

General science questions:

1. (2 points) What is science?

2. (2 points) What are the goals of scientific inquiry?

3. (2 points) How is scientific knowledge gained?

4. (2 points) How are new scientific discoveries integrated into existing knowledge?

5. (2 points) Why is saying something is "just a theory" not correct in the context of what you understand about the scientific process?

Physiology questions:

6. (5 points) Lambert-Eaton myasthenic syndrome (LEMS) is an autoimmune disease — a disease in which the immune system attacks the body's own tissues. Specifically, the immune system attacks the voltage gated calcium channels on nerve endings that are required to trigger the release of neurotransmitters chemicals. Specificity against voltage-gated calcium channels (VGCCs) in the cell membrane of the presynaptic motor nerve terminal.

How might this affect a person initially and over long-term ?

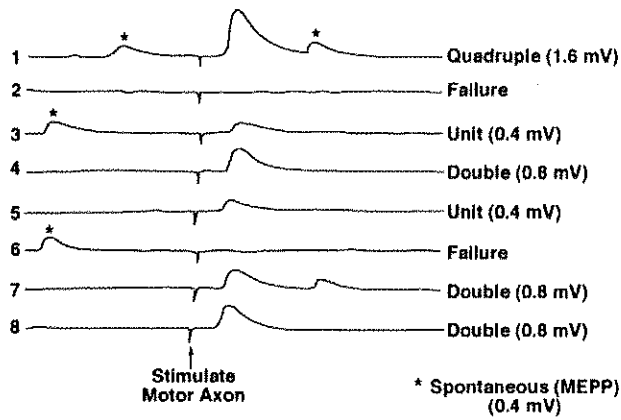
What do you think would happen over time to the neuromuscular junctions as the disease progresses? (WHY and LOGIC to your answers are needed)

7. (2 points) If a nerve membrane suddenly became equally permeable to both Na^+ and K^+ , the membrane potential would:

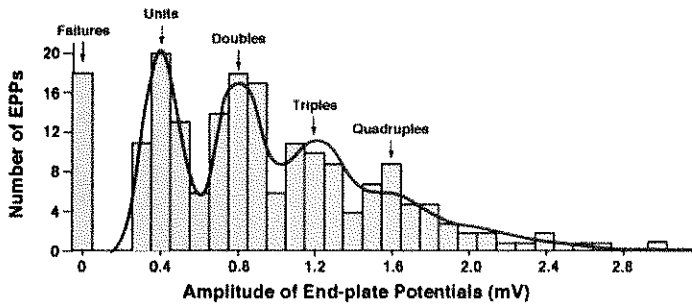
- A. Not change
- B. Approach the new K^+ equilibrium potential
- C. Approach the new Na^+ equilibrium potential
- D. Approach a value of about 0 mV
- E. Approach a constant value of about +55 mV

8. (4 points) In seeing this data below (Figure A) from experiments at the frog neuromuscular junction of stimulating the motor nerve but keeping the muscle fiber below the threshold of activating an action potential, why is it that when one records without stimulating the nerve terminal and records the responses most of these events fit with the 1st distribution in the histograms shown in figure B.

A

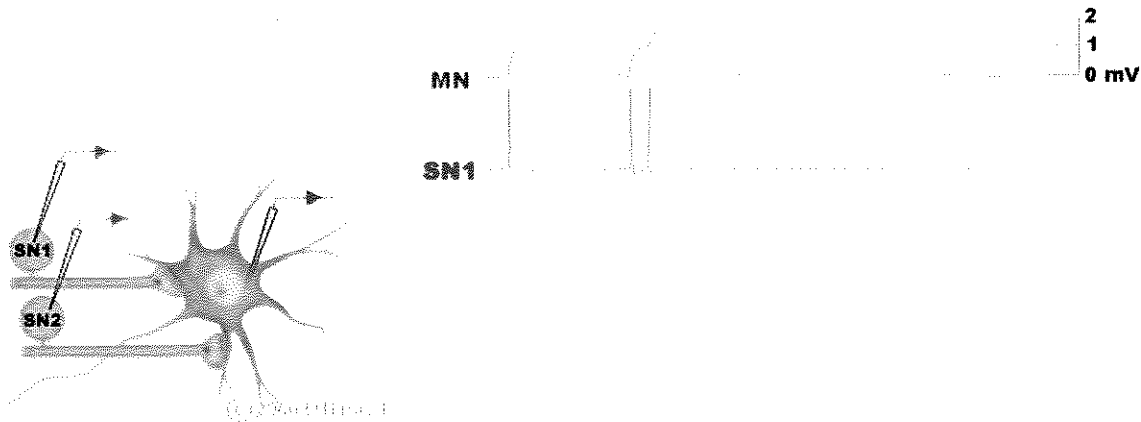


B



OPEN response answer.... EXPLAIN WELL YOUR ANSWER.

9. (6 points) In relation to the figure below the motor neuron (mn) is being recorded with an intracellular electrode while the sensory neuron (SN1) is being stimulated. Explain the recording shown in the motor neuron in as much detail as you can in relation to the shape of the events and the phenomenon which occurred to produce the traces. (hint it is a chemical synaptic event from sensory to motor neuron).



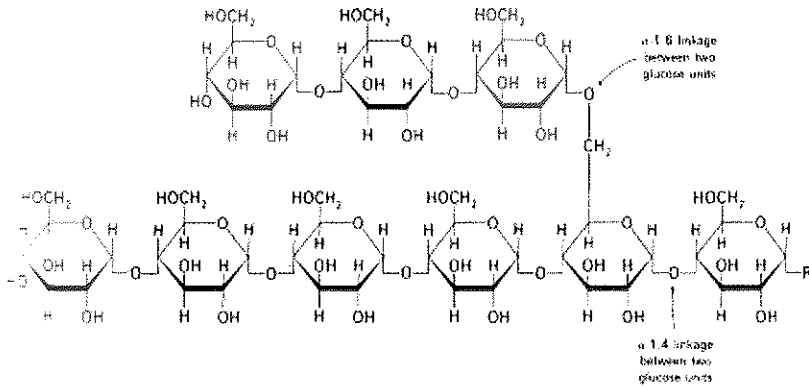
10. (2 points) define Homeostasis:

11. (4 points) How is ATP used in a cell ? (name at least 3 examples)

Why is it referred to as an energy molecule for the cell ?

12. (2 points) Why do animals store glycogen instead of just storing glucose in tissue as an energy source ?

Glycogen-storage of glucose



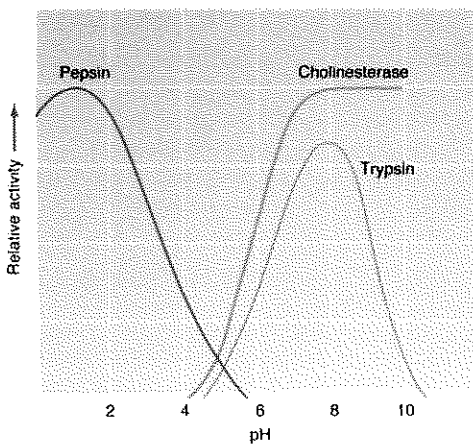
13. (2 points) Functions of membrane integral proteins does NOT include:

- a. as enzymes
- b. as ion channels
- c. as ion reservoirs
- d. as recognition molecules
- e. as membrane pumps and carriers

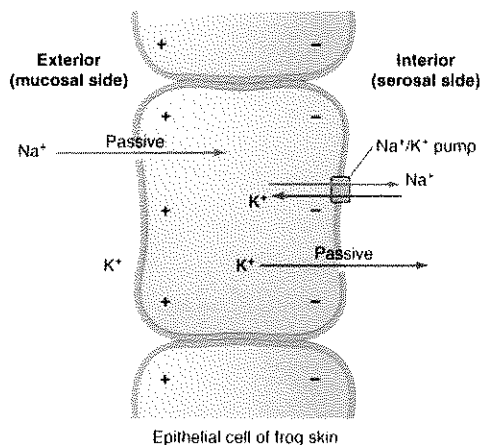
14. (4 points) Explain why these enzymes show different activity profiles for pH ?

What is the molecular reason they may show this differently pH sensitivity?

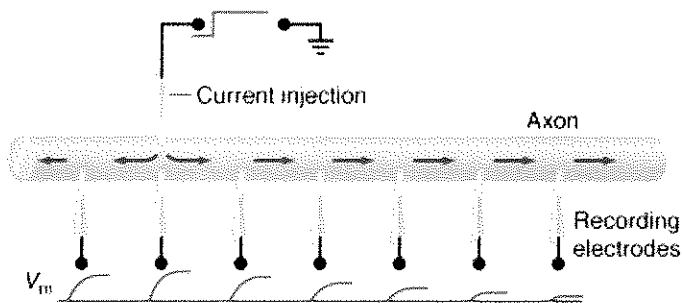
(b) Enzyme activity versus pH



15. (4 points) Explain in detail what is driving the Na^+ on the exterior side into the cell? What must be occurring for this to happen? How does this occur mechanistically? How might this frog skin experiment relate to functions in your body?



16. (4 points) Explain in detail how one could measure lambda (λ) in the electrophysiological data shown below of an axon.



17. (2 points) Drug X, when applied to a nerve axon, results in both a gradual decrease in the amplitude of individual action potentials and a depolarization of the resting potential, both of which develop over a period of several hours. The drug is most likely:

- A. Blocking the voltage-dependent Na^+ permeability
- B. Blocking the voltage-dependent K^+ permeability
- C. Blocking the (Na^+ - K^+) pump
- D. Blocking the process of Na^+ inactivation
- E. Increasing the rate at which voltage-dependent changes in K^+ permeability occur

18. (2 points) How does depolarization of a neuron membrane cause an ion channel to open?

- a. Ions bind to the channel protein, causing it to change shape.
- b. Alteration of the electric field across the membrane causes a region of the channel protein to change conformation.
- c. A depolarization-dependent change in plasma membrane fluidity allows the channel to open.
- d. When depolarized, the membrane becomes more 'leaky', allowing uncharged molecules to enter the cell.

19. (2 points) If the equilibrium potential for chloride ions is equal to a cell's resting membrane potential, and chloride-specific channels in the plasma membrane are suddenly opened, what would most likely happen?

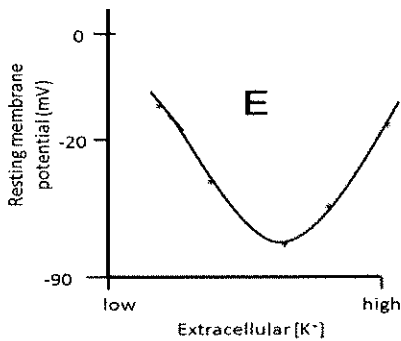
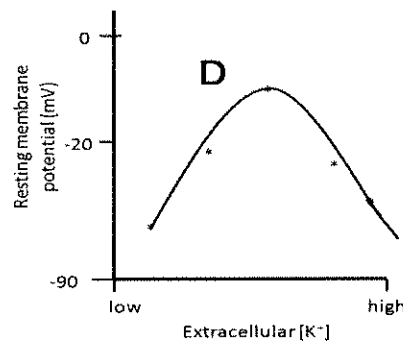
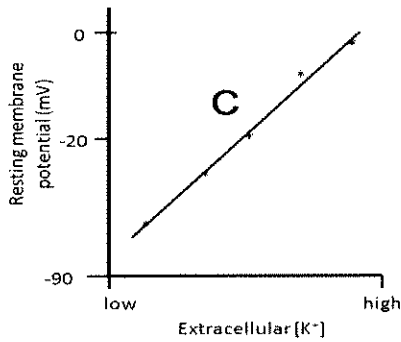
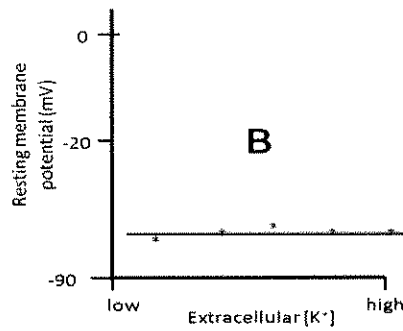
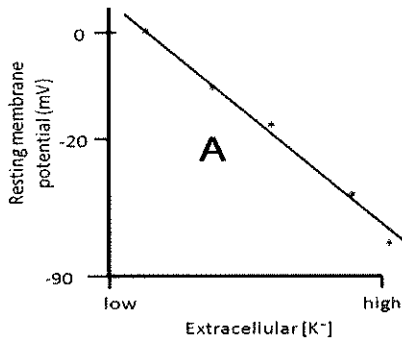
- a. Sodium ions would leave the cell rapidly.
- b. The membrane potential would become more negative.
- c. Chloride ions would leave the cell rapidly.
- d. The membrane potential would not change.
- e. The Na^+/K^+ ATPase pump would accelerate its action.

20. (2 points) Which of the following would NOT INCREASE the conduction velocity in an axon?

- a. Myelinating the axon
- b. Increasing the extracellular sodium concentration
- c. Increasing axon diameter
- d. Replacing the intracellular fluid with a fluid of lower electrical resistance
- e. Making internodes shorter

21. (4 points) Explain and discuss the differences between the Nernst equation and the Goldman-Hodgkin-Katz equation. What information is gained from these equations?

22. (4 points) Which of the following graphs is a logical representation of the findings that you or your class mates likely obtained from the experiments you conducted in the laboratory? Explain why you chose the answer you did.



23. (4 points total) **With respect to cellular metabolism (mark the correct answer 2 points)**

Why are the other choices not correct (2 points)

- A) Citric-acid cycle (or sometimes called the TCA or Krebs cycle) takes place in the cytosol.
- B) Glycolysis requires oxygen for the reactions to take place.
- C) The Citric-acid cycle and the electron transport chain reactions only take place under anaerobic conditions.
- D) the reactions of the electron transport chain take place in the mitochondria
- E) The reactions for the Citric-acid cycle take place in the nucleus.

24. (4 points) How does one get ATP produced from Fats, protein as well as glucose ? (explain with enough information to understand How this could work with going into each enzymatic step)

26. (4 points) In order to function properly, membranes must remain fluid. A key mechanism by which temperature conformers, like blue mussels, cope with changing temperatures is to vary the relative proportion of saturated and unsaturated fatty acids in their lipid membranes. To acclimatize to hot summer temperatures, these animals increase their membrane levels of _____

and how mechanistically would this help alter membrane function ?

27. (4 points) What would be the most likely reason that an action potential is not generated in the dendrites or on the soma of a motor neuron that is depolarized ? (Various answers could be correct... it is the logic I want you to use)

28. (2 Points) **The water that is produced from the end result of the electron transport chain is ?**

- a) ionic water
- b) heavy water
- c) metabolic water

29. (4 points) Tetrodotoxin (TTX) is generally associated with pufferfish, which in fact gain it from symbiotic bacteria residing in them. Interestingly, the pufferfish themselves aren't affected by this neurotoxin. The most plausible explanation for the fish's insensitivity to TTX is.....? (Explain with some logical answers). AT LEAST 2 reasonable answers for full credit.

30. MATCH 37-39 with the following (you can use an answer more than once):

- a) . . . typically occurs in gradual manner over many generations.
- b)....changes that occur within an individual's life time in natural conditions
- c)maintaining a consistent internal environment
- d)changes that occur within an individual's life time in laboratory conditions
- e)..... No changes over the animal's life time

37. (2 Points) ADAPTATION-

38. (2 Points) ACCLIMATIZATION-

39. (2 Points) ACCLIMATION-

40. (2 Points) What level of protein structure is a protein that is small with only 5 amino acids in a straight line?

- a) primary
- b) secondary
- c) tertiary
- d) quaternary

41. (2 Points) The structural basis for capacitance of a biological membrane are the channels ?

- A) True
- B) False

42. (5 points) With the data presented below please summarize the findings in words and relate to the physiological mechanisms.

The data ^{came} from a paper ^{The} "The Energy Metabolism of ~~the~~ Foot Muscle of the Jumping Cockle, *Cardium tuberculatum*: Sustained Anoxia Versus Muscular Activity* by Gerd Gaide

Table 2. Comparison of the ATP equivalents derived from arginine phosphate and from glycolysis in the foot of *C. tuberculatum* during 2 min of muscular activity (19–31 jumps) and after 10 h of anoxia

Physiological situation	ATP equivalents ^a		% of total ATP equivalents	
	Glycolysis	Arg-P	Glycolysis	Arg-P
Muscular activity	3.0	13.6	18	82
Anoxia	9.3	11.2	45	55

^a ATP equivalents for glycolysis are calculated from the changes in the concentrations of alanine (1.5), octopine (1.5), succinate (3.0) and D-lactate (1.5) compared to the control values. ATP equivalents for the different metabolic routes are given in brackets for each end product (see de Zwaan, 1977)

43. (5 points) Bonus now we are over a 100 points in the exam... **107 total points possible**)

Design a logical but hypothetical experiment to measure your oxygen consumption while taking this exam as compared to sleeping. Would there be any difference in O₂ use and why? What other parameters might one measure as an index of cellular metabolism and how do they relate to the experiment proposed?

