



20 AP-style MCQs across topics 2.1 to 2.10. Practice, review, revisit.

WHAT'S INSIDE

- ✓ 20 MCQs, four options each, in the style of the real AP exam
- ✓ Every question tagged to a Unit 2 topic so you know what to revise
- ✓ Full answer key with a short explanation for every question
- ✓ Mix of standalone and stimulus-style stems, matching real AP question formats

HOW TO USE IT

- 1. Untimed pass.** Work through slowly, aiming for around 90 seconds per question. Read every option before you commit.
- 2. Timed pass.** Redo the pack in 30 minutes. That matches AP exam pace (1.5 minutes per MCQ) and builds stamina.
- 3. Review.** Check the answer key and mark every miss. Revise those topics on Cognito, then retry after a week.

TOPICS COVERED

- **2.1** Cell Structure and Function
- **2.2** Cell Size
- **2.3** Plasma Membrane
- **2.4** Membrane Permeability
- **2.5** Membrane Transport
- **2.6** Facilitated Diffusion
- **2.7** Tonicity and Osmoregulation
- **2.8** Mechanisms of Transport
- **2.9** Cell Compartmentalization
- **2.10** Origins of Cell Compartmentalization

STRUGGLING WITH A TOPIC?



Any topic tricky? Scan the QR to jump straight to the Unit 2 notes on Cognito. For the full AP Biology course (all 8 units, lessons, quizzes, flashcards and past-paper FRQs), head to **cognitoedu.link/ap-bio-notes**. Rework the questions you got wrong a week later to lock the concepts in.

AP EXAM CONTEXT

10-13%

UNIT WEIGHT (MCQ SECTION)

60

MCQS ON THE REAL EXAM

1.5m

AVERAGE TIME PER MCQ

AP BIOLOGY

Unit 2: Cells

SECTION I · MULTIPLE CHOICE

Time—30 minutes

20 Questions

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and mark it clearly on your answer sheet or circle your choice below.

Questions 1, 2 refer to the following information.

A cell lysate was separated by differential centrifugation and the specific activity of four marker enzymes was measured in each pellet. Each enzyme is a marker for the organelle listed in parentheses.

Table 1. Marker enzyme activity by fraction (relative units)

Fraction	Cytochrome oxidase (mitochondrion)	Acid phosphatase (lysosome)	Glucose-6-phosphatase (ER)	Catalase (peroxisome)
Nuclear pellet	3	1	2	1
Mitochondrial pellet	84	6	10	12
Lysosomal/peroxisomal pellet	8	82	12	79
Microsomal pellet (ER fragments)	5	11	76	8

- Based on Table 1, which fraction is most enriched in endoplasmic reticulum membrane?
(A) Nuclear pellet
(B) Mitochondrial pellet
(C) Lysosomal/peroxisomal pellet
(D) Microsomal pellet
- A student concludes from Table 1 that lysosomes and peroxisomes have similar sedimentation properties. Which piece of evidence best supports this conclusion?
(A) Cytochrome oxidase activity is highest in the mitochondrial pellet, well above the other three pellets.
(B) The microsomal pellet contains a low level of catalase activity.
(C) Every fraction contains at least some measurable activity of every marker enzyme in the assay.
(D) Acid phosphatase and catalase peak together in the same pellet at similar high activity.

Questions 3, 4 refer to the following information.

A researcher measured the volumes and surface areas of four spherical cell models with different radii, and calculated the surface-area-to-volume (SA:V) ratio of each.

Table 2. Geometry of four spherical cell models

Cell	Radius (μm)	Surface area (μm^2)	Volume (μm^3)	SA:V (μm^{-1})
W	1	12.6	4.2	3.00
X	2	50.3	33.5	1.50
Y	5	314	524	0.60
Z	10	1257	4189	0.30

- Based on Table 2, what happens to the SA:V ratio when the radius of a spherical cell is doubled?
(A) It is halved
(B) It stays the same
(C) It doubles
(D) It quadruples

AP BIOLOGY · Unit 2: Cells · Section I (continued)

4. Which prediction about the four spherical cells in Table 2 is best supported by the data?
- (A) Cell W will exchange nutrients and wastes with its environment faster per unit volume than cell Z.
- (B) Cell Z will exchange nutrients and wastes with its environment faster per unit volume than cell W.
- (C) All four cells will exchange materials at the same rate per unit volume, because they are all spheres.
- (D) Cell Z will meet its metabolic needs most efficiently because it has the largest total surface area.
5. Which statement best describes the arrangement of phospholipids in a plasma membrane?
- (A) A single layer with heads facing the cytoplasm and tails facing outside the cell
- (B) A bilayer with hydrophobic tails facing both aqueous surfaces and hydrophilic heads in the interior
- (C) A random mixture of phospholipids interspersed with proteins throughout the cytoplasm
- (D) A bilayer with hydrophilic heads facing both aqueous surfaces and hydrophobic tails in the interior
6. Cholesterol is embedded among the fatty acid tails in animal cell membranes. How does cholesterol affect membrane fluidity at high temperatures?
- (A) It increases fluidity by preventing phospholipids from packing tightly.
- (B) It restrains the movement of phospholipids, reducing excessive fluidity.
- (C) It replaces phospholipids in the bilayer, converting the membrane into a solid layer.
- (D) It has no effect on fluidity, because it lies outside the bilayer.

Questions 7, 8 refer to the following information.

The relative permeability of a synthetic phospholipid bilayer to different molecules was measured, expressed as the log of the permeability coefficient relative to water.

Table 3. Relative permeability of a phospholipid bilayer

Molecule	Property	$\log_{10}$ (relative permeability)
O ₂	Small, nonpolar	+2.5
Urea	Small, polar, uncharged	-1.0
Glucose	Large, polar, uncharged	-6.0
Na ⁺	Small, charged	-8.5
Cl ⁻	Small, charged	-8.0

7. Which pattern best describes the data in Table 3?
- (A) Permeability increases with molecular size, regardless of charge.
- (B) Small charged ions cross most readily; large uncharged molecules cross the least.
- (C) Permeability is unrelated to polarity, because all molecules can dissolve in the bilayer.
- (D) Small nonpolar molecules cross most readily; charged ions cross the least.

AP BIOLOGY · Unit 2: Cells · Section I (continued)

8. Based on the data in Table 3, which additional molecule would most likely require a protein channel or transporter to cross the membrane at a physiologically useful rate?
- (A) Carbon dioxide (small, nonpolar)
 - (B) Steroid hormones (moderately sized, nonpolar)
 - (C) Potassium ions (small, positively charged)
 - (D) Nitrogen gas (small, nonpolar)
9. Which of the following best describes how a white blood cell takes up a large bacterium during an immune response?
- (A) Passive diffusion of the bacterium directly through the plasma membrane, driven by the concentration gradient.
 - (B) Facilitated diffusion of the bacterium through a channel protein in the plasma membrane.
 - (C) Endocytosis, in which the plasma membrane wraps around the bacterium and pinches off as an internal vesicle.
 - (D) Exocytosis, in which a vesicle fuses with the plasma membrane to release its contents out of the cell.

Question 10 refers to the following information.

Membrane vesicles containing a specific glucose transporter were placed in buffer with varying external glucose concentrations. The initial rate of glucose uptake into the vesicle was measured. A second run added an inhibitor of the transporter.

Table 4. Glucose uptake rate ($\text{nmol} \cdot \text{min}^{-1} \cdot \text{mg}^{-1}$)

External glucose (mM)	No inhibitor	With inhibitor
1	22	9
5	61	32
10	79	50
20	92	69
40	100	85
80	105	96

10. Which claim about the inhibitor is best supported by the data in Table 4?
- (A) The inhibitor permanently destroys the transporter, so the transporter activity cannot recover.
 - (B) The inhibitor slows glucose diffusion through the phospholipid bilayer directly.
 - (C) The inhibitor speeds transport by increasing the affinity of the transporter for glucose.
 - (D) The inhibitor competes with glucose for the transporter and is overcome at high glucose.

AP BIOLOGY · Unit 2: Cells · Section I (continued)

Questions 11, 12, 13 refer to the following information.

Students placed identical potato cylinders (initial mass 5.0 g) into sucrose solutions of different molarities for 90 minutes, then blotted and reweighed each cylinder.

Table 5. Percent mass change of potato cylinders

Sucrose (M)	Final mass (g)	Percent change (%)
0.0	5.60	+12.0
0.2	5.20	+4.0
0.4	4.80	-4.0
0.6	4.55	-9.0
0.8	4.30	-14.0

11. Based on Table 5, what is the best estimate of the sucrose concentration that is isotonic to the potato cells?

(A) 0.0 M
(B) 0.2 M
(C) 0.3 M
(D) 0.6 M

12. Which claim is best supported by the data in Table 5?
- (A) Water moved net from the sucrose solution into the potato cylinders in every treatment tested.
(B) Sucrose molecules crossed the potato cell membranes down their concentration gradient.
(C) Above 0.3 M sucrose, water moved net out of the potato cells by osmosis.
(D) The potato cells actively pumped water out of themselves in the 0.8 M treatment.
13. The potato cells have cell walls. In the 0.0 M sucrose treatment, which observation would be expected?
- (A) The cells would burst, releasing their contents into the beaker.
(B) The cells would become turgid as water entered them, with the walls preventing lysis.
(C) The cells would shrivel as water left them and their membranes pulled away from the walls.
(D) No net water movement would occur, because plant cell walls block osmosis.

AP BIOLOGY · Unit 2: Cells · Section I (continued)

Questions 14, 15 refer to the following information.

Red blood cells were placed in solutions of varying NaCl concentration for 10 minutes. The percentage of intact cells (not lysed and not shriveled beyond recognition) was recorded.

Table 6. Effect of NaCl concentration on red blood cells

NaCl (%)	Intact cells (%)	Appearance
0.0	3	Lysed
0.45	58	Swollen
0.90	97	Normal biconcave
1.80	62	Shriveled (crenated)
3.60	18	Severely shriveled

14. Based on Table 6, which NaCl concentration is closest to isotonic to the cytoplasm of a human red blood cell?
- (A) 0.0%
(B) 0.45%
(C) 0.90%
(D) 3.60%

15. A patient in the emergency department needs an intravenous fluid that will not damage red blood cells. Which additional experiment would best confirm that a candidate fluid is safe on this criterion?
- (A) Measure the pH of the candidate fluid and confirm it matches the pH of arterial blood at rest.
(B) Repeat the Table 6 protocol with the candidate fluid and confirm the intact-cell rate matches 0.90% NaCl.
(C) Chemically test the candidate fluid to confirm it contains no charged solutes.
(D) Measure the fluid's glucose concentration and confirm it matches blood plasma glucose.
16. A researcher measured K^+ and Na^+ inside and outside nerve cells and found K^+ was ~30 times higher inside than outside, while Na^+ was ~10 times higher outside than inside. When ATP was depleted with a metabolic poison, both concentration differences collapsed over time. Which statement best describes the transport that maintains these gradients?
- (A) Primary active transport that hydrolyzes ATP to move ions against their gradients.
(B) Facilitated diffusion driven by the concentration gradients of Na^+ and K^+ .
(C) Secondary active transport that uses the H^+ gradient across the plasma membrane as its energy source.
(D) Osmosis, in which ions follow water across the membrane.

AP BIOLOGY · Unit 2: Cells · Section I (continued)

Questions 17, 18 refer to the following information.

The abundance of four organelles in three human cell types was estimated by electron microscopy and expressed as the percentage of total cell membrane area.

Table 7. Organelle abundance (% of total cell membrane area) in three cell types

Cell type	Mitochondria	Rough ER	Smooth ER	Lysosomes
Cardiac muscle cell	36	3	2	1
Pancreatic acinar cell (protein-secreting)	8	60	1	3
Hepatocyte (liver cell)	18	35	16	2

17. Which claim about cell structure and function is best supported by the data in Table 7?
 - (A) All human cells devote the same fraction of their membrane area to each organelle.
 - (B) Organelle abundance is matched to the metabolic role of the cell type.
 - (C) Rough ER is always the most abundant organelle in mammalian cells.
 - (D) The number of mitochondria is unrelated to a cell's energy demand.
18. Based on Table 7, which prediction about pancreatic acinar cells is best supported?
 - (A) They secrete large quantities of steroid hormones that are synthesized in their smooth ER.
 - (B) They rely mainly on anaerobic respiration because they lack mitochondria.
 - (C) They synthesize large quantities of proteins for secretion via the endomembrane system.
 - (D) They function primarily as long-term storage cells for lipids and glycogen.
19. The endosymbiotic theory proposes that mitochondria arose from a free-living prokaryote engulfed by an early eukaryotic cell. Which observation provides the strongest support for this theory?
 - (A) Mitochondria contain their own circular DNA and ribosomes similar in size to bacterial ribosomes.
 - (B) Mitochondria carry out oxidative phosphorylation, which generates ATP for the cell.
 - (C) The inner mitochondrial membrane is folded into cristae that increase its surface area substantially over a smooth membrane.
 - (D) Mitochondria are found in the cytoplasm of nearly all eukaryotic cells.
20. Lysosomes contain digestive enzymes that function at an internal pH of about 4.8, while the surrounding cytoplasm is near pH 7.2. Which statement best explains the biological importance of this compartmentalization?
 - (A) It concentrates the enzymes into a small volume, which prevents them from working at all.
 - (B) It allows the enzymes to work at their acidic optimum, while the neutral cytoplasm limits damage if a few leak out.
 - (C) It creates a proton gradient used to synthesize ATP directly across the lysosomal membrane, similar to mitochondrial ATP synthesis.
 - (D) It prevents any exchange of material between the lysosome and the rest of the cell.

Q1. Answer: D

Topic 2.1 · Cell Structure and Function

Glucose-6-phosphatase is a marker enzyme for the endoplasmic reticulum, and its specific activity is 76 units in the microsomal pellet (fragments of ER form microsomes during homogenization), far above the other fractions (2 to 12). Enrichment (specific activity) tells you which fraction is proportionally richest in ER membrane, which is exactly what the microsomal pellet is. The nuclear, mitochondrial, and lysosomal/peroxisomal pellets each peak in a different marker enzyme, so ER is a minor contaminant in those fractions.

Q2. Answer: D

Topic 2.1 · Cell Structure and Function

Differential centrifugation separates organelles by sedimentation rate (which depends on size, shape, and density). Acid phosphatase (lysosome marker) and catalase (peroxisome marker) both peak in the same pellet at 82 and 79 units, so lysosomes and peroxisomes sediment together and therefore have similar sedimentation properties. A speaks to mitochondria, not the lysosome-peroxisome comparison. B describes trace contamination, and C describes background, neither of which supports the co-sedimentation claim.

Q3. Answer: A

Topic 2.2 · Cell Size

For a sphere, $SA:V = 3/r$, so doubling r halves the ratio. Cell W to X (r : 1 to 2 μm) shows 3.00 to 1.50; Y to Z (r : 5 to 10 μm) shows 0.60 to 0.30. Both pairs halve. Doubling or quadrupling the ratio contradicts the inverse relationship, and it clearly does not stay the same as r changes.

Q4. Answer: A

Topic 2.2 · Cell Size

Exchange with the environment is limited by surface area, while metabolic demand scales with volume. A higher $SA:V$ ratio means more surface per unit of interior, so the smallest cell (W, $SA:V = 3.00$) exchanges materials most efficiently per unit volume. Cell Z has the lowest ratio (0.30), so despite its large total surface area it lags in exchange relative to its own volume, ruling out B and D. C ignores the tenfold change in the ratio across the table.

Q5. Answer: D

Topic 2.3 · Plasma Membrane

The plasma membrane is a phospholipid bilayer. The polar phosphate heads face the aqueous cytoplasm and extracellular fluid, while the fatty acid tails hide from water in the interior of the bilayer. B reverses this and would expose the tails to water. A gives no bilayer at all. C describes a dispersion, not a membrane.

Q6. Answer: B

Topic 2.3 · Plasma Membrane

Cholesterol acts as a fluidity buffer. At high temperatures it restrains phospholipid movement, keeping the membrane from becoming too fluid; at low temperatures it prevents tight packing that would freeze the membrane. A describes only the cold-temperature effect. C misstates what cholesterol does (it does not replace phospholipids), and D contradicts its location among the tails.

Q7. Answer: D

Topic 2.4 · Membrane Permeability

O_2 (small, nonpolar) has the highest relative permeability (+2.5), while Na^+ and Cl^- (charged) have the lowest (about -8). The hydrophobic interior of the bilayer excludes charged ions and slows large polar molecules like glucose. A reverses the size trend (glucose is larger than urea but crosses more slowly). B flips ions and nonpolar molecules. C ignores the roughly 11 orders of magnitude difference in the data.

Q8. Answer: C

Topic 2.4 · Membrane Permeability

The table shows that charged species (Na^+ , Cl^-) cross the bilayer roughly 11 orders of magnitude more slowly than nonpolar O_2 . K^+ is also small and charged, so it will behave like Na^+ and needs a channel or transporter to cross fast enough. CO_2 , N_2 , and steroids are nonpolar (like O_2) and diffuse directly through the bilayer.

Q9. Answer: C

Topic 2.5 · Membrane Transport

Large particles cannot cross the plasma membrane by diffusion or through transporters. In endocytosis (specifically phagocytosis for large particles like bacteria), the membrane engulfs the particle and pinches off as a vesicle inside the cell. This is one of the bulk-transport mechanisms that supplements smaller-scale membrane transport. A and B are limited to small molecules and cannot move a whole bacterium. D describes the opposite direction of movement (out of the cell).

Q10. Answer: D

Topic 2.6 · Facilitated Diffusion

The inhibitor lowers the uptake rate at low glucose concentrations (22 to 9 at 1 mM) but the two curves converge at high glucose (100 to 85 at 40 mM, then 105 to 96 at 80 mM). This is the signature of competitive inhibition: excess substrate outcompetes the inhibitor for the binding site. A predicts equal inhibition at all concentrations. B ignores that the transporter, not the bilayer, is being blocked. C reverses the direction of the effect.

Q11. Answer: C

Topic 2.7 · Tonicity and Osmoregulation

In an isotonic solution, water enters and leaves the cell at the same rate, so mass does not change. Interpolating between 0.2 M (+4.0%) and 0.4 M (−4.0%), the zero-crossing sits at about 0.3 M sucrose. In 0.0 and 0.2 M the cylinders gained mass (hypotonic external solutions), and in 0.6 M they lost mass (hypertonic), so those solutions do not match the potato cells osmotically.

Q12. Answer: C

Topic 2.7 · Tonicity and Osmoregulation

Above 0.3 M the cylinders lost mass, showing net water movement out of the cells. In hypertonic external solutions, water moves passively down its own concentration gradient out of the cells. A is false for treatments where mass fell (net movement was outward). B is unlikely because sucrose does not freely cross the membrane. D invokes active water pumping, which cells do not do; osmosis is passive.

Q13. Answer: B

Topic 2.7 · Tonicity and Osmoregulation

Pure water is hypotonic to potato cell contents, so water enters the cells by osmosis, matching the 12% mass gain in Table 5. The rigid cell wall resists further expansion and prevents bursting, producing a turgid cell. A applies to animal cells without walls. C describes plasmolysis, which happens in hypertonic external solutions. D is wrong because cell walls are freely permeable to water.

Q14. Answer: C

Topic 2.7 · Tonicity and Osmoregulation

At 0.90% NaCl, 97% of red blood cells remained intact with normal biconcave shape, so water was not moving net into or out of the cells. This is the definition of isotonic. Pure water and 0.45% NaCl are hypotonic (cells swelled and many lysed), while 1.80% and 3.60% are hypertonic (crenation).

Q15. Answer: B

Topic 2.7 · Tonicity and Osmoregulation

The relevant safety criterion here is tonicity: the fluid must not lyse or crenate red blood cells. The experiment in Table 6 measures exactly that, so re-running it with the candidate fluid tests the claim directly. pH matters clinically but does not test tonicity (A). Absence of charged solutes tells you nothing about whether the fluid is isotonic, since safe IV fluids like normal saline contain charged solutes (C). Glucose concentration is another clinical parameter but says nothing about osmotic balance (D).

Q16. Answer: A

Topic 2.8 · Mechanisms of Transport

The data show that maintaining these steep ion gradients requires ATP: when ATP is depleted, the gradients decay. That is the signature of primary active transport, in which ATP hydrolysis directly drives ions against their concentration gradients (the Na⁺/K⁺ ATPase in nerve cells). B is wrong because facilitated diffusion moves solutes down their gradients, not against, and needs no ATP. Secondary active transport (C) uses a pre-existing gradient (typically Na⁺ in animal cells, not H⁺) as its direct energy source, so it does not fit the ATP-hydrolysis dependence shown here. Osmosis refers to water movement, not ion transport (D).

Q17. Answer: B

Topic 2.1 · Cell Structure and Function

Cardiac muscle cells have high ATP demand and lead in mitochondria (36%). Pancreatic acinar cells secrete digestive enzymes and lead in rough ER (60%), which builds and packages secreted proteins. Hepatocytes have the highest smooth ER of the three cell types (16%), consistent with their detoxification role. Each pattern matches the cell's function, contradicting A, C, and D.

Q18. Answer: C

Topic 2.1 · Cell Structure and Function

The 60% rough ER dominance is characteristic of protein-secreting cells: ribosomes on the rough ER surface synthesize proteins that enter the endomembrane system for modification, packaging, and export. Smooth ER is only 1%, so steroid hormone production (A) is not the answer. Mitochondria are at 8%, not absent (B). D describes fat cells or hepatocytes, not the ER-heavy signature seen here.

Q19. Answer: A

Topic 2.10 · Origins of Cell Compartmentali...

Circular DNA and bacteria-sized (70S) ribosomes are features shared with prokaryotes and not with the rest of the eukaryotic cell, which points to a bacterial ancestry that persists inside the organelle. B and C describe what mitochondria do and how they are structured, but neither is uniquely bacterial. D reports abundance, not origin.

Q20. Answer: B

Topic 2.9 · Cell Compartmentalization

Lysosomal enzymes have an acidic pH optimum, so the low internal pH keeps them active for digestion. The nearly neutral cytoplasm is a safety margin: if a few enzymes leak out, they work poorly at pH 7.2 and cannot digest the cell. A contradicts that the enzymes function inside the lysosome. C describes mitochondrial ATP synthesis, not lysosomal function. D is false because lysosomes fuse with vesicles and exchange contents.