

Monday, Dec 13<sup>th</sup>, 2021

Following directions on the mark-sense form, write your **name, and student number** in the blanks and fill in the bubbles. In addition, write your **name** on this exam.

When finished with the test, turn in both the mark-sense form and the exam at the front of the room.

**PLACE ALL ANSWERS ON THE MARK-SENSE FORM**

**MULTIPLE CHOICE: Choose the BEST answer. (2 points each) Correct answers in red.**

1. The major determinant of ECF (extracellular fluid) volume is
  - a) **the amount of Na<sup>+</sup> in the ECF.**
  - b) mean arterial pressure.
  - c) the amount of Na<sup>+</sup> inside cells.
  - d) the amount of protein in the blood.
  - e) the osmolarity of the ECF.
  
2. The renal tubule
  - a) is not a part of the nephron.
  - b) consists of fenestrated capillaries surrounded by podocytes.
  - c) is formed by the vasa recta.
  - d) is lined with uroepithelium.
  - e) **is formed from by a simple epithelium.**
  
3. The amount of a substance excreted in the urine is equal to
  - a) the amount reabsorbed minus the filtered load.
  - b) the filtered load plus the glomerular filtration rate.
  - c) the amount secreted minus the filtered load.
  - d) the filtered load minus the amount secreted plus the amount reabsorbed.
  - e) **the filtered load minus the amount reabsorbed plus the amount secreted.**
  
4. Proteinuria is indicative of damage to the
  - a) uroepithelium.
  - b) loop of Henle.
  - c) **filtration membrane.**
  - d) afferent arteriole.
  - e) collecting duct.

5. Which of the following is true about the glomerular filtration rate (GFR)?
- a) GFR can be measured by determining the clearance of glucose.
  - b) A major determinant of the GFR is the hydrostatic pressure in the glomerular capillaries.**
  - c) GFR typically changes with changes in systemic blood pressure.
  - d) GFR increases in chronic kidney disease.
  - e) Constriction of the efferent arteriole decreases the GFR.
6. Supposing mean arterial pressure decreases from 80 to 60 mmHg. Which of the following happens as a result?
- a) tubuloglomerular feedback increases GFR
  - b) afferent arteriole dilates
  - c) somatic nervous system input to the kidney activates renal autoregulation
  - d) sympathetic nervous system input to the kidney activates constriction of the afferent arteriole**
  - e) regulated water reabsorption by the kidney is inhibited
7. The macula densa
- a) is a sensor that detects changes that result from changes in GFR.**
  - b) is located in the proximal tubule.
  - c) contains cells that secrete renin.
  - d) ALL of the above are true.
  - e) NONE of the above are true.
8. Which of the following is TRUE about SGLT2 inhibitors?
- a) SGLT2 inhibitors reduce hyperglycemia.
  - b) Some SGLT2 inhibitors are approved by the FDA to treat patients with heart failure.
  - c) SGLT2 inhibitors target a protein located in the proximal tubule.
  - d) SGLT2 inhibitors cause glucose excretion in the urine.
  - e) ALL of the above are true.**
9. Transporters with broad specificity (meaning one transporter can transport multiple differing substances) are important for
- a) glomerular filtration.
  - b)  $\text{Na}^+$  reabsorption.
  - c) pH regulation.
  - d) organic molecule secretion.**
  - e) organic molecule reabsorption.
10. Which of the following drugs targets the  $\text{Na}^+/\text{K}^+/\text{2Cl}^-$  cotransporter (NKCC2)?
- a) adrenergic agonist
  - b) adrenergic antagonist
  - c) loop diuretic**
  - d) thiazide diuretic
  - e) SGLT2 inhibitor

11. ALL of the following are properties of the loop of Henle, EXCEPT
- a) ascending limb is impermeable to water
  - b) descending limb is permeable to water
  - c) countercurrent flow between the descending and ascending limbs
  - d) active reabsorption of solute by the descending limb**
  - e) osmolarity in descending limb equilibrates with surrounding interstitial fluid
12. The largest difference in osmolarity occurs between
- a) the ascending limb of the loop of Henle and the descending limb of the loop of Henle.
  - b) the ascending limb of the loop of Henle and the vasa recta.
  - c) the cortex and the papilla.**
  - d) the collecting duct and the loop of Henle.
  - e) the collecting duct and the medullary interstitial fluid.
13. Which of the following describes the effect of vasopressin on the kidney?
- a) increases the number of aquaporins in the collecting duct**
  - b) stimulates expression of epithelial Na<sup>+</sup> channel (ENaC)
  - c) increases water permeability in the loop of Henle
  - d) decreases filtration of water
  - e) decreases activity of the Na<sup>+</sup>/glucose cotransporter
14. Renin secretion is stimulated when
- a) atrial natriuretic peptide secretion is also stimulated.
  - b) there is increased pressure in the afferent arteriole.
  - c) mean arterial pressure increases.
  - d) there is decreased sympathetic nervous system input to the kidney
  - e) there is decreased delivery of Na<sup>+</sup> to the distal tubule.**
15. Which of the following directly affects cells in the cortical collecting duct to increase Na<sup>+</sup> reabsorption?
- a) NKCC2
  - b) aldosterone**
  - c) vasopressin
  - d) angiotensinogen
  - e) angiotensin I
16. In heart failure, low blood flow to the kidney leads to increased renin secretion. Which of the following can occur as a consequence?
- a) decreased blood pressure
  - b) decreased ECF volume
  - c) fluid leaves the circulation and builds up in the tissues (edema)**
  - d) increased Na<sup>+</sup> excretion
  - e) polyuria

17. Which of the following muscles contracts during urination?
- a) the external urethral sphincter
  - b) the detrusor muscle**
  - c) BOTH the external urethral sphincter and the detrusor muscle
18. Vaccines mainly prevent disease because they
- a) stimulate a secondary immune response and development of plasma cells.
  - b) contain antibodies.
  - c) bypass the innate immune response.
  - d) stimulate a primary immune response and development of memory cells.**
  - e) upregulate barrier mechanisms of defense.
19. Which of the following is NOT a phagocyte?
- a) dendritic cell
  - b) cytotoxic T cell**
  - c) neutrophil
  - d) macrophage
  - e) antigen-presenting cell
20. Which of the following best describes complement?
- a) set of inactive precursor proteins secreted by cytotoxic T cells
  - b) when activated, it forms the membrane attack complex**
  - c) set of signaling molecules released by helper T cells that shapes the immune response
  - d) group of factors that reduce inflammation
  - e) is primarily involved in immune tolerance
21. Which of the following is a location where antigen-presenting cells stimulate lymphocytes to cause an adaptive/specific immune response?
- a) mucosa-associated lymphoid tissue (MALT)**
  - b) bone marrow
  - c) thymus
  - d) capillaries of the circulatory system
  - e) connective tissue
22. The specificity of an antibody is determined by its
- a) epitope
  - b) Fc region
  - c) variable region**
  - d) size
  - e) heavy chain

23. Lymphocytes whose receptors bind to self antigens
- a) are called NK cells.
  - b) are eliminated by phagocytes.**
  - c) undergo apoptosis.**
  - d) undergo clonal expansion.
  - e) undergo somatic recombination.
24. What is a B cell receptor?
- a) a secreted molecule that specifically binds to antigens
  - b) an antibody with a transmembrane domain expressed on the surface of a B cell**
  - c) a protein on dendritic cells that binds to molecules expressed on the surface of a B cell
  - d) a generic molecule that presents antigen on the surface of a B cell
  - e) a protein that specifically recognizes a helper T cell
25. A T cell receptor on a helper T cell binds to
- a) the antibody Fc region
  - b) an opsonin
  - c) an intracellular antigen presented on an MHC molecule
  - d) a B cell receptor
  - e) an extracellular antigen presented by an antigen-presenting cell**
26. A cytotoxic T cell recognize a virally infected cell by binding to
- a) antigen that is bound to an antibody.
  - b) antigen that is bound to a B cell receptor.
  - c) cytokines released by the virally infected cell.
  - d) antigen presented on an MHC I molecule.**
  - e) antigen presented on an MHC II molecule.
27. The specific part of an antigen that is recognized by an antibody is called the
- a) clone.
  - b) allergen.
  - c) complement.
  - d) epitope.**
  - e) variable region.
28. Monoclonal antibody drugs
- a) are usually designed to be taken as an oral medication.
  - b) can only be used to treat infectious diseases.
  - c) are large proteins that must be administered by injection or infusion.**
  - d) bind to multiple epitopes on their target proteins.
  - e) mainly work to stimulate T cell responses.

29. Dexamethasone is a glucocorticoid drug that has been shown to improve survival in severely ill patients with COVID-19. What effect do glucocorticoids have on the immune system?
- a) activate complement
  - b) reduce inflammation**
  - c) increase cytokine release
  - d) stimulate proliferation of lymphocytes
  - e) stimulate plasma cells
30. Cytokine signaling can be blocked by drugs that inhibit
- a) the renin-angiotensin-aldosterone system.
  - b) ACE (angiotensin converting enzyme).
  - c) JAK (janus kinase).**
  - d) complement activation.
  - e) adenylyl cyclase.
31. Water
- a) is one the building blocks of the cell membrane.
  - b) is a dynamic network of hydrogen-bonded H<sub>2</sub>O molecules.**
  - c) is a dipole with a uniform distribution of electron density.
  - d) forms covalent bonds with ions in solution.
  - e) is a highly concentrated amphipathic solution.
32. The cell membrane
- a) is freely permeable to anions.
  - b) is a rigid bilayer of pure lipid.
  - c) contains proteins that use ATP to transport H<sub>2</sub>O.
  - d) is a fluid mosaic of phospholipids and proteins.**
  - e) varies in thickness in different kinds of cells.
33. The cell membrane potential
- a) persists in the absence of ion concentration gradients.
  - b) is the consequence of polarized enzymatic activity.
  - c) requires a membrane with selective ion permeability.**
  - d) is generated by osmosis.
  - e) is present in most but not all living cells.

34. Ion channels

- a) **may be opened by a change in temperature.**
- b) are amphipathic lipids with selective ion permeability.
- c) are proteins that are permeable to nonpolar molecules.
- d) function to prevent intercellular communication.
- e) are only active when they are bonded to G-proteins.

35. Electrical signals in cells

- a) are produced by gated lipids.
- b) occur in the absence of changes in membrane voltage.
- c) **ultimately result in changes in intracellular  $\text{Ca}^{2+}$ .**
- d) are always depolarizing.
- e) are always hyperpolarizing.

36. Action potentials

- a) **are all-or-nothing depolarizing voltage changes.**
- b) get smaller and slower as they spread away from their site of generation.
- c) are present in all living cells.
- d) vary in amplitude with the strength of the stimulus that evoked them.
- e) are small amplitude spontaneous changes in resting membrane potential.

37. Intracellular  $\text{Ca}^{2+}$  signals

- a) are the result of changes in the extracellular concentration of  $\text{Ca}^{2+}$ .
- b) block saltatory conduction of the nerve impulse.
- c) can only be produced by ligand gated ion channels.
- d) **may be produced by the release of  $\text{Ca}^{2+}$  from intracellular  $\text{Ca}^{2+}$  stores.**
- e) are produced by  $\text{Na}^+-\text{K}^+$  ATPase.

38. G-proteins

- a) are heterotrimeric membrane receptor proteins that are activated by directly binding an extracellular ligand.
- b) are only functional in the presence of voltage-gated  $\text{Ca}^{2+}$  channels.
- c) are shut off by phospholipase C and  $\text{IP}_3$ .
- d) bind cAMP and dephosphorylate protein kinase.
- e) **are activated when GTP replaces GDP.**

39. Synaptic transmission in the central nervous system
- a) has a high safety factor and always generates an action potential in the postsynaptic cell.
  - b) is triggered by a decrease in intracellular  $\text{Ca}^{2+}$ .
  - c) may be mediated by gap junctions that couple cells electrically and metabolically.**
  - d) is mediated by the graded release of G-protein subunits.
  - e) is blocked by the myelination.
40. Which of the following is key in the triggering of long-term potentiation?
- a) G-protein signal transduction evoked by excitatory synaptic input
  - b) Co-release of GABA and glutamate at an inhibitory synapse
  - c) decreased intracellular  $\text{Ca}^{2+}$  at an excitatory synapse
  - d) stimulation of acetylcholinesterase activity at the neuromuscular junction
  - e) depolarization to allow  $\text{Ca}^{2+}$  entry through NMDA-type glutamate receptors**
41. In the labeled-line model, the function of any one neuron in an afferent pathway is to signal
- a) the transcription of a single gene.
  - b) the onset and offset of all sensations.
  - c) the presence of several different kinds of stimuli.
  - d) the presence of one type of stimulus.**
  - e) different types of action potentials.
42. Sharp, focused pain is transmitted to the central nervous system along
- a) unmyelinated A-delta fibers.
  - b) myelinated A-delta fibers.**
  - c) unmyelinated C-fibers.
  - d) myelinated A-beta fibers.
  - e) myelinated C-fibers
43. The transduction mechanism operating in olfactory sensory neurons is similar to that involved in which of the following types of taste cells?
- a) salty and sour
  - b) salty and bitter
  - c) sweet and salty
  - d) umami and salty
  - e) sweet, umami and bitter**

44. The three ossicles in the middle ear provide a mechanical linkage between
- a) different types of hair cells.
  - b) the basilar membrane and the tectorial membrane.
  - c) the tympanic membrane and the oval window of the cochlea.**
  - d) the helicotrema and the oval window of the cochlea.
  - e) the semicircular canals and the cochlea.
45. The principal function of the vestibulo-ocular reflex is to
- a) help stabilize the visual field when the head is moving.**
  - b) help track slowly moving objects in the visual field.
  - c) override the pupillary light reflex.
  - d) make postural adjustments to the lower body during running.
  - e) ensure that visual tracking is not influenced by ambient sounds.
46. Our capacity to distinguish different colors depends in part on
- a) the existence of different types of cones that express different photopigments.**
  - b) the presence of densely-packed specialized rods.
  - c) the composition of the vitreous humor.
  - d) the size of visual receptive fields.
  - e) the spial photopigments found only in the rods.
47. The formation of crossbridges between the heads of myosin molecules and actin filaments in skeletal muscle fibers depends on all of the following events **except**
- a) calcium release from the sarcoplasmic reticulum.
  - b) serotonin release at the neuromuscular junction**
  - c) binding of calcium to troponin.
  - d) exposure of myosin binding sites on actin
  - e) hydrolysis of ATP.

48. Regardless of the speed of a movement or the amount of force that is required, motor units in the active muscles are recruited
- a) in order of decreasing size.
  - b) in order of increasing resistance to fatigue.
  - c) in order of decreasing axonal conduction velocity.
  - d) from largest to smallest.
  - e) in the same order.**
49. Muscarinic acetylcholine receptors are found
- a) on the targets of sympathetic postganglionic neurons
  - b) on the targets of parasympathetic postganglionic neurons**
  - c) at the neuromuscular junction
  - d) at the synapses in autonomic ganglia
  - e) on the t-tubules
50. Given that language is usually localized in the left hemisphere, a patient who has had his corpus callosum severed (a split-brain patient) is unable to
- a) read aloud a word presented to his right visual field.
  - b) name an object in a picture presented to his right visual field.
  - c) name an object in a picture presented to his left visual field.**
  - d) see an object presented to his left visual field.
  - e) identify an object he can touch with the right hand.

**END OF TEST**

Turn in your mark-sense form  
and your question sheets  
at the front of the room.