McCance: Pathophysiology, 6th Edition

Chapter 01: Cellular Biology

Test Bank

TRUE/FALSE

1. Eukaryotic cells are characterized by a lack of a distinct nucleus, whereas prokaryotic cells have intracellular compartments bordered by membranes and a well-defined nucleus.

ANS: F
Eukaryotic cells have a characteristic set of membrane-bound intracellular compartments called *organelles* that includes a well-defined nucleus. **Prokaryotes** contain no organelles, and their nuclear material is not encased by a nuclear membrane. Prokaryotic cells are characterized by lack of a distinct nucleus.

REF: p. 2

2. The primary functions of the cell nucleus are cell division and control of genetic information.

ANS: T
The primary functions of the nucleus are cell division and control of genetic information.

REF: p. 2

3. The chief function of ribosomes is to provide sites for lipid synthesis.

ANS: F
Their chief function is to provide sites for cellular protein synthesis.

REF: p. 5

4. Lysosomes remain fully active by maintaining an acid pH created by pumping hydrogen ions into their interiors.

ANS: T
Lysosomes remain fully active by maintaining a low internal pH. They do this by pumping hydrogen ions into their interiors.

REF: p. 5

5. Lipids and proteins are the major components of the plasma membrane.

ANS: T
The major chemical components of all membranes are lipids and proteins, but the percentage of each varies among different membranes.

REF: p. 11

6. If cells are deprived of communication from extracellular chemical messengers, most cells experience apoptosis.

ANS: T
If deprived of appropriate signals, most cells undergo a form of cell suicide known as *programmed cell death,* or *apoptosis*.

REF: p. 19

7. The function of adenosine triphosphate (ATP) is to store energy in molecules of carbohydrates, proteins and lipids, but not to transfer energy from one molecule to another.

ANS: F
The function of ATP is not only to *store* energy but also to *transfer* it from one molecule to another.

REF: p. 23

8. Diffusion is an example of active transport.

ANS: F
This process, called **passive transport,** occurs naturally through any semipermeable barrier. It is driven by osmosis, hydrostatic pressure, and diffusion, all of which depend on the laws of physics and do not require life.

REF: p. 25

9. Phagocytosis is an example of exocytosis.

ANS: F
Two types of endocytosis are designated based on the size of the vesicle formed. **Pinocytosis** (cell drinking) involves the ingestion of fluids and solute molecules through formation of small vesicles, and **phagocytosis** (cell eating) involves the ingestion of large particles, such as bacteria, through formation of large vesicles (also called *vacuoles*).

REF: p. 31

10. All body cells are electrically polarized, with the inside of the cell being more negatively charged than the outside.

ANS: T
All body cells are electrically polarized, with the inside of the cell more negatively charged than the outside.

REF: p. 32

MULTIPLE CHOICE

1. Which of the following best describes the cellular function of metabolic absorption?
a. Cells can produce proteins.
b. Cells can secrete digestive enzymes.
c. Cells can take in and use nutrients.
d. Cells can synthesize fats.

ANS: C
In metabolic absorption all cells take in and use nutrients and other substances from their surroundings.

REF: p. 2

2. Most of a cell's genetic information, including RNA and DNA, is contained in the:
a. mitochondria.
b. ribosome.
c. nucleolus.
d. lysosome

ANS: C
The nucleus contains the **nucleolus,** a small dense structure composed largely of RNA; most of the cellular DNA; and the DNA-binding proteins, the histones, that regulate its activity.

REF: p. 2

3. Which component of the cell produces hydrogen peroxide (H_2O_2) by using oxygen to remove hydrogen atoms from specific substrates in an oxidative reaction?
a. Lysosomes
b. Peroxisome
c. Ribosomes
d. Oxyhydrosomes

ANS: B
Peroxisomes are so named because they usually contain enzymes that use oxygen to remove hydrogen atoms from specific substrates in an oxidative reaction that produces H_2O_2. Hydrogen peroxide is a powerful oxidant and potentially destructive if it accumulates or escapes from peroxisomes.

REF: p. 7

4. Which cell component is capable of cellular autodigestion when it is released during cell injury?
a. Ribosome
b. Golgi complex
c. Smooth endoplasmic reticulum
d. Lysosomes

ANS: D
The lysosomal membrane acts as a protective shield between the powerful digestive enzymes within the lysosome and the cytoplasm, preventing their leakage into the cytoplasmic matrix. Disruption of the membrane by various treatments or cellular injury leads to a release of the lysosomal enzymes, which can then react with their specific substrates, causing *cellular self-digestion*.

REF: p. 5

5. What is the sequence of steps in the development of a digestive enzyme by the pancreas cells from the initial transcription to the release from the cell?
a. The enzyme is transcribed from DNA by RNA in the nucleus, proceeds to the ribosome for synthesis, and is transported in a secretory vesicle to the cell membrane.
b. The enzyme is transcribed from RNA by DNA in the nucleus, proceeds to the lysosome for synthesis, and is transported in an encapsulated membrane to the cell membrane.
c. The enzyme is transcribed by the mitochondria in the nucleus, proceeds to the ribosome for synthesis, and is transported in a cytoskeleton to the cell membrane.
d. The enzyme is transcribed from DNA by RNA in the nucleus, proceeds to the Golgi complex for synthesis, and is transported in a cytosol to the cell membrane.

ANS: A
The enzyme is transcribed from DNA by RNA in the nucleus, proceeds to the ribosome for synthesis, and is transported in a secretory vesicle to the cell membrane.

REF: pp. 6-8; Figure 1-5

6. What are the major chemical components of the cell membranes?
a. Lipids and proteins
b. Sodium and potassium ions
c. Carbohydrates and water
d. DNA and RNA

ANS: A
The major chemical components of all cell membranes are lipids and proteins, but the percentage of each varies among different membranes.

REF: p. 11

7. What organic compound facilitates transportation across cell membranes by acting as receptors, transport channels for electrolytes, and enzymes to drive active pumps?
a. Lipids
b. Proteolytic cascade
c. Proteins
d. Carbohydrates

ANS: C
Proteins act as (1) recognition and binding units (receptors) for substances moving in and out of the cell; (2) pores or transport channels for various electrically charged particles called *ions* or *electrolytes* and specific carriers for amino acids and monosaccharides; (3) specific enzymes that drive active pumps that promote concentration of certain ions, particularly potassium (K^+), within the cell while keeping concentrations of other ions, for example, sodium (Na^+), below concentrations found in the extracellular environment;

REF: p. 12

8. Understanding the various steps of proteolytic cascades such as caspase-mediated apoptosis and complement cascade may be useful in designing drug therapy for which human diseases?
a. Cardiac and vascular disorders
b. Autoimmune and malignant disorders
c. Gastrointestinal and renal disorders
d. Endocrine disorders

ANS: B
Understanding the various steps involved is crucial for designing drug interventions. Dysregulation of proteases features prominently in many human diseases, including cancer, autoimmunity, and neurodegenerative disorders.

REF: p. 13

9. What prevents water-soluble molecules from entering cells across the plasma membrane?
a. Carbohydrate chains
b. Glycoprotein channels
c. Membrane channel proteins
d. Phospholipid bilayer

ANS: D
The bilayer's structure accounts for one of the essential functions of the plasma membrane—it is impermeable to most water-soluble molecules (molecules that dissolve in water) because they are insoluble in the oily core region. The bilayer serves as a barrier to the diffusion of water and hydrophilic substances while allowing lipid-soluble molecules, such as O_2 and CO_2, to diffuse through it readily.

REF: pp. 11, 14; Figure 1-13

10. The fluid mosaic model explains:
a. how a cell membrane functions.
b. why our bodies appear to be solid.
c. how tissue is differentiated.
d. how fluid moves between the intracellular and extracellular compartments.

ANS: A
The fluid mosaic model accounts for the flexibility of cellular membranes, their self-sealing properties, and their impermeability to many substances.

REF: p. 13

11. Using the fluid mosaic model, a cell is actively capable of protecting itself against injurious agents by:
a. closing down the membrane transport channels to hormones and chemicals.
b. altering the number and patterns of receptors to bacteria, antibodies, and chemicals.
c. increasing the number and sensitivity of lysosomes to destroy bacteria.
d. shifting the bilayer from hydrophobic to hydrophilic in response to antibodies.

ANS: B
Hormones, bacteria, viruses, drugs, antibodies, chemicals that transmit nerve impulses (neurotransmitters), and other substances attach to the plasma membrane by means of receptor molecules on its outer layer. The number of receptors present may vary at different times, and the cell is capable of modulating the effects of injurious agents by altering receptor number and pattern. This aspect of the fluid mosaic model has drastically modified previously held concepts concerning the onset of disease.

REF: p. 13

12. In cirrhosis, how does cholesterol alter the fluidity of the plasma membrane of erythrocytes?
a. Cholesterol decreases the membrane fluidity of the erythrocyte, which reduces its ability to carry oxygen.
b. Cholesterol decreases the membrane fluidity of erythrocytes, which reduces its ability to carry hemoglobin.
c. Cholesterol increases the membrane fluidity of erythrocytes, which allows binding of excess glucose.
d. Cholesterol increases the membrane fluidity of erythrocytes, which prolongs it life span beyond 120 days.

ANS: A
The concentration of cholesterol in the plasma membrane affects membrane fluidity.
In cirrhosis of the liver, for example, the cholesterol content of the red blood cell's plasma membrane increases. This causes an overall decrease in membrane fluidity that seriously affects the cell's ability to transport oxygen.

REF: p. 13

13. Which form of cell communication is used to communicate within the cell itself and with other cells in direct physical contact?
a. Protein channel (gap junction)
b. Plasma membrane-bound signaling molecules (involving receptors)
c. Hormone secretion such as neurotransmitters
d. Extracellular chemical messengers such as ligands

ANS: B
Cells communicate in three ways: (1) they form protein channels (gap junctions) that directly coordinate the activities of adjacent cells; (2) they display plasma membrane–bound signaling molecules (receptors) that affect the cell itself and other cells in direct physical contact; and (3) (the most common means) they secrete chemicals that signal to cells some distance away (Figure 1-16).

REF: p. 18

14. Which mode of chemical signaling uses blood to transport communication to cells some distance away?
a. Paracrine signaling
b. Autocrine signaling
c. Neurotransmitter signaling
d. Hormone signaling

ANS: D

Hormonal signaling involves specialized endocrine cells that secrete hormone chemicals (e.g., thyroid-stimulating hormone) released by one set of cells and travel through the tissue and through the bloodstream to produce a response in other sets of cells (see Chapter 20).

REF: p. 18

15. Which mode of chemical signaling uses local chemical mediators that are quickly taken up, destroyed or immobilized?
a. Paracrine signaling
b. Autocrine signaling
c. Neurotransmitter signaling
d. Hormone signaling

ANS: A
In **paracrine signaling,** cells secrete local chemical mediators that are quickly taken up, destroyed, or immobilized.

REF: p. 18

16. Neurotransmitters affect the postsynaptic membrane by binding to:
a. lipids.
b. ribosomes.
c. amphipathic lipids.
d. receptors.

ANS: D
In each type of chemical signaling, the target cell receives the signal by first attaching to its receptors.

REF: p. 18

17. How do cells receive communication from the extracellular fluid surrounding them?
a. Protein channel (gap junction)
b. Plasma membrane–bound signaling molecules (involving receptors)
c. Hormone secretion such as neurotransmitters
d. Chemical messengers such as ligands

ANS: D
Channel opening and closing can be initiated in one of three ways:
(1) by binding a ligand to a specific membrane receptor that is closely associated with the channel (for example, G proteins); (2) by changes in electric current in the plasma membrane, altering flow of Na^+ and K^+; and (3) by stretching or other chemical deformation of the channel. Figure 1-19 summarizes ways by which

extracellular messengers regulate channel function for the other two methods of controlling channels.

REF: pp. 20, 28

18. When a second message is necessary for extracellular communication to be activated, it is provided by:
a. guanosine triphosphate (GTP).
b. adenosine monophosphate (AMP).
c. adenosine triphosphate (ATP).
d. guanosine diphosphate (GDP).

ANS: B
The two major second messenger pathways are **cyclic adenosine monophosphate (cyclic AMP, cAMP)** and Ca^{++}.

REF: p. 20

19. Under anaerobic conditions, the process of _____ provides energy for the cell.
a. oxidative phosphorylation
b. glycolysis
c. lactolysis
d. passive transport

ANS: B
Glycolysis produces a net of two molecules of ATP per glucose molecule through the process of **oxidation,** or the removal and transfer of a pair of electrons.

REF: p. 23

20. What is the mechanism by which the energy produced from carbohydrates, proteins and lipids is transferred to adenosine triphosphate (ATP)?
a. Anaerobic glycolysis
b. Oxidative cellular metabolism
c. Oxidative phosphorylation
d. Tricarboxylic acid phosphorylation

ANS: C
Oxidative phosphorylation occurs in the mitochondria and is the mechanism by which the energy produced from carbohydrates, fats, and proteins is transferred to ATP.

REF: p. 24

21. How is passive transport described?

a. It is driven by osmosis, filtration, and diffusion.
b. It involves receptors that can bind with substances being transported.
c. It is capable of transporting macromolecules.
d. It requires energy generated by the cell.

ANS: A
Water and small electrically uncharged molecules move easily through pores in the plasma membrane's lipid bilayer. This process, called **passive transport,** occurs naturally through any semipermeable barrier. It is driven by osmosis, hydrostatic pressure, and diffusion, all of which depend on the laws of physics and do not require life.

REF: p. 25

22. Active transport occurs across membranes that:
a. have a higher concentration of the solute on the outside of the cell.
b. are semipermeable to water and small electrically uncharged molecules.
c. have receptors that are capable of binding with the substances to be transported.
d. have a cell membrane that is hydrophobic rather than hydrophilic.

ANS: C
Other molecules cannot be driven across the plasma membrane solely by forces of diffusion, hydrostatic pressure, or osmosis because they are too large or are ligands that have bound with receptors on the cell's plasma membrane.

REF: p. 25

23. What is the name of the method of transport that uses transmembrane proteins with receptors that have a high degree of specificity for the substance being transported?
a. Active transport
b. Mediated transport
c. Transmembranous transport
d. Passive transport

ANS: B
Mediated transport (passive and active) involves integral or transmembrane proteins with receptors having a high degree of specificity for the substance being transported. Inorganic anions and cations (e.g., Na^+, K^+, Ca^{++}, Cl^-, HCO_3^-) and charged and uncharged organic compounds (e.g., amino acids, sugars) require specific transport systems to facilitate movement through different cellular membranes.

REF: p. 28

24. The movement of fluid across the arterial end of capillary membranes into the interstitial fluid surrounding the capillary is an example of which process of fluid movement?
a. Hydrostatic pressure
b. Osmosis
c. Diffusion
d. Active transport

ANS: A
Hydrostatic pressure is the mechanical force of water pushing against cellular membranes. In the vascular system, hydrostatic pressure is the *blood pressure* generated in vessels by the contraction of the heart. Blood reaching the capillary bed has a hydrostatic pressure of 25 to 30 mmHg, which is sufficient force to push water across the thin capillary membranes into the interstitial space.

REF: pp. 26-27

25. Why is "osmolality" preferred over "osmolarity" as the measurement of osmotic activity in the clinical assessment of individuals?
a. Because plasma contains sodium and chloride, which influence the volume of solution
b. Because the volume affects perfusion more than the weight of solutes
c. Because more of the weight of plasma is influenced by solutes, such as protein and glucose, rather than by water
d. Because osmotic activity depends on the concentration of solutes present in plasma, such as proteins and glucose

ANS: C
In plasma, less of the plasma weight is water and the overall concentration of particles is therefore greater. The osmolality will be greater than the osmolarity because of the smaller proportion of water. Osmolality is thus the preferred measure of osmotic activity in clinical assessment of individuals.

REF: p. 27

26. A patient who has diarrhea receives a 3% saline solution intravenously to replace the sodium and chloride lost in the stool. What effect will this fluid replacement have on cells?
a. Cells will become hydrated.
b. Cells will swell or burst.
c. Cells will shrink.
d. Cells will divide.

ANS: C

A **hypertonic solution** has a concentration of more than 285 to 294 mOsm/kg. An example of a hypertonic solution is 3% saline solution. Water can be pulled out of the cells by a hypertonic solution, so the cells shrink.

REF: p. 28

27. How is the transport of glucose from the blood to the cell accomplished?
a. By active-mediated transport (active transport)
b. By active diffusion
c. By passive osmosis
d. By passive-mediated transport (facilitated diffusion)

ANS: D
Perhaps the most widely referred to passive transport system is that for glucose in erythrocytes (red blood cells).

REF: p. 29

28. How are potassium and sodium transported across plasma membranes?
a. By passive electrolyte channels
b. By coupled channels
c. By adenosine triphosphate enzyme (ATPase)
d. By diffusion

ANS: C
The exact mechanism for transport of Na^+ and K^+ across the membrane is uncertain. One proposal is that ATPase induces the transporter protein to undergo several conformational changes, causing Na^+ and K^+ to move short distances (Figure 1-29).

REF: p. 30

29. What occurs during exocytosis?
a. Macromolecules can be secreted across eukaryotic cell membranes.
b. All substances are secreted into the cellular matrix.
c. No repairs in the plasma membrane can take place.
d. Solute molecules flow freely into and out of the cell.

ANS: A
In eukaryotic cells, secretion of macromolecules almost always occurs by exocytosis (Figure 1-30, *B*).

REF: p. 31

30. Why is potassium able to diffuse easily in and out of cells?
a. Because potassium has a greater concentration in the intracellular fluid (ICF)

b. Because sodium has a greater concentration in the extracellular fluid (ECF)
c. Because the resting plasma membrane is more permeable to potassium
d. Because there is an excess of anions inside the cell

ANS: C
Because the resting plasma membrane is more permeable to K^+ than to Na^+, K^+ can diffuse easily from its area of higher concentration in the ICF to its area of lower concentration in the ECF. Because Na^+ and K^+ are both cations, the net result is an excess of anions inside the cell, resulting in the resting membrane potential.

REF: p. 32

31. The cellular uptake of cholesterol depends on:
a. receptor-mediated exocytosis.
b. antiport system.
c. receptor-mediated endocytosis.
d. passive transport.

ANS: C
The cellular uptake of cholesterol, for example, depends on receptor-mediated endocytosis.

REF: p. 31

32. What causes the rapid change in the resting membrane potential that initiates an action potential?
a. Potassium gates open and potassium rushes into the cell, changing the membrane potential from negative to positive.
b. Sodium gates open and sodium rushes into the cell, changing the membrane potential from negative to positive.
c. Sodium gates close allowing potassium into the cell to change the membrane potential from positive to negative.
d. Potassium gates close allowing sodium into the cell to change the membrane potential from positive to negative.

ANS: B
When a resting cell is stimulated through voltage-regulated channels, the cell membranes become more permeable to sodium. There is a net movement of sodium into the cell, and the membrane potential decreases, or "moves forward," from a negative value (in millivolts) to zero. The sodium gates open, and sodium rushes into the cell, causing the membrane potential to reduce to zero and then become positive (depolarization).

REF: pp. 32-33

33. The action of platelet-derived growth factor is to stimulate production of:

a. platelets.
b. epidermal cells.
c. connective tissue cells.
d. fibroblast cells.

ANS: C
Different types of cells require different factors; for example, **platelet-derived growth factor** stimulates the production of connective tissue cells.

REF: p. 35

34. What is the role of cytokines in cell reproduction?
a. They provide growth factor for tissue growth and development.
b. They block progress of cell reproduction through the cell cycle.
c. They restrain cell growth and development.
d. They provide nutrients for cell growth and development.

ANS: A
Growth factors, also called *cytokines*, are peptides that transmit signals within and between cells. They have a major role in the regulation of tissue growth and development (Table 1-6).

REF: p. 35

35. Which cells, if any, lose their ability to replicate and divide?
a. None; all cells have the ability to replicate and divide.
b. Cells of the lung and intestinal tract
c. Cells of the skin
d. Cells of the lens of the eye and skeletal muscle

ANS: D
All types of cells undergo mitosis during formation of the embryo, but many adult cells, such as nerve cells, lens cells of the eye, and muscle cells, lose their ability to replicate and divide.

REF: p. 35
36. Cellular reproduction is a process that:
a. often takes months or years to complete.
b. typically has a short interphase.
c. results in two diploid cells called *daughter* cells.
d. involves the interaction of male and female cells.

ANS: C
The M phase of the cell cycle, mitosis and cytokinesis, begins with **prophase,** the first appearance of chromosomes. As the phase proceeds, each chromosome is seen as two identical halves called **chromatids,** which lie together and are attached at

some point by a spindle attachment site called a **centromere.** (The two chromatids of each chromosome, which are genetically identical, are sometimes called *sister chromatids*.)

REF: p. 34

37. During which phase of the cell cycle is DNA synthesized?
a. G_1
b. S
c. G_2
d. M

ANS: B
The four designated phases of the cell cycle are: (1) the G_1 phase (G = gap), which is the period between the M phase and the start of DNA synthesis; (2) the S phase (S = synthesis), in which DNA is synthesized in the cell nucleus; (3) the G_2 phase, in which RNA and protein synthesis occurs, the period between the completion of DNA synthesis and the next phase (M); and (4) the M phase (M = mitosis), which includes nuclear and cytoplasmic division (Figure 1-33).

REF: p. 34

MATCHING

Match the structure with its function. Answers may be used more than once.
a. Endoplasmic reticulum
b. Ribosome
c. Secretory vesicle
d. Lysosomes

1. Packages and transports proteins
2. Fuses with the plasma membrane to release contents from the cell
3. Synthesizes and transports lipids
4. Provides energy to digest proteins into amino acids

1. ANS: A REF: p. 5
NOT: The endoplasmic reticulum (endo = "within"; plasma = "cytoplasm"; reticulum = "network") is a membrane factory that specializes in the synthesis and transport of the protein and lipid components of most of the cell's organelles.

2. ANS: C REF: p. 5
NOT: Proteins from the endoplasmic reticulum are processed and packaged into small membrane-bound sacs or vesicles called secretory vesicles that collect at the end of the membranous folds of the Golgi bodies The secretory vesicles then break off from the Golgi complex and migrate to a variety of intracellular and extracellular destinations, including the plasma membrane. The vesicles fuse with

the plasma membrane, and their contents are released from the cell.

3. ANS: A REF: p. 5
NOT: The endoplasmic reticulum (endo = "within"; plasma = "cytoplasm"; reticulum = "network") is a membrane factory that specializes in the synthesis and transport of the protein and lipid components of most of the cell's organelles.

4. ANS: D REF: p. 5
NOT: Lysosomes function as the intracellular digestive system (Figure 1-6). Lysosomal enzymes are capable of digesting most cellular constituents down to their basic forms, such as amino acids, fatty acids, and sugars.

Match the structure with its function. Answers may be used more than once.
a. Passive-mediated transport
b. Active-mediated transport
c. Osmosis

5. Movement of water
6. Protein carrier
7. Facilitated diffusion

5. ANS: C REF: p. 27
NOT: Osmosis is the movement of water "down" a concentration gradient, that is, across a semipermeable membrane from a region of higher water concentration to a lower water concentration.

6. ANS: B REF: p. 29
NOT: In active mediated transport, also called active transport, the protein transporter moves molecules against, or up, the concentration gradient. Unlike passive mediated transport, active mediated transport requires the expenditure of energy.

7. ANS: A REF: p. 29
NOT: In passive mediated transport, also called facilitated diffusion, the protein transporter moves solute molecules through cellular membranes without expending metabolic energy.