

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?

6. (5 points) Some studies in the medical literature indicate that the problem for this question may be an autoimmune disorder. Autoimmune disorders are caused when the body's natural defenses (e.g., antibodies) against "foreign" or invading organisms begin to attack healthy tissue for unknown reasons. Most of those affected have antibodies to glutamic acid decarboxylase (GAD), a protein in inhibitory nerve cells that is involved in the creation (synthesis) of the main inhibitory neurotransmitter called gamma-aminobutyric acid (GABA). The exact role that deficiency of GAD plays in the development of SPS is not fully understood. Antibodies to GAD-65 are associated with several other disorders including diabetes. In fact, GAD-65 is the most common antibody produced by people with autoimmune diabetes and many people have these antibodies in that context. In some individuals with SPS no antibodies to GAD are detectable. The cause of SPS in these individuals may ultimately be unknown (idiopathic), but testing for other causes (e.g. amphiphysin antibodies) is usually appropriate. More research is necessary to determine the exact, underlying mechanisms that ultimately cause of this disorder and the exact role that anti-GAD antibodies play in the development and progression of the disorder. The exact incidence and prevalence of this disorder is unknown, although one estimate places the incidence at approximately 1 in 1,000,000 individuals in the general population.

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

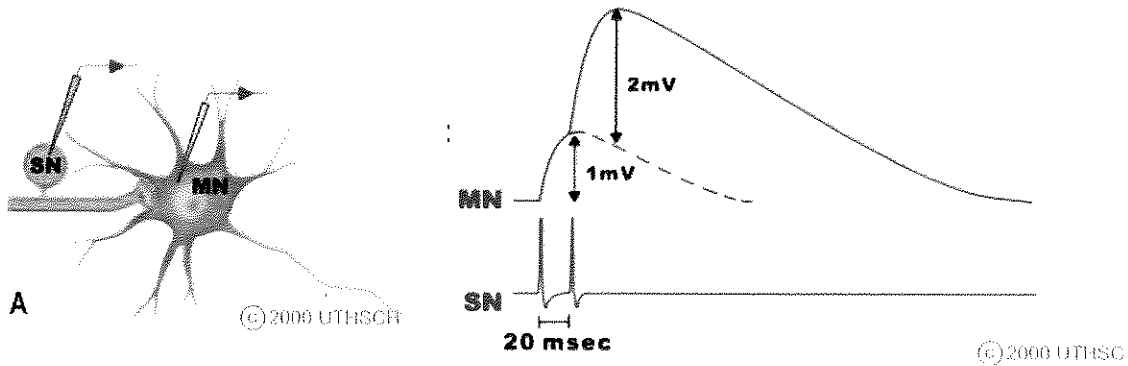
What do you think would happen over time to the individual and what type of body position might this person be in ? (WHY and LOGIC to your answers are needed)

7. (2 points) Passive diffusion of a gas through a biological membrane will require ATP.

A) True

B) False

8. (5 points) In the figure below the sensory neuron (SN) is stimulated and the motor neuron (Mn) is being recorded with an intracellular electrode. Explain the possible (logical) reasons why in such a short time the 2nd stimulus produced the response it does.



9. (2 points) Where does the process of glycolysis take place.

A) cell cytoplasm

B) inside the mitochondria cytoplasm

C) on the mitochondria inner membrane

10. (5 points) In a normal biological situation at rest for a cell, if the Na/K pump was blocked with an inhibitor what would be the most likely occur to the membrane potential and why? (Provide details) Over time hours what would likely happen to the cell and why would what you propose happen ?

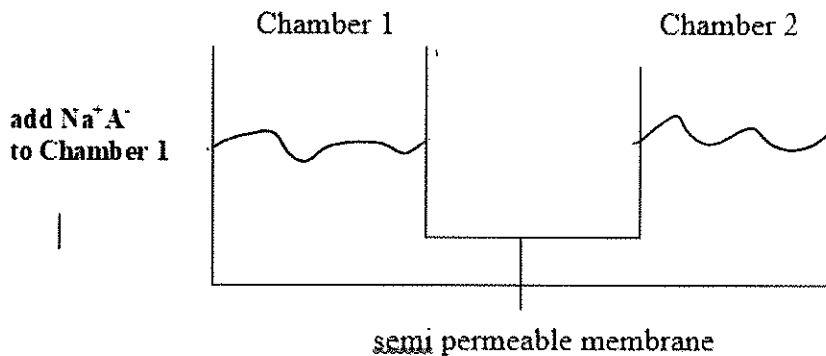
11. (4 points) The rate of glycolysis and the Krebs (TCA) cycle is regulated as not to break down all the glucose stores at once in cell by which general means? Give some general examples how the rate of glucose breakdown is regulated at a cell level.

12. (2 points) The potassium channels that are primarily responsible for repolarization of the plasma membrane after the initiation of an action potential are activated by

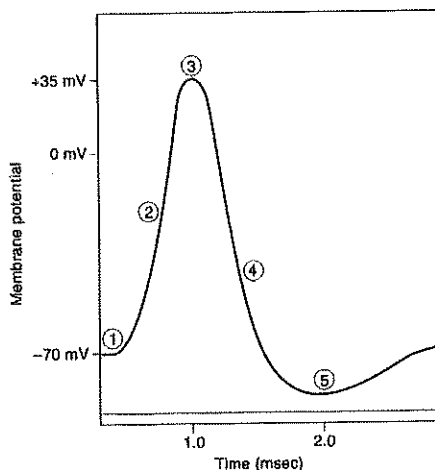
- a) cold temperature
- b) epinephrine
- c) cAMP
- d) membrane depolarization
- e) membrane hyperpolarization

13. (4 points) If a cell membrane has a longer time constant and a graded depolarizing potential was traveling along the dendrites towards the cell body and on to the base of a axon (where a high density of voltage gated sodium channels are located) would be it more likely to reach a threshold for generating an action potential than say a cell with a shorter time constant ? Explain your answer with drawings and text descriptions.

14. (4 points) If Na^+ and Cl^- are at equilibrium in chambers 1 & 2 across a semi permeable membrane, what will happen to the ion balance at equilibrium following the addition of Na^+ and A^- to chamber 1 (see diagram below). Assume that the semi permeable membrane is impermeable to A^- but permeable to both Na^+ and Cl^- . Also assume the chamber are half way filled with warm water. Explain the rationale for your answer.



15. (4 points) In the figure below, at which labeled point on the action potential is the K^+ closest to its electrochemical equilibrium? Also explain why you choose the answer you did based on the physiological concepts.



16. (5 points) In order to function properly, membranes must remain fluid. A key mechanism by which temperature conformers, like fish or a rodent, cope with changing temperatures is to vary the relative proportion of saturated and unsaturated fatty acids in their lipid membranes. List 3 various ways membranes can remain fluid by the physiological difference which could occur as animal conditions itself to warm temperatures. Explain your answers in how the membrane fluidity is changed use diagrams if that helps as well.

17. (2 points) The equilibrium potential for Na⁺ in a particular cell is +50 mV and the resting membrane potential is -60 mV. What is the net electrical driving force (i.e. emf for Na⁺) for Na⁺ while the cell is at rest ?

- a) 60 mV
- b) 50 mV
- c) 0 mV
- d) 110 mV
- e) 120 mV

18. (2 points) What term is given to the period of time in which a second action potential can not be initiated with a second stimulus even though the second stimulus has a greater current pulse?

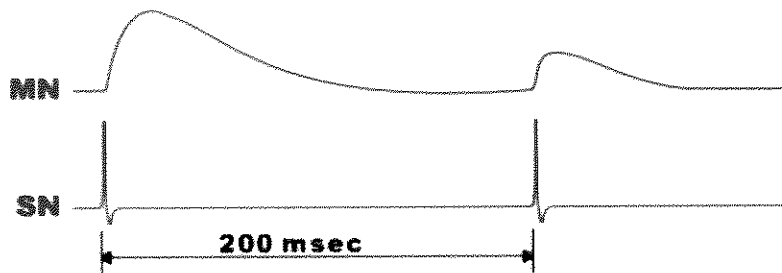
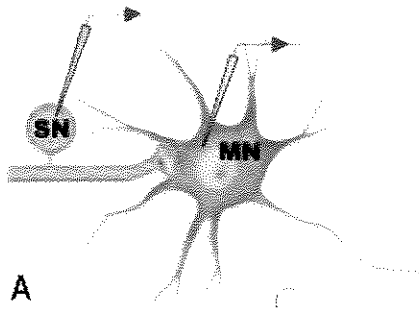
- A) depolarization
- B) relative refractory period
- C) absolute refractory period
- D) it is the time constant of the cell ($\tau = RC$)
- E) none of the above

19. (5 points) How would these factor below alter conduction velocity of an axon and why ?

- (i) decreasing axon diameter
- (ii) increasing membrane capacitance
- (iii) increasing axon diameter
- (iv) increasing the axial resistance in the cytoplasm of the cell
- (v) decreasing the membrane capacitance with many wrappings of myelination.

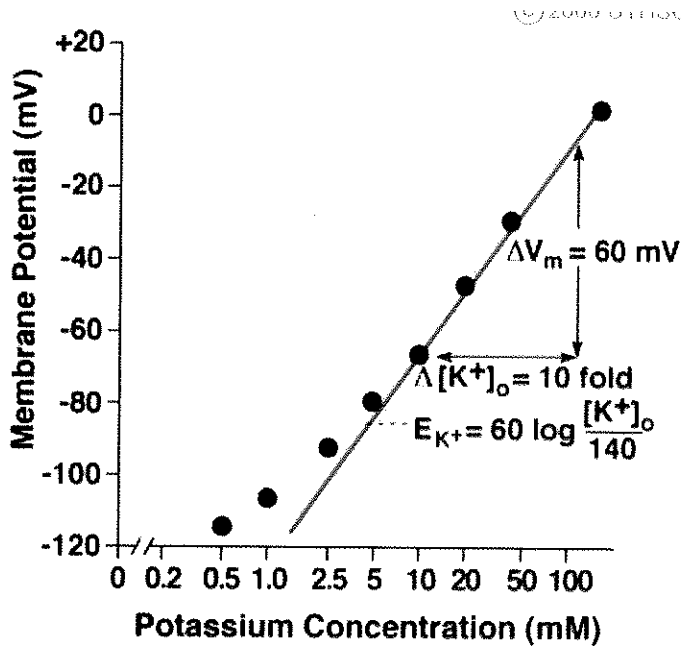
20. (5 points) If one injected calcium ions into the motor nerve terminal at the neuromuscular junction of a frog preparation, what would most likely occur initially and over time if a slow steady injection were to occur. Answer from the results as if one was recording in the muscle fiber with an intracellular electrode? (Use diagrams and text to explain your answers).

21. (5 points) In the figure below the sensory neuron (SN) is stimulated and the motor neuron (Mn) is being recorded with an intracellular electrode. Explain the possible (logical) reasons why in such a short time the 2nd stimulus produced the response it does.



22. (5 points) What is the evidence that an endplate potential is composed of smaller units called miniature endplate potentials. You may use diagrams and experimental techniques that used in the past to describe your reasoning.

23. (5 points) Explain the results below and the rationale for why the curve is shaped the way it is due to the physiological parameters of the cell being used to measure the membrane potentials.



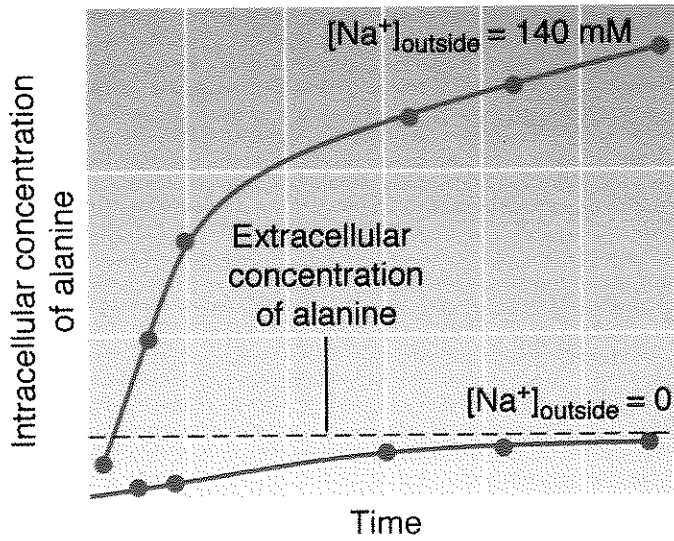
24. (4 points) Why might neurotransmitters be of the type shown in the table below? (give a couple of reasons)

Table 6-2 Typical small neurotransmitters, their structures, and functions

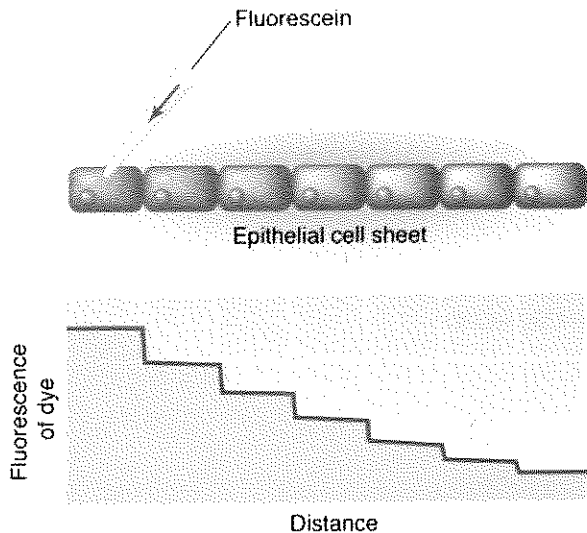
Neurotransmitter	Typical effects*	Structure
Acetylcholine (ACh)	Fast excitation; slow inhibition	$\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OCH}_2\text{CH}_2-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{N}^+}}-\text{CH}_3$
Glycine (Gly)	Fast inhibition	$\begin{array}{c} \text{H} \\ \\ \text{}^+\text{H}_3\text{N}-\text{C}-\text{H} \\ \\ \text{COO}^- \end{array}$
γ -Aminobutyric acid (GABA)	Fast inhibition; slow inhibition	$\text{}^+\text{H}_3\text{N}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{COO}^-$
Glutamate (Glu)	Fast excitation; slow change in postsynaptic metabolism	$\begin{array}{c} \text{H} \\ \\ \text{}^+\text{H}_3\text{N}-\text{C}-\text{CH}_2-\text{CH}_2-\text{COO}^- \\ \\ \text{COO}^- \end{array}$

*Notice that the effect of a neurotransmitter depends on the properties of the postsynaptic cell. For most neurotransmitters, however, it is possible to identify their most probable effect.

25. (4 points) In the figure below one is measuring the concentration of alanine in a cell over time. The two different conditions are having no Na⁺ in the bath as compared to having 140 mM Na⁺ in the bath. Why are there differences in the amount of alanine going into the cell over time and why is this change not instantaneous? (explain your answers with details).



26. (3 points) Injecting a dye on one cell starts to show up in the neighboring cells. What might be the most logical explanation for this phenomena based on what we covered in class? (3 points)



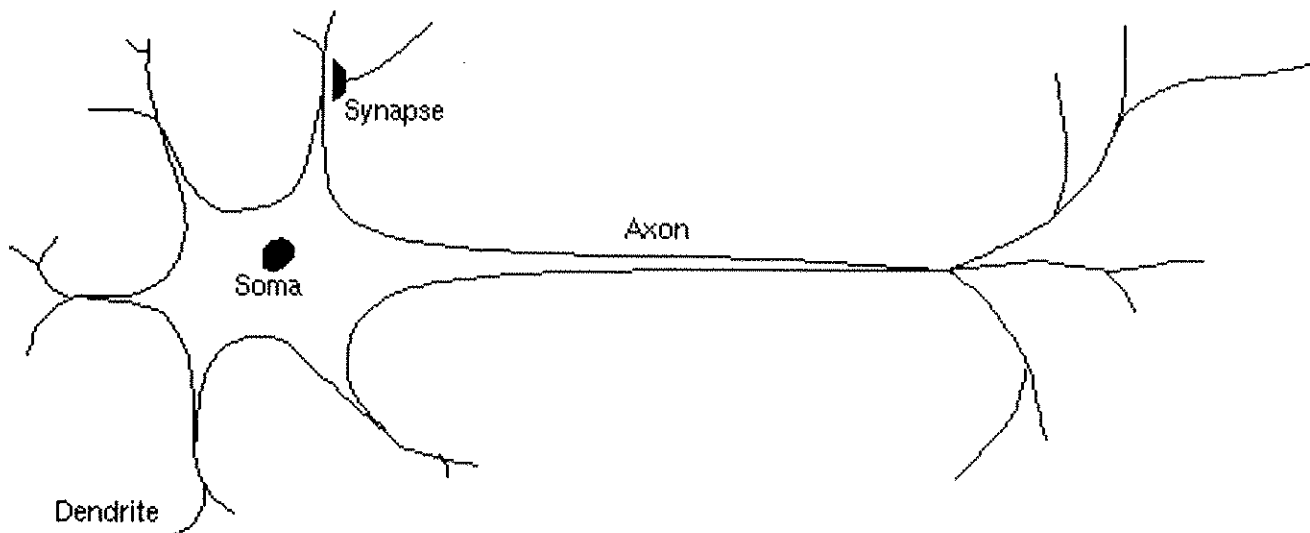
27. (2 points) What level of protein structure is a protein that is small with only 5 amino acids in a straight line?

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

28. (2 points) An ion channel can discriminate between ions of the same charge but different sizes going through the pore by.?

- a) the amino acid charges that line the pore
- b) the size of the pore
- c) the voltage-sensitive nature of the ion channel
- d) none of the above

29. (6 points) Design an experiment using multiple approaches which are feasible to examine where the site of initiating an action potential could be occurring in a neuron in a culture dish such as the one shown below. Details of the veracious experiments and what the experiment determines is required.



30. (5 points) In relation to the three graphs below explain the physiological properties occurring for the animals based on the data presented. What do the results mean in terms of physiological consequences for the animal? Interpretation of the data is needed.

Dehydration of Carabids

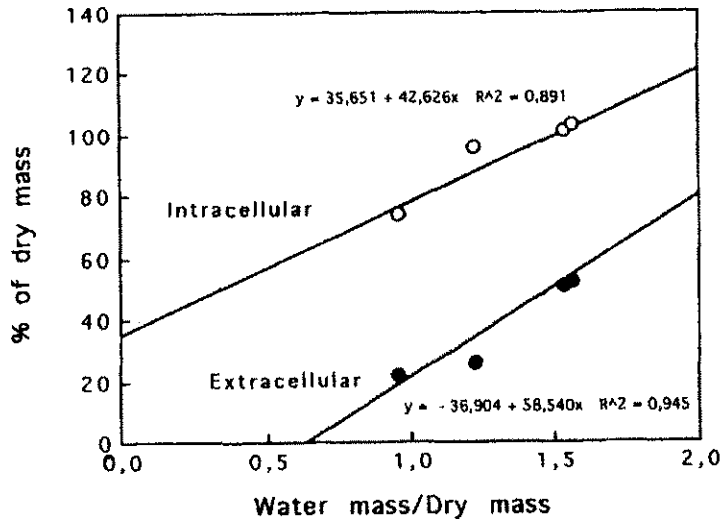


FIG. 1. Changes in extracellular (●) and intracellular (○) water content of beetles undergoing evaporative dehydration. Lines are linear regression lines for the tenebrionid beetles *Rhytinota praelonga*, taken from Zachariassen and Einarson (24). The points represent corresponding values for four *Cyphaloba* beetles.

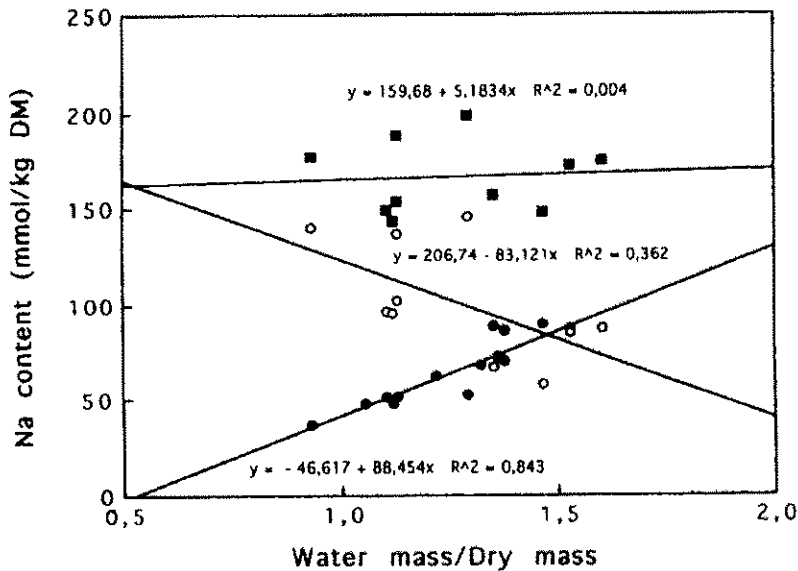


FIG. 7. Sodium content in extracellular (●), intracellular (○) body fluid and whole body (■) of *Cyphaloba* carabid beetles undergoing evaporative dehydration plotted as a function of the quotient between body water mass and dry body mass. Each point represents one individual. Lines are calculated linear regression lines of the two groups of data points.

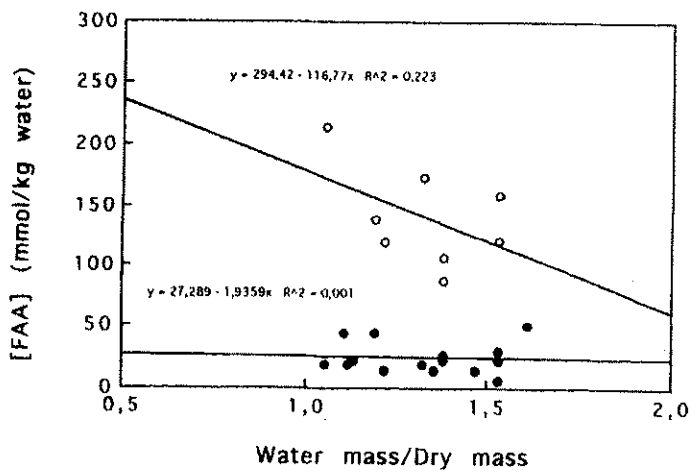


FIG. 8. Extracellular (●) and intracellular (○) concentrations of free amino acids of *Cyphaloba* carabid beetles undergoing evaporative dehydration plotted as a function of the quotient between body water mass and dry body mass. The concentrations were measured as concentration of taurine equivalents of free ninhydrin positive substances. Each point represents one individual. Solid lines are calculated linear regression lines.

