

Cell Physiology Practice Exam September 2007

Please select ONE BEST answer to each of the following questions.

1. A patient presents in your office with an irregular heartbeat. Review of his electrolytes reveals elevated serum potassium (7 mM). You immediately recall what you learned in your first-year physiology course, and conclude that:
 - A) the threshold for action potentials is elevated (harder to cross)
 - B) cell membranes are depolarized
 - C) cardiac action potentials are blocked
 - D) sodium channels are inactivated
 - E) calcium activation gates are maximally open

2. Which of the following will cause a cell to swell?
 - A) Decreasing temperature
 - B) Activation of the Na-K-ATPase pump
 - C) Increasing serum osmotic pressure
 - D) Increasing Na efflux
 - E) All of the above

- 3) In designing a new therapeutic drug, a pharmaceutical chemist is interested in maximizing the diffusion of the drug into cells. Factors she must bear in mind include:
 - A) the area of the membrane through which the drug is absorbed
 - B) the thickness of the membrane
 - C) the diffusibility of the drug across the membrane
 - D) the concentration difference across the membrane
 - E) all of the above

- 4) An elderly patient is brought to the emergency room by his daughter who brings along an empty bottle of digitalis. After stabilizing the patient, thoughts that run through your mind include:
 - A) sodium-potassium-ATPase pumps are likely inhibited
 - B) serum K^+ is likely reduced
 - C) extracellular sodium is increased
 - D) resting membrane potentials are normal
 - E) all of the above

5) Characteristics of the falling phase of the action potential include:

- A) sodium inactivation gates are closing
- B) calcium channels are inactivated
- C) potassium channels are inactivated
- D) sodium activation gates are opening
- E) none of the above

6) During the relative refractory period

- A) sodium activation gates cannot be opened
- B) potassium inactivation gates are closed
- C) a strong stimulus can generate a smaller action potential
- D) sodium inactivation gates are completely closed
- E) none of the above

7) At a Seattle sushi bar you order puffer fish, not knowing that the novice chef did not remove the glands containing tetrodotoxin (a poison that blocks voltage-gated sodium channels). As you begin to feel faint, your last correct thoughts could include:

- A) my nerve membranes are becoming depolarized
- B) potassium channels could compensate for my blocked Na channels
- C) my nerve membranes may no longer conduct action potentials
- D) during my nerve action potentials, inward current would be normal
- E) none of the above

8) A nerve action potential occurs because:

- A) Na influx exceeds K efflux and Cl influx
- B) Voltage gated sodium channels are open
- C) Na inactivation gates are at least partially open
- D) Na moves down its electrical and chemical gradients
- E) All of the above

9) Characteristics of voltage gated sodium channels include:

- A) the inactivation gate closes faster than the activation gate opens
- B) the channel is stabilized by magnesium
- C) in the absence of K the gate will not open
- D) channel open time decreases with increasing temperature
- E) none of the above

10) Nerve conduction velocity will be decreased by:

- A) decreasing axoplasmic resistance
- B) increasing membrane resistance
- C) wrapping the axon in myelin
- D) decreasing axon diameter
- E) none of the above

11) A patient presents with high plasma pH (decreased H⁺ concentration). Consistent with this condition you would expect:

- A) hyperexcitable nerve membranes
- B) sodium channels would be blocked
- C) nerves would no longer conduct action potentials
- D) potassium gates would be closed
- E) all of the above

12) Concerning accommodation in cell membranes:

- A) action potentials are easily elicited
- B) calcium channels are hyperexcitable
- C) it occurs when a stimulus is applied quickly
- D) sodium inactivation gates are closed
- E) none of the above

13) If the heart is exposed to a high concentration of K⁺ (20 mM),

- A) sodium (or calcium) inactivation gates are open
- B) K efflux from cells increases
- C) Membranes are depolarized
- D) The heart beats strongly
- E) All of the above

14) The role of calcium in nerves includes:

- A) It stabilizes Na channels
- B) It readily passes through K channels
- C) If the Ca channel is open, Ca will tend to flow outward
- D) Its channel is rarely found in nerve terminals
- E) None of the above

- 15) A patient with multiple sclerosis has difficulty moving. Underlying explanations include;
- A) nerve membranes are demyelinated
 - B) action potential conduction velocity is decreased
 - C) membrane resistance is decreased
 - D) increasing temperature worsens the problem
 - E) all of the above
- 16) Potential effects of elevated serum calcium include:
- A) seizures
 - B) depolarized membranes
 - C) higher threshold (more difficult to generate action potentials)
 - D) activation of Na-K pumps
 - E) cell swelling
- 17) On a medical mission to Peru, you mistakenly ingest a plant containing a toxin that blocks nerve and muscle chloride channels. You would expect that:
- A) nerve and muscle membranes would become hyperexcitable
 - B) membranes would become depolarized
 - C) sodium channels would become inactivated
 - D) the threshold for generating action potentials would be higher (more difficult to cross)
 - E) none of the above
- 18) Membrane depolarization could be caused by:
- A) poisoning the Na-K ATPase pump
 - B) elevated serum potassium
 - C) increasing the number of Na leakage channels
 - D) decreasing body temperature
 - E) all of the above
- 19) Aminopyridine is an experimental drug for cardiac and other problems that blocks voltage-gated K channels, and is now in clinical trial. The value of this drug could be explained by the fact that:
- A) it reduces repolarization during the falling phase of the action potential
 - B) it hyperpolarizes membranes
 - C) it increases the speed of the rising phase of the action potential
 - D) it accommodates excitable membranes
 - E) all of the above

- 20) Which of the following sensations are mediated by free nerve endings?
- A) Smell
 - B) Taste
 - C) Extreme Heat
 - D) Light
 - E) Vibration
- 21) The intensity of a stimulus is encoded as:
- A) the amplitude of the generator potential
 - B) the amount of transmitter released from a receptor cell on to its primary afferent fiber
 - C) the frequency of action potentials in the primary afferent
 - D) the level of depolarization in the receptor (except for photoreceptors)
 - E) all of the above
- 22) Characteristics of pain receptors include:
- A) They are at the ends of axons that are always myelinated
 - B) They are surrounded by a capsule
 - C) They are associated with a specialized receptor cell
 - D) Activation results in a depolarizing generator potential
 - E) They have voltage sensitive channels
- 23) An example of a fast-adapting receptor is:
- A) pain receptor
 - B) muscle stretch receptor
 - C) Pacinian corpuscle
 - D) Joint position receptor
 - E) None of the above
- 24) Olfactory receptor cells
- A) are part of their primary afferent axons
 - B) are regularly regenerated from stem cells
 - C) all cilia within a single cell have the same receptor type
 - D) have G-proteins that participate in the transduction process
 - E) all of the above

- 25) The sense of taste:
- A) is mediated by receptors on free nerve endings
 - B) always involves G proteins
 - C) is uniquely sensitive to over 1,000 tastants
 - D) requires a specialized taste cell
 - E) all of the above
- 26) Secondary afferent neurons for olfaction:
- A) also receive axon collaterals from taste receptors
 - B) are located in the nasal neuroepithelium
 - C) receive input from only one type of receptor
 - D) are replaced by olfactory stem cells
 - E) none of the above
- 27) A patient presents with a selective loss of sensitivity to high frequency sounds. Possible causes would include:
- A) ear wax in the external ear canal
 - B) loss of hair cells near the basal (oval window) part of the cochlea
 - C) middle ear infection
 - D) ruptured tympanum (ear drum)
 - E) none of the above
- 28) The reason why low frequency sounds cause depolarization of hair cells near the helicotrema is that:
- A) this region of the basilar membrane is short and stiff
 - B) there are fewer hair cells in this region
 - C) this region of the basilar membrane is wider and more compliant
 - D) there are more primary afferent fibers exiting this region
 - E) none of the above
- 29) The function of the middle ear ossicles is:
- A) they amplify the movement of the tympanum
 - B) their main purpose is to separate the tympanum from the round window
 - C) the ossicles are in the internal ear
 - D) they reduce the movement of the basilar membrane
 - E) they produce the endolymph

- 30) The peripheral retina:
- A) has more cones than rods
 - B) is responsible for scotopic vision
 - C) is the point of focus by the lens system
 - D) has receptors that produce generator potentials smaller than those in the fovea
 - E) is especially sensitive to day vision
- 31) When a photon of light is absorbed:
- A) 11-cis retinal is converted to its all-trans form
 - B) Rhodopsin becomes activated rhodopsin
 - C) All-trans retinal migrates to the pigment epithelium
 - D) Vitamin A (all-trans retinol) is required for resynthesis of 11-cis retinal;
 - E) All of the above
- 32) A patient presents with macular degeneration. Observations that are associated with this disease include:
- A) smoking
 - B) complement factor H
 - C) neo-vascularization
 - D) genetic predisposition
 - E) all of the above
- 33) In an electrical synapse:
- A) pre- and post- synaptic proteins called connexins line up and allow passage of current
 - B) postsynaptic receptors must be activated to permit depolarization
 - C) charge movement is slow compared to a chemical synapse
 - D) proteins pass through the pores
 - E) the synaptic cleft is larger than in a chemical synapse
- 34) A patient has a rare and fatal disease in which he does not have voltage gated calcium channels in the nerve terminals of his neuromuscular junctions.
- A) His nerve terminals would not support an action potential
 - B) The used synaptic vesicles could not be recycled
 - C) He would not be able to release neurotransmitter
 - D) The docking proteins would be missing essential sequences
 - E) Neurotransmitter would flood the synapse

- 35) The end-plate potential (EPP) that occurs at the neuromuscular junction:
- A) Is larger than it needs to be to produce the muscle response
 - B) Is caused by the opening of a channel that permits the movement of Na and K through its central pore.
 - C) Produces a depolarization that produces a muscle action potential
 - D) Is blocked by curare, a South American Indian arrow poison
 - E) All of the above
- 36) Miniature end-plate potentials (MEPPs):
- A) are produced in response to nerve stimulation
 - B) can trigger a muscle action potential
 - C) are increased in frequency in high magnesium
 - D) represent the contents of a single vesicle
 - E) are eliminated with anti-cholinesterase drugs
- 37) During botulism poisoning,
- A) the patient may notice increase muscle strength
 - B) respiration is stimulated by the toxin
 - C) the muscles become paralyzed because sodium channels are blocked
 - D) the toxin incapacitates proteins that facilitate exocytosis of vesicles
 - E) the physician's greatest concern is keeping the heart muscle stimulated
- 38) Which of the following is NOT true concerning myasthenia gravis?
- A) It may be treated with immunosuppressive drugs such as prednisone
 - B) Patients tire easily during muscular activity
 - C) Patients release abnormally low amounts of transmitter from their motor nerve terminals
 - D) Acetylcholine esterase inhibitors may be beneficial
 - E) It can be fatal if the respiratory muscles are severely affected
- 39) During an experiment in which motor neurons receive input from antagonistic muscles, it is found that an inhibitory synaptic potential (IPSP) is produced. You conclude that:
- A) calcium channels are being opened in the postsynaptic cell
 - B) sodium channels are opened in the postsynaptic cell
 - C) chloride channels are being opened in the postsynaptic cell
 - D) histamine is being released from the presynaptic terminal
 - E) sodium inactivation is occurring

40) The NMDA receptor:

- A) binds glutamate
- B) allows Na, Ca and K to move through a central pore
- C) is found at some excitatory synapses in the spinal cord
- D) when opened leads to depolarization
- E) all of the above

41) The normal site of initiation of an action potential in a motor neuron is:

- A) a region with a high density of Ca channels
- B) the dendrites
- C) the cell body
- D) the axon terminal
- E) the axon hillock containing the maximum number of voltage gated Na channels

42) Peptide neurotransmitters are synthesized:

- A) in the axon
- B) in the nerve terminal
- C) in the cell body and transported to the terminal
- D) in the dendrite
- E) in the axon hillock

43) What do the receptor potential, EPP, EPSP and IPSP have in common?

- A) They are all caused by the opening of voltage-gated ion channels
- B) They all involve the movement of Na ions
- C) They all cause depolarization
- D) They occur in all nerves
- E) They are graded and local

Key to Cell Physiology Practice exam #1:

- 1) B
- 2) A
- 3) E
- 4) A
- 5) A
- 6) C
- 7) C
- 8) E
- 9) D
- 10) D
- 11) A
- 12) D
- 13) C
- 14) A
- 15) E
- 16) C
- 17) A
- 18) E
- 19) A
- 20) C
- 21) E
- 22) D
- 23) C
- 24) E
- 25) D
- 26) C
- 27) B
- 28) C
- 29) A
- 30) B
- 31) E
- 32) E
- 33) A
- 34) C
- 35) E
- 36) D
- 37) D
- 38) C
- 39) C
- 40) E
- 41) E
- 42) C
- 43) E