Name: _____

Physiology: Neurophysiology Worksheet

Directions: Write in and circle best answer on this sheet.

1. The **2** general cell types found in the Nervous System are:

1) _____; function _____. There are ____ functional types.

2) _____; function _____. There are ____ functional types.

Changes in the Membrane Potential Create Electrical Signals

2. All living cells have resting membrane potentials: *True or False*?

3. How do cells create electrical signals?

Ans: _____.

3. At rest, which ion is the cell membrane most permeable to, **Na^+** or **K^+**? Ans ____.

Therefore, it is the _____ ion that is the major contributor to resting membrane potential (RMP) of neurons. The RMP of a neuron has a value of = _____.

Ion Movement across the Cell Membrane Creates Electrical Signals (circle ***best*** answer)

4. A sudden (***increase/decrease***?) in Na^+ permeability allows Na^+ to (***leave/enter***?) the cell. When Na^+ moves, it is moving (***down/up***?) its concentration gradient and (***down/up***?) it electrical gradient. The (***influx/efflux***?) of Na^+ ions (***hyperpolarizes/depolarizes/repolarizes***?) the membrane potential, creating an electrical signal.

Gated Ion Channels Control the Ion Permeability of the Neuron

5. How do cells alter their permeability to ions? _____

a) List four ions that move through membrane channels: _____

b) Mechanically gated ion channels open in response to: _____

c) Chemically gated ion channels open in response to: _____

d) Voltage-gated ion channels open in response to: _____

6. In the axon terminal, _____ gated Ca^{2+} channels open in response to the _____ _____ arriving. The Ca^{2+} moves from the (***cytoplasm/ECF?)*** to the (***cytoplasm/ECF***?). The movement of Ca^{2+} is a signal that initiates what event? _____.

When chemically gated Cl^- channels on a postsynaptic neuron open, Cl^- moves (***out of/into?)*** the cell. Cl^- movement (***depolarizes/hyperpolarizes?***) the membrane.

Why does the Cl^- move in the direction it does? _____.

Why does the Na^+ move in the direction it does? _____.

Graded Potentials Reflect <u>the Strength of the Stimulus</u> that initiates them

7. What determines the strength of a graded potential? _____.

8. Opening K^+ channels on the plasma membrane will cause membrane to (**depolarize/hyperpolarize**)?

9. Opening Cl^- channels on the plasma membrane will cause membrane to (***depolarize/hyperpolarize***)?

10. If strong enough, graded potentials travel on cell body until reaching the _____,

and if it reaches threshold at the above location, what happens? Ans: _____.

11. What happens when several graded potentials reach the axon hillock (trigger zone) at the same time?

Ans: They _____.

12. Specifically list the 6 ways that **GPs** and **APs** are different from each other as discussed in lecture:

Graded Potentials	**Action Potentials**
1)	1)
2)	2)
3)	3)
4)	4)
5)	5)
6)	6)

13. The purpose of the ***Absolute*** Refractory Period is:

15. The purpose of the ***Relative*** Refractory Period is:

16. Why can a greater-than-normal stimulus trigger an AP during the relative refractory period but not during the absolute refractory period? _____.

17. List the 3 factors that affect the speed of conduction of an Action Potential (AP).

1) _____; **2)** _____; **3)** _____.

**Of the 3 factors, which has the most significant impact on human nerve impulses? = # ____.*

18. The nodes of Ranvier are gaps in PNS axons between Schwann cells that have (*high/low*?) concentrations of voltage-gated Na^+ and K^+ channels in nodes. This (*slows down/speeds up*) the signal.

19. Saltatory conduction of an AP means the signal _____.

20. How is conduction changed through axons that have lost their myelin? _____.

21. Name a disorder causing the deterioration of the myelin sheath _____.

22. What would happen to the conduction of an action potential (AP) if the voltage gated Na^+ channels that normally open during an AP have been **blocked**? _____.

23. Is it true that if Na^+ channels in the middle of an axon were opened and caused a depolarizing local current flow that the signal would spread <u>in both directions</u> along the axon? Why or why not?

24. In the body, why don't action potentials (APs) reverse and move back toward the soma?

25. Which of the following statements about the Na^+/K^+ pump is <u>true</u>?
a) Na^+ moves down its concentration gradient **b)** K^+ is actively transported out of the cell
c) ATP is used indirectly **d)** Na^+ is actively transported out of the cell **e)** c and d

26. At the <u>peak</u> of an action potential, which of the following are <u>true</u>?
1. K^+ channels are open **2.** Na^+ channels close **3.** it is in the middle of the relative refractory period
4. Na^+ channels open **5.** cell then begins the downward depolarization phase **6.** membrane = +60 mV
a) 1, 5, 2 and 3 **b)** 3, 4 and 1 **c)** 4, 5 and 3 **d)** 2, 6 and 1 **e)** 1 and 2

27. A gated ion channel that is triggered to open by deformation (distention) of the plasma membrane
a) is a type of thermoreceptor **b)** is a mechanically gated ion channel **c)** is a voltage gated channel
d) is opened by specific chemicals **e)** is a ligand (chemically) gated ion channel

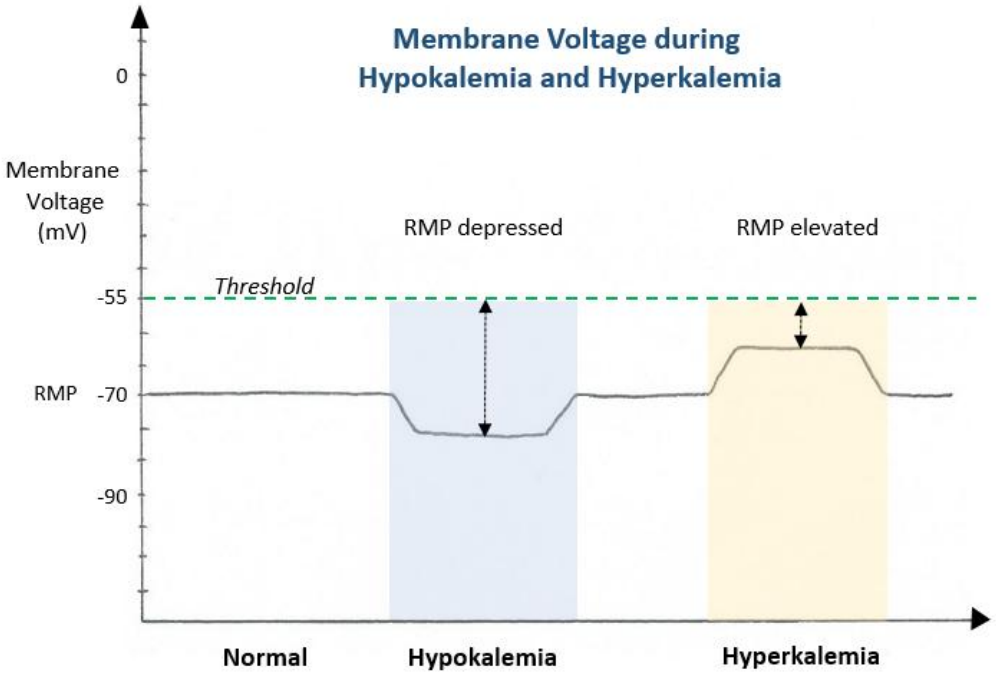
28. The Ca^{2+} ion channel at the end of the axon which responds to an action potential is
a) a voltage gated channel **b)** a type of photo-sensitive channel **c)** open all the time
d) stimulated by mechanical changes **e)** a ligand gated channel

29. An **Agonist** is
a) a blocker **b)** a signal molecule very similar to the true ligand but fails to trigger the cellular event
c) a signal molecule that binds to receptors and acts like the true ligand (has similar effects)
d) the type of receptor that triggers a response in any tissue **e)** any drug that opens Cl^- channels

30. Cell receptor <u>down regulation</u> in the body can occur when:
a) all receptors are blocked **b)** inhibitors are present **c)** there is an increased sensitivity of the cell
d) there is an excessive amount of stimulation of the cell by a signal molecule
e) there is a diminished amount of stimulation of the cell by a signal molecule

Electrical Activity in the Nervous System can be altered by a Variety of Chemical Factors

31. What is the normal physiological range for K^+ levels in the body? Answer: _____ mEq/L. Look at the graph below for the membrane voltage (mV) of a neuron during hypokalemia and hyperkalemia and use it to help answer questions 32 and 33.



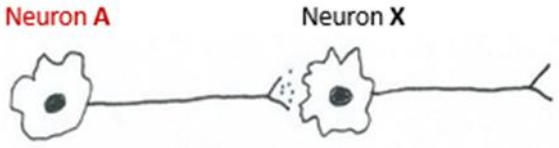
32. Define **hyperkalemia**. Then explain how hyperkalemia increases neuronal excitability.

33. Define **hypokalemia**. Then explain how hyperkalemia decreases neuronal excitability.

34. If you have elevated K^+ levels, what organ system is responsible for elimination of excess K^+ in order to maintain homeostasis? _____.

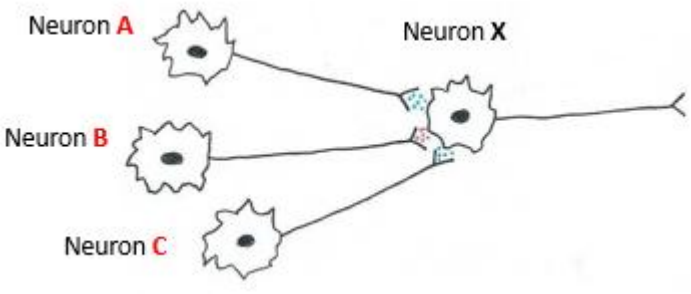
35. What's the likelihood of firing an action potential when the extracellular K^+ increases? _____.

Temporal Summation occurs when repeated stimulation from one neuron increases its frequency.
In other words, as the frequency of a signal from Neuron A (seen below) to another neuron (Neuron X below) increases, the graded potentials (from A) can summate, which is called temporal summation.



Multiple Graded Potentials are Integrated and Summated at the Axon Hillock (Trigger Zone)

36. What happens when several graded potentials reach the axon hillock (trigger zone) at the same time?
Answer: The _____.



For **Figure 1.** (left) here is the information provided: An EPSP from neuron **A** causes a 10 mV change (from RMP); an IPSP from neuron **B** causes a 6 mV change and; an EPSP from neuron **C** causes 6 mV change.

Neurons A, B and C are signaling **Neuron X**. Use this information to answer the questions posed below.

Figure 1. Neurons A, B, C and X, where X is the postsynaptic neuron.

Questions related to **Figure 1** above:

36. Given the information above, which of the following would be **true**?
a) summation of A and X would reach threshold
b) summation of C and A would be a graded potential
c) stimulation by A would depolarize cell
d) stimulation by B would be a subthreshold depolarization
e) summation of B and C would be a graded potential with the net value of 12 mV depolarization

37. Again, given the information above, which of the following would be **false**?
a) summation of B and C would not change membrane
b) summation of B would be an IPSP
c) summation of C and A = suprathreshold stimuli
d) stimulation by A would depolarize cell
e) repeated stimulation by A could spatially summate and reach threshold

38. The inhibitory postsynaptic potential (IPSP) alone would have what effect on the postsynaptic neuron?
a) depolarization **b)** repolarization **c)** hyperpolarization **d)** absolute refractory period
e) it would depend on the type of receptor on the postsynaptic membrane

39. Define and briefly describe the 2 ways that **postsynaptic neurons** respond to neurotransmitters.

1) Ionotropic -

2) Metabotropic -

40. Briefly List/describe the 3 ways that the synaptic cleft is cleaned up to end nerve signal transmission.
1)

2)

3)