Faculty of Medicine 2012

Past Papers & review test of costanzo

PHYSIOLOGY

Medical Committee
The University of Jordan

Price :

٣٥ دينار

Done by :

[redacted]

Medical Committee
The University of Jordan

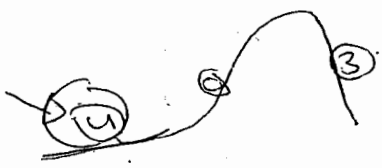
Physiology Questions-2010 – medical committee - 1st year

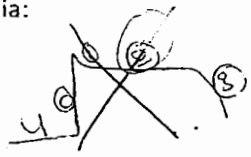
From the first ,second and final exams (summer semester 2010)

1.If you want to prepare isotonic solution of Na2SO3,which concentration would be the best:
A,200 mOsm
b.300 mOsm *
c.150 mOsm
d.500 mOsm
e.100 mOsm

2. One of the following is true about positive feedback:
a. if an action decrease the response will increase
b. Opening Na+ channels is an example of positive feedback. *
c. Keeping the Arterial blood pressure in a normal range is an example of positive feedback.

3. In the SA nodal action potential which phase should be faster to cause tachycardia:
a. Phase 0
b. Phase 1
c. Phase 2
d. Phase 3
e. Phase 4

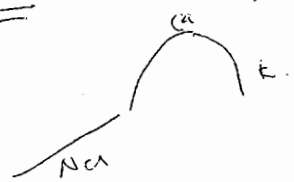




4. In the action potential for the SA node, in which phase the number of positive charges entering is more than the number of positive charges leaving:

a. Phase 0
b. Phase 1
[redacted]
d. Phase 3
e. Phase 4

5. During the action potential for the SA nodal cell in the heart, the permeability changes for:
a. Na+
b. Na+, Ca++
c. Na+, Ca++ and K+
d. Na+, K+
e. Na+, Cl-



6. About Schizophrenia which one is true:
a. caused by Dopamine increases.
b. related to chromosome 11.
c. has no treatment.
d. the patient suffers hallucinations.

7. After the action potential happens:
a. [K+] increase 1% in the extracellular fluid.
b. [K+] decrease 1% in the intracellular fluid.
c. [Na+] increases 1% in the intracellular fluid.
d. Both [Na+] and [K+] changes won't be more than 1%.
e. [Ca++] increases 1% in the intracellular fluid.

8. About the body fluids, intracellular share with extracellular:
a. Number of cations.
b. concentration of protons.
c. osmolarity.
d. volume of body water.

9. The highest permeability through a biological membrane is:
a. Albumin
b. Na+
c. Glucose
d. O2
e. CO2 *

10. Which of the following affects the "colloid osmotic pressure":
a. Na+
b. Albumin *

c. Glucose

11. About Saturday night syndrome , all the following are true except:
a. The patient would have wrest drop
b. Someone with stabs in the brachial plexus may have it
c. multipeak CMAP.
d. Normal CMAP. *
e. A person could suffer from this if he uses crutches.

12. One of the following does not happen when you are stressed:
a. Activated Hypothalamus.
b. Increased blood pressure.
c. Increased heart rate.
d. Increased glucose in the blood.
e. Increased the gastric secretion.

13. The enzyme that break down norepinephrine in the Tissues:
a. Catechol-O-methyl transferase. * ← tissue
b. Monoamine oxidase. ← brain
c. acetylcholine esterase.
d. Amphetamines.
e. Botox.

14. The glutamate receptor can bind to all the following except:
a. Glycine.
b. Magnesium.
c. GABA.
d. Zinc.
e. Glutamate.

15. All the following are caused by vagotomy except:
a. Decrease the motility and secretion.
b. Increase the heart rate.
c. Constipation and slow digestion.
d. Decrease the heart rate. *

16. All the following are used to treat axillary hyperhidrosis except:
a. Botox injection
b. Hyponosis.
c. Cholinergic drug. *
d. Endoscopic thoracic sympectomy
e. Antiperspirants.

ACh

17. cGMP dependent protein kinase converts:
a. ATP to cAMP
b. cGMP to GTP *
c. cAMP to GTP
d. GTP to cAMP
e. GTP to cGMP

18. One of the following has a receptor on the cell membrane:
a. Cortisol.
b. Vitamin D.
c. Insuline. *
d. Thyroid.
e. NO.

19. Calcium-calmodulin is:
a. Hormone.
b. Ca binding protein. *

20. The IP3 (inositol triphosphate) function is:
a. Activates phospholipase C.
b. Activates protein kinase C to phosphorylate protein.
c. Binds to a receptor on ER to release Ca++. *
d. Stimulate G-protein.

21. Which of the following is used to suppress pain:
a. Norepinephrine
b. Enkephaline *
c. NO
d. Glutamic acid

22. One of the following will happens if you use diuretic drug:
a. Hyper-osmotic, dehydration.
b. Hypo-osmotic, dehydration. *
c. Hypo-osmotic, over hydration.

Study well
مع دعاتنا لكم بالتوفيق..... لـــــــــــجنة سنة أولى

بسم الله الرحمن الرحيم

أسئلة مقترحة لامتحان

Mid

Physiology

سنة أولى

Summer coarse 2008

Which of the following characteristics is shared by simple and facilated diffusion of glucose?

a. occurs down an electrochemical gradient
b. is saturable
c. requires metabolic energy
d. is inhibited by the presence of galactose
e. requires a Na^+ gradient

During the upstroke of the action potential:

a. there is net outward current and the cell interior becomes more negative
b. there is net outward current and the cell interior becomes less negative
c. there is net inward current and the cell interior becomes more negative
d. there is net inward current and the cell interior becomes less negative

Solution A and B are separated by a semipermeable membrane that is permeable to K^+ but not to Cl^-. Solution A is 100 mM KCl, and solution B is 1 mM KCl. Which of the following statements about solution A and B is true ?

a. K^+ ions will will diffuse from solution A to solution B until the concentration of K^+ of both solutions is 50.5 mM
b. K^+ ions will diffuse from solution B to solution A until the $[K^+]$ of both solutions is 50.5 mM
c. KCl will diffuse from solution A to solution B until the [KCl] of both solutions 50.5 mM
d. K^+ will diffuse from solution A to solution B until a membrane potential develops with solution A negative with respect to solution B
e. K^+ will diffuse from solution A to solution B until a membrane potential develops with solution A positive with respect to solution B

The correct temporal sequence for events at the neuromuscular junction is:

a. action potential in the motor nerve; depolarization of muscle end plate; uptake of Ca^{+2} into the presynaptic nerve terminal
b. uptake of Ca^{+2} into the presynaptic terminal; release of acytel choline (Ach), depolarization of the muscle end plate
c. release of Ach; action potential in the motor nerve; action potential in the muscle
d. uptake of Ca^{+2} into the motor end plate; action potential in the motor end plate; action potential in the muscle
e. release of Ach; action potential in the muscle end plate; action potential the muscle

Which characteristic or component is shared by skeletal and smooth muscle:

a. thick and thin filaments are arranged in sarcomeres
b. Troponin
c. Elevation of intracellular $[Ca^{+2}]$ for excitation-contraction coupling
d. Spontaneous depolarization of the membrane potential
e. High degree of electrical coupling between cells

Repeated stimulation of a skeletal muscle fiber causes titanic contraction because the intracellular concentration of which solute increase and remains at high level:

a. Na^+
b. K^+
c. Mg^{+2}
d. Ca^{+2}
e. Troponin
f. Calmodulin
g. ATP

Solution A and B are separated by a membrane that is penneable to Ca^{+2} and impermeable to Cl^-. Solution A contains 10 mM $CaCl_2$, and solution B contains 1 mM $CaCl_2$. Assuming that 2.3 RT/F = 60 mV, Ca^{+2} will at electrochemical equilibrium when:

$E_{Ca} = 30 \log \frac{10}{1}$

$E_{Ca} = +30$

a. Solution A is +60 mV
b. Solution A is +30 mV
c. Solution A is – 60 mV
d. Solution A is – 30 mV
e. Solution A is +120 mV
f. Solution A is – 120 mV
g. The Ca^{+2} concentrations of two solutions are equal
h. The Cl^- concentrations of two solutions are equal

A person with myasthenia gravis notes increased muscle strength when treated with an Acytelcholine esterase inhibitor. The basis of his improvement is increased:

a. amount of Ach released from motor nerve
b. levels of Ach at the muscle end plates
c. number of Ach receptors on the muscle end plate
d. amount of norepinephrine released from motor nerve
e. synthesis of nrepinephrine in motor nerves

In error, a patient is infused with large volumes of a solution that causes lysis of his RBCs. The solution was most likely:

a. 0.9 % NaCl
b. 2% NaCl
c. isotonic manitol
d. hypertonic manitol
e. hypotonic urea
f. hypertonic urea

During a nerve action potential, a stimulus is delivered as indicated by the arrow shown in the following figure. In response to the stimulus a second action potential

a. of smaller magnitude will occur
b. of normal magnitude will occur
c. of normal magnitude will occur, but will be delayed
d. will occur but will not have an overshoot
e. will not occur

Solution A and B are separated by a membrane that is permeable to urea. Solution A is 10 mM urea, and solution B is 5 mM urea. If the concentration of urea in solution A is doubled the flux of urea across the membrane will:

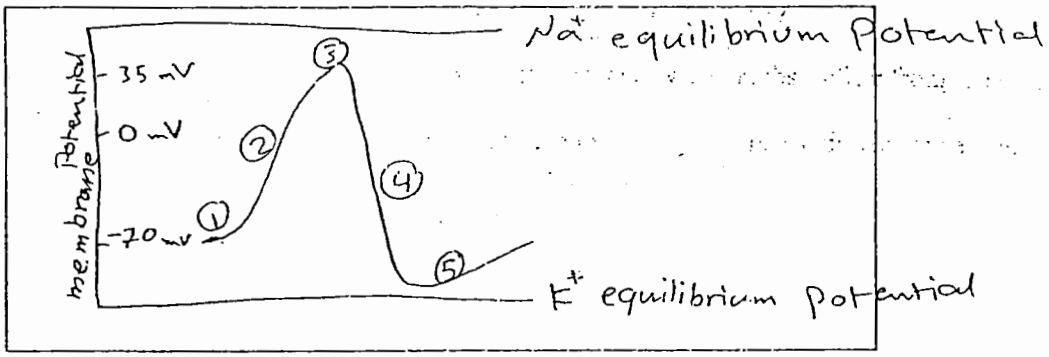
a. double
b. triple
c. be unchanged
d. decrease to one half
e. decrease to one third

A muscle cell has an intracellular [Na^+] of 14 mM and an extracellular [Na^+] of 140 mM. Assuming that 2.3 RT/F = 60 mV, what would the membrane potential be if the muscle cell membrane were permeable only to Na^+ ?

$E_m = 60 \log \frac{[K]_i}{[K]_o}$

a. 80 mV
b. – 60 mV
c. 0 mV
d. + 60 mV
e. + 80 mV

Answer the following 3 questions according to the diagram below:



At which labeled point on the action potential is the K+ closest to electrochemical equilibrium?

a. 1
b. 2
c. 3
d. 4
e. 5

What process is responsible for the change in membrane potential that occurs between point 1 and point 3?

a. movement of Na^+ into the cell
b. movement of Na^+ out of the cell
c. movement of K^+ into the cell
d. movement of K^+ out of the cell
e. activation of Na^+ - K^+ pump
f. inhibition of Na^+ - K^+ pump

What process is responsible for the change in membrane potential that occurs between point 3 and point 4?

a. movement of Na^+ into the cell
b. movement of Na^+ out of the cell
c. movement of K^+ into the cell
d. movement of K^+ out of the cell
e. activation of Na^+ - K^+ pump
f. inhibition of Na^+ - K^+ pump

The rate of conduction of action potential will be increased by :

a. stimulating the Na^+ - K^+ pump
b. inhibiting the N^+ - K^+ pimp
c. decreasing the diameter of the nerve
d. myelinating the nerve
e. lengthing the nerve fiber

Solution A and B are separated by a semipermeable membrane. Solution A contains 1 mM sucrose and 1 mM urea. Solution B contains 1 mM sucrose. The reflection coefficient for sucrose is 1 and the reflection coefficient for urea is zero. Which of the following statements about these solutions is correct?

a. solution A has a higher effective osmotic pressure than solution B
b. solution A has a lower effective osmotic pressure than solution B
c. solution A and B are isosmotic
d. solution A is hyperosmotic with respect to solution B. and the solutions are isotonic
e. solution A is hyposmotic with respect to solution S . And the solutions are isotonic

Transport of D- and L- glucose proceeds at the same rate down an electrochemical gradient by which of the following process?

a. simple diffusion
b. facilitated diffusion
c. primary active transport
d. cotransport
e. counter transport

The permeability of a solute in lipid bilayer will be increased by the increase of:

a. molecular radius of the solute
b. oil/water partition coefficient of the solute
c. thickness of the bilayer
d. concentration difference of the solute across the bilayer

A drug completely blocks Na^+ channels in nerves. Which of the following effects on the action potential would it be expected to produce?

a. block the occurrence of action potential
b. increase the rate of rise of the upstroke of the action potential
c. shortens the absolute refractory period
d. abolish the hyperpolerization after potential
e. increase the Na^+ equilibrium potential

At the muscle end plate, Ach causes the opening of:

a. Na^+ channels and depolerization toward the Na^+ equilibrium potential
b. K^+ channels and depolerization toward the K^+ equilibrium potential
c. Ca^{+2} channels and depolerization toward the Ca^{+2} equilibrium potential
d. Na^+ and K^+ channels and hyperpolerization to a value halfway between the Na^+ and K^+ equilibrium potentials
e. Na^+ and K^+ channels and depolarization to a value halfway between the Na^+ and K^+ equilibrium potentials

An inhibitory post synaptic potential:

a. depolarizes the postsynaptic membrane by opening Na^+ channels
b. depolarizes the post postsynaptic membrane by opening K^+ channels
c. hyperpolerizes the postsynaptic membrane by opening Ca^{+2} channels
d. hyperpolarizes the postsynaptic membrane by opening Cl^- channels

Which of the following would occur as a result of the inhibition of Na^+,K^+ ATPase?

a. decrease intracellular Na^+ concentration
b. increase intracellular K^+ concentration
c. increase intracellular Ca^{+2} concentration
d. increase Na^+-glucose cotransport
e. increased Na^+ - Ca^{+2} exchange

Which of the following temporal sequences is correct for excitation-contraction coupling in skeletal muscles?

a. increased intracellular [Ca^{+2}]; action potential; cross bridge formation
b. action potential in the muscle membrane; depolarization; depolarization of the T-tubules; release of Ca^{+2} from the sacroplasmic reticulum
c. action potential in the muscle membrane; depilerization of the T tubules; release of Ca^{+2} from the sacroplasmic reticulum
d. release of Ca^{+2} from the SR; depolarization of the T tubules; bindinf of Ca^{+2} to troponin C

Which of the following transport processes is involved if transport of glucose from the intestinal lumen into a small intestinal cell is inhibited by abolishing the usual Na^+ gradient across the cell membrane?

a. simple diffusin
b. facilitated diffusion
c. primary active transport
d. cotransport
e. countertransport

Which of the following events occurs before depolarization of the T tubules in skeletal muscle in the mechanism of excitation-contraction coupling

a. depoerization of the sacrolemma membrane
b. opening of the Ca^{+2} release channels on the sacroplasmic reticulum
c. uptake of Ca^{+2} into the sacroplasmic reticulum by Ca^{+2} ATPase
d. binding of Ca^{+2} to troponin C
e. binding of actin and myosin

Which of the following is an inhibitory neurotransmitter in the central nervous system?

a. Norepinephrine
b. Glutamate
c. GABA
d. Serotonin
e. Histamine

ATP is used indirectly in which of the following processes?

a. Accumulation of Ca^{+2} by the sacroplasmic reticulum
b. Transport of sodium from intracellular to extracellular fluid
c. Transport of K^+ from the extracellular to intracellular fluid
d. Transport of hydrogen from parietal cells into the lumen of the stomach
e. Absorption of glucose by intestinal epithelial cells

Assuming complete dissociation of all solutes, which of the following solutions would be hyperosmotic to 1 mM NaCl?

a. 1 mM glucose
b. 1.5 mM glucose
c. 1 mM $CaCl_2$
d. 1 mM sucrose
e. 1 mM KCl

Secretion of H+ by gastric parietal cell occurs by which of the following processes?

a. simple diffusion
b. facilitated diffusion
c. primary active transport
d. cotransport
e. countertransport

Which of the following causes rigor mortis?

a. no action potentials in motoneurons
b. an increase in intercellular Ca+2 level
c. a decrease in Ca+2 levels
d. an decrease in ATP level

At which site the systolic blood pressure is the highest?

a. aorta
b. central vein
c. pulmonary artery
d. right atrium
e. renal artery
f. renal vein

A person ECG has no p waves, but has normal QRS complex and normal T wave. There fore, his pacemaker is located in the :

a. SA node
b. AV node
c. bundle of his
d. purkinje system

An increase in contractility is demonstrated on frank starling diagram by:

a. increase cardiac output for a given end diastolic volume
b. increase cardiac output for a given end systolic volume
c. decrease cardiac output for a given end diastolic volume
d. decrease cardiac output for a given end systolic volume

In a capillary Pc is 30 mmHg, Pi is -2 mmHg, $\prod c$ is 25 mmHg, and $\prod i$ is 2 mmHg What is the direction of fluid movement and the net driving force?

a. absorption 6 mmHg
b. absorption 9 mmHg
c. filtration 6 mmHg
d. filtration 9 mmHg
e. there is no net fluid movement

In the previous question, if K_f is 0.5 ml/min/mmHg. What is the rate of water flow across the capillary wall?

a. 0.06
b. 0.45
c. 4.5
d. 9.00
e. 18.00

An acute decrease in arterial blood pressure elicits which of the following compensatory changes:

a. Decrease firing rate from the carotid sinus nerve
b. Increased parasympathetic outflow to the heart
c. Decrease heart rate
d. Decrease contractility
e. Decrease mean systolic pressure

The tendency for edema to occur will be increased by:

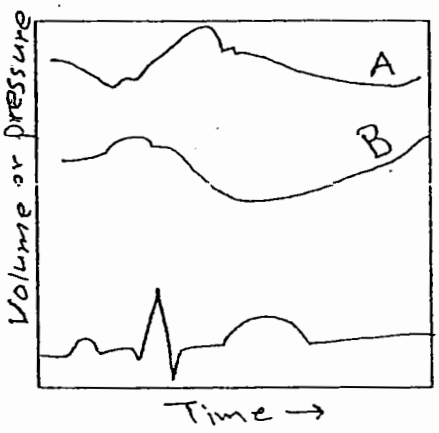
a. Arteriolar constriction
b. Increased venous pressure
c. Increased plasma protein concentration
d. Muscular activity

Curve A in the figure represents:

a. Aortic pressure
b. Ventricular pressure
c. Atrial pressure
d. Ventricular volume

Curve B in the figure represents:

a. left atrial pressure
b. ventricular pressure
c. atrial pressure
d. ventricular volume



Which of the following is the result of an inward Na+ current?

a. upstroke of the action potential in the SA node
b. upstroke of the action potential in the purkenji fibers
c. plateau of the action potential in the ventricular muscle
d. repolerization of the action potential on ventricular muscle
e. repolerization of the action potential in the SA node

In the SA node, phase 4 depolerization (pacemaker potential) is attributable to:

a. an increase in K+ conductance
b. an increase in Na+ conductance
c. a decrease in Cl- conductance
d. a decrease in Ca+2 conductance
e. simultaneous increase in K+ and Cl- conductance

During which phase of cardiac cycle is the aortic pressure highest (very difficult one):

a. atrial systole
b. isovolumetric ventricular contraction
c. rapid ventricular ejection
d. isovolumetric ventricular relaxation
e. rapid ventricular filling
f. reduced ventricular filling

Myocardial contractility is best correlated with the intercellular concentration of:

a. Na+
b. K+
c. Ca+2
d. Mg+2

Carbon dioxide CO2 regulates the blood flow to:

a. heart
b. skin
c. brain
d. skeletal muscles

The physiological function of the delay of conduction in the AV node is to allow sufficient time for:

a. runoff blood from the aorta to the arteries
b. venous return to the atria
c. filling of the ventricles
d. contraction of the ventricles
e. repolerization of the ventricles

Which of the following substances cosses the capillary walls primarily through water filled clefts between the endothelial cells?

a. O2
b. CO2
c. CO
d. Glucose

During which phase of the ventricular action potential is the membrane potential closest to the K+ equilibrium potential?

a. phase 0
b. phase 1
c. phase 2
d. phase 3
e. phase 4

During which phase of the ventricular action potential is the conductance to Ca+2 is the highest?

a. phase 0
b. phase 1
c. phase 2
d. phase 3
e. phase 4

Which phase of the ventricular action potential coincides with diastole?

a. phase 0
b. phase 1
c. phase 2
d. phase 3
e. phase 4

The low resistant pathways between myocardial cells that allow for the spread of action potentials are the:

a. gap junctions
b. T tubules
c. Sacroplasmic reticulum
d. Intercalated discs
e. Mitochondria

Which agent is released after hemorrhage and causes an increase in renal Na+ reabsorption:

a. Aldosterone
b. Angiotensin I
c. Angiotensin II
d. ADH
e. Atrial natriuretic peptide

Subjects A and B are 70 Kg men. Subject A drinks 2 Liters of distilled water, and subject B drinks 2 liters of isotonic NaCl. Subject B will have:

a. greater change in intracellular fluid volume
b. higher positive free water clearance
c. greater change in plasma osmolariy
d. higher urine osmolarity
e. higher urine flow rate

One gram of mannitol was injected in a woman. After equilibration, a plasma sample had a mannitol concentration of 0.08 g/L. during the equilibration period 20% of the injected mannitol was excreted in urine. The subject's:

a. ECF volume is 1 L
b. ICF volume is 1 L
c. ECF volume is 10 L
d. ICF volume is 10 L
e. Interstitial volume is 12.5

Which of the following substances or combinations could be used to measure the interstitial fluid volume?

a. manitol
b. D2O
c. Evans blue
d. Inulin and D2O
e. inulin and radioactive albumin

Compared with a person who ingests 2 L of distilled water, a person with water deprivation will have:

a. higher free water clearance
b. lower plasma osmolarity
c. lower level of ADH
d. higher rate of water reabsorption from the collecting ducts

Which of the following ions has a higher concentration in the ICF than ECF ?

a. Na+
b. K+
c. Cl-
d. HCO3
e. Ca+2

A woman runs a marathon in 90°F weather and replaces all volume lost in sweat by drinking distilled water. After the marathon she will have:

a. decrease total body water
b. decrease hematocrit
c. decrease ICF volume
d. decreased plasma osmolarity
e. increased intracellular osmolarity

REVIEW TEST of costanzo

1. Which of the following characteristics is shared by simple and facilitated diffusion of glucose?

(A) Occurs down an electrochemical gradient
(B) Is saturable
(C) Requires metabolic energy
(D) Is inhibited by the presence of galactose
(E) Requires a Na^+ gradient

2. During the upstroke of the action potential

(A) there is net outward current and the cell interior becomes more negative
(B) there is net outward current and the cell interior becomes less negative
(C) there is net inward current and the cell interior becomes more negative
(D) there is net inward current and the cell interior becomes less negative

3. Solutions A and B are separated by a semipermeable membrane that is permeable to K^+, but not to Cl^-. Solution A is 100 mM KCl, and solution B is 1 mM KCl. Which of the following statements about solution A and solution B is true?

(A) K^+ ions will diffuse from solution A to solution B until the $[K^+]$ of both solutions is 50.5 mM
(B) K^+ ions will diffuse from solution B to solution A until the $[K^+]$ of both solutions is 50.5 mM
(C) KCl will diffuse from solution A to solution B until the [KCl] of both solutions is 50.5 mM
(D) K^+ will diffuse from solution A to solution B until a membrane potential develops with solution A negative with respect to solution B
(E) K^+ will diffuse from solution A to solution B until a membrane potential develops with solution A positive with respect to solution B

4. The correct temporal sequence for events at the neuromuscular junction is

(A) action potential in the motor nerve; depolarization of the muscle end plate; uptake of Ca^{2+} into the presynaptic nerve terminal
(B) uptake of Ca^{2+} into the presynaptic terminal; release of acetylcholine (ACh); depolarization of the muscle end plate
(C) release of ACh; action potential in the motor nerve; action potential in the muscle
(D) uptake of Ca^{2+} into the motor end plate; action potential in the motor end plate; action potential in the muscle
(E) release of ACh; action potential in the muscle end plate; action potential in the muscle

5. Which characteristic or component is shared by skeletal muscle and smooth muscle?

(A) Thick and thin filaments arranged in sarcomeres
(B) Troponin
(C) Elevation of intracellular $[Ca^{2+}]$ for excitation–contraction coupling
(D) Spontaneous depolarization of the membrane potential
(E) High degree of electrical coupling between cells

6. Repeated stimulation of a skeletal muscle fiber causes a sustained contraction (tetanus). Accumulation of which solute in intracellular fluid is responsible for the tetanus?

(A) Na^+
(B) K^+
(C) Cl^-
(D) Mg^{2+}
(E) Ca^{2+}
(F) Troponin
(G) Calmodulin
(H) Adenosine triphosphate (ATP)

7. Solutions A and B are separated by a membrane that is permeable to Ca^{2+} and impermeable to Cl^-. Solution A contains 10 mM $CaCl_2$, and solution B contains 1 mM $CaCl_2$. Assuming that 2.3 RT/F = 60 mV, Ca^{2+} will be at electrochemical equilibrium when

(A) solution A is +60 mV
(B) solution A is +30 mV
(C) solution A is –60 mV
(D) solution A is –30 mV
(E) solution A is +120 mV
(F) solution A is –120 mV
(G) the Ca^{2+} concentrations of the two solutions are equal
(H) the Cl^- concentrations of the two solutions are equal

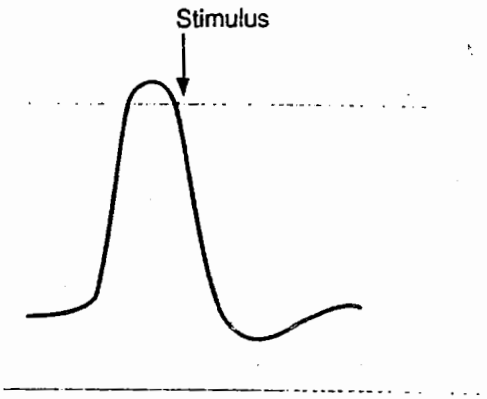
8. A person with myasthenia gravis notes increased muscle strength when he is treated with an acetylcholinesterase (AChE) inhibitor. The basis for his improvement is increased

(A) amount of acetylcholine (ACh) released from motor nerves
(B) levels of ACh at the muscle end plates
(C) number of ACh receptors on the muscle end plates
(D) amount of norepinephrine released from motor nerves
(E) synthesis of norepinephrine in motor nerves

9. In error, a patient is infused with large volumes of a solution that causes lysis of his red blood cells (RBCs). The solution was most likely

(A) isotonic NaCl
(B) isotonic mannitol
(C) hypertonic mannitol
(D) hypotonic urea
(E) hypertonic urea

10. During a nerve action potential, a stimulus is delivered as indicated by the arrow shown in the following figure. In response to the stimulus, a second action potential



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(D) will occur, but will not have an overshoot
(E) will not occur

11. Solutions A and B are separated by a membrane that is permeable to urea. Solution A is 10 mM urea, and solution B is 5 mM urea. If the concentration of urea in solution A is doubled, the flux of urea across the membrane will

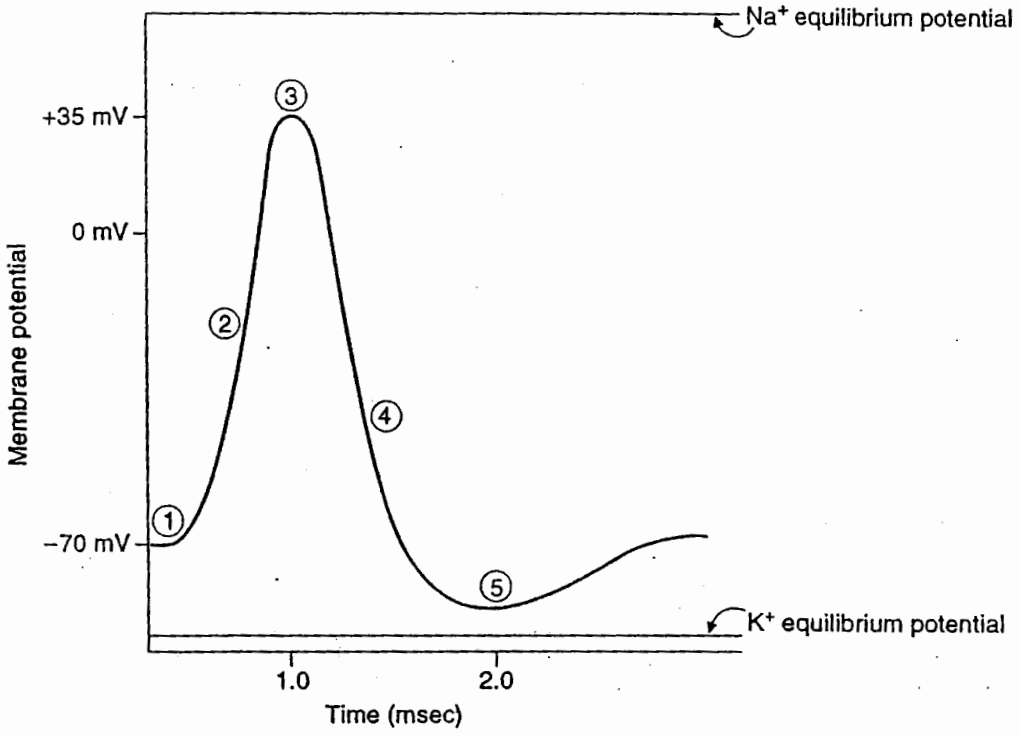
(A) double
(B) triple
(C) be unchanged
(D) decrease to one-half
(E) decrease to one-third

12. A muscle cell has an intracellular $[Na^+]$ of 14 mM and an extracellular $[Na^+]$ of 140 mM. Assuming that 2.3 RT/F = 60 mV, what would the membrane potential be if the muscle cell membrane were permeable only to Na^+?

(A) 80 mV
(B) –60 mV
(C) 0 mV
(D) +60 mV
(E) +80 mV

Questions 13–15

The following diagram of a nerve action potential applies to Questions 13–15.



13. At which labeled point on the action potential is the K^+ closest to electrochemical equilibrium?

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

14. What process is responsible for the change in membrane potential that occurs between point 1 and point 3?

(A) Movement of Na^+ into the cell
(B) Movement of Na^+ out of the cell
(C) Movement of K^+ into the cell
(D) Movement of K^+ out of the cell
(E) Activation of the Na^+–K^+ pump
(F) Inhibition of the Na^+–K^+ pump

15. What process is responsible for the change in membrane potential that occurs between point 3 and point 4?

(A) Movement of Na^+ into the cell
(B) Movement of Na^+ out of the cell
(C) Movement of K^+ into the cell
(D) Movement of K^+ out of the cell
(E) Activation of the Na^+–K^+ pump
(F) Inhibition of the Na^+–K^+ pump

16. The rate of conduction of action potentials along a nerve will be increased by

(A) stimulating the Na^+–K^+ pump
(B) inhibiting the Na^+–K^+ pump
(C) decreasing the diameter of the nerve
(D) myelinating the nerve
(E) lengthening the nerve fiber

17. Solutions A and B are separated by a semipermeable membrane. Solution A contains 1 mM sucrose and 1 mM urea. Solution B contains 1 mM sucrose. The reflection coefficient for sucrose is one and the reflection coefficient for urea is zero. Which of the following statements about these solutions is correct?

(A) Solution A has a higher effective osmotic pressure than solution B
(B) Solution A has a lower effective osmotic pressure than solution B
(C) Solutions A and B are isosmotic
(D) Solution A is hyperosmotic with respect to solution B, and the solutions are isotonic
(E) Solution A is hyposmotic with respect to solution B, and the solutions are isotonic

18. Transport of D- and L-glucose proceeds at the same rate down an electrochemical gradient by which of the following processes?

(A) Simple diffusion
(B) Facilitated diffusion
(C) Primary active transport
(D) Cotransport
(E) Countertransport

19. The permeability of a solute in a lipid bilayer will be increased by an increase in the

(A) molecular radius of the solute
(B) oil/water partition coefficient of the solute
(C) thickness of the bilayer
(D) concentration difference of the solute across the bilayer

20. A drug completely blocks Na^+ channels in nerves. Which of the following effects on the action potential would it be expected to produce?

(A) Block the occurrence of action potentials
(B) Increase the rate of rise of the upstroke of the action potential
(C) Shorten the absolute refractory period
(D) Abolish the hyperpolarizing afterpotential
(E) Increase the Na^+ equilibrium potential
(F) Decrease the Na^+ equilibrium potential

21. At the muscle end plate, acetylcholine (ACh) causes the opening of

(A) Na^+ channels and depolarization toward the Na^+ equilibrium potential
(B) K^+ channels and depolarization toward the K^+ equilibrium potential
(C) Ca^{2+} channels and depolarization toward the Ca^{2+} equilibrium potential
(D) Na^+ and K^+ channels and depolarization to a value halfway between the Na^+ and K^+ equilibrium potentials
(E) Na^+ and K^+ channels and hyperpolarization to a value halfway between

22. An inhibitory postsynaptic potential

(A) depolarizes the postsynaptic membrane by opening Na^+ channels
(B) depolarizes the postsynaptic membrane by opening K^+ channels
(C) hyperpolarizes the postsynaptic membrane by opening Ca^{2+} channels
(D) hyperpolarizes the postsynaptic membrane by opening Cl^- channels

23. Which of the following would occur as a result of the inhibition of Na^+,K^+-ATPase?

(A) Decreased intracellular Na^+ concentration
(B) Increased intracellular K^+ concentration
(C) Increased intracellular Ca^{2+} concentration
(D) Increased Na^+–glucose cotransport
(E) Increased Na^+–Ca^{2+} exchange

24. Which of the following temporal sequences is correct for excitation–contraction coupling in skeletal muscle?

(A) Increased intracellular $[Ca^{2+}]$; action potential in the muscle membrane; cross-bridge formation
(B) Action potential in the muscle membrane; depolarization of the T tubules; release of Ca^{2+} from the sarcoplasmic reticulum (SR)
(C) Action potential in the muscle membrane; splitting of adenosine triphosphate (ATP); binding of Ca^{2+} to troponin C
(D) Release of Ca^{2+} from the SR; depolarization of the T tubules; binding of Ca^{2+} to troponin C

25. Which of the following transport processes is involved if transport of glucose from the intestinal lumen into a small intestinal cell is inhibited by abolishing the usual Na^+ gradient across the cell membrane?

(A) Simple diffusion
(B) Facilitated diffusion
(C) Primary active transport
(D) Cotransport

26. In skeletal muscle, which of the following events occurs before depolarization of the T tubules in the mechanism of excitation–contraction coupling?

(A) Depolarization of the sarcolemmal membrane
(B) Opening of Ca^{2+} release channels on the sarcoplasmic reticulum (SR)
(C) Uptake of Ca^{2+} into the SR by Ca^{2+}-adenosine triphosphatase (ATPase)
(D) Binding of Ca^{2+} to troponin C
(E) Binding of actin and myosin

27. Which of the following is an inhibitory neurotransmitter in the central nervous system (CNS)?

(A) Norepinephrine
(B) Glutamate
(C) γ-aminobutyric acid (GABA)
(D) Serotonin
(E) Histamine

28. Adenosine triphosphate (ATP) is used indirectly for which of the following processes?

(A) Accumulation of Ca^{2+} by the sarcoplasmic reticulum (SR)
(B) Transport of Na^+ from intracellular to extracellular fluid
(C) Transport of K^+ from extracellular to intracellular fluid
(D) Transport of H^+ from parietal cells into the lumen of the stomach
(E) Absorption of glucose by intestinal epithelial cells

29. Which of the following causes rigor in skeletal muscle?

(A) No action potentials in motoneurons
(B) An increase in intracellular Ca^{2+} level
(C) A decrease in intracellular Ca^{2+} level
(D) An increase in adenosine triphosphate (ATP) level
(E) A decrease in ATP level

30. Degeneration of dopaminergic neurons has been implicated in

(A) schizophrenia
(B) Parkinson's disease
(C) myasthenia gravis
(D) curare poisoning

31. Assuming complete dissociation of all solutes, which of the following solutions would be hyperosmotic to 1 mM NaCl?

(A) 1 mM glucose
(B) 1.5 mM glucose
(C) 1 mM $CaCl_2$
(D) 1 mM sucrose
(E) 1 mM KCl

32. Secretion of H^+ by gastric parietal cells occurs by which of the following processes?

(A) Simple diffusion
(B) Facilitated diffusion
(C) Primary active transport
(D) Cotransport
(E) Countertransport

33. A woman with severe muscle weakness is hospitalized. The only abnormality in her laboratory values is an elevated serum K^+ concentration. The elevated serum K^+ causes muscle weakness because

(A) the resting membrane potential is hyperpolarized
(B) the K^+ equilibrium potential is hyperpolarized
(C) the Na^+ equilibrium potential is hyperpolarized
(D) K^+ channels are closed by depolarization
(E) K^+ channels are opened by depolarization
(F) Na^+ channels are closed by depolarization
(G) Na^+ channels are opened by depolarization

ANSWERS AND EXPLANATIONS

1. The answer is A [II A 1, C]. Both types of transport occur down an electrochemical gradient ("downhill"), and do not require metabolic energy. Saturability and inhibition by other sugars are characteristic only of carrier-mediated glucose transport; thus, facilitated diffusion is saturable and inhibited by galactose, whereas simple diffusion is not.

2. The answer is D [IV D 1 a, b, 2 b]. During the upstroke of the action potential, the cell depolarizes, or becomes less negative. The depolarization is caused by inward current, which is, by definition, the movement of positive charge into the cell. In nerve and in most types of muscle, this inward current is carried by Na^+.

3. The answer is D [IV B]. Because the membrane is permeable only to K^+ ions, K^+ will diffuse down its concentration gradient from solution A to solution B, leaving some Cl^- ions behind in solution A. A diffusion potential will be created, with solution A negative with respect to solution B. Generation of a diffusion potential involves movement of only a few ions and, therefore, does not cause a change in the concentration of the bulk solutions.

4. The answer is B [V B 1–6]. Acetylcholine (ACh) is stored in vesicles and is released when an action potential in the motor nerve opens Ca^{2+} channels in the presynaptic terminal. ACh diffuses across the synaptic cleft and opens Na^+ and K^+ channels in the muscle end plate, depolarizing it (but not producing an action potential). Depolarization of the muscle end plate causes local currents in adjacent muscle membrane, depolarizing the membrane to threshold and producing action potentials.

5. The answer is C [VI A, B 1–4; VII B 1–4]. An elevation of intracellular $[Ca^{2+}]$ is common to the mechanism of excitation–contraction coupling in skeletal and smooth muscle. In skeletal muscle, Ca^{2+} binds to troponin C, initiating the cross-bridge cycle. In smooth muscle, Ca^{2+} binds to calmodulin. The Ca^{2+}–calmodulin complex activates myosin light-chain kinase, which phosphorylates myosin so that shortening can occur. The striated appearance of the sarcomeres and the presence of troponin are characteristic of skeletal, not smooth, muscle. Spontaneous depolarizations and gap junctions are characteristics of unitary smooth muscle but not skeletal muscle.

6. The answer is E [VI B 6]. During repeated stimulation of a muscle fiber, Ca^{2+} is released from the sarcoplasmic reticulum (SR) more quickly than it can be reaccumulated; therefore, the intracellular $[Ca^{2+}]$ does not return to resting levels as it would after a single twitch. The increased $[Ca^{2+}]$ allows more cross-bridges to form and, therefore, produces increased tension (tetanus). Intracellular Na^+ and K^+ concentrations do not change during the action potential. Very few Na^+ or K^+ ions move into or out of the muscle cell, so bulk concentrations are unaffected. Adenosine triphosphate (ATP) levels would, if anything, decrease during tetanus.

7. The answer is D [IV B]. The membrane is permeable to Ca^{2+}, but impermeable to Cl^-. Although there is a concentration gradient across the membrane for both ions, only Ca^{2+} can diffuse down this gradient. Ca^{2+} will diffuse from solution A to solution B, leaving negative charge behind in solution A. The magnitude of this voltage can be calculated for electrochemical equilibrium with the Nernst equation as follows: $E_{Ca^{2+}} = 2.3\ RT/zF \log C_A/C_B = 60\ mV/+2 \log 10\ mM/1\ mM = 30\ mV \log 10 = 30\ mV$. The sign is determined

develops a negative voltage (–30 mV). Net diffusion of Ca^{2+} will cease when this voltage is achieved, that is, when the chemical driving force is exactly balanced by the electrical driving force (not when the Ca^{2+} concentrations of the solutions become equal).

8. **The answer is B** [V B 8]. Myasthenia gravis is characterized by a decreased density of acetylcholine (ACh) receptors at the muscle end plate. An acetylcholinesterase (AChE) inhibitor blocks degradation of ACh in the neuromuscular junction, so levels at the muscle end plate remain high, partially compensating for the deficiency of receptors.

9. **The answer is D** [III B 2 d]. Lysis of the patient's red blood cells (RBCs) was caused by entry of water and swelling of the cells to the point of rupture. Water would flow into the RBCs if the extracellular fluid became hypotonic (had a lower osmotic pressure) relative to the intracellular fluid—hypotonic urea. By definition, isotonic solutions do not cause water to flow into or out of cells because the osmotic pressure is the same on both sides of the cell membrane. Hypertonic mannitol would cause shrinkage of the RBCs.

10. **The answer is E** [IV D 3 a]. Because the stimulus was delivered during the absolute refractory period, no action potential occurs. The inactivation gates of the Na^+ channel were closed by depolarization and remain closed until the membrane is repolarized. As long as the inactivation gates are closed, the Na^+ channels cannot be opened to allow for another action potential.

11. **The answer is B** [II A]. Flux is proportional to the concentration difference across the membrane, $J = -PA (C_A - C_B)$. Originally, $C_A - C_B = 10\ mM - 5\ mM = 5\ mM$. When the urea concentration was doubled in solution A, the concentration difference became 20 mM – 5 mM = 15 mM, or three times the original difference. Therefore, the flux would also triple. Note that the negative sign preceding the equation is ignored if the lower concentration is subtracted from the higher concentration.

12. **The answer is D** [IV B 3 a, b]. The Nernst equation is used to calculate the equilibrium potential for a single ion. In applying the Nernst equation, we assume that the membrane is freely permeable to that ion alone. $E_{Na^+} = 2.3\ RT/zF \log C_e/C_i = 60\ mV \log 140/14 = 60\ mV \log 10 = 60\ mV$. Notice that the signs were ignored and that the higher concentration was simply placed in the numerator to simplify the log calculation. To determine whether E_{Na+} is +60 mV or –60 mV, use the intuitive approach—Na^+ will diffuse from extracellular to intracellular fluid down its concentration gradient, making the cell interior positive.

13. **The answer is E** [IV D 2 d]. The hyperpolarizing afterpotential represents the period during which K^+ permeability is highest, and the membrane potential is closest to the K^+ equilibrium potential. At that point, K^+ is closest to electrochemical equilibrium. The force driving K^+ movement out of the cell down its chemical gradient is balanced by the force driving K^+ into the cell down its electrical gradient.

14. **The answer is A** [IV D 2 b (1)–(3)]. The upstroke of the nerve action potential is caused by opening of the Na^+ channels (once the membrane is depolarized to threshold). When the Na^+ channels open, Na^+ moves into the cell down its electrochemical gradient, driving the membrane potential toward the Na^+ equilibrium potential.

15. **The answer is D** [IV D 2 c]. The process responsible for repolarization is the opening of K^+ channels. The K^+ permeability becomes very high and drives the membrane potential toward the K^+ equilibrium potential by flow of K^+ out of the cell.

16. **The answer is D** [IV D 4 b]. Myelin insulates the nerve, thereby increasing conduction velocity; action potentials can be generated only at the nodes of Ranvier, where there are breaks in the insulation. Activity of the Na^+–K^+ pump does not directly affect the formation or conduction of action potentials. Decreasing nerve diameter would increase internal resistance and, therefore, slow the conduction velocity.

17. **The answer is D** [III A, B 4]. Solution A contains both sucrose and urea at concentrations of 1 mM, whereas solution B contains only sucrose at a concentration of 1 mM. The calculated osmolarity of solution A is 2 mOsm/L, and the calculated osmolarity of solution B is 1 mOsm/L. Therefore, solution A, which has a higher osmolarity, is hyperosmotic with respect to solution B. Actually, solutions A and B have the same effective osmotic pressure (i.e., they are isotonic) because the only "effective" solute is sucrose, which has the same concentration in both solutions. Urea is not an effective solute because its reflection coefficient is zero.

18. **The answer is A** [II A 1, C 1]. Only two types of transport occur "downhill"—simple and facilitated diffusion. If there is no stereospecificity for the D- or L-isomer, one can conclude that the transport is not carrier-mediated and, therefore, must be simple diffusion.

19. **The answer is B** [II A 4 a–c]. Increasing oil/water partition coefficient increases solubility in a lipid bilayer and therefore increases permeability. Increasing molecular radius and increased membrane thickness decrease permeability. The concentration difference of the solute has no effect on permeability.

20. **The answer is A** [IV D 2 b (2), (3), d, 3 a]. Complete blockade of the Na^+ channels would prevent action potentials. The upstroke of the action potential depends on the entry of Na^+ into the cell through these channels and therefore would also be abolished. The absolute refractory period would be lengthened because it is based on the availability of the Na^+ channels. The hyperpolarizing afterpotential is related to increased K^+ permeability. The Na^+ equilibrium potential is calculated from the Nernst equation and is the theoretical potential at electrochemical equilibrium (and does not depend on whether the Na^+ channels are open or closed).

21. **The answer is D** [V B 5]. Binding of acetylcholine (ACh) to receptors in the muscle end plate opens channels that allow passage of both Na^+ and K^+ ions. Na^+ ions will flow into the cell down its electrochemical gradient, and K^+ ions will flow out of the cell down its electrochemical gradient. The resulting membrane potential will be depolarized to a value that is approximately halfway between their respective equilibrium potentials.

22. **The answer is D** [V C 2 b]. An inhibitory postsynaptic potential hyperpolarizes the postsynaptic membrane, taking it farther from threshold. Opening Cl^- channels would hyperpolarize the postsynaptic membrane by driving the membrane potential toward the Cl^- equilibrium potential (about –90 mV). Opening Ca^{2+} channels would depolarize the postsynaptic membrane by driving it toward the Ca^{2+} equilibrium potential.

23. **The answer is C** [II D 2 a]. Inhibition of Na^+,K^+-adenosine triphosphatase (ATPase) leads to an increase in intracellular Na^+ concentration. Increased intracellular Na^+ concentration decreases the Na^+ gradient across the cell membrane, thereby inhibiting Na^+–Ca^{2+} exchange and causing an increase in intracellular Ca^{2+} concentration. Increased intracellular Na^+ concentration also inhibits Na^+–glucose cotransport.

24. **The answer is B** [VI B 1–4]. The correct sequence is action potential in the muscle membrane; depolarization of the T tubules; release of Ca^{2+} from the sarcoplasmic reticulum (SR); binding of Ca^{2+} to troponin C; cross-bridge formation; and splitting of adenosine triphosphate (ATP).

25. **The answer is D** [II D 2 a, E 1]. In the "usual" Na^+ gradient, the $[Na^+]$ is higher in extracellular than in intracellular fluid (maintained by the Na^+–K^+ pump). Two forms of transport are energized by this Na^+ gradient—cotransport and countertransport. Because glucose is moving in the same direction as Na^+, one can conclude that it is cotransport.

26. **The answer is A** [VI A 3]. In the mechanism of excitation–contraction coupling, excitation always precedes contraction. Excitation refers to the electrical activation of the muscle cell, which begins with an action potential (depolarization) in the sarcolemmal membrane that spreads to the T tubules. Depolarization of the T tubules then leads to the release of Ca^{2+} from the nearby sarcoplasmic reticulum (SR), followed by an increase in intracellular Ca^{2+} concentration, binding of Ca^{2+} to troponin C, and then contraction.

27. **The answer is C** [V C 2 a–b]. γ-Aminobutyric acid (GABA) is an inhibitory neurotransmitter. Norepinephrine, glutamate, serotonin, and histamine are excitatory neurotransmitters.

28. **The answer is E** [II D 2]. All of the processes listed are examples of primary active transport [and therefore use adenosine triphosphate (ATP) directly], except for absorption of glucose by intestinal epithelial cells, which occurs by secondary active transport (i.e., cotransport). Secondary active transport uses the Na^+ gradient as an energy source and, therefore, uses ATP indirectly (to maintain the Na^+ gradient).

29. **The answer is E** [VI B]. Rigor is a state of permanent contraction that occurs in skeletal muscle when adenosine triphosphate (ATP) levels are depleted. With no ATP bound, myosin remains attached to actin and the cross-bridge cycle cannot continue. If there were no action potentials in motoneurons, the muscle fibers they innervate would not contract at all, since action potentials are required for release of Ca^{2+} from the sarcoplasmic reticulum (SR). When intracellular Ca^{2+} concentration increases, Ca^{2+} binds troponin C, permitting the cross-bridge cycle to occur. Decreases in intracellular Ca^{2+} concentration cause relaxation.

30. **The answer is B** [V C 4 b (3)]. Dopaminergic neurons and D_2 receptors are deficient in people with Parkinson's disease. Schizophrenia involves increased levels of D_2 receptors. Myasthenia gravis and curare poisoning involve the neuromuscular junction, which uses acetylcholine (ACh) as a neurotransmitter.

31. **The answer is C** [III A]. Osmolarity is the concentration of particles (osmolarity = $g \times C$). When two solutions are compared, that with the higher osmolarity is hyper-

osmotic. The 1 mM $CaCl_2$ solution (osmolarity = 3 mOsm/L) is hyperosmotic to 1 mM NaCl (osmolarity = 2 mOsm/L). The 1 mM glucose, 1.5 mM glucose, and 1 mM sucrose solutions are hyposmotic to 1 mM NaCl, whereas 1 mM KCl is isosmotic.

32. The answer is C [II D c]. H^+ secretion by gastric parietal cells occurs by H^+–K^+–adenosine triphosphatase (ATPase), a primary active transporter.

33. The answer is F [IV D 2]. Elevated serum K^+ concentration causes depolarization of the K^+ equilibrium potential, and therefore depolarization of the resting membrane potential in skeletal muscle. Sustained depolarization closes the inactivation gates on Na^+ channels and prevents the occurrence of action potentials in the muscle.