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Cell Membrane & Transport

Study Guide — Cell Membrane

Pre-med style questions on membrane structure, fluid mosaic model, diffusion, osmosis, active transport, and vesicular transport

30 items — Study Guide with Answers

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Generated February 20, 2026

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1 **Which statement best describes the basic structure of the plasma membrane according to the fluid mosaic model?**

A A rigid layer of triglycerides with scattered DNA and RNA

B **A phospholipid bilayer with proteins embedded and moving within it** ✓

C A single layer of phospholipids covered by a continuous protein coat

D A double layer of carbohydrates with proteins embedded

E A rigid protein lattice with phospholipids trapped inside

▶ **Explanation:** The fluid mosaic model describes the membrane as a dynamic phospholipid bilayer with proteins that can move laterally within it.

2 **Phospholipids in the plasma membrane are described as amphipathic. What does this mean?**

A They are both proteins and lipids at the same time

B **They contain both hydrophobic and hydrophilic regions** ✓

C They carry both positive and negative charges on the head group

D They can freely flip from one leaflet of the bilayer to the other

E They are composed of both DNA and RNA

▶ **Explanation:** Each phospholipid has a hydrophilic (polar) head and hydrophobic (non-polar) fatty acid tails, making the molecule amphipathic.

3 **Where are carbohydrate chains typically located in relation to the plasma membrane of animal cells?**

A On the cytosolic side attached to phospholipids

B **On the extracellular side attached to lipids and proteins** ✓

C Embedded within the hydrophobic core of the bilayer

D Inside the nucleus attached to histones

E Evenly distributed on both cytosolic and extracellular sides

▶ **Explanation:** Membrane carbohydrates are found on the extracellular surface as part of glycoproteins and glycolipids, forming the glycocalyx.

4 Which type of membrane protein spans the entire lipid bilayer and often forms channels or transporters?

A Peripheral membrane protein

B **Integral transmembrane protein** ✓

C Cytosolic enzyme

D Extracellular matrix protein

E Nuclear pore protein

▶ **Explanation:** Integral transmembrane proteins have one or more hydrophobic segments that span the bilayer and can form channels or carriers.

5 Cholesterol molecules in the plasma membrane of animal cells mainly:

A Form ion channels for Na^+ and K^+

B Act as receptors for peptide hormones

C **Modulate membrane fluidity and reduce permeability to small polar molecules** ✓

D Bind directly to DNA to regulate gene expression

E Provide most of the membrane's structural rigidity through covalent cross-links

▶ **Explanation:** Cholesterol intercalates between phospholipids, decreasing membrane fluidity and permeability at physiological temperatures and preventing solidification at low temperatures.

6 **Which of the following molecules diffuses most readily across a pure phospholipid bilayer WITHOUT the help of transport proteins?**

A Na^+

B Glucose

C Cl—

D **O2** ✓

E A small charged peptide

▶ **Explanation:** Small non-polar molecules like O2 and CO2 can cross the hydrophobic core of the bilayer by simple diffusion; ions and large polar molecules require transport proteins.

7 **Simple diffusion differs from facilitated diffusion in that simple diffusion:**

A Requires ATP hydrolysis

B Can move solutes against their concentration gradient

C **Does not saturate because it does not depend on a limited number of transport proteins** ✓

D Is specific for particular solutes

E Occurs only in prokaryotic membranes

▶ **Explanation:** Facilitated diffusion uses specific transport proteins, so it can saturate at high substrate concentrations, whereas simple diffusion through the bilayer does not.

8 **Which statement about facilitated diffusion through membrane proteins is CORRECT?**

A It requires ATP directly

B **It moves substances down their electrochemical gradient** ✓

C It can transport solutes only from low to high concentration

D It is non-specific and transports any solute

E It involves vesicle formation and membrane fusion

▶ **Explanation:** Facilitated diffusion uses channels or carriers but does not use metabolic energy and cannot move solutes against their electrochemical gradients.

9 **Which feature distinguishes carrier (transporter) proteins from channel proteins?**

A Channels are specific but carriers are non-specific

B **Carriers undergo conformational changes to transport solutes; channels provide a continuous pore** ✓

C Carriers always require ATP whereas channels do not

D Channels are used only in prokaryotes; carriers only in eukaryotes

E Carriers transport only water molecules

▶ **Explanation:** Carriers bind specific solutes and change shape to move them across; channels create hydrophilic pores that allow specific ions or water to pass more freely.

10 **Aquaporins in cell membranes primarily facilitate:**

A Active transport of Na^+ ions

B **Passive diffusion of water across the membrane** ✓

C Facilitated diffusion of glucose

D Exocytosis of proteins

E Endocytosis of lipids

▶ **Explanation:** Aquaporins are water channels that greatly increase the permeability of membranes to water, enabling rapid osmosis.

11 **Osmosis is best defined as the:**

A Diffusion of any solute across a selectively permeable membrane

B **Movement of water across a selectively permeable membrane from a region of low solute concentration to high solute concentration** ✓

C Active transport of water using ATP

D Bulk flow of fluid driven by pressure differences

E Movement of water only when channels are closed

▶ **Explanation:** Osmosis is the passive movement of water down its own potential (effectively towards higher solute concentrations) across a semipermeable membrane.

12 **A red blood cell is placed in a solution that is hypotonic relative to its cytoplasm. What is the most likely outcome?**

A Water leaves the cell; the cell shrinks (crenates)

B **Water enters the cell; the cell may swell and lyse** ✓

C No net movement of water; cell volume remains constant

D Only solutes move; water cannot cross the membrane

E The cell actively pumps out water using ATP

▶ **Explanation:** In a hypotonic solution, the extracellular fluid has lower solute concentration than the cytoplasm, so water enters the cell by osmosis, causing swelling and possible lysis.

13 **A plant cell placed in a hypertonic solution will most likely:**

A Become turgid as water enters

B **Undergo plasmolysis as the plasma membrane pulls away from the cell wall** ✓

C Lyse due to cell wall rupture

D Remain unchanged because plant cells are impermeable to water

E Gain solutes without losing water

▶ **Explanation:** In hypertonic conditions, water leaves the plant cell, the vacuole shrinks, and the membrane separates from the cell wall (plasmolysis).

14 **Which transport process is correctly matched with its energy requirement?**

A Simple diffusion – requires ATP

B Facilitated diffusion – requires ATP

C **Primary active transport – directly uses energy from ATP hydrolysis** ✓

D Secondary active transport – requires no energy at all

E Osmosis – requires GTP

▶ **Explanation:** Primary active transport uses ATP directly to move solutes against their gradients; facilitated diffusion and osmosis are passive; secondary active transport uses existing gradients indirectly built by ATP-dependent pumps.

15 **The Na^+/K^+ ATPase (sodium–potassium pump) in animal cell membranes typically:**

A Moves 3 K^+ out and 2 Na^+ in per ATP hydrolysed

B **Moves 3 Na^+ out and 2 K^+ in per ATP hydrolysed** ✓

C Moves Na^+ and K^+ down their concentration gradients

D Functions by facilitated diffusion

E Has no effect on membrane potential

▶ **Explanation:** The Na^+/K^+ ATPase uses ATP to pump 3 Na^+ ions out and 2 K^+ ions in, both against their gradients and contributing to a more negative interior (electrogenic).

16 **Secondary active transport (cotransport) differs from primary active transport in that secondary active transport:**

A Uses ATP directly at the transport protein

B Always moves solutes down their concentration gradients

C **Uses the energy stored in an ion gradient generated by primary active transport** ✓

D Does not require membrane proteins

E Occurs only in prokaryotic cells

▶ **Explanation:** Secondary active transport uses ion gradients (often Na^+ or H^+) established by ATP-driven pumps to drive the uphill movement of other solutes.

17 **A Na^+/glucose symporter in the intestinal epithelium transports glucose into cells against its concentration gradient by coupling it to Na^+ movement. This is an example of:**

A Simple diffusion

B Primary active transport driven by ATP at the symporter

C **Secondary active transport using the Na^+ electrochemical gradient** ✓

D Osmosis

E Exocytosis

▶ **Explanation:** The Na^+/glucose symporter uses the Na^+ gradient created by the Na^+/K^+ pump to drive glucose uptake; Na^+ moves down its gradient, glucose moves uphill.

18 **Which combination correctly describes uniport, symport, and antiport?**

A Uniport: two solutes in opposite directions; symport: one solute; antiport: two solutes in same direction

B **Uniport: one solute; symport: two solutes in same direction; antiport: two solutes in opposite directions** ✓

C Uniport: one solute; symport and antiport: bulk vesicle movement

D Uniport: one solute; symport: no solute; antiport: one solute

E Uniport: passive; symport and antiport: always active

▶ **Explanation:** A uniporter transports a single type of solute; symporters move two or more solutes in the same direction; antiporters move them in opposite directions.

19 **Which process is an example of bulk (vesicular) transport across the plasma membrane?**

A Na^+/K^+ ATPase activity

B Simple diffusion of oxygen

C **Exocytosis of neurotransmitters from synaptic vesicles** ✓

D Facilitated diffusion of glucose via GLUT transporters

E Osmosis through aquaporins

▶ **Explanation:** Bulk transport involves membrane fusion and vesicles, as in exocytosis of neurotransmitters or endocytosis of particles.

20 **Phagocytosis is best described as:**

A Non-specific uptake of extracellular fluid in small vesicles

B Receptor-mediated uptake of specific ligands in clathrin-coated vesicles

C **Engulfment of large particles or cells into large vesicles by specialised cells** ✓

D Release of substances from the cell by vesicle fusion with the plasma membrane

E Diffusion of solutes down their concentration gradients

▶ **Explanation:** Phagocytosis is 'cell eating', a form of endocytosis used by certain cells (e.g. macrophages) to engulf large particles or microorganisms.

21 **Receptor-mediated endocytosis is characterised by:**

A Non-specific uptake of solutes and fluid

B **Involvement of specific receptors and often clathrin-coated pits** ✓

C Transport of ions through open channels

D Active pumping of solutes using ATP

E Formation of gap junctions between cells

▶ **Explanation:** Receptor-mediated endocytosis selectively concentrates ligands that bind specific receptors in coated pits, which then invaginate to form vesicles.

22 The resting membrane potential of a typical animal cell is mainly generated by:

A Equal permeability to all ions

B High permeability to K^+ and the concentration gradient of K^+ across the membrane ✓

C High permeability to Na^+ and the Na^+ concentration gradient

D Osmosis of water through aquaporins

E Active import of Cl— into the cell

▶ **Explanation:** Although the Na^+/K^+ pump contributes, the resting membrane potential is largely due to K^+ diffusion through leak channels down its gradient, leaving the inside negative.

23 Which type of membrane transport typically exhibits a maximum rate (Vmax) when substrate concentration is high, analogous to enzyme saturation?

A Simple diffusion of O2

B Facilitated diffusion via carrier proteins ✓

C Facilitated diffusion via open ion channels

D Osmosis through aquaporins

E Bulk flow of fluid in capillaries

▶ **Explanation:** Carrier-mediated transport has a finite number of transporters, so transport rate plateaus at high substrate concentrations (saturation kinetics).

24 **GLUT transporters (e.g. GLUT1) that mediate glucose uptake into many cells are examples of:**

A Primary active transporters

B Secondary active symporters

C Na^+-dependent glucose cotransporters

D **Facilitated diffusion uniporters** ✓

E Voltage-gated ion channels

▶ **Explanation:** GLUT transporters move glucose down its concentration gradient without using ATP or ion gradients; they are uniporters mediating facilitated diffusion.

25 **Which factor would generally INCREASE the rate of simple diffusion of a solute across a membrane?**

A Decreasing temperature

B Increasing the thickness of the membrane

C **Increasing the concentration gradient of the solute across the membrane** ✓

D Decreasing membrane surface area

E Making the solute more charged and hydrophilic

▶ **Explanation:** Fick's law predicts that diffusion increases with a steeper concentration gradient, higher temperature, greater surface area, and thinner membranes; hydrophobic solutes diffuse more easily.

26 **Cystic fibrosis is caused by mutations in a gene encoding CFTR, which functions as:**

A A Na^+/K^+ ATPase

B A voltage-gated Na^+ channel

C **A Cl− channel regulated by ATP binding** ✓

D A glucose symporter

E A K^+ leak channel

▶ **Explanation:** CFTR is an ATP-gated Cl− channel in epithelial cells; its dysfunction alters ion and water transport, leading to thick mucus in cystic fibrosis.

27 **Which statement correctly describes pinocytosis?**

A Uptake of specific ligands via receptors in clathrin-coated pits

B **Non-specific uptake of extracellular fluid and dissolved solutes into small vesicles** ✓

C Engulfment of large particles like bacteria

D Fusion of vesicles with the plasma membrane to secrete proteins

E Diffusion of water through aquaporins

▶ **Explanation:** Pinocytosis is 'cell drinking' and involves continuous, non-specific uptake of extracellular fluid into small vesicles.

28 **Which of the following processes is DIRECTLY dependent on ATP hydrolysis at the transport protein itself?**

A **Na^+/K^+ pump** ✓

B Na^+/glucose symporter

C GLUT-mediated glucose transport

D Aquaporin-mediated water flow

E Voltage-gated K^+ channels opening during an action potential

▶ **Explanation:** The Na^+/K^+ ATPase is a primary active transporter that hydrolyses ATP directly at the pump; others listed are passive or secondary active.

29 An ion moves across a membrane from an area of high concentration to low concentration, but against the electrical component of its electrochemical gradient (e.g. a positive ion moving into a more positive compartment). Which of the following best describes this movement?

A Always energetically favourable because concentration decreases

B Determined by the net electrochemical gradient, which may still drive net movement without ATP ✓

C Impossible without vesicle formation

D An example of primary active transport

E An example of osmosis

▶ **Explanation:** The electrochemical gradient includes both concentration and electrical components. If the concentration gradient is strong enough, it can overcome an opposing electrical gradient so net movement remains passive.

30 Which situation will most likely cause a cell to gain water by osmosis?

A The cell is placed in a hypertonic solution

B The cell is placed in an isotonic solution

C The cell is placed in a hypotonic solution ✓

D Solute concentrations are equal inside and outside

E The cell expresses more aquaporins but is in an isotonic medium

▶ **Explanation:** In a hypotonic solution, the extracellular fluid has lower solute concentration than the cytosol, so water enters the cell by osmosis.