1. Why are animals used in biomedical research?
   a) because many of their physiological systems are similar to humans.
   b) because they are exactly the same as humans.
   c) because it is fine to inflict pain to animals.
   d) because researchers hate them.
   e) animals are not used for biomedical research because their physiology is too different from humans.

2. The philosopher and physiologist Rene Descartes is well remembered for his theory of brain function. Which of the following statements best describes his theory?
   a) The heart was the seat of the mind, which controlled behavior, while the brain mainly served to cool blood.
   b) The brain gives rise to the mind, which controls behavior.
   c) The brain and mind exist independently, but the mind ultimately interacts with the brain to control behavior.
   d) The brain and mind exist independently, but do not interact; the brain controls all body functions and rational behaviors.
   e) The brain provides a bridge to the mind for the control of behavior, through electric-like functions of nerve cells.

3. The first scientist(s) to record from the giant axon of the squid was:
   a) J.Z. Young.
   b) Andrew Hodgkin.
   c) Roberts Bartholow.
   d) Alan Huxley.
   e) both b and d.

4. Which of the following individuals is given credit for the "neuron doctrine" that the nervous system is made of independent units/cells that can communicate with each other?
   a) Rene Descartes
   b) Charles Darwin
   c) Camillo Golgi
   d) Santiago Ramon y Cajal
   e) John Hughlings-Jackson

5. How many connections between neurons have been estimated in the human neocortex alone?
   a) 20 thousands.
   b) 60 trillions.
   c) 6 millions.
   d) 1 trillion.
   e) 6 billions.
6. Which of the following function is not carried out by neurons?
   a) the production of microtubules.
   b) the reuptake of neurotransmitters.
   c) the production of metabotropic receptors.
   d) the myelination of axons.
   e) the control of genes regulating metabolic proteins.

7. Where do neurons store the genetic information they use to code and build all the proteins required for their functions?
   a) in the nucleus.
   b) in the endoplasmic reticulum.
   c) in the axon.
   d) in the synapse.
   e) in the messenger ribonucleic acids (mRNAs).

8. Where do neurons produce and store the energy required for many of their functions?
   a) mitochondria.
   b) nucleus.
   c) ribosomes.
   d) cytoplasm.
   e) golgi body.

9. Which part(s) of the neuron receive(s) information (from synapses)?
   a) axons.
   b) dendrites.
   c) cell soma.
   d) all of the above.
   e) b and c only.

10. Myelin sheaths are produced by _______________ in the central nervous system.
    a) astrocytes.
    b) oligodendrocytes.
    c) microglia.
    d) Schwann cells.
    e) ependymal cells.

11. Which glial cell type is responsible for reuptaking neurotransmitters once released in the synapse?
    a) pyramidal cells.
    b) ependymal cells.
    c) oligodendrocytes.
    d) Schwann cells.
    e) astrocytes.

12. The synapse:
    a) is the specialized structure that makes action potentials travel faster.
    b) shield neurons from viral and bacterial invaders.
    c) allows neurons to communicate with each other.
    d) is the specialized structure allowing action potentials to travel directly between neurons.
    e) is the specialized structure that allows the action potential to regenerate itself between myelin sheets.
13. Which type of neuron is more likely to send signals about a rock under your left foot?
   a) motor neuron.
   b) multipolar neuron.
   c) interneuron.
   d) pseudounipolar neuron.
   e) both c and d.

14. The structure that divides the inside and outside of neurons are made of:
   a) a lipid bilayer.
   b) a protein layer.
   c) channel proteins.
   d) a lipid monolayer.
   e) ions.

Which letter represents the nerve cell parts in the next three questions?

15. Axon? (mark A, B, C, D, or E)

16. Dendrites? (mark A, B, C, D, or E)

17. Axon hillock? (mark A, B, C, D, or E)

18. The effect of tetrodotoxin (puffer fish poison) on axons demonstrates:
   a) the role of potassium channels in hyperpolarization.
   b) the role of sodium channels in depolarization.
   c) the role of potassium channels in depolarization.
   d) the role of chloride channels in hyperpolarization.
   e) the role of sodium channels in hyperpolarization.

19. Which of the following is not true?
   a) the cell membrane is impermeable to large charged protein molecules.
   b) the semi-permeable membrane keeps sodium ions outside and potassium inside neurons.
   c) neuron membranes have sodium/potassium ion pumps that take out potassium ions.
   d) the summed charges of the unequally distributed ions leave the inside of the membrane at approximately -65 mV relative to the outside of the cell. This is the cell’s resting potential.
   e) two important passive forces responsible for the resting membrane potential include the electrostatic and diffusion pressures.
20. Neuron Jack makes an excitatory synaptic contact onto the distal (far) end of neuron Bob's dendrite. Neuron Jane makes an inhibitory synaptic contact on neuron Bob's soma. Given that Jack and Jane both activate their synapses, what are you most likely to see in neuron Bob when recording from its soma?
   a) Bob might display an excitatory postsynaptic potential only.
   b) Bob might display an inhibitory postsynaptic potential only.
   c) Bob will release excitatory neurotransmitters.
   d) Bob might display both a small excitatory and a large inhibitory postsynaptic potentials.
   e) Bob will release inhibitory neurotransmitters.

21. Which of the following statements is correct with regard to ionic concentrations at the normal resting membrane potential?
   a) higher sodium and potassium, and lower chloride inside relative to outside of neurons.
   b) lower sodium, potassium, and chloride inside relative to outside of neurons.
   c) lower sodium and chloride, and higher potassium inside relative to outside of neurons.
   d) higher sodium, potassium, and chloride inside relative to outside of neurons.
   e) lower sodium, and higher potassium and chloride inside relative to outside of neurons.

22. If I tell you that our very own Dr. Strangelove has just discovered a new membrane channel that can change the membrane potential of neurons from -65 mV to -60 mV when activated, how would you characterize it?
   a) as a new depolarizing action potential.
   b) as a new hyperpolarizing IPSP.
   c) as a new depolarizing IPSP.
   d) as a new hyperpolarizing EPSP.
   e) as a new depolarizing EPSP.

23. A neuron cannot produce an action potential:
   a) during the relative refractory period.
   b) when there is an inhibitory postsynaptic potential.
   c) when the voltage-dependent potassium channels are closed.
   d) during the absolute refractory period.
   e) both b and d.

24. The event that takes the resting membrane potential from -65 mV to +30 mV is normally called:
   a) an IPSP.
   b) an EPSP.
   c) a graded inhibitory potential.
   d) hyperpolarization.
   e) an action potential.

25. Which of the following mechanisms allows the membrane potential to go back to its resting value when the membrane potential is at the peak of the action potential?
   a) opening of voltage sensitive (gated) potassium channels.
   b) opening of voltage sensitive (gated) sodium channels.
   c) opening of voltage sensitive (gated) calcium channels.
   d) opening of neurotransmitter (ligand) -gated potassium channels.
   e) none of the above
26. As you are recording the activity of a neuron, you observe multiple EPSPs and IPSPs of various sizes mixed together. This is an example of:
   a) probably temporal summation only.
   b) probably spatial summation only.
   c) probably both spatial and temporal summation.
   d) probably only algebraic summation.
   e) none of the above.

27. What would happen to the resting membrane potential of a neuron if sodium (Na⁺) channels were normally open in the membrane, but everything else was the same?
   a) nothing much would happen, and it would remain at approximately -65 mV.
   b) it would definitely be less negative than the normal resting potential.
   c) it would definitely be more negative than the normal resting potential.
   d) it would lose its polarization and stand at exactly 0 mV (no difference between inside and outside of the neuron).
   e) none of the above.

28. During development of the nervous system, the neurotransmitter GABA is excitatory at many synapses, not inhibitory. Which of the statement below would be a possible mechanism to explain GABA’s functional reversal during development into an excitatory neurotransmitter (i.e., produce EPSPs)?
   a) The resting membrane potential of developing neurons is more positive than in mature neurons.
   b) There are fewer GABA receptors on the post-synaptic membranes.
   c) The concentration of chloride ions (Cl⁻) is higher inside than outside developing neurons.
   d) The concentration of potassium ions (K⁺) is higher inside than outside developing neurons.
   e) There are fewer GABA channels linked to GABA receptors in developing neurons.

29. What is the main mechanism contributing to the absolute refractory period in neurons:
   a) potassium ions can only flow outside the neurons.
   b) autoreceptors are inhibiting the opening of ionotropic sodium channels.
   c) the voltage-dependent sodium channels cannot be opened.
   d) the voltage-dependent potassium channels cannot be opened.
   e) there are too many sodium ions inside the cell to permit another action potential.

30. You are having a shower, and all of a sudden, the water turns ice cold! How do you think your temperature sensory neurons code this very noticeable and strong stimulus?
   a) They produce larger EPSPs at the same rate as under the warm water condition.
   b) They produce larger, but the same number of, action potentials as under the warm water condition.
   c) They produce smaller EPSPs at a higher rate than under the warm water condition.
   d) They produce the same number and size action potentials that travel faster down the neurons than under the warm water condition.
   e) They produce more action potentials of the same size as under the warm water condition.

31. Gray's type I synapses are typically located
   a) at astrocytes' endfeet.
   b) on myelin sheets.
   c) on the soma (cell body).
   d) on dendritic spines.
   e) on the axon hillock.
32. Conduction of action potentials is faster in myelinated axons. This happens **mainly** because these axons  
a) avoid sending their action potentials through the nodes of Ranvier.  
b) expend (use) less energy.  
c) are usually short.  
d) make use of faster internodal passive electrical conduction.  
e) produce bigger action potentials.

33. Synaptic **autoreceptors** normally:  
a) increase the number of excitatory postsynaptic potentials at a synapse.  
b) reduce neurotransmitter release at a synapse.  
c) increase the size of action potentials in the post-synaptic neuron.  
d) decrease the size of action potentials in the post-synaptic neuron.  
e) increase neurotransmitter release at a synapse.

34. The process whereby the content of synaptic vesicles is released into the synaptic cleft/gap is called:  
a) exocytosis.  
b) endocytosis.  
c) phagocytosis.  
d) pinocytosis.  
e) none of the above.

35. We discussed the discovery of chemical neurotransmission by Otto Loewi. What critical experimental manipulation allowed him to deduce that nerve cells likely release chemicals to produce some of their effects?  
a) He stimulated the vagus nerve of an isolated frog heart.  
b) He stimulated the vagus nerves of two frog hearts simultaneously.  
c) He connected the vagus nerves from multiple frog hearts and stimulated them simultaneously.  
d) He simply added fluid from a vagus nerve stimulated heart, to another isolated unstimulated heart.  
e) He isolated a frog heart and applied acetylcholine to it.

36. Small transmitter molecules are:  
a) packaged in large synaptic vesicles.  
b) made in the soma, packaged in small synaptic vesicles and transported down axons.  
c) neuropeptides that are synthesized in synaptic terminals.  
d) packaged in small synaptic vesicles.  
e) soluble gases that freely cross lipid membranes.

37. Which one of the following is **not** a criterion for small neurotransmitter (NT) status?  
a) postsynaptic receptor sites.  
b) isolation of neurotransmitter substance from presynaptic terminal.  
c) predictable pharmacological action.  
d) evidence of presynaptic release.  
e) none of the above.

38. Which channel membrane protein is specifically important in the process of neurotransmitter release?  
a) neurotransmitter receptor sodium channels.  
b) voltage-dependent (gated) calcium channels.  
c) neurotransmitter receptor potassium channels.  
d) voltage-dependent (gated) chloride channels.  
e) voltage-dependent (gated) potassium channels.
39. What determines the effect of neurotransmitter release on the post-synaptic neurons?
   a) the size of the action potential.
   b) the post-synaptic receptors.
   c) the neurotransmitter contained in the synaptic vesicles.
   d) the concentration of calcium ions reached in presynaptic terminals.
   e) the size of the synaptic vesicles.

40. Enkephalins are peptide neurotransmitters that function in the perception of pain. This is because
   a) they interact with specific opioid receptor proteins to produce their effects.
   b) they are small enough to directly enter post-synaptic membranes.
   c) they have special membrane channels that let them through the post-synaptic cells.
   d) they interact with morphine.
   e) they are found in very high concentrations at nociceptive (pain related) synapses.

41. Regulation of gene expression is associated with which membrane protein in a neuron?
   a) the second-messenger cyclic AMP (cAMP).
   b) ionotropic receptors.
   c) metabotropic receptors.
   d) voltage-dependent (sensitive) sodium channels.
   e) both c and d.

42. How are neurotransmitters removed from the synapse?
   a) re-uptake into postsynaptic terminals.
   b) re-uptake by surrounding glial cells.
   c) enzymatic degradation.
   d) all of the above.
   e) b and c only.

43. We discussed the fact that Parkinson's disease is associated with the loss of neurons containing a specific
catecholamine neurotransmitter. What is this neurotransmitter?
   a) serotonin.
   b) indolamines.
   c) norepinephrine.
   d) GABA
   e) dopamine.

44. In the movie “Awakenings”, the physician (Oliver Sacks) treats what kind of patient with what drug?
   a) Myesthenia gravis, muscarine.
   b) Schizophrenia, dopamine receptor antagonist.
   c) Parkinson’s disease, L-dopa.
   d) Depression, Serotonin-specific reuptake inhibitors.
   e) Alzheimer’s disease, acetylcholine.

45. Which neurotransmitter is found in motor neurons and is responsible for producing muscle contraction
through its release at the neuromuscular junction?
   a) adenosine.
   b) acetylcholine.
   c) dopamine.
   d) serotonin.
   e) glutamate.
46. Which of the following molecules is endogenous to the body?
   a) morphine.
   b) aspirine.
   c) vitamins.
   d) acetylcholinesterase.
   e) nicotine.

47. Which of the following neurotransmitters is relatively slow-acting?
   a) norepinephrine.
   b) glycine.
   c) aspartate.
   d) gamma-amino butyric acid (GABA).
   e) glutamate.

48. Nitric oxide (NO) is a gas neurotransmitter that
   a) is stored in synaptic vesicles.
   b) is synthesized in the nucleus.
   c) dilates blood vessels.
   d) does not cross lipid membranes.
   e) is transported to the synaptic terminals via microtubules.

49. Serotonin-specific reuptake inhibitors (SSRIs) are widely prescribed to treat clinical depression. Which of the following procedures do you think would most likely worsen symptoms in untreated depressed patients?
   a) increase the concentration of serotonin in the brain.
   b) decrease the concentration of serotonin in the brain.
   c) give a serotonin autoreceptor antagonist (inhibits or reduce autoreceptor function).
   d) give a drug that increases the vesicular release (in the synapse) of serotonin.
   e) give a dopamine receptor antagonist (reduce the function of dopamine receptors).

50. Which of the following mechanisms would you associate with an antagonist drug action?
   a) a drug that binds postsynaptic receptors and mimics the effect of the endogenous neurotransmitter.
   b) a drug that binds and blocks normal autoreceptor function.
   c) a drug that prevents the normal reuptake of neurotransmitters inside presynaptic terminals.
   d) a drug that increases the enzymatic synthesis of neurotransmitters.
   e) a drug that binds postsynaptic receptors and blocks the normal action of the endogenous neurotransmitter.

Cheers, it’s over!!! Good work. Remember to turn in your scantrons (bubble sheet)!!!

Answers:


* all answers accepted due to poorly worded question.