

Correct answers are in **bold, red type**.

1. In a negative feedback regulatory system, what is the term for the response pathway that acts to restore the regulated condition back to the ideal range?
 - a. **effector**
 - b. afferent
 - c. integrator
 - d. sensor
 - e. countercurrent multiplier

2. Which of these structures is found in the renal medulla?
 - a. distal tubule
 - b. Bowman's capsule
 - c. peritubular capillaries
 - d. glomerulus
 - e. **collecting duct**

3. What is the main thing the kidneys change in order to regulate the ECF volume?
 - a. pH of the ECF
 - b. glucose concentration in the ECF
 - c. osmolarity of the ECF
 - d. **reabsorption or excretion of Na⁺**

4. Which of the following typically causes proteinuria (protein in the urine)?
 - a. increased secretion of protein
 - b. decreased reabsorption of protein
 - c. decreased GFR
 - d. **damage to the filtration membrane**
 - e. constriction of the afferent arteriole

5. All of the following are part of the filtration membrane EXCEPT
 - a. podocytes
 - b. glomerular basement membrane
 - c. **macula densa**
 - d. slit diaphragm
 - e. fenestrated endothelium

6. Suppose the mean arterial pressure (average blood pressure) increases from 100 to 110 mm Hg. What happens as a result?
- GFR increases
 - myogenic response causes constriction of the afferent arteriole**
 - myogenic response causes constriction of the efferent arteriole
 - myogenic response causes dilation of the afferent arteriole
 - tubuloglomerular feedback causes dilation of the afferent arteriole
7. In the proximal tubule
- aquaporin expression is regulated.
 - Na^+ reabsorption is mostly passive.
 - Na^+ reabsorption is mostly regulated by aldosterone.
 - cells are full of mitochondria to produce ATP that supports active transport.**
 - cells express the NKCC2 cotransporter that is the target of the loop diuretic furosemide.
8. Which of the following can occur in someone with hyperglycemia?
- a high filtered load of glucose
 - increased urine volume
 - glucose in the collecting duct pulls water into the forming urine via osmosis
 - SGLT2 proteins become saturated
 - ALL of the above can occur in someone with hyperglycemia**
9. Which of the following is TRUE about thiazide diuretics?
- inhibit the Na^+/Cl^- cotransporter found in the distal tubule**
 - decrease ECF volume by increasing Na^+ reabsorption
 - increase urine volume by increasing Na^+ reabsorption
 - increase urine volume by increasing Na^+ filtration
 - ALL of the above are TRUE
10. Organic molecule secretion
- occurs mainly in the loop of Henle.
 - is a passive process.
 - depends upon transporters that have a broad specificity and are subject to competitive inhibition.**
 - involves the transport of substances from the lumen of the renal tubule into the ECF.
 - is stimulated by sympathetic nervous system input to the afferent arteriole.
11. Countercurrent flow occurs in the (choose best)
- proximal tubule
 - distal tubule
 - collecting duct
 - afferent arteriole
 - vasa recta**

12. In the kidney, the largest gradient of osmolarity exists along an axis between the
- proximal and distal tubules
 - cortex and the papilla**
 - collecting duct and the loop of Henle
 - collecting duct and the medullary interstitial fluid
 - ascending limb and the descending limb of the loop of Henle
13. Which of the following increases vasopressin secretion?
- decreased AP firing by hypothalamic osmoreceptors
 - atrial natriuretic peptide
 - increased delivery of Na⁺ to the distal tubule
 - increased plasma osmolarity**
 - increased stretch of the afferent arteriole
14. What is the location of the granular cells that release renin?
- macula densa
 - afferent arteriole**
 - proximal tubule
 - sympathetic nervous system
 - cortical collecting duct
15. What decreases in a person treated with an ACE inhibitor?
- angiotensinogen
 - renin
 - angiotensin II**
 - erythropoietin
 - polyuria
16. Which of the following leads to increased renin secretion?
- decreased blood flow to the kidney
 - activation of sympathetic nervous system input to the afferent arteriole
 - decreased delivery of Na⁺ to the distal tubule
 - a drop in mean arterial pressure
 - ALL of the above lead to increased renin secretion**
17. What type of neuron innervates the detrusor muscle?
- sympathetic postganglionic neuron
 - parasympathetic postganglionic neuron**
 - somatic efferent neuron

18. Which of the following best describes what happens in someone who is vaccinated?
- vaccination bypasses the innate immune response
 - the vaccine depletes specific helper T cells to prevent a cytokine storm
 - the person has immunity due to antibodies that were injected in the vaccine
 - the vaccine upregulates NK cells to prevent viral infection
 - immune memory results in a more rapid secondary immune response to prevent disease**
19. Neutrophils are short-lived white blood cells that are abundant in the circulation. What is the main role of neutrophils?
- phagocytosis of pathogens**
 - secreting antibodies
 - inducing apoptosis in virally infected cells
 - binding to antigens presented on MHC-I molecules
 - secreting complement factors
20. ALL of the following occur during inflammation EXCEPT
- vasodilation
 - edema
 - clonal expansion**
 - recruitment of phagocytes
 - pain
21. The membrane attack complex
- is created by B cells
 - forms when perforin is released
 - forms when complement is activated**
 - is created by opsonins
 - is a key feature of the specific immune response
22. In an adult, when a specific immune response is stimulated, antigen-presenting cells activate lymphocytes by displaying peptide antigens on their surface. Where does this typically occur?
- within the circulation
 - in secondary lymphoid tissues**
 - in the bone marrow
 - in the thymus
23. Which of the following cells expresses MHC-II molecules on its surface?
- skin cell
 - ciliated respiratory epithelial cell
 - dendritic cell**
 - neuron
 - liver cell

24. In what way do helper T cells provide “help” in a specific immune response?
- activate complement
 - release cytokines that stimulate immune effectors**
 - stimulate somatic recombination in B cells
 - secrete MHC molecules
 - kill self-reactive B cells
25. What is the role of plasma cells in the specific immune response?
- secrete antibodies**
 - activate complement
 - display peptide antigens on MHC-II molecules
 - secrete cytokines that stimulate lymphocyte proliferation
 - ALL of the above are performed by plasma cells
26. An important step, that always occurs during the stimulation of clonal expansion of a naïve B cell, is when antigen binds to
- a B cell receptor**
 - a pattern recognition receptor
 - an MHC-I molecule
 - a cytokine receptor
 - an NK cell
27. Which of the following mechanisms most directly prevents viral infection?
- release of perforin and granzymes by cytotoxic T-cells
 - activation of JAK-STAT signaling pathway
 - activation of complement
 - neutralizing antibodies binding to virus**
 - display of viral peptides on an antigen presenting cell
28. An epitope is part of
- an MHC molecule
 - the complement cascade
 - the variable region of an antibody
 - an antigen**
 - a cytokine receptor
29. Which of the following is an intracellular receptor?
- receptor associated with JAK kinase
 - cytokine receptor
 - B-cell receptor
 - T-cell receptor
 - glucocorticoid receptor**

30. Which of the following is an example of passive immunity?
- treatment with a JAK inhibitor
 - treatment with a glucocorticoid drug
 - treatment with a monoclonal antibody drug that targets a pathogen**
 - response to vaccination with mRNA to a pathogen protein
 - response to vaccination with a heat-killed pathogen
31. H₂O:
- is an amphipathic molecule.
 - provides a favorable environment for lipid soluble compounds.
 - is a dipole with an uneven distribution of electron density.**
 - is a network of covalently bonded molecules.
 - is a highly concentrated nonpolar solution.
32. The cell membrane is
- impermeable to hydrophobic compounds.
 - a bilayer of phospholipids.**
 - permeable to large polar compounds.
 - devoid of proteins.
 - impermeable to water.
33. The membrane potential of all living cells:
- is approximately +70 mV at rest.
 - is the consequence of an osmotic gradient
 - exists independently of any ion concentration gradients.
 - depends on the cell membrane having selective ion permeability.**
 - is generated by electron transport.
34. Ion channels
- are enzymes that mediate transmembrane ion permeation.
 - are never open all the time.
 - are closed by ATP hydrolysis.
 - may be opened by an applied mechanical force.**
 - are only present in nerve and muscle cells.

35. Electrical signals in cells

- a. **result ultimately in a change in intracellular Ca^{++} .**
- b. are always hyperpolarizing.
- c. are exclusively the consequence of voltage-gated ion channels.
- d. are dependent on regenerative protein synthesis.
- e. are driven by the hydrolysis of ATP.

36. Graded changes in membrane potential

- a. are all or none voltage changes.
- b. get larger and faster as they spread away from their site of generation.
- c. are modulated by dephosphorylation.
- d. **vary with the strength of the signal that produced them.**
- e. are always depolarizing.

37. Intracellular Ca^{++} signals

- a. are generated by Ca^{++} entry through voltage gated Na^+ channels.
- b. block the conduction of action potentials in excitable cells.
- c. **may trigger changes in gene expression.**
- d. can only be produced by ligand gated ion channels.
- e. none of the above are true.

38. Myelinated axons

- a. are present in the peripheral but not the central nervous system.
- b. in the autonomic nervous system are coupled to Schwann cells by gap junctions.
- c. have a sheath that insulates nodes of Ranvier.
- d. **have an increased action potential conduction velocity relative to unmyelinated axons.**
- e. can conduct graded potentials over long distances.

39. Synaptic transmission in the central nervous system

- a. always results in an increase in action potential production in the post synaptic cell.
- b. is initiated by a decrease in Ca^{++} .
- c. **makes use of ligand gated ion channels.**
- d. is triggered by the graded release of G-protein beta/gamma subunits.
- e. is mediated by the active transport of specific neurotransmitters.

40. Gap junctions
- are formed by adhesion molecules that provide structural support
 - are only present in nerve cells.
 - are specialized for fast excitatory chemical transmission.
 - provide a mechanism for the exchange of intracellular organelles.
 - are formed by intercellular channels that couple cells electrically and metabolically.**
41. The 'neural code' is a term used to describe the relationship between the intensity of a stimulus and
- the sequence of amino acids within the receptor protein.
 - its duration.
 - its effect on thalamic relay cells.
 - the frequency of action potentials generated by a sensory neuron.**
 - the type of receptor that responds to it.
42. Dull, poorly localized and persistent pain is transmitted to the central nervous system along
- large, unmyelinated C-fibers.
 - small, myelinated A-delta fibers.
 - small, unmyelinated C-fibers.**
 - large, myelinated B-fibers.
 - large, myelinated C-fibers
43. Each olfactory sensory neuron responds to a limited number of odors because it expresses
- only muscarinic receptors.
 - many, but not all, olfactory receptor proteins.
 - only five primary modalities.
 - only one type of olfactory receptor protein.**
 - only voltage-gated channels.
44. The capacity of the auditory system to discern sounds of different frequencies originates with
- the different sizes of the hair cells along the basilar membrane.
 - the structure of the helicotrema.
 - the shape and structure of the basilar membrane.**
 - the auditory thalamus.
 - the shape of the tympanic window.

45. Which of the following behaviors will trigger the vestibulo-ocular reflex?
- a. **rapid head movements**
 - b. flashes of bright light
 - c. loud sounds
 - d. rapid limb flexion
 - e. strong odors
46. Which of the following factors contributes to the high visual acuity of the retinal fovea?
- a. the optic chiasm
 - b. **specialized cones**
 - c. specialized rods
 - d. the optic disc
 - e. the tapetum lucidum
47. Which of these protein molecules is NOT involved in skeletal muscle contraction?
- a. myosin
 - b. actin
 - c. **beta-arrestin**
 - d. tropomyosin
 - e. troponin
48. For slowly executed delicate movements, motor units are recruited in order of increasing size. For rapidly executed powerful movements, motor units are recruited
- a. **in the same order.**
 - b. in a random sequence.
 - c. in the opposite sequence.
 - d. in order of decreasing size.
 - e. in order of decreasing axonal conduction velocity.
49. At the synapses between postganglionic neurons and their target tissues, most sympathetic neurons release
- a. substance P.
 - b. glutamate.
 - c. aspartate.
 - d. **norepinephrine.**
 - e. acetylcholine.

50. Which of the following mechanisms is thought to be most important for learning and memory?

- a. **changes in the strength of synaptic connections between neurons in the brain**
- b. changes in the type of neurotransmitters used at synapses in the brain
- c. increases in the number of neurons in the brain
- d. increases in the size of neurons in the brain
- e. increasing the distances between neurons in the brain