Biology 2100 – Human Physiology Name: _____**KEY**_____
C. Iltis – Section: _002__ Exam #_____

Midterm Examination #1

Directions: Put your name on this exam and on your scantron form. Fill in the scantron form as shown below. In the space where it says "Test No." transfer the "Exam#" that is written in on this exam just below the line for your name.

You may write on this exam. However, you must answer all of the questions on the scantron form provided for you in order to receive credit for your answers. The answers on your scantron are the only ones that count so fill them in carefully! Essay questions should be answered on this exam form.

Multiple Choice/Matching Questions (2 points each)

1. Which of the following statements regarding the diffusion of nonpolar (hydrophobic) solutes across cell membranes is correct?
   A. At equilibrium for solute X, the flux of X across cell membranes is zero.
   B. At equilibrium for solute X, the NET flux of X across cell membranes is zero.
   C. At equilibrium for solute X, the concentration of X inside the cell is equal to its concentration outside the cell.
   D. both A and C are correct.
   E. both B and C are correct.

2. Which of the following types of membrane transport demonstrate a transport maximum?
   A. simple diffusion through the lipid bilayer
   B. simple diffusion through a protein channel
   C. facilitated diffusion
   D. osmosis
   E. all of the above

3. "Osmosis" refers to the movement of _____ across semi-permeable membranes.
   A. glucose **B. water** C. lipids D. ions E. sodium

4. If pure water and a solution containing a *nonpenetrating* solute are separated by a membrane that *is* permeable to water,
   A. No movements will occur between the compartments
   B. Both water and the solute will diffuse across the membrane down their concentration gradients until a state of equilibrium is established.
   C. Water will diffuse down its concentration gradient until the water concentrations in the two compartments become equal.
   D. The solute will diffuse down its concentration gradient until its concentration in the two compartments becomes equal.
   E. none of the above are correct.

5. Which of the following statements about the sodium potassium pump is FALSE?
   A. It is constantly active in all cells.
   B. It transports sodium out of the cell and potassium into the cell
   C. It binds to and hydrolyzes (splits) ATP
   D. Its activity requires the expenditure of energy
   E. It transports sodium and potassium in a 1:1 ratio

6. Carrier-mediated transport:
   A. Always requires the direct expenditure of energy
   B. Involves a specific membrane protein that functions as a carrier molecule.
   C. Always involves the movement of substances against a concentration gradient.
   D. All of the above are true
   E. B and C only

7. Which of the following mechanisms is used to transport glucose into a cell against a concentration gradient?
   A. Simple diffusion through lipid bilayer
   B. Simple diffusion through a protein channel
   C. Facilitated diffusion
   D. Primary active transport
   E. Secondary active transport

8. The concentration gradient for potassium:
   A. Is maintained by the sodium/potassium pump
   B. Favors its movement into the cell at resting membrane potential
   C. Favors its movement out of the cell at resting membrane potential
   D. Both A and B are correct
   E. Both A and C are correct

9. When a scientist graphs data, which of the following goes on the vertical (Y) axis? (Fill in ALL statements that are correct).
   A. The independent variable
   B. The dependent variable
   C. The data the scientist measured
   D. The data the scientist set at the outset of the experiment.

10. Membrane Potential
   A. refers to a separation of charges across the membrane.
   B. Is measured in units of millivolts, with the sign always designating the charge on the inside of the membrane
   C. Is more negative at the equilibrium potential for potassium than at resting membrane potential
   D. All of the above are correct
   E. Only A and B are correct

11. Which of the following is a feature that distinguishes active transport from facilitated diffusion?
   A. Carrier proteins show saturation.
   B. Requirement for a carrier molecule
   C. Specificity for the substance to be transported
   D. Presence of a transport maximum (T_m)
   E. Requirement for energy input

Matching Questions (Questions 12 - 19)

Match the molecule in column A with the appropriate method of transport across the cell membrane in column B. (You will end up using some answer choices more than once)

Column A	**Column B**
12. Sodium (into the cell) **D**	a) facilitated diffusion
13. Carbon Dioxide **D**	b) primary active transport
14. Estrogen (a steroid hormone) **D**	c) secondary active transport
15. Oxygen **D**	d) simple diffusion
16. Potassium (into the cell) **B**	e) osmosis
17. Potassium (out of the cell) **D**	
18. Glucose (along a concentration gradient) **A**	
19. Glucose (against a concentration gradient) **C**	

You are given a cell with a solute concentration of 10% inside the cell. If you put the cell into a solution with the solute concentrations given in column A, what is the correct term in column B that describes the solute concentration of the extracellular environment?

A	**B**
Solute concentration of the ECF	**The extracellular environment is _____with respect to A.**
20. 25% **A**	a) hypertonic
21. 10% **C**	b) hypotonic
22. 5% **B**	c) isotonic

The following terms relate to action potentials. Match each definition in column A with the associated word in column B.

Column A	**Column B**
23. Occurs after voltage-gated sodium channels close and voltage-gated potassium channels open. **C**	a. depolarization
24. Occurs after opening of voltage-gated sodium channels. **A**	b. hyperpolarization
25. The point at which a cell is depolarized enough to initiate the positive feedback loop involving opening of sodium channels. **D**	c. repolarization
26. A membrane potential between -70 and -90 millivolts. **B**	d. threshold
27. At this voltage, the cell is relatively impermeable to sodium. **E**	e. resting membrane potential

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28. For an action potential to occur:
    - A. The stimulus must reach or exceed threshold
    - B. Sodium influx must exceed potassium efflux
    - C. The membrane must be out of the absolute refractory period
    - **D. All of the above are correct**
    - E. Only A and B are correct

29. The relative refractory period of an action potential coincides with the period of:
    - A. Activation and inactivation of voltage-gated sodium channels
    - B. Increased sodium flux into the cell
    - **C. Increased potassium flux out of the cell**
    - D. Increased potassium flux into the cell
    - E. Increased sodium flux out of the cell.

30. For an excitable cell, the neural code that signals stimulus strength is:
    - A. The size of action potentials
    - **B. The frequency of action potentials**
    - C. The duration of action potentials
    - D. All of the above
    - E. Only A and B are correct

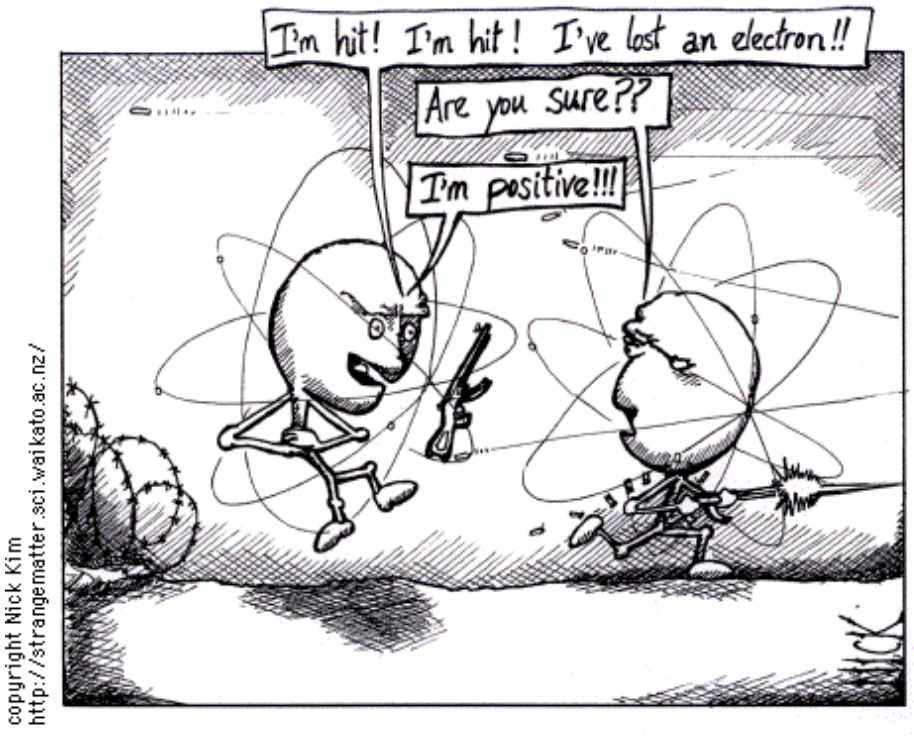
31. Which of the following is true regarding the equilibrium potential of a given ion across a membrane?
    A. It is a function of the concentration of that ion on both sides of the membrane.
    B. It is the potential at which there is no net movement of that ion across the membrane.
    C. It is the potential across the membrane at which the flux due to the electrical gradient is equal in magnitude, but opposite in direction, to the flux due to the concentration gradient for the ion in question.
    D. All of the above are correct
    E. Only A and C are correct

32. True or False. With a graded potential, the intensity of the stimulus is coded for by the frequency of potentials.
    A. True **B. False**

33. True or False: Graded potentials can be either depolarizing or hyperpolarizing.
    A. True B. False

34. The primary mechanism by which the human body maintains homeostasis is via:
    A. secondary active transport B. positive feedback loop
    C. primary active transport **D. negative feedback loops**
    E. none of the above

35. The control of physiological functions, whether via positive or negative feedback mechanisms, generally involves an integrating center. Which body organ most often serves as the integrating center?
    A. the heart B. the lungs **C. the brain** D. the skin E. the kidneys



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Essay/Short Answer Questions (15 points each)

1. In the space below, draw a graph of an action potential. Be sure to include all of the following points on your graph.

RMP E_{Na+} E_{K+} Threshold 0 mV

In the space below your graph, describe the sequence of events that occurs during each phase of an action potential. Be sure to include all of the following terms in your response:

RMP	positive feedback loop	afterhyperpolarization
Depolarization	repolarization	voltage-gated
Threshold	peak	

SEE THE ACTION POTENTIAL HANDOUT IN YOUR NOTES PACKET FOR THE ANSWER.

2. Using the Nernst Equation, calculate the equilibrium potential for Calcium using the information given below: (15 points total)
BE SURE TO SHOW ALL YOUR WORK FOR FULL AND/OR (especially!) PARTIAL CREDIT!

Concentration of Calcium in the ICF	0.001 mmol
Concentration of Calcium in the ECF	1.8 mmol
Charge carried by Calcium ion:	+2

A. Write the Nernst Equation and explain what each variable (symbol) stands for. (5 points)

$$E_x = \frac{61}{Z} \log \frac{Co}{Ci}$$

E_x = equilibrium potential for ion X
Z = valence (charge) of the ion in question
Co = concentration of the ion in the ECF
Ci = concentration of the ion in the ICF

B. Enter appropriate values for Calcium into the Nernst Equation (5 points)

$$E_{Ca} = \frac{61}{2} \log \frac{1.8}{.001}$$

C. Calculate your results (be sure to include units in your answer!). (5 points)

E_{Ca} = (30.5) log (1800)

E_{Ca} = (30.5) (3.25)

E_{Ca} = + 99 mV

D. (+5 Bonus) Does your answer make sense to you? Why or why not?

Yes. At rest, both the chemical and electrical gradients for Calcium are directed into the cell. Thus, there is a huge driving force for Calcium to enter the cell. In addition, because Calcium has a valence of +2, each one ion that enters the cell brings with it 2 positive charges. The equilibrium potential for Calcium is very positive (+99) and this is expected.