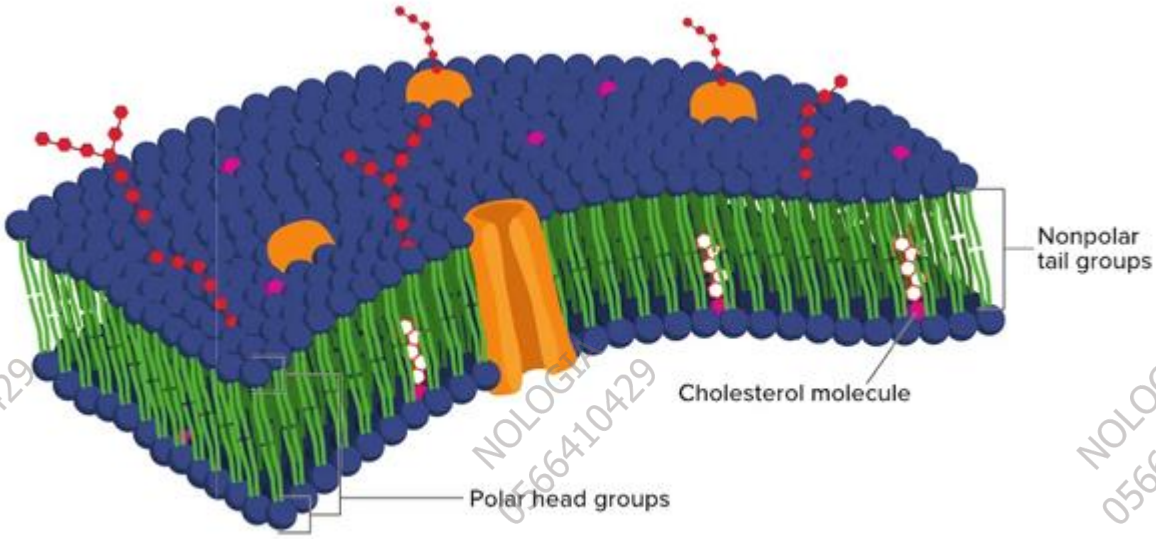
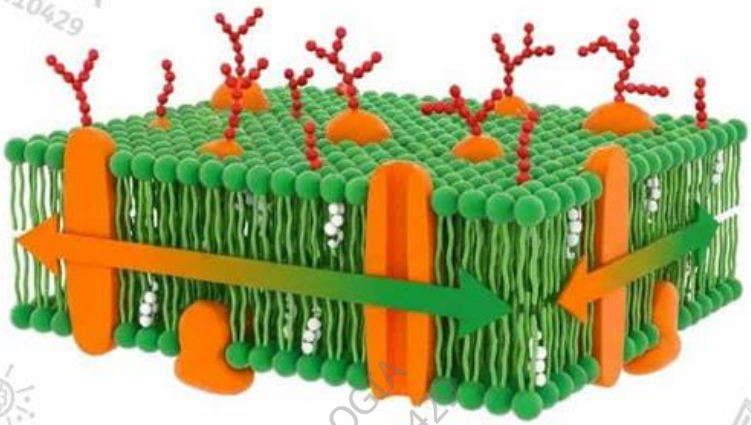


Figure 6 The fluid mosaic model refers to a plasma membrane with substances that can move around within the membrane.

The Fluid Sea

Phospholipids create a "sea" in which other molecules can float. They move sideways continuously.

Analogy: Like apples floating in a barrel of water.



The Mosaic Pattern

Because there are different substances (proteins, carbs) moving among the lipids, a shifting pattern—or mosaic—is created on

The Mosaic Pattern

Because there are different substances (proteins, carbs) moving among the lipids, a shifting pattern—or mosaic—is created on the surface.

Questions :

Question 1: In Figure 6, what is the role of cholesterol inside the phospholipid bilayer?

(A) It prevents fatty acid tails from sticking together and maintains membrane fluidity	(B) It captures sunlight to make glucose sugar
(C) It stores hereditary DNA chromosomes	(D) It pumps water out of the nucleus

Question 2: What is the fluid mosaic model?

(A) A model of a rigid brick wall that never moves	(B) A model of the plasma membrane where phospholipids form a fluid sea in which proteins and other components float
(C) A model of how DNA copies itself inside the nucleus	(D) A model of how ice crystals float on liquid water

Question 3: Why is the plasma membrane described as "fluid"?

(A) Because phospholipids can move sideways within the membrane like water in a sea	(B) Because the membrane is made of 100% pure water
(C) Because the membrane melts at 0°C	(D) Because it has no proteins or lipids

Question 4: Why is the plasma membrane described as a "mosaic"?

(A) Because it is made of colored glass tiles	(B) Because it contains only one type of molecule
(C) Because proteins, cholesterol, and carbohydrates form a pattern on the membrane surface	(D) Because it is found only in plant leaves

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Question 5: What is the function of transport proteins in Figure 6?

(A) They store genetic information in the nucleus	(B) They make proteins on the rough ER
(C) They digest old cell parts	(D) They span the membrane to move needed substances or wastes through the plasma membrane

Question 6: What is homeostasis?

(A) The bursting of a cell in pure water	(B) The division of a cell into four spores
(C) The process of maintaining balance in a cell's internal environment for survival	(D) The freezing of cytoplasm in winter

Question 7: In Figure 6, which protein goes all the way through both layers of the membrane?

(A) Inner anchor protein	(B) Carbohydrate chain
(C) Transport protein	(D) Cholesterol lipid

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Q20 : Module 7: Cellular Structure and Function

Lesson 2: The Plasma Membrane

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

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Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 7 (Selective Permeability of the Plasma Membrane) · Page 46):

A key property of the plasma membrane is selective permeability, by which a membrane allows some substances to pass through while keeping others out (just like a fishing net has holes that let water through but trap fish). As shown in Figure 7, the plasma membrane controls how, when, and how much of various substances enter and leave a cell: Needed substances such as Oxygen, Water, and Glucose enter the cell (top arrow). Products and wastes such as Wastes, Water, and Carbon dioxide leave the cell (bottom arrow). Notice that water moves both into and out of the cell.

Key Ideas from the Student Book:

- Selective permeability is the property by which a membrane allows some substances to pass through while keeping others out.
- In Figure 7, oxygen, water, and glucose enter the cell.
- In Figure 7, wastes, water, and carbon dioxide leave the cell.
- Selective permeability is essential for maintaining cellular homeostasis.

Direction / Property in Figure 7	Substances & Description
Selective Permeability	Property of a membrane that allows some substances to pass through while keeping others out
Analogy	Like a fish net that allows water to pass through its holes but keeps fish from escaping
Substances ENTERING the Cell (Figure 7)	Oxygen (O2), Water (H2O), and Glucose (nutrients)
Substances LEAVING the Cell (Figure 7)	Wastes, Water (H2O), and Carbon dioxide (CO2)
Substance Moving BOTH In and Out	Water (H2O) enters and leaves the cell across the plasma membrane

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Remember:

✓ Selective permeability = allows some substances to pass through while keeping others out.

✓ Figure 7 ENTERING cell: Oxygen, Water, Glucose.

✓ Figure 7 LEAVING cell: Wastes, Water, Carbon dioxide.

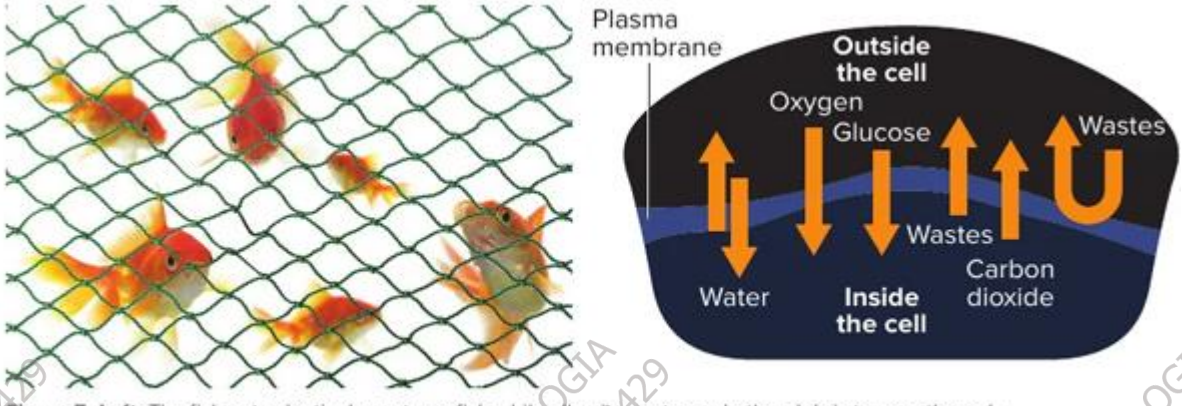
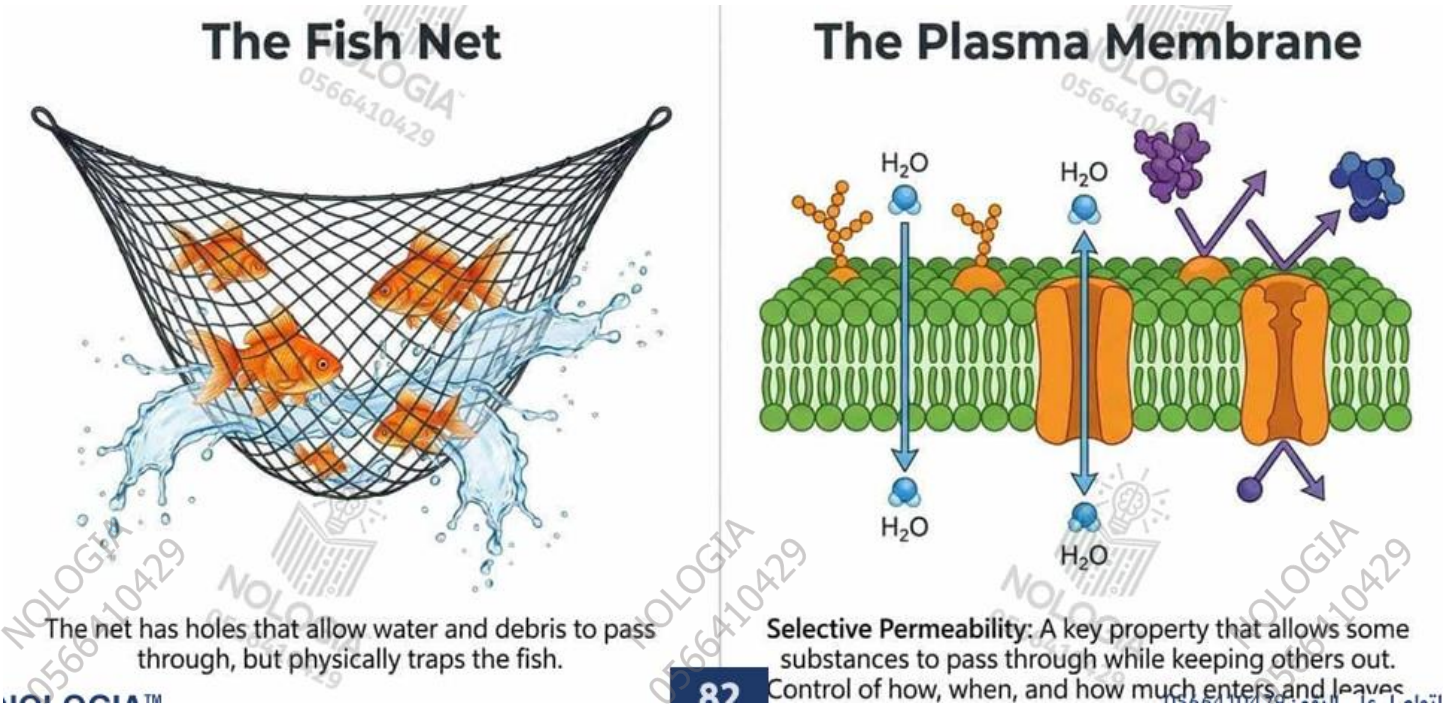


Figure 7 Left: The fish net selectively captures fish while allowing water and other debris to pass through. **Right:** Similarly, the plasma membrane is selective for substances entering and leaving the cell.



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Questions :

Question 1: According to Figure 7, which substances enter the cell through the plasma membrane?

(A) Oxygen, water, and glucose	(B) Wastes and carbon dioxide only
(C) Whole bacteria and viruses	(D) Nuclei and mitochondria

Question 2: What is the definition of selective permeability?

(A) A property that blocks all molecules including water from crossing	(B) A property of a membrane that allows some substances to pass through while keeping others out
(C) A property that lets every substance enter and leave freely	(D) The process of breaking down glucose in mitochondria

Question 3: According to Figure 7, which substances leave the cell across the plasma membrane?

(A) DNA and chromosomes	(B) Ribosomes and nucleoli
(C) Wastes, water, and carbon dioxide	(D) Glucose and oxygen only

Question 4: According to Figure 7, which substance moves BOTH into and out of the cell?

(A) Water	(B) DNA
(C) Starch	(D) Cellulose

Question 5: In Figure 7, where is the cytoplasm located relative to the plasma membrane?

(A) Outside the cell	(B) Inside the fishing net only
(C) Inside the cell	(D) Above the cell wall

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Question 6: In Figure 7, what does the top arrow pointing from "Outside the cell" to "Inside the cell" show?

(A) Oxygen, water, and glucose entering the cell	(B) Wastes and carbon dioxide entering the cell
(C) DNA leaving the cell	(D) Mitochondria leaving the cell

Question 7: In Figure 7, what does the bottom arrow pointing from "Inside the cell" to "Outside the cell" show?

(A) Glucose and oxygen leaving the cell	(B) Wastes, water, and carbon dioxide leaving the cell
(C) Ribosomes entering the cell	(D) Sunlight leaving the cell

Question 8: Depending on the type of substance, in what two main ways can substances cross the plasma membrane?

(A) Only by destroying the cell membrane	(B) Only by freezing the cytoplasm
(C) Directly through the phospholipid bilayer or through transport proteins	(D) Through carbohydrate chains or cholesterol

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Q21 : Module 7: Cellular Structure and Function

Lesson 3: Cellular Transport

BIO.3.1.01.057 Explain the processes of diffusion and osmosis and their roles within a cell.

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Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 8 (Diffusion of Ink in Water & Dynamic Equilibrium) · Page 47):

Particles in liquids and gases are in constant random motion (Brownian motion). Diffusion is the net movement of particles from an area where there are many particles of the substance (high concentration) to an area where there are fewer particles of the substance (low concentration). Because particles are already in motion, diffusion requires NO additional energy (it is passive transport). As shown in Figure 8, when blue and red ink drops are placed in a beaker of water, the ink particles diffuse from high concentration to low concentration until they are evenly mixed throughout the beaker. This state is called dynamic equilibrium, where particles continue to move randomly, but there is no further change in concentration.

Key Ideas from the Student Book:

- Diffusion is the net movement of particles from an area of high concentration to an area of low concentration.
- Diffusion is a form of passive transport: it requires NO additional energy input from the cell.
- In Figure 8, red and blue ink diffuse in water until they reach dynamic equilibrium (equal concentration everywhere, while particles keep moving).
- Increasing concentration, temperature, or pressure increases the rate of diffusion.

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Term / Stage in Figure 8	Definition & Key Facts
Diffusion	Net movement of particles from an area of HIGH concentration to an area of LOW concentration
Energy Required?	NO additional energy is required (Passive transport) because particles are already in random motion
Figure 8 (Beaker 1 -> 2 -> 3)	Red and blue ink drops start concentrated, spread out, and mix evenly to turn the water purple
Dynamic Equilibrium	Condition in which there is continuous movement of particles, but no overall change in concentration
3 Factors Affecting Diffusion Rate	1. Concentration (higher = faster) 2. Temperature (higher = faster) 3. Pressure (higher = faster)

Remember:

✓ Diffusion = movement of particles from HIGH concentration to LOW concentration; requires NO energy.

✓ Dynamic equilibrium = particles keep moving, but concentrations stay equal everywhere.

✓ Higher concentration, higher temperature, or higher pressure -> FASTER diffusion.

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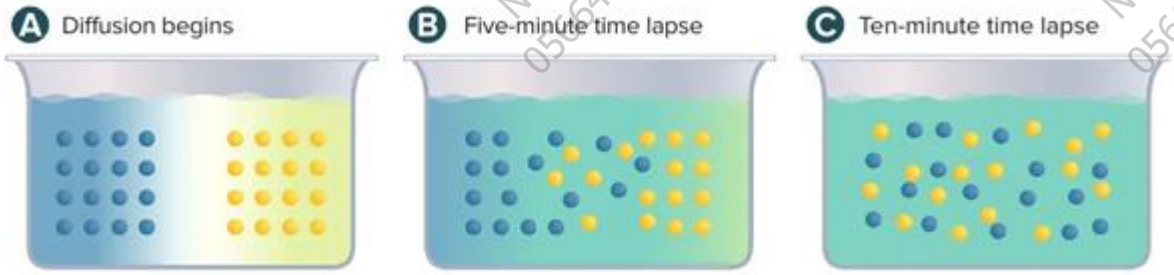
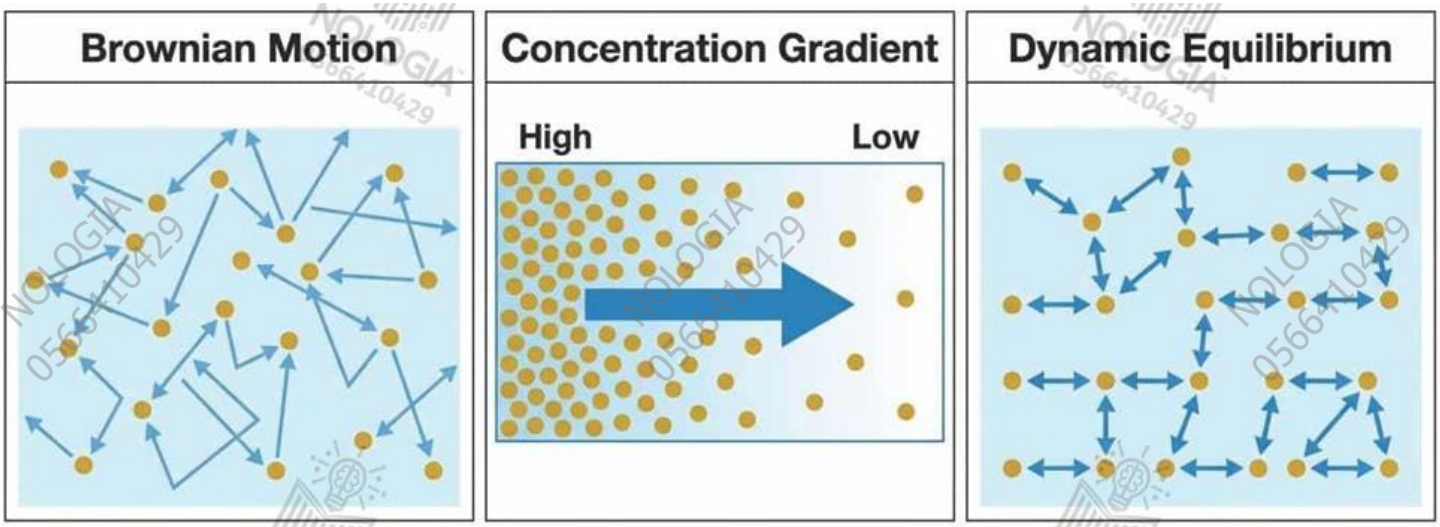


Figure 8 Diffusion causes the inks to move from high-ink concentration to low-ink concentration until the color become evenly blended in the water.



Substances dissolved in water are in constant, random motion. They collide and bounce.

Diffusion is the net movement of particles from an area of many particles (High) to fewer particles

Particles continue to move randomly, but there is no overall change in concentration.

Questions :

Question 1: In Figure 8, in which direction do the ink particles move during diffusion?

(A) From an area of high concentration to an area of low concentration	(B) From an area of low concentration to an area of high concentration
(C) Only upward against gravity using ATP energy	(D) They do not move at all in liquid water

Question 2: What is the definition of diffusion?

(A) The pumping of ions from low to high concentration using ATP	(B) The net movement of particles from an area of high concentration to an area of low concentration
(C) The division of the cell nucleus during mitosis	(D) The synthesis of proteins on ribosomes

Question 3: Does diffusion require additional energy (ATP) from the cell?

(A) No, diffusion requires no additional energy (passive transport)	(B) Yes, diffusion requires large amounts of ATP
(C) Yes, diffusion requires sunlight energy	(D) Yes, diffusion requires protein pumps

Question 4: Why do particles diffuse without needing extra energy?

(A) Because mitochondria push every water molecule	(B) Because gravity pulls particles upward
(C) Because particles in gases and liquids are already in random motion	(D) Because enzymes carry every ink particle

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Question 5: What is Brownian motion?

(A) The circular movement of planets	(B) The folding of a protein chain
(C) The freezing of water into ice	(D) The random movement of particles suspended in a fluid

Question 6: What is the definition of dynamic equilibrium?

(A) A state where all particles freeze and stop moving completely	(B) A state with continuous particle movement, but no overall change in concentration
(C) A state where all ink particles settle to the bottom of the beaker	(D) A state where water evaporates out of the beaker

Question 7: In Figure 8, which beaker shows that dynamic equilibrium has been reached?

(A) The first beaker on the left, when ink is just dropped in	(B) An empty beaker with no water
(C) The third beaker on the right, where the purple color is uniform throughout	(D) None of the beakers

Question 8: What is the concentration of a substance?

(A) The color of a liquid under a microscope	(B) The temperature at which water boils
(C) The length of a cell membrane	(D) The amount of a substance in a particular area or volume

Question 9: Which three main factors affect the rate (speed) of diffusion?

(A) Color, shape, and sound	(B) Concentration, temperature, and pressure
(C) Gravity, magnetism, and pH	(D) Light, darkness, and wind

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Q22 : Module 7: Cellular Structure and Function

Lesson 3: Cellular Transport

BIO.3.1.01.057 Explain the processes of diffusion and osmosis and their roles within a cell.

(Page 48)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 9 (Diffusion Across the Plasma Membrane & Facilitated Diffusion) · Page 48):

Water and small nonpolar molecules can diffuse directly across the plasma membrane (Figure 9A), while most other substances (such as ions and sugars) cannot pass through the nonpolar lipid core and need help from transport proteins. Facilitated diffusion is the diffusion of ions and small molecules across the plasma membrane using water-filled transport proteins. Because particles still move from HIGH concentration to LOW concentration, facilitated diffusion is a form of passive transport and requires NO additional energy. Figure 9 shows the two types of transport proteins used in facilitated diffusion: (1) Channel proteins (Figure 9B) open and close to let ions/small molecules diffuse through a water-filled tunnel; (2) Carrier proteins (Figure 9C) change shape as molecules pass through.

Key Ideas from the Student Book:

- Facilitated diffusion uses transport proteins (channel proteins and carrier proteins) to move ions and sugars across the plasma membrane.
- In Figure 9B, channel proteins open and close like gates/tunnels across the membrane.
- In Figure 9C, carrier proteins change shape to move substances across the membrane.
- Facilitated diffusion moves substances from HIGH to LOW concentration and requires NO additional energy (passive transport).

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Part of Figure 9	Transport Mechanism	Direction & Energy Required
Figure 9 (A): Simple Diffusion	Water and small nonpolar molecules diffuse directly through the phospholipid bilayer	High -> Low concentration; NO energy required
Facilitated Diffusion (B & C)	Diffusion of ions (Cl-, Na+) and sugars across the membrane using transport proteins	High -> Low concentration; NO energy required (Passive transport)
Figure 9 (B): Channel Proteins	Water-filled channels that open and close to allow specific ions or small molecules to diffuse across	High -> Low concentration; NO energy required
Figure 9 (C): Carrier Proteins	Transport proteins that change shape to help substances diffuse across the membrane	High -> Low concentration; NO energy required

Remember:

✓ Facilitated diffusion = diffusion from HIGH to LOW concentration using transport proteins; requires NO energy.

✓ Figure 9B Channel protein = opens and closes like a tunnel.

✓ Figure 9C Carrier protein = changes shape as the molecule passes through.

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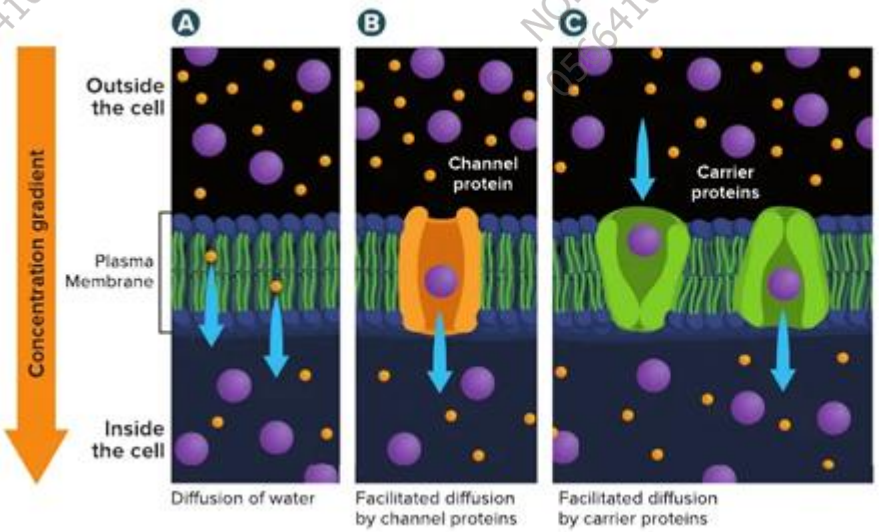
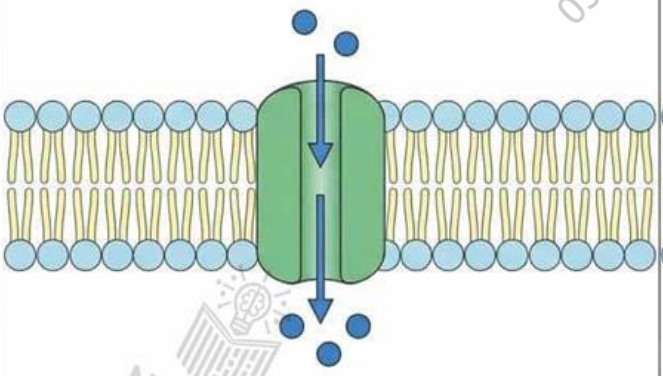
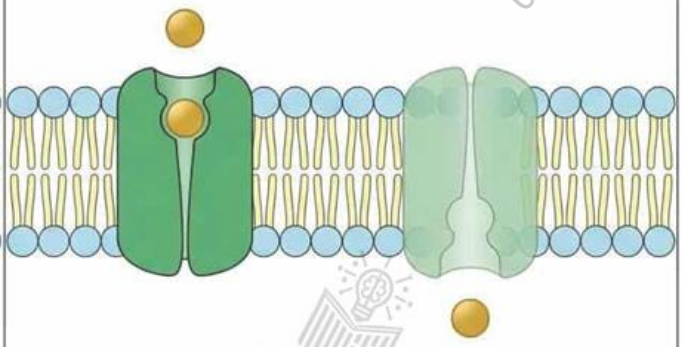


Figure 9 Although water moves freely through the plasma membrane (A), other substances cannot pass through the phospholipid bilayer on their own. Channel proteins (B) and carrier proteins (C) are kinds of transport proteins that help ions and small molecules move across the membrane in a process called facilitated diffusion.

Facilitated Diffusion: Getting Help Across the Border

Water, ions, and small molecules (like sugars) use transport proteins to bypass the hydrophobic membrane core. Zero energy required.

Channel Proteins	Carrier Proteins
	
The Tunnel: Opens and closes to allow substances to flow straight through	**The Shape-Shifter:** Binds to the particle and physically changes shape to move it across

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Questions :

Question 1: In Figure 9, how do carrier proteins (C) differ from channel proteins (B) during facilitated diffusion?

(A) Carrier proteins change shape to move substances, while channel proteins open and close	(B) Carrier proteins use ATP energy, while channel proteins make glucose
(C) Channel proteins move DNA, while carrier proteins move whole nuclei	(D) Both move substances from low to high concentration using ATP

Question 2: What is facilitated diffusion?

(A) Movement of particles against a concentration gradient using ATP	(B) Diffusion of ions and small molecules across the plasma membrane using transport proteins
(C) The engulfing of large solid particles by vesicles	(D) The synthesis of phospholipids in the smooth ER

Question 3: In which direction do particles move during facilitated diffusion?

(A) From low concentration to high concentration	(B) Only out of the cell against the gradient
(C) From an area of high concentration to an area of low concentration	(D) Particles do not move across the membrane

Question 4: What are the two types of transport proteins used in facilitated diffusion (Figure 9)?

(A) Hemoglobin and collagen	(B) Amylase and keratin
(C) Actin and myosin	(D) Channel proteins and carrier proteins

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Question 5: In Figure 9B, how do channel proteins help substances cross the plasma membrane?

(A) They open and close to provide a water-filled pathway through the membrane	(B) They dissolve the entire phospholipid bilayer
(C) They burn ATP to pump ions uphill	(D) They leave the membrane and enter the nucleus

Question 6: In Figure 9C, how do carrier proteins help substances cross the plasma membrane?

(A) They stay rigid like an open pipe at all times	(B) They change shape as the molecule passes through the membrane
(C) They turn sugars into fatty acids	(D) They use ATP to push molecules against the gradient

Question 7: What is shown in Figure 9A?

(A) Water molecules diffusing directly across the phospholipid bilayer	(B) Active transport using a sodium-potassium pump
(C) Exocytosis of a large secretory vesicle	(D) Endocytosis of a bacterial cell

Question 8: How is facilitated diffusion similar to simple diffusion?

(A) Both require carrier proteins to change shape	(B) Both move substances from high concentration to low concentration without using energy
(C) Both move substances from low to high concentration	(D) Both require ATP energy from mitochondria

Question 9: How is facilitated diffusion different from simple diffusion?

(A) Facilitated diffusion uses ATP, while simple diffusion does not	(B) Simple diffusion uses carrier proteins, while facilitated diffusion does not
(C) Facilitated diffusion requires transport proteins, while simple diffusion does not	(D) Facilitated diffusion moves particles from low to high concentration

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Q23 : Module 7: Cellular Structure and Function

Lesson 3: Cellular Transport

BIO.3.1.01.057 Explain the processes of diffusion and osmosis and their roles within a cell.

(Page 49)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 10 (Osmosis across a Selectively Permeable Membrane in a U-Tube) · Page 49):

Osmosis is the diffusion of water across a selectively permeable membrane (mostly through channel proteins called aquaporins). Water moves from an area of HIGHER water concentration (lower solute concentration) to an area of LOWER water concentration (higher solute concentration). In Figure 10 (Before Osmosis), a U-tube is divided by a selectively permeable membrane: the left side has low sugar concentration and high water concentration, while the right side has high sugar concentration and low water concentration. Sugar molecules are too large to pass through the membrane, but water molecules can pass freely. Therefore, water diffuses from the left side to the right side until both sides have the same concentration of sugar solution (After Osmosis / Dynamic Equilibrium), causing the water level on the right side to rise.

Key Ideas from the Student Book:

- Osmosis is the diffusion of water across a selectively permeable membrane (often through aquaporin channels).
- Water moves from high water concentration (low solute concentration) to low water concentration (high solute concentration).
- In Figure 10, sugar molecules cannot cross the membrane, so water moves from the left side (low sugar) to the right side (high sugar).
- After osmosis in Figure 10, the liquid level on the right side is higher, and both sides have equal sugar concentration (dynamic equilibrium).

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Feature / Stage in Figure 10	Left Side of U-Tube	Right Side of U-Tube
Before Osmosis (Left U-Tube)	Low sugar (solute) concentration / HIGH water concentration	High sugar (solute) concentration / LOW water concentration
Selectively Permeable Membrane	Water molecules CAN pass through	Sugar molecules CANNOT pass through (too large)
Direction of Water Movement	Water moves OUT of the left side ->	-> Water moves INTO the right side (toward higher solute)
After Osmosis (Right U-Tube)	Water level drops; concentrations become equal	Water level rises; both sides reach equal concentration (dynamic equilibrium)

Remember:

✓ Osmosis = diffusion of WATER across a selectively permeable membrane (requires NO energy).

✓ Water always moves from HIGH water (low solute) concentration -> LOW water (high solute) concentration ("Water follows solute").

✓ In Figure 10, water moves from Left (low sugar) to Right (high sugar), raising the right side's water level until concentrations are equal.

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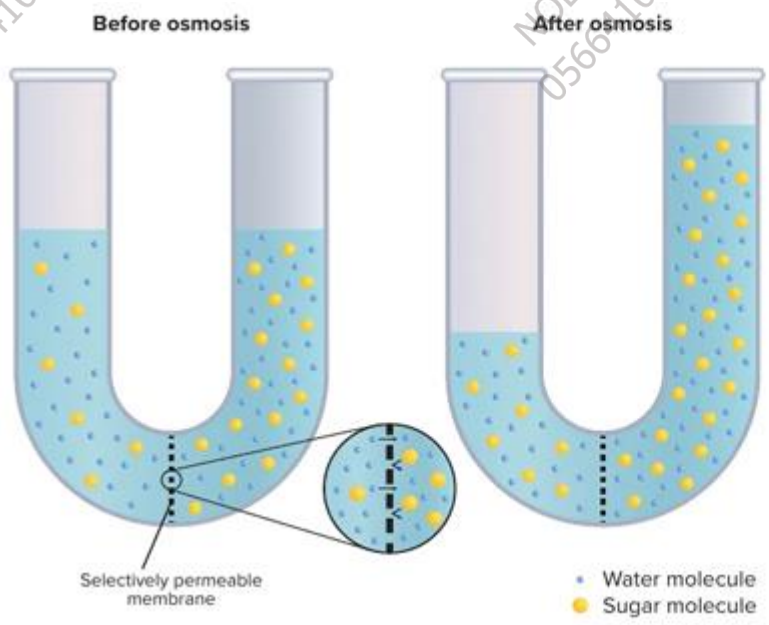


Figure 10 Before osmosis, the sugar concentration is greater on the right side. After osmosis, the concentrations are the same on both sides. Water molecules continue to move across the membrane.

Name *the term for the phenomenon shown in this figure.*

Questions :

Question 1: In Figure 10, why does water move from the left side to the right side of the U-tube?

(A) Water moves from higher water (low sugar) concentration to lower water (high sugar) concentration	(B) Sugar molecules diffuse from the right side to the left side
(C) Active transport pumps push sugar across the membrane using ATP	(D) Water moves from low water concentration to high water concentration

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Question 2: What is the definition of osmosis?

(A) The active pumping of sodium ions using ATP	(B) The diffusion of water across a selectively permeable membrane
(C) The movement of large sugar molecules through a cell wall	(D) The engulfing of food particles by endocytosis

Question 3: Does osmosis require additional energy (ATP) from the cell?

(A) Yes, osmosis requires large amounts of ATP	(B) Yes, osmosis is a type of active transport
(C) No, osmosis is a type of passive transport and requires no energy	(D) Yes, osmosis requires sunlight energy

Question 4: In Figure 10 (Before Osmosis), which side of the U-tube has a HIGHER concentration of water?

(A) The left side (which has lower sugar concentration)	(B) The right side (which has higher sugar concentration)
(C) Neither side contains any water	(D) Both sides have zero water molecules

Question 5: In Figure 10 (Before Osmosis), which side of the U-tube has a HIGHER concentration of sugar (solute)?

(A) The left side	(B) The right side
(C) Neither side has sugar	(D) Both sides have equal sugar at the start

Question 6: Why do the green sugar molecules NOT move from the right side to the left side in Figure 10?

(A) Sugar molecules are nonpolar gases	(B) There is no water on the left side
(C) Sugar molecules have zero concentration	(D) The sugar molecules cannot pass through the selectively permeable membrane

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Q24 : Module 7: Cellular Structure and Function

Lesson 3: Cellular Transport

BIO.3.1.01.071 Explain the swelling of the cells of living organisms when put in water and its shrinking when put in salt solution, and generalize the phenomenon on all living organisms.

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Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 11 A, B, C (Isotonic, Hypotonic, and Hypertonic Solutions) · Page 51):

Figure 11 A, B, and C show how animal cells (red blood cells) and plant cells respond when placed in three types of solutions: (A) Isotonic Solution: the outside solution and inside of the cell have the SAME concentration of water and solutes. Water moves in and out at the same rate, and cells retain their normal shape. (B) Hypotonic Solution (e.g., pure water): the outside solution has a LOWER concentration of solute (and HIGHER concentration of water) than inside the cell. Net movement of water is INTO the cell by osmosis. An animal cell swells and may burst (lyse), while a plant cell swells and becomes firmer (increased turgor pressure) because its rigid cell wall prevents it from bursting. (C) Hypertonic Solution (e.g., strong salt solution): the outside solution has a HIGHER concentration of solute (and LOWER concentration of water) than inside the cell. Net movement of water is OUT of the cell. An animal cell shrivels (shrinks), and in a plant cell the central vacuole loses water and the plasma membrane shrinks away from the cell wall, causing the plant to wilt.

Key Ideas from the Student Book:

- Figure 11(A) Isotonic solution: equal solute/water concentrations; water enters and leaves at the same rate; normal cell shape.
- Figure 11(B) Hypotonic solution (pure water): lower solute outside; water moves INTO the cell -> animal cell swells and may burst; plant cell becomes firm (cell wall prevents bursting).
- Figure 11(C) Hypertonic solution (salt water): higher solute outside; water moves OUT of the cell -> animal cell shrivels; plant cell membrane shrinks away from the cell wall (wilting).

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Solution Type in Figure 11	Solute & Water Outside vs Inside	Direction of Water Movement	Effect on Animal Cell vs. Plant Cell
(A) Isotonic Solution	Equal solute & equal water concentration outside and inside	Water moves in and out at the SAME rate (no net movement)	Animal cell: Normal shape | Plant cell: Normal shape
(B) Hypotonic Solution (e.g. pure water)	LOWER solute (HIGHER water) outside than inside cell	Net water movement INTO the cell (H_2O enters)	Animal cell: Swells and may burst | Plant cell: Becomes firmer (cell wall prevents bursting)
(C) Hypertonic Solution (e.g. salt solution)	HIGHER solute (LOWER water) outside than inside cell	Net water movement OUT of the cell (H_2O leaves)	Animal cell: Shrivels (shrinks) | Plant cell: Membrane pulls away from cell wall -> plant wilts

Remember:

✓ Isotonic (Figure 11A) = equal concentration -> water moves in & out equally -> normal cell shape.

✓ Hypotonic (Figure 11B, pure water) = lower solute outside -> water moves IN -> animal cell swells/bursts; plant cell becomes firm.

✓ Hypertonic (Figure 11C, salt water) = higher solute outside -> water moves OUT -> animal cell shrivels; plant cell wilts.

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Figure 11(A) In an isotonic solution, water molecules move into and out of the cell at the same rate, and cells retain their normal shape. The animal cell and the plant cells have their normal shapes in an isotonic solution.



Figure 11(B) In a hypotonic solution, water enters a cell by osmosis, causing the cell to swell. Animal cells may continue to swell until they burst. Plant cells swell beyond their normal size as internal pressure increases.

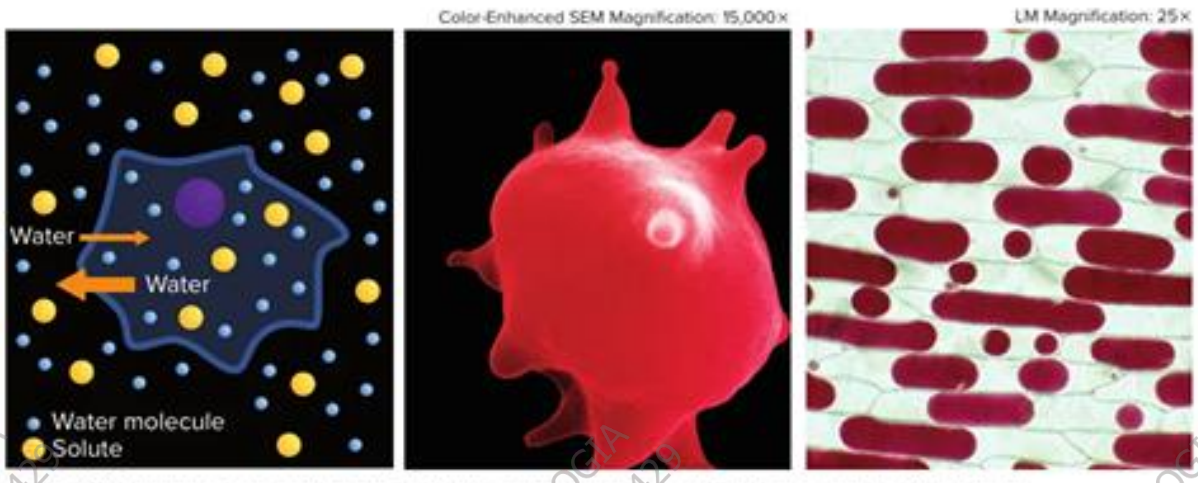


Figure 11(C) In a hypertonic solution, water leaves a cell by osmosis, causing the cell to shrink. Animal cells shrivel up as they lose water. As plant cells lose internal pressure, the plasma membrane shrinks away from the cell wall.

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Questions :

Question 1: According to Figure 11, what happens when a cell is placed in a hypertonic salt solution (C)?

(A) Water moves out of the cell, causing animal cells to shrivel and plant cells to wilt	(B) Water moves into the cell, causing animal cells to swell and burst
(C) Water moves in and out at the same rate, keeping normal cell shape	(D) Salt pumps water into the central vacuole to make the plant firmer

Question 2: What is an isotonic solution (Figure 11A)?

(A) A solution with much higher salt concentration than the cell	(B) A solution that has the same concentration of water and solutes as the cytoplasm inside the cell
(C) Pure distilled water with zero solutes	(D) A solution that causes red blood cells to burst

Question 3: What happens to the shape of animal and plant cells in an isotonic solution (Figure 11A)?

(A) Water enters and leaves at the same rate, so the cells keep their normal shape	(B) The cells swell and burst immediately
(C) The cells shrivel and lose all their water	(D) The plasma membrane pulls away from the cell wall

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Question 4: What is a hypotonic solution (Figure 11B)?

(A) A solution with a higher concentration of salt than inside the cell	(B) A solution with the exact same solute concentration as the cell
(C) A solution that has a lower concentration of solute (and higher water) than inside the cell	(D) A solution with zero water molecules

Question 5: In which direction does water move when a cell is placed in a hypotonic solution (pure water, Figure 11B)?

(A) Net movement of water is OUT of the cell	(B) No water crosses the membrane
(C) Salt moves out of the cell by osmosis	(D) Net movement of water is INTO the cell by osmosis

Question 6: What happens to an animal cell (red blood cell) placed in a hypotonic solution (pure water, Figure 11B)?

(A) Water enters the cell, causing it to swell and possibly burst	(B) Water leaves the cell, causing it to shrivel
(C) The cell stays the exact same size	(D) Its rigid cell wall prevents it from bursting

Question 7: Why do grocery stores mist fresh vegetables with pure (hypotonic) water?

(A) To make the plant cells shrivel and wilt	(B) To draw water out of the central vacuoles
(C) Water enters the plant cells by osmosis, keeping the vegetables crisp and firm	(D) To dissolve the cellulose cell walls

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Question 8: What is a hypertonic solution (Figure 11C)?

(A) Pure water with zero dissolved solutes	(B) A solution with lower solute concentration than inside the cell
(C) A solution with equal solute concentration to the cell	(D) A solution that has a higher concentration of solute (and lower water) than inside the cell

Question 9: In which direction does water move when a cell is placed in a hypertonic salt solution (Figure 11C)?

(A) Net movement of water is OUT of the cell	(B) Net movement of water is INTO the cell
(C) Water moves in and out at equal rates	(D) No water moves across the membrane

Question 10: What happens to an animal cell (red blood cell) in a hypertonic salt solution (Figure 11C)?

(A) It gains water and bursts	(B) It loses water and shrivels (shrinks)
(C) It grows twice as large	(D) It forms a green cell wall

Question 11: In Figure 11, which letter shows a cell in an ISOTONIC solution?

(A) Diagram (A), where H2O enters and leaves at the same rate	(B) Diagram (B)
(C) Diagram (C)	(D) None of the diagrams

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Q25 : Module 7: Cellular Structure and Function

Lesson 4: Structures and Organelles

BIO.3.1.01.043 Build a model of the cell membrane indicating the active and passive transport in terms of the difference in concentration, the required energy, and the movement direction of the particle and explain how the movement of a particle affects the cell.

(Page 57)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Information from text + Figure 18 (Cytoskeleton & Active vs. Passive Transport) · Page 57):

This item covers both Page 57 (Cytoplasm and Cytoskeleton, Figure 18) and the Learning Outcome comparing Passive and Active Transport: (1) Cytoplasm and Cytoskeleton (Page 57, Figure 18): The semifluid environment inside the plasma membrane is the cytoplasm. Organelles do not float freely; they are supported by the cytoskeleton—a supporting network of long, thin protein fibers that forms a framework for the cell, anchors organelles, and assists in cell movement. The cytoskeleton is made of two main protein substructures: Microtubules (long, hollow protein cylinders that form a rigid skeleton and help move substances) and Microfilaments (thin protein threads that help give the cell shape and enable cell movement). Both slide past one another using ATP energy. (2) Active vs. Passive Transport (LO BIO.3.1.01.043): Passive transport (diffusion, facilitated diffusion, osmosis) moves particles from HIGH to LOW concentration (with the gradient) and requires NO energy. Active transport moves particles from LOW to HIGH concentration (against the gradient) and REQUIRES energy (ATP) and carrier protein pumps (e.g., Na+/K+ ATPase pump, endocytosis, exocytosis).

Key Ideas from the Student Book:

- The cytoplasm is the semifluid environment inside the plasma membrane.
- In Figure 18 (Page 57), the cytoskeleton is a network of protein fibers (hollow microtubules and thin microfilaments) that supports cell shape, anchors organelles, and aids movement.
- Passive transport moves particles from high to low concentration WITH NO energy required.
- Active transport moves particles from low to high concentration (against the concentration gradient) and REQUIRES ATP energy.

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Topic / Structure (Page 57 & LO)	Key Scientific Facts
Cytoplasm (Page 57)	Semifluid environment inside the plasma membrane where cellular chemical processes occur
Cytoskeleton (Page 57, Figure 18)	Supporting network of long, thin protein fibers that gives the cell shape, anchors organelles, and helps cell movement
Microtubules (Figure 18)	Long, hollow protein cylinders that form a rigid skeleton for the cell and assist in moving substances
Microfilaments (Figure 18)	Thin protein threads that help give the cell shape and enable the entire cell or parts of it to move
Passive Transport (LO)	Movement from HIGH to LOW concentration; requires NO energy (diffusion, facilitated diffusion, osmosis)
Active Transport (LO)	Movement from LOW to HIGH concentration (against gradient); REQUIRES ATP energy (carrier pumps, Na+/K+ pump, endocytosis, exocytosis)

Remember:

✓ Cytoskeleton (Figure 18) = network of protein fibers (hollow Microtubules + thin Microfilaments) that gives the cell shape and anchors organelles.

✓ Passive Transport = HIGH -> LOW concentration, NO energy required.

✓ Active Transport = LOW -> HIGH concentration (against gradient), REQUIRES ATP energy (pumps, endocytosis, exocytosis).

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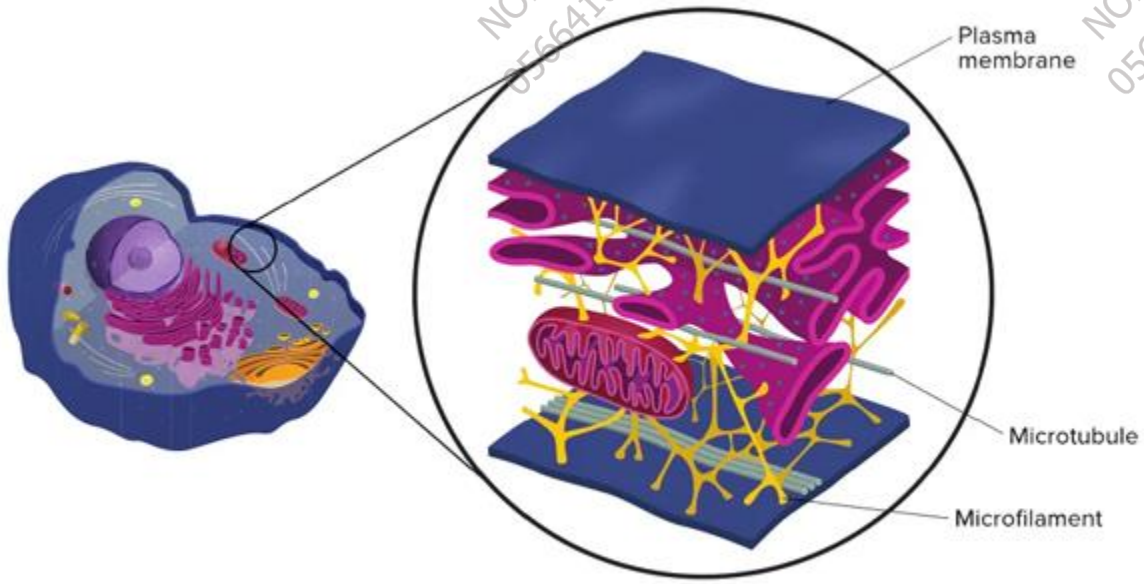
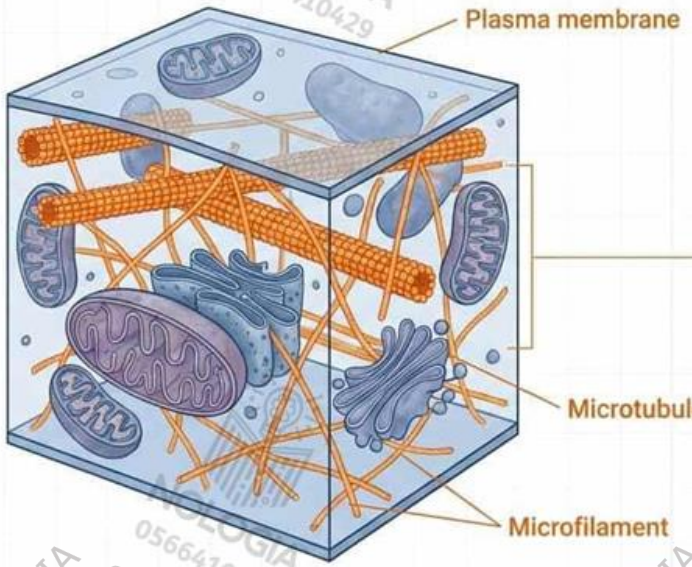


Figure 18 The cytoskeleton forms a framework for the cell.

Internal Infrastructure: The Cytoskeleton Framework



The Cytoplasm

The semifluid environment inside the plasma membrane. In prokaryotes, this is where all chemical processes occur directly.

The Cytoskeleton

A supporting network of long, thin protein fibers that rapidly assembles, disassembles, and slides to allow cellular movement.

Component Breakdown

- **Microtubules:** Long, hollow protein cylinders forming a rigid skeleton and assisting substance movement.
- **Microfilaments:** Thin protein threads that give the cell shape and enable entire parts to move.

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Questions :

Question 1: In Figure 18, what is the function of the cytoskeleton inside a cell?

(A) It forms a protein fiber framework that gives the cell shape, anchors organelles, and helps movement	(B) It captures light energy to make sugar during photosynthesis
(C) It stores hereditary DNA code inside the nucleolus	(D) It digests worn-out cell parts using enzymes

Question 2: What is the definition of the cytoplasm?

(A) The rigid outer wall of a plant cell	(B) The semifluid environment inside the plasma membrane
(C) The double membrane around the nucleus	(D) The green pigment inside chloroplasts

Question 3: What is the definition of the cytoskeleton?

(A) A supporting network of long, thin protein fibers that forms a framework for the cell	(B) A double layer of phospholipids on the outside of the cell
(C) A stack of membranes that packages proteins	(D) A sac that stores water and waste in plants

Question 4: What are microtubules?

(A) Solid droplets of fat in the cytoplasm	(B) Small RNA particles that build proteins
(C) Green disks that trap sunlight	(D) Long, hollow protein cylinders that form a rigid skeleton for the cell and assist in moving substances

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Question 5: What are microfilaments?

(A) Hollow tubes made of cellulose carbohydrate	(B) Thin protein threads that help give the cell shape and enable parts or all of the cell to move
(C) Pores in the nuclear envelope	(D) Cholesterol rings in the plasma membrane

Question 6: Do organelles float freely in a cell, or are they anchored in place?

(A) They do not float freely; they are anchored and supported by the cytoskeleton	(B) They float completely freely with no support
(C) They are glued to the outside of the cell wall	(D) They are stored inside the nucleolus

Question 7: What is active transport?

(A) The movement of water from high to low concentration without energy	(B) The simple diffusion of oxygen gas into a cell
(C) The movement of substances across the plasma membrane against a concentration gradient (from low to high) using energy	(D) The settling of sand in a heterogeneous suspension

Question 8: What is endocytosis?

(A) The release of wastes from inside the cell to the outside	(B) The simple diffusion of oxygen gas
(C) The osmosis of water through aquaporins	(D) The active transport process by which a cell surrounds a large substance in the outside environment and takes it inside

Question 9: What is exocytosis?

(A) The active transport secretion of large materials at the plasma membrane from inside to outside the cell	(B) The taking in of bacteria by white blood cells
(C) The diffusion of ink drops in a beaker	(D) The shrinking of a plant cell in salt water

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Q26 : Module 7: Cellular Structure and Function

Lesson 4: Structures and Organelles

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

(Page 60)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 22 (The Nucleus: Nuclear Envelope, Nuclear Pores, Nucleolus, and Chromatin) · Page 60):

The nucleus (Figure 22) is the cell's managing structure (control center) that contains most of the cell's DNA, which stores information used to make proteins for cell growth, function, and reproduction. As shown in Figure 22, the nucleus has four key parts: (1) Nuclear envelope: a double membrane (similar to the plasma membrane) that surrounds the nucleus. (2) Nuclear pores: small openings in the nuclear envelope that allow larger-sized substances (such as RNA and ribosome subunits) to move into and out of the nucleus. (3) Chromatin: long strands of DNA attached to proteins that fill the nucleus. (4) Nucleolus: a dense region inside the nucleus that is the site of ribosome production.

Key Ideas from the Student Book:

- The nucleus is the managing control center of the cell and contains most of the cell's DNA.
- In Figure 22, the nucleus is surrounded by a double membrane called the nuclear envelope, which has nuclear pores for substances to pass in and out.
- Chromatin is DNA attached to proteins inside the nucleus.
- The nucleolus inside the nucleus is the site of ribosome production.

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Part of Nucleus in Figure 22	Structure & Function
Nucleus	Managing control center of the eukaryotic cell; contains most of the cell's DNA and directs cell activities
Nuclear Envelope	Double membrane surrounding and protecting the nucleus
Nuclear Pores	Openings in the nuclear envelope that allow large substances (like RNA and ribosomes) to move in and out
Chromatin	Complex of DNA attached to proteins inside the nucleus (stores genetic instructions for making proteins)
Nucleolus	Dense organelle region inside the nucleus that produces ribosomes

Remember:

✓ Nucleus (Figure 22) = control center of the cell; contains DNA (chromatin) and directs all cellular activities.

✓ Nuclear envelope = double membrane around the nucleus with Nuclear pores.

✓ Nucleolus = dense structure inside the nucleus that makes RIBOSOMES.

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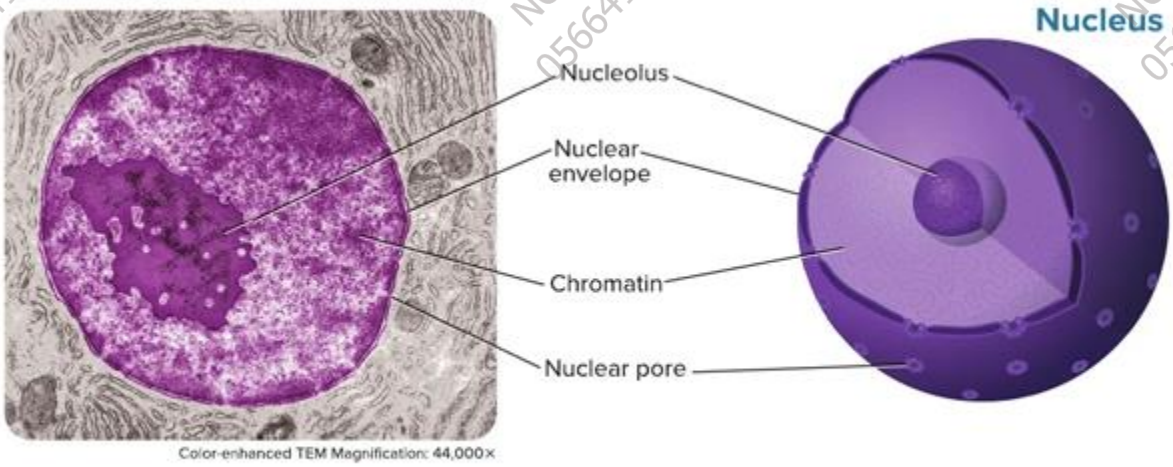
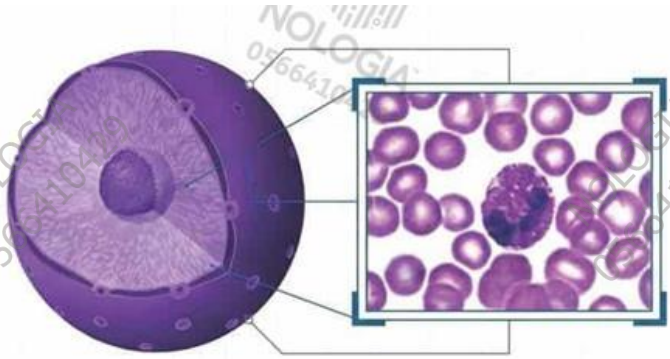


Figure 22 The nucleus of a cell is a three-dimensional shape. The photomicrograph shows a cross section of a nucleus.



The Nucleus [Eukaryotes]

Function: The managing structure containing most of the cell's DNA (instructions for growth, function, and reproduction).

Envelope: Surrounded by a double-membrane with nuclear pores for selective substance transport.

Chromatin: Complex DNA attached to protein, spread throughout the interior.

Nucleolus: The dense central site dedicated to ribosome production.

Questions :

Question 1: In Figure 22, what is the main function of the nucleolus inside the nucleus?

(A) It is the site of ribosome production	(B) It captures sunlight for photosynthesis
(C) It pumps excess water out of the cell	(D) It breaks down glucose to make ATP

Question 2: What is the main function of the nucleus in a eukaryotic cell?

(A) It digests worn-out organelles and bacteria	(B) It directs all cellular activities and stores most of the cell's DNA
(C) It forms a rigid cellulose wall outside the cell	(D) It converts light energy into sugar

Question 3: What is the nuclear envelope in Figure 22?

(A) A double membrane that surrounds the nucleus	(B) A single layer of carbohydrates around the cell
(C) A protein tail used for swimming	(D) A storage sac for water in plant cells

Question 4: What is the function of the nuclear pores shown in Figure 22?

(A) They trap sunlight for photosynthesis	(B) They synthesize fatty acids and lipids
(C) They allow larger substances (like RNA and ribosome subunits) to move into and out of the nucleus	(D) They prevent any molecule from ever leaving the nucleus

Question 5: What is chromatin?

(A) Green pigment found in plant leaves	(B) A lipid that keeps membranes fluid
(C) An enzyme in human saliva	(D) Long strands of DNA attached to proteins inside the nucleus

Question 6: Where are ribosomes produced inside a eukaryotic cell?

(A) In the Golgi apparatus	(B) In the nucleolus inside the nucleus
(C) In the smooth endoplasmic reticulum	(D) In the central vacuole

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Q27 : Module 7: Cellular Structure and Function

Lesson 4: Structures and Organelles

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

(Page 61)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Information from text + Figure 23 (Mitochondria) · Page 61):

Cells have organelles that process energy. Mitochondria (singular, mitochondrion) are the energy generators ("powerhouses") of eukaryotic cells that convert fuel particles (mainly sugars like glucose) into usable energy (ATP). As shown in Figure 23, a mitochondrion has an outer membrane and a highly folded inner membrane. The many folds of the inner membrane provide a large surface area for breaking chemical bonds within sugar molecules. The energy released from breaking those bonds is stored in molecules of ATP and used by the cell for other life reactions.

Key Ideas from the Student Book:

- Mitochondria are known as the "powerhouses" (energy generators) of the cell.
- Mitochondria convert fuel particles (mainly sugars) into usable energy (ATP).
- In Figure 23, a mitochondrion has an outer membrane and a highly folded inner membrane.
- The folded inner membrane provides a large surface area for breaking bonds in sugar molecules to produce ATP.

Mitochondrion Feature (Page 61 & Figure 23)	Description & Importance
Main Function of Mitochondria	Convert fuel particles (mainly sugars/glucose) into usable chemical energy (ATP)
Nickname	"Powerhouses" (energy generators) of the cell
Outer Membrane	Smooth outer boundary of the mitochondrion
Highly Folded Inner Membrane	Provides a large surface area for chemical reactions that break sugar bonds to produce ATP
Which Cells Have Mitochondria?	Almost all eukaryotic cells (BOTH animal cells and plant cells)

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Remember:

✓ Mitochondria (Figure 23) = "powerhouses" of the cell; convert sugars into usable energy (ATP).

✓ Structure = Outer membrane + Highly folded inner membrane.

✓ Why is the inner membrane folded? To provide a LARGE surface area for energy-producing reactions.

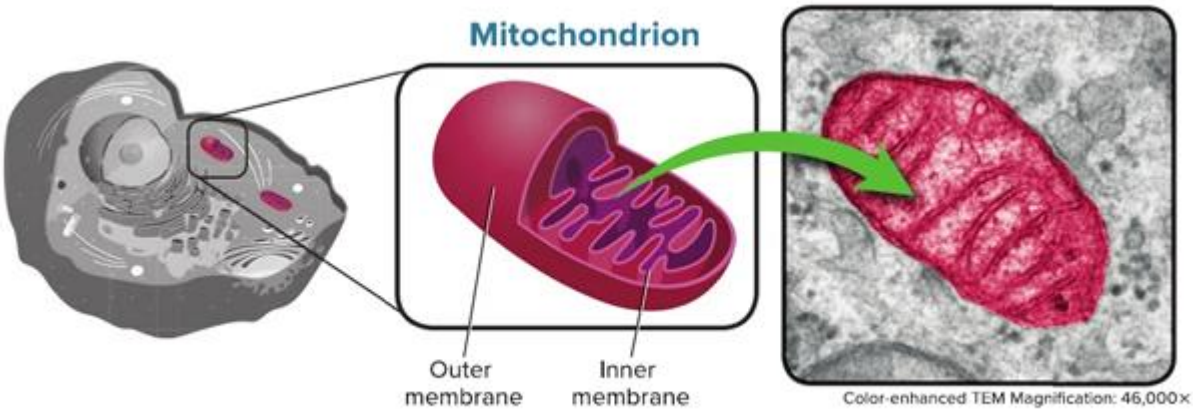
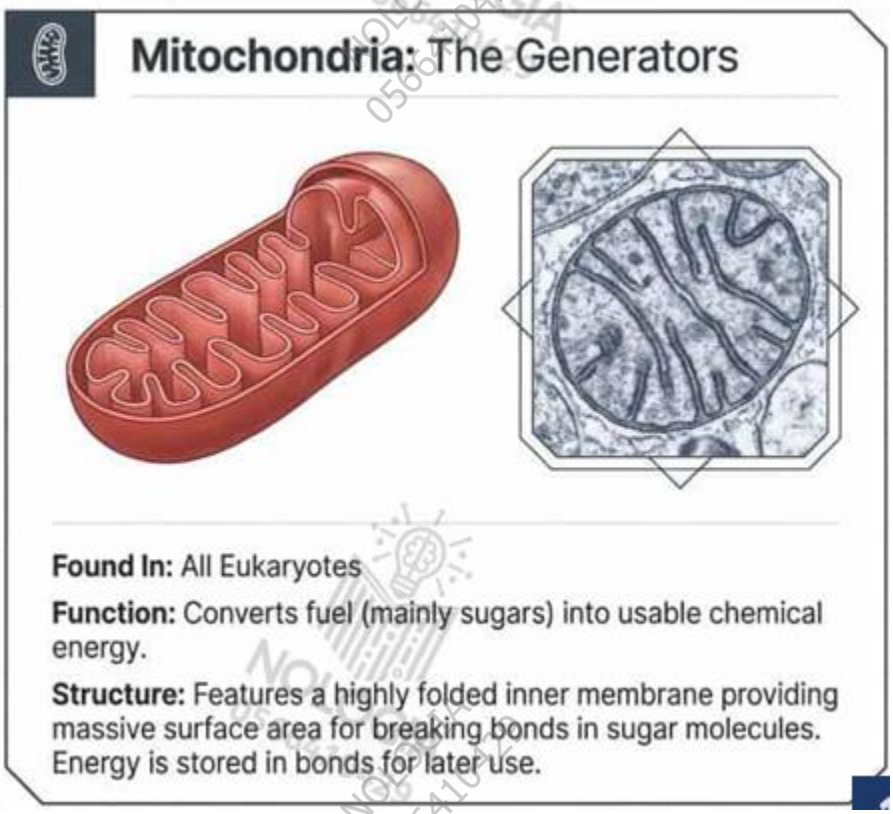


Figure 23 Mitochondria make energy available to the cell.



Questions :

Question 1: In Figure 23, what is the main function of mitochondria?

(A) To convert fuel particles (mainly sugars) into usable energy (ATP)	(B) To capture light energy and convert it into glucose
(C) To produce ribosomes inside the nucleus	(D) To form a rigid cell wall around plant cells

Question 2: Which organelle is known as the "powerhouse" of the cell?

(A) Golgi apparatus	(B) Mitochondrion
(C) Lysosome	(D) Nucleolus

Question 3: What fuel particles do mitochondria mainly break down to produce energy?

(A) Sugars (such as glucose)	(B) DNA chromosomes
(C) Cellulose cell walls	(D) Water and salt ions

Question 4: Do plant cells have mitochondria as well as chloroplasts?

(A) No, only animal cells have mitochondria	(B) No, only bacterial cells have mitochondria
(C) Yes, both plant cells and animal cells have mitochondria to make ATP	(D) No, neither plant nor animal cells have mitochondria

Question 5: Do prokaryotic cells (bacteria) have mitochondria?

(A) Yes, bacteria are full of mitochondria	(B) Yes, bacteria have both mitochondria and chloroplasts
(C) Yes, bacteria have a nucleus and mitochondria	(D) No, prokaryotes do not have membrane-bound organelles like mitochondria

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Question 6: What is the singular form of the word "mitochondria"?

(A) Mitochondrias	(B) Microtubule
(C) Microfilament	(D) Mitochondrion

Question 7: In Figure 23, which membrane of the mitochondrion has deep folds?

(A) The outer membrane	(B) The inner membrane
(C) The nuclear envelope	(D) The plasma membrane

Question 8: How do active transport pumps in the plasma membrane depend on mitochondria?

(A) Mitochondria block active transport from occurring	(B) Active transport needs no energy from mitochondria
(C) Mitochondria supply the ATP energy required to run active transport pumps	(D) Mitochondria turn pumps into phospholipids

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Q28 : Module 7: Cellular Structure and Function

Lesson 4: Structures and Organelles

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

(Page 61)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Information from text + Figure 24 (Chloroplasts, Thylakoids, and Chlorophyll) · Page 61):

Plant cells and some other eukaryotes (like algae) contain chloroplasts—organelles that capture light energy and convert it into chemical energy (sugar) through a process called photosynthesis. As shown in Figure 24, a chloroplast is enclosed by an outer and inner double membrane. Inside the inner membrane are many small, disk-shaped compartments called thylakoids (arranged in stacks called grana, surrounded by fluid stroma). Here, energy from sunlight is trapped by a pigment called chlorophyll. Chlorophyll gives leaves and stems their green color. Animal cells do NOT have chloroplasts (or cell walls).

Key Ideas from the Student Book:

- Chloroplasts are organelles in plant cells (and algae) that capture light energy and convert it into chemical energy through photosynthesis.
- In Figure 24, chloroplasts have an outer and inner membrane and contain stacked, disk-shaped compartments called thylakoids.
- Sunlight energy is trapped in the thylakoids by the green pigment chlorophyll.
- Chloroplasts belong to a group of plant organelles called plastids (which can also store starches, lipids, or red/orange/yellow pigments). Animal cells do NOT have chloroplasts.

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Chloroplast Feature (Page 61 & Figure 24)	Structure & Function
Chloroplast	Plant organelle that captures light energy and converts it into chemical energy (sugar) via photosynthesis
Photosynthesis	Process of converting light energy (with CO2 and H2O) into chemical energy (glucose sugar)
Thylakoids (Figure 24)	Small, stacked disk-shaped inner compartments that contain chlorophyll
Chlorophyll	Light-trapping pigment in thylakoids that captures sunlight and gives leaves/stems their green color
Double Membrane	Outer membrane and inner membrane enclosing the stroma and thylakoids
Cell Wall (Page 63)	Thick, rigid mesh of cellulose fibers surrounding outside of plant plasma membrane for support/protection

Remember:

✓ Chloroplasts (Figure 24) = capture light energy and convert it into chemical energy (sugar) during photosynthesis.

✓ Thylakoids = disk-shaped compartments inside chloroplasts.

✓ Chlorophyll = green pigment inside thylakoids that traps sunlight energy.

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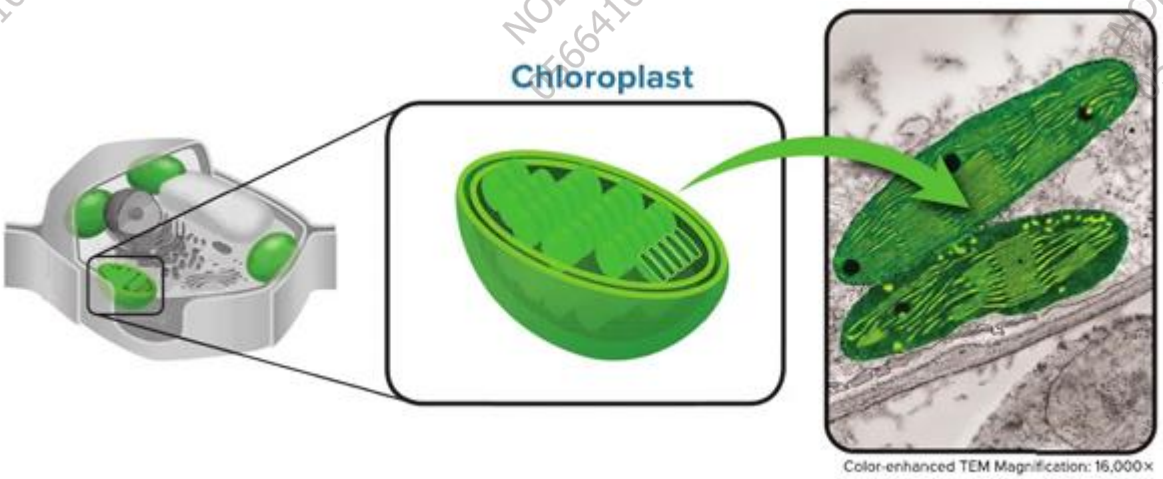
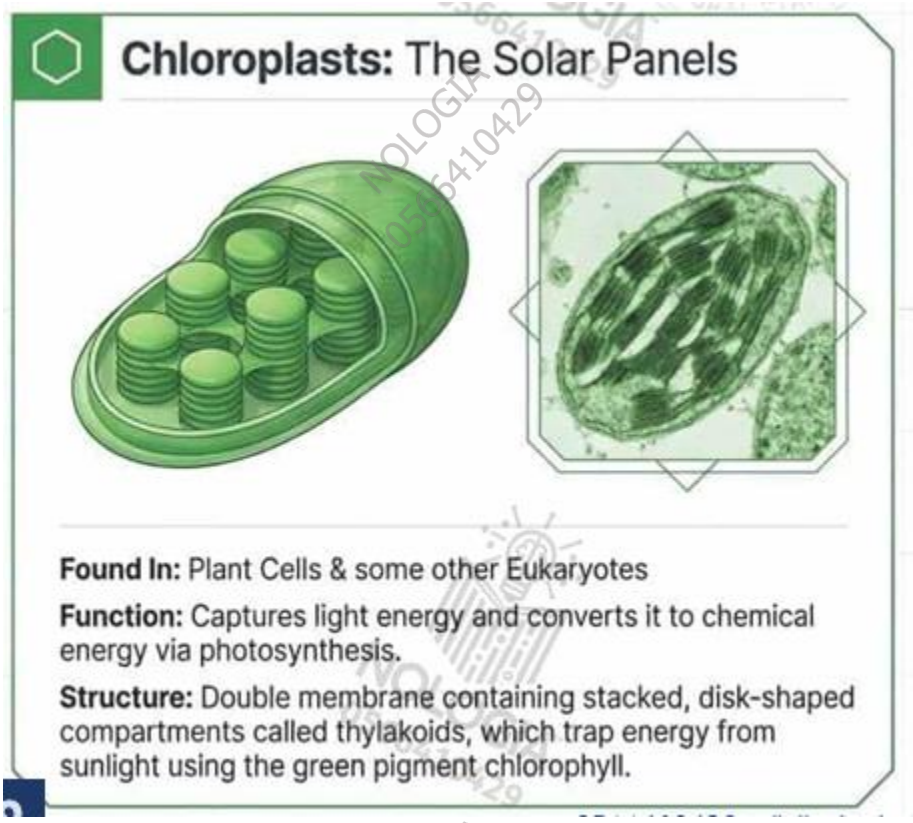


Figure 24 In plants, chloroplasts capture and convert light energy to chemical energy.



Questions :

Question 1: In Figure 24, what is the main function of chloroplasts in plant cells?

(A) To capture light energy and convert it into chemical energy during photosynthesis	(B) To digest cellular waste and worn-out cell parts
(C) To produce ribosomes inside the nuclear envelope	(D) To pump sodium and potassium ions across animal membranes

Question 2: What is the definition of chloroplasts?

(A) Organelles that break down old cell parts in animal cells	(B) Organelles that capture light energy and convert it into chemical energy through photosynthesis
(C) Small non-membrane particles that assemble amino acids	(D) Protein fibers that form the cytoskeleton

Question 3: What process takes place inside chloroplasts?

(A) Photosynthesis	(B) Endocytosis
(C) Mitosis	(D) Phagocytosis

Question 4: What color does chlorophyll give to plant leaves and stems?

(A) Blue	(B) Green
(C) Bright red	(D) Black

Question 5: Do animal cells contain chloroplasts?

(A) No, animal cells do not have chloroplasts	(B) Yes, all human cells are filled with chloroplasts
(C) Yes, animal muscle cells use chloroplasts to move	(D) Yes, red blood cells are green because of chloroplasts

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Question 6: Into what form of energy do chloroplasts convert light energy?

(A) Sound energy	(B) Magnetic energy
(C) Chemical energy	(D) Nuclear energy

Question 7: Besides trapping light, what can other plastids in plant cells store?

(A) Starches, lipids, or red, orange, and yellow pigments (in flowers and fruits)	(B) Bone and muscle fibers
(C) Hemoglobin and blood plasma	(D) Chitin shells

Question 8: In Figure 24, what is a stack of disk-shaped thylakoids called?

(A) Cilium	(B) Flagellum
(C) Vesicle	(D) Granum

Question 9: What is the cell wall found in plant cells?

(A) A thick, rigid mesh of cellulose fibers that surrounds the outside of the plasma membrane to protect and support the plant	(B) A soft lipid layer found only in animal cells
(C) The inner membrane of a mitochondrion	(D) A small vesicle that transports proteins

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Q29 : Module 7: Cellular Structure and Function

Lesson 4: Structures and Organelles

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

(Page 62)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Information from text + Figure 25 (Ribosomes & Endoplasmic Reticulum) · Page 62):

Page 62 and Figure 25 explain how cells manufacture proteins and lipids: (1) Ribosomes: Organelles that help manufacture proteins. Ribosomes are made of two components—RNA and protein—and are NOT bound by a membrane (unlike other organelles). Ribosomes are produced in the nucleolus inside the nucleus. Free ribosomes float freely in the cytoplasm and produce proteins used INSIDE the cell. Bound ribosomes are attached to the rough endoplasmic reticulum and produce proteins that are bound in membranes or exported for use OUTSIDE the cell. (2) Endoplasmic Reticulum (ER, Figure 25): A membrane system of folded sacs and interconnected channels that serves as the site for protein and lipid synthesis. Its pleats and folds provide a large surface area. Rough ER has ribosomes attached (looks bumpy) and synthesizes proteins for export to other cells. Smooth ER has NO ribosomes attached; it synthesizes complex carbohydrates and lipids (including phospholipids) and in the liver detoxifies harmful substances.

Key Ideas from the Student Book:

- Ribosomes are the site of protein synthesis; they are made of RNA and protein in the nucleolus and are NOT surrounded by a membrane.
- Free ribosomes make proteins used inside the cell; bound ribosomes (on Rough ER) make proteins exported outside the cell.
- The Endoplasmic Reticulum (ER, Figure 25) is a folded membrane system for protein and lipid synthesis.
- Rough ER has attached ribosomes and makes proteins; Smooth ER has NO ribosomes, makes carbohydrates and lipids, and detoxifies harmful substances in the liver.

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Structure on Page 62 (Figure 25)	Key Characteristics & Function
Ribosomes	Site of protein synthesis; made of RNA and protein; produced in the nucleolus; NOT bound by a membrane
Free Ribosomes	Float freely in the cytoplasm -> make proteins used INSIDE the cell
Bound Ribosomes	Attached to the Rough ER -> make proteins inserted into membranes or exported OUTSIDE the cell
Endoplasmic Reticulum (ER)	Membrane system of folded sacs and interconnected channels for protein and lipid synthesis (folds provide large surface area)
Rough ER (Figure 25)	Studded with ribosomes (bumpy appearance) -> synthesizes proteins for export to other cells
Smooth ER (Figure 25)	NO ribosomes attached -> synthesizes complex carbohydrates and lipids (phospholipids); detoxifies harmful substances in the liver

Remember:

✓ Ribosomes = make proteins; made of RNA + protein in the nucleolus; NO membrane.

✓ Free ribosomes = proteins for INSIDE the cell; Bound ribosomes (Rough ER) = proteins for OUTSIDE the cell.

✓ Rough ER (has ribosomes) = makes proteins; Smooth ER (NO ribosomes) = makes lipids/carbohydrates & detoxifies poisons in the liver.

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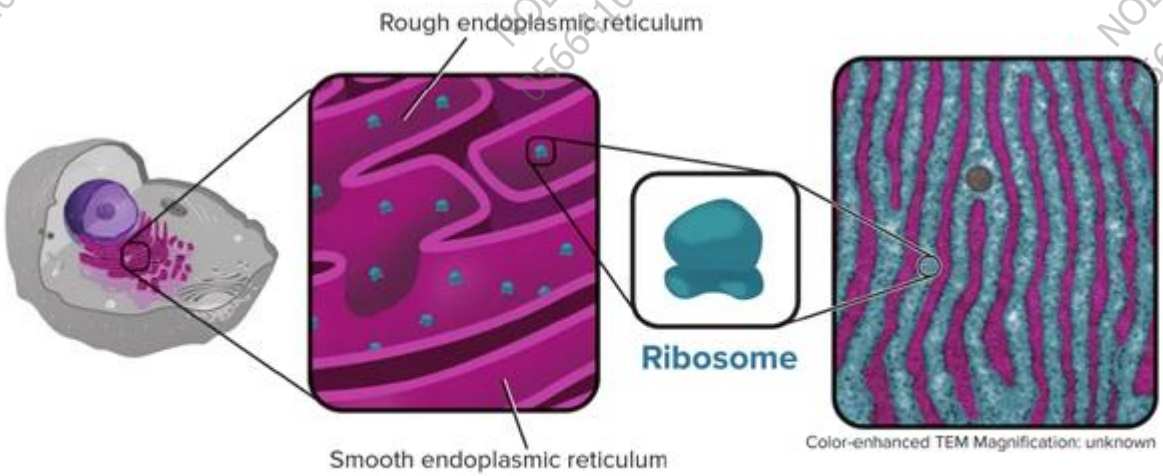
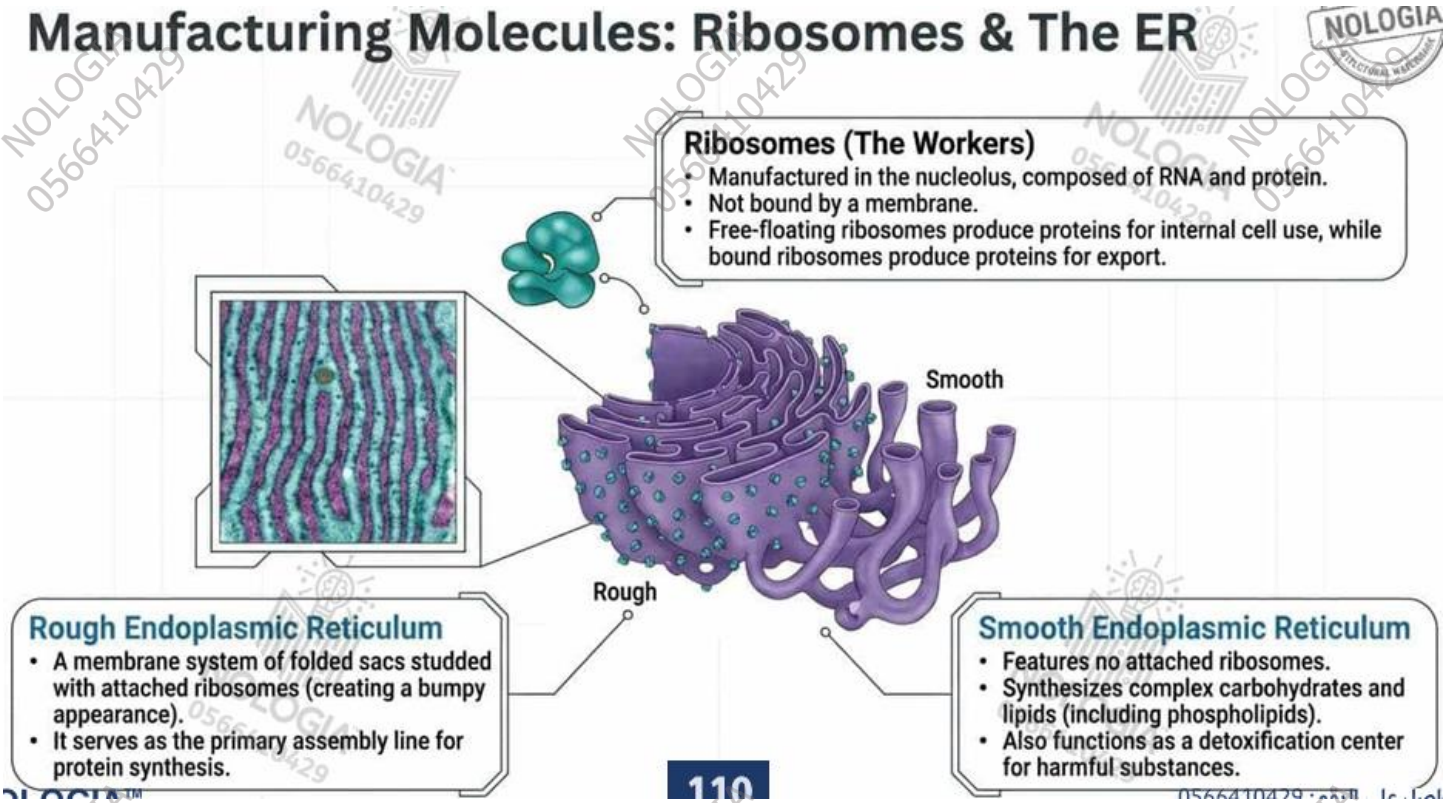


Figure 25 Ribosomes are simple structures made of RNA and protein that may be attached to the surface of the rough endoplasmic reticulum. They look like bumps on the endoplasmic reticulum.



Questions :

Question 1: In Figure 25, how does the Smooth ER differ from the Rough ER?

(A) Smooth ER has no ribosomes, makes lipids/carbohydrates, and detoxifies harmful substances in the liver	(B) Smooth ER is covered in ribosomes and only makes DNA chromosomes
(C) Rough ER has no ribosomes and captures sunlight for photosynthesis	(D) Both Rough ER and Smooth ER lack membranes

Question 2: What is the main function of ribosomes in a cell?

(A) They store water and waste in plant cells	(B) They are the site of protein synthesis (they help manufacture proteins)
(C) They trap sunlight using chlorophyll	(D) They break down glucose into ATP

Question 3: What two chemical components make up a ribosome?

(A) RNA and protein	(B) Cholesterol and fatty acids
(C) Cellulose and starch	(D) DNA and phospholipids

Question 4: How are ribosomes different from most other organelles in the cell?

(A) Ribosomes have a triple membrane	(B) Ribosomes are larger than the nucleus
(C) Ribosomes are NOT bound (surrounded) by a membrane	(D) Ribosomes are found only in dead cork

Question 5: Where are ribosomes produced inside a eukaryotic cell?

(A) In the Golgi apparatus	(B) In the smooth ER
(C) In the lysosome	(D) In the nucleolus inside the nucleus

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Question 6: What is the function of FREE ribosomes that float in the cytoplasm?

(A) They produce proteins that are used INSIDE the cell	(B) They produce lipids for export outside the cell
(C) They detoxify alcohol in the liver	(D) They store calcium ions in muscle

Question 7: What is the endoplasmic reticulum (ER)?

(A) A rigid wall of cellulose outside a plant cell	(B) A tail that helps sperm cells swim
(C) A membrane system of folded sacs and interconnected channels that serves as the site for protein and lipid synthesis	(D) A green plastid that traps light

Question 8: Why does the Rough ER appear bumpy in Figure 25?

(A) Because it has many ribosomes attached to its surface	(B) Because it is covered in starch grains
(C) Because it is made of solid salt crystals	(D) Because it is full of chloroplasts

Question 9: What is the main function of the Rough ER?

(A) It detoxifies poisons in the liver without ribosomes	(B) Its attached ribosomes synthesize proteins for export to other cells
(C) It captures light energy during photosynthesis	(D) It stores hereditary DNA chromatin

Question 10: Why is the Smooth ER called "smooth"?

(A) Because it is covered in thousands of ribosomes	(B) Because it has no membrane
(C) Because it has NO ribosomes attached to its surface	(D) Because it is located outside the cell wall

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Q30 : Module 7: Cellular Structure and Function

Lesson 4: Structures and Organelles

BIO.3.1.01.050 Identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each.

(Page 63)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Figure 26 (Golgi Apparatus, Vesicles, and Vacuoles) · Page 63):

Once proteins are made on the rough endoplasmic reticulum, some are transferred to the Golgi apparatus (Figure 26). The Golgi apparatus is a flattened stack of tubular membranes that modifies, sorts, and packages proteins into sacs called vesicles. These vesicles can then fuse with the cell's plasma membrane to release (export) the proteins to the environment outside the cell (exocytosis). Page 63 also describes Vacuoles—membrane-bound sacs (vesicles) that store food, enzymes, water, and waste products needed by the cell. Plant cells typically have one large central vacuole (taking up most of the cell's volume), whereas animal cells generally have no vacuoles or very small ones. Lysosomes are vesicles containing digestive enzymes that break down excess/worn-out cell parts, bacteria, and viruses.

Key Ideas from the Student Book:

- In Figure 26, the Golgi apparatus is a flattened stack of tubular membranes.
- The Golgi apparatus modifies, sorts, and packages proteins into sacs called vesicles.
- Vesicles fuse with the plasma membrane to release proteins to the environment outside the cell.
- Vacuoles are membrane-bound sacs that store food, water, enzymes, and wastes (plant cells have a large central vacuole).
- Lysosomes contain digestive enzymes to break down worn-out cell parts and bacteria/viruses.

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Organelle on Page 63 (Figure 26)	Structure & Main Function
Golgi Apparatus (Figure 26)	Flattened stack of tubular membranes that modifies, sorts, and packages proteins into sacs called vesicles
Vesicles (Figure 26)	Small membrane-bound sacs that transport packaged proteins to the plasma membrane for release outside the cell
Vacuoles (Page 63)	Membrane-bound sacs for temporary storage of food, enzymes, water, and wastes (plant cells have one large central vacuole)
Lysosomes	Vesicles containing digestive enzymes that digest excess or worn-out organelles, food particles, and engulfed bacteria/viruses
Pathway of Exported Protein	Nucleus (DNA) -> Ribosomes on Rough ER (synthesis) -> Golgi Apparatus (modify, sort, package) -> Vesicle -> Plasma Membrane (release outside)

Remember:

✓ Golgi apparatus (Figure 26) = flattened stack of membranes that MODIFIES, SORTS, and PACKAGES proteins into vesicles.

✓ Vesicles = sacs that carry packaged proteins to fuse with the plasma membrane and release them outside the cell.

✓ Vacuole = stores food, water, and waste (plant cells have one large central vacuole); Lysosome = digests worn-out cell parts and bacteria.

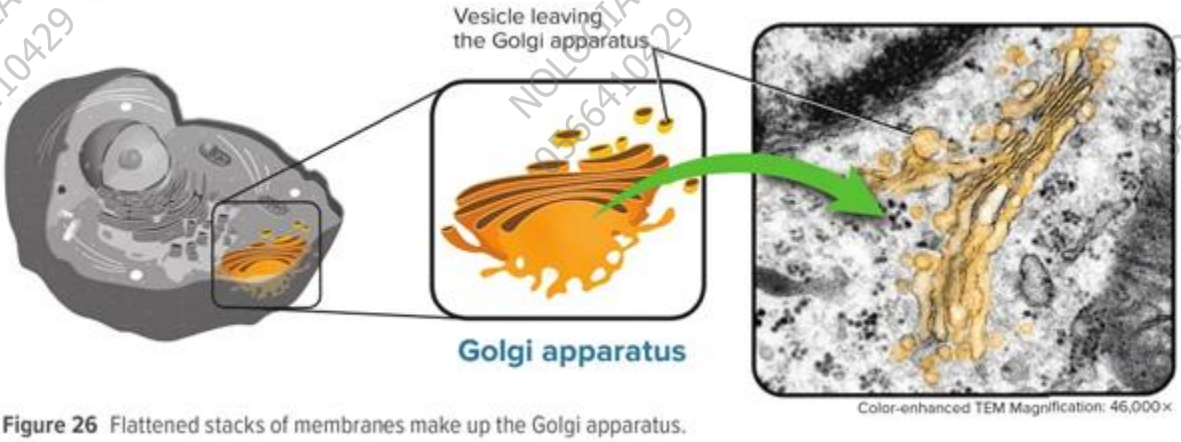


Figure 26 Flattened stacks of membranes make up the Golgi apparatus.

Golgi Apparatus (The Shipping Dept)

Energetic Orange

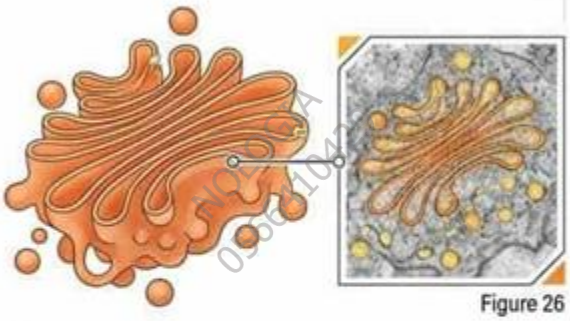


Figure 26

A flattened stack of membranes. It modifies, sorts, and packages proteins into sacs called vesicles, which can fuse with the plasma membrane to release proteins outside the cell.

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Questions :

Question 1: According to Figure 26, what is the main function of the Golgi apparatus?

(A) It modifies, sorts, and packages proteins into sacs called vesicles	(B) It captures light energy to make glucose sugar
(C) It converts glucose into ATP energy	(D) It stores all of the cell's DNA chromosomes

Question 2: What is the definition of the Golgi apparatus?

(A) A double membrane containing chromatin and the nucleolus	(B) A flattened stack of tubular membranes that modifies, sorts, and packages proteins into vesicles
(C) A green organelle containing thylakoids and chlorophyll	(D) A network of hollow microtubules and microfilaments

Question 3: What is the definition of a vacuole?

(A) A membrane-bound sac (vesicle) for temporary storage of materials like food, water, enzymes, and wastes	(B) A non-membrane particle that builds polypeptide chains
(C) A protein cylinder that moves chromosomes	(D) The site of ATP synthesis during cellular respiration

Question 4: What are lysosomes?

(A) Organelles that capture sunlight in plant leaves	(B) Pores in the nuclear envelope
(C) Stacks of thylakoids in chloroplasts	(D) Vesicles that contain digestive enzymes to break down excess or worn-out organelles and bacteria

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Question 5: What are centrioles?

(A) Green pigments that absorb sunlight	(B) Storage sacs for starch in roots
(C) Organelles made of microtubules that function during cell division	(D) Folds of the inner mitochondrial membrane

Question 6: What are cilia?

(A) One or two long whiplike tails on a cell	(B) Short, numerous projections that look like hairs and move like oars on the cell surface
(C) Flattened stacks of Golgi membranes	(D) Pores in the nuclear membrane

Question 7: What are flagella?

(A) Thousands of short hairlike oars covering a cell	(B) Small RNA particles on the rough ER
(C) Cellulose fibers in the plant cell wall	(D) Projections that are longer and less numerous than cilia (1 or 2 per cell) and move with a whiplike motion

Question 8: Do prokaryotic cells have a Golgi apparatus, vacuoles, or ER?

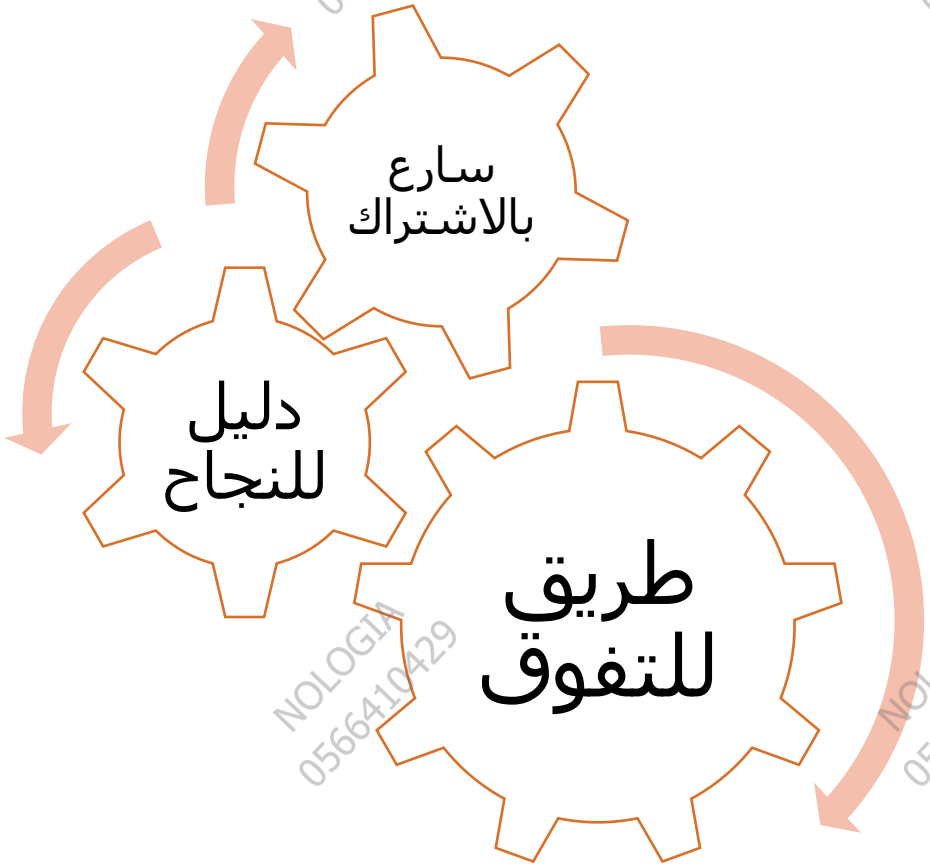
(A) No, prokaryotes do not have membrane-bound organelles like the Golgi apparatus or ER	(B) Yes, bacteria have a large Golgi apparatus and central vacuole
(C) Yes, bacteria have rough ER and chloroplasts	(D) Yes, all cells have a Golgi apparatus

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