

DEPARTMENT OF PHYSIOLOGY AND BIOPHYSICS
SCHOOL OF MEDICINE AND THE GRADUATE SCHOOL

HUMAN PHYSIOLOGY

FIRST EXAMINATION

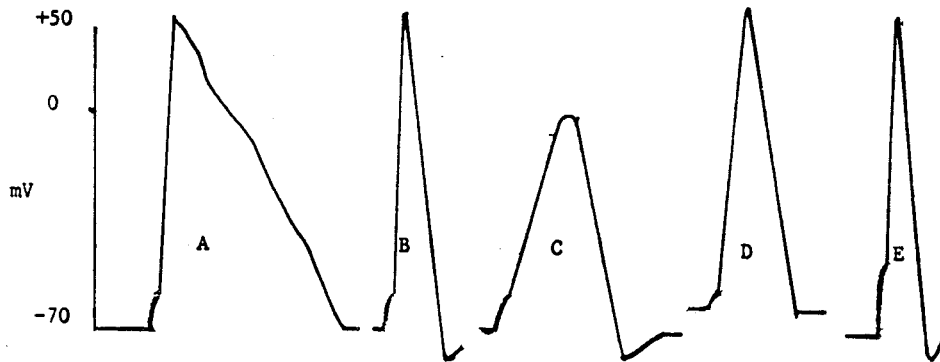
MONDAY, FEBRUARY 13, 1995

Instructions for Use of Optical Scan Answer Sheet

1. DO NOT bend fold or tear answer sheet in any way.
2. Use ONLY a #2 pencil. DO NOT use a pen.
3. DO NOT make any marks along the edge with the black lines. The computer will not be able to grade your sheet if you do so.
4. Print your name (last name first) in the boxes provided on the sheet.
5. Darken the blanks which correspond to each letter in your name and initial.
6. In the box marked "Student I.D. Number" write your 7-digit identifying number. DO NOT WRITE IN YOUR SOCIAL SECURITY NUMBER! Darken the corresponding number box.
7. For each question, darken the letter blank which corresponds to the correct answer. DO NOT write in more than one answer -- the computer will reject your answer sheet and it will be marked wrong (i.e. no credit). Erase thoroughly any mismarked blanks.
8. NO EXTRA TIME WILL BE ALLOWED TO TRANSCRIBE ANSWERS ONTO THE ANSWER SHEET.
9. IF YOU DO NOT FOLLOW THE ABOVE INSTRUCTIONS, IT WILL NOT BE POSSIBLE TO GRADE YOUR EXAM.

5. A student weighing 50 kg drinks a six-pack of diet soda (each can is 350 ml and contains 3.5 mosmoles of solute). Assuming all the contents of the cans were absorbed and no losses occurred (and her initial osmolality was 300 mOsm/L), the osmolality of the extracellular fluid after osmotic equilibration would be approximately
- A. 249 mOsm/L
 - B. 272 mOsm/L
 - C. 281 mOsm/L
 - D. 290 mOsm/L
 - E. 300 mOsm/L
6. Select the **FALSE** statement concerning fluid movement across a capillary endothelium.
- A. Filtration exceeds reabsorption when the net (capillary minus interstitial fluid) hydrostatic pressure exceeds the net oncotic pressure.
 - B. Edema often occurs when albumin synthesis by the liver is substantially reduced.
 - C. An increase in the plasma sodium concentration will increase net fluid uptake into a capillary.
 - D. An increase in interstitial hydrostatic pressure will favor fluid uptake into a capillary.
 - E. Plasma oncotic pressure is always greater than interstitial oncotic pressure.
7. Primary active transport
- A. utilizes the concentration gradient of an ion as a primary driving force.
 - B. involves direct coupling of the transporter to hydrolysis of high energy bonds.
 - C. increases for substances with a high partition coefficient.
 - D. is described by the Fick equation.
 - E. is dependent on the binding of a second molecule to the transporter.
8. Select the **FALSE** statement about membrane capacitance.
- A. It is created by the presence of channels in the membrane.
 - B. It alters the time it takes to change the voltage across the membrane.
 - C. It allows charge to be stored on the membrane.
 - D. It is a factor in the time constant, tau.
 - E. It minimizes the number of ions that move for each voltage change across the membrane

For questions 9-11 refer to the diagram provided below:



9. Which of the axonal action potentials above would be most typically seen when the concentration of Na^+ in the external medium was significantly reduced from its normal value?
 - A. A
 - B. B
 - C. C
 - D. D
 - E. E

10. Which of the axonal action potentials above would be most typically seen when the inactivation of the voltage-gated Na^+ channel was significantly slowed?
 - A. A
 - B. B
 - C. C
 - D. D
 - E. E

11. Which of the axonal action potentials above would be most typically seen when the level of Ca^{++} in the external medium was increased above its normal value?
 - A. A
 - B. B
 - C. C
 - D. D
 - E. E

For questions 12 - 14 refer to the diagram below.

Note: A^- is an impermeant anion; $\log 5 = .699$

OUTSIDE	INSIDE
10 mM Na^+	100 mM Na^+
100 mM Cl^-	5 mM Cl^-
50 mM K^+	5 mM K^+
50 mM X^+	50 mM X^+
10 A^-	150 A^-

12. The resting potential for the experimental cell pictured above is a Nernst potential for Na^+ . Select the TRUE statement.
- A. The resting potential is a steady state, not an electrochemical equilibrium.
 - B. The value of the potential is -100 mV.
 - C. The membrane is solely permeable to Na^+ .
 - D. I_{Na} is zero at +60 mV.
 - E. Changing external Na^+ concentration would have no effect on the resting potential.
13. The membrane potential for the cell pictured above suddenly changes to -70 mV. This potential could be generated when,
- A. $V_m = E_{Cl}$
 - B. $P_{Na} > P_K$
 - C. $P_K \gg P_{Cl}$
 - D. $V_m = E_X$
 - E. $P_{Cl} \gg P_K$
14. An experiment is performed where the above cell is treated with a drug. A voltage clamp of the cell showed that the conductance for Cl^- and K^+ , in the presence of the drug, was the same (10×10^{-6} Siemens). The value of the new membrane potential produced was:
- A. 0 mV
 - B. -78 mV
 - C. -69 mV
 - D. -9 mV
 - E. +60 mV

15. The treatment of a cell membrane with a neurotransmitter results in a rapid conductance change and a depolarization. The channel involved in this process is most likely a
- A. non-gated channel.
 - B. symporter.
 - C. secondary ligand-gated channel.
 - D. voltage-gated channel.
 - E. primary ligand-gated channel.
16. An unknown non-ionic substance, 'x', is found to move into a cell. Which of the following would clearly identify the movement of 'x' as simple diffusion?
- A. Movement of 'x' into the cell is against a concentration gradient.
 - B. Metabolic energy is required for the movement of 'x'.
 - C. The flux of 'x' is dependent on a concentration gradient into the cell.
 - D. Movement of 'x' can be competitively inhibited.
 - E. The relationship between flux of 'x' and the concentration in the outside medium is linear over all concentrations.
17. A resting potential of a cell hyperpolarizes when the medium is changed. This hyperpolarization is most readily explained if the new medium contained
- A. less potassium than normal.
 - B. more sodium than normal.
 - C. an inhibitor of mitochondrial oxidative phosphorylation.
 - D. more calcium than normal.
 - E. ouabain (digitalis).
18. Select the FALSE statement about the Na/K pump.
- A. It is electrogenic.
 - B. It keeps the membrane potential at the equilibrium potential for K^+ .
 - C. It offsets the net fluxes of K^+ and Na^+ across the membrane.
 - D. It contributes to the maintenance of the membrane potential steady state.
 - E. It utilizes about 2/3 of the ATP production of a typical neuron.
19. Which ionic channel would produce the greatest amount of membrane depolarization when it is opened by a neurotransmitter?
- A. A channel specifically permeable to Ca^{2+} .
 - B. A channel equally permeable to K^+ and Na^+ .
 - C. A channel specifically permeable to K^+ .
 - D. A channel equally permeable to K^+ , Na^+ , and Ca^{2+} .
 - E. A channel specifically permeable to Na^+ .

20. The relationship between membrane potential and the log of the external concentration of K^+ ion was plotted for an unknown cell. When the slope of this curve was found, it had a value of about 50. This most likely means that
- A. an accurate value of the membrane potential can be calculated by using the Nernst potential for K^+ .
 - B. no net flux of ions is seen.
 - C. the Goldman-Hodgkin-Katz equation is a better estimate of V_m than the Nernst in this case.
 - D. the membrane potential will not change when the external concentration of K^+ is changed.
 - E. the cell membrane is permeable only to K^+ .
21. Select the **FALSE** statement about the K^+ conductance associated with the axonal action potential.
- A. The peak of K^+ conductance coincides with the peak of Na^+ conductance.
 - B. The increase in K^+ conductance produces the hyperpolarization after the spike.
 - C. K^+ conductance is voltage dependent.
 - D. K^+ conductance demonstrates the same threshold for activation as the Na^+ conductance.
 - E. K^+ conductance is associated with the relative refractory period.
22. The spread of local currents during propagation of an axonal action potential
- A. is decremental with distance from the source of the current.
 - B. is dependent only on internal resistance.
 - C. can be described by the time constant, τ .
 - D. is unidirectional.
 - E. is independent of the axon diameter.
23. Select the **FALSE** statement about the node of Ranvier.
- A. It has few, if any, axonal voltage-gated K^+ channels.
 - B. It has a low density of voltage-gated Na^+ channels.
 - C. It is the recharging zone for current spread during saltatory conduction.
 - D. It is not wrapped with myelin.
 - E. It has a high density of Na^+/K^+ pumps.

24. A typical excitatory end plate potential
- A. is propagated along the sarcolemma.
 - B. is created by the sequential opening and closing of separate Na and K channels.
 - C. has an overshoot similar to an axonal action potential.
 - D. is terminated by the removal of the neurotransmitter.
 - E. is produced by the opening of a single channel with high permeability to sodium and low permeability to potassium.
25. The demyelination seen during multiple sclerosis
- ~~A.~~ decreases the membrane capacitance in the affected areas.
 - ~~B.~~ is inhibited by heat.
 - ~~C.~~ results in a shorter space constant.
 - ~~D.~~ increases conduction velocity of the affected nerve.
 - E. affects peripheral nerves only.
26. Select the **FALSE** statement regarding the release of acetylcholine at the neuromuscular junction.
- A. The release of vesicles can be modified by second messenger-induced processes.
 - B. The entry of calcium into the nerve terminal is voltage-dependent.
 - C. Synaptic vesicles docked at the release site undergo exocytosis when intraterminal calcium levels rise.
 - D. The increase in nerve terminal calcium levels during transmitter release is due primarily to the release of calcium from internal stores such as the endoplasmic reticulum.
 - E. Recycling of vesicles occurs at coated pits.
27. Stimulation of an α -motorneuron always results in activation of the muscle fibers in the motor unit because
- A. the skeletal muscle fibers are electrically coupled.
 - B. the amount of acetylcholine released from each nerve terminal per impulse is more than enough to stimulate a muscle action potential.
 - C. acetylcholine receptors are located on all regions of the muscle fiber surface.
 - D. acetylcholine directly opens voltage-gated calcium channels on the muscle fiber membrane.
 - E. the end plate potential has a large, depolarizing overshoot like the axonal action potential

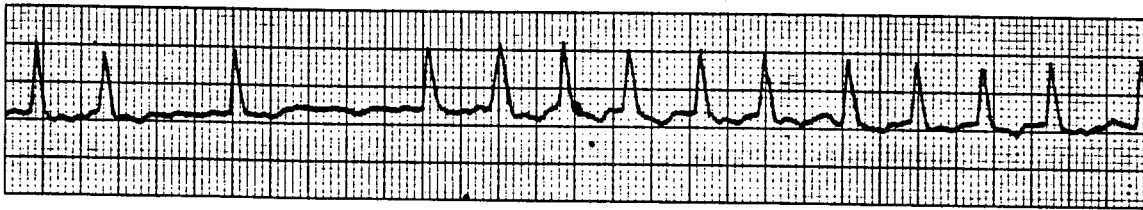
28. Myoglobin
- A. is a calcium transporter found only in red muscle.
 - B. is associated with Type II motor units.
 - C. provides a rapid source of glycogen for metabolism.
 - D. provides an increased amount of oxygen for oxidative metabolism.
 - E. increases the $V_{\max}$ of the force-velocity relationship.
29. Which of the following is an important factor in the "moment-to-moment" regulation of skeletal muscle fibers?
- A. an increase in the muscle fiber diameter
 - B. hyperplasia
 - C. the length-tension relationship
 - D. steroid hormones
 - E. the recruitment of motor units
30. Inhibition of cross-bridge cycling in normal skeletal muscle is directly due to
- A. lack of ATP.
 - B. the decremental voltage decay of the end plate potential.
 - C. a decrease in phosphocreatine concentrations.
 - D. the action of acetylcholinesterase.
 - E. active uptake of Ca^{++} into the SR.
31. The interaction of calcium ions with troponin on the actin filaments
- A. allows the dissociation of ATP from the myosin head.
 - B. induces phosphorylation of the actin active site.
 - C. causes troponin to diffuse away from actin thereby directly releasing the inhibition over the actin active site.
 - D. activates the ATPase on the actin molecule.
 - E. removes the inhibition of tropomyosin over the actin active site.
32. When a sarcomere is stretched so that the overlap between actin and myosin is reduced, less tension is produced because
- A. the speed of ATP hydrolysis is decreased.
 - B. fewer crossbridges are formed.
 - C. the parallel elastic elements are overstretched.
 - D. the distance for calcium diffusion is increased.
 - E. the myosin aggregate dissociates into individual units.

33. Select the FALSE statement about the voltage sensor in the T-tubule membrane of skeletal muscle.
- A. It is identical to the N- or P-type voltage-gated Ca^{++} channel seen in nerve terminals.
 - B. It senses the depolarization of the T-tubule membrane.
 - C. It initiates the opening of Ca^{++} channels on the SR membrane.
 - D. Its action is associated with the 'fast' release phase for Ca^{++} .
 - E. It is inhibited by dihydropyridine.
34. According to the force-velocity relationship for contraction of a skeletal muscle
- A. the maximal rate of shortening occurs over a wide range of loads.
 - B. the relationship between force and velocity is a bell-shaped curve, demonstrating a maximum velocity at the peak of the curve.
 - C. the highest rate of shortening occurs at the lightest load.
 - D. V_{max} is the same for all muscle types.
 - E. there is no point on this curve which corresponds to isometric contraction.
35. Contraction in smooth muscle compared to skeletal muscle
- A. has a faster, but a more sustained level of crossbridge cycling.
 - B. involves interaction of calmodulin with the actin active site.
 - C. is inhibited by the action of a myosin light chain phosphatase which removes a phosphate group from myosin.
 - D. is not dependent on a rise in intracellular calcium.
 - E. uses a protein called the 'intermediate filament' instead of myosin.
36. Select the FALSE statement about a unitary smooth muscle.
- A. It is typically found in the lining of hollow organs like the GI tract or uterus.
 - B. It is mechanically coupled by special connective tissue fibers and by dense membrane patches.
 - C. It is electrically coupled by the presence of gap junctions in the membrane.
 - D. It has receptor operated calcium channels.
 - E. Each muscle is innervated by one nerve fiber.
37. The parasympathetic nerves have a greater influence than the sympathetic nerves on which of the following?
- A. vasodilation
 - B. gastrointestinal motility and secretion
 - C. increasing the use of energy stores in the liver
 - D. the 'fight or flight' response
 - E. kidney

38. Drugs that increase acetylcholine (ACh)-mediated transmission, such as inhibitors of acetylcholinesterase, affect sympathetic and parasympathetic responses because
- A. ACh is the neurotransmitter at all sympathetic and parasympathetic post-ganglionic junctions.
 - B. ACh is the only neurotransmitter involved in the peripheral leg of the autonomic nervous system.
 - C. ACh receptors are located on all organs supplied by the autonomic nervous system.
 - D. ACh is the transmitter at all pre-ganglionic synapses.
 - E. ACh has both inhibitory and excitatory actions.
39. The sympathetic nerves are characterized by the presence of
- A. short pre-ganglionic fibers.
 - B. short post-ganglionic fibers.
 - C. a cranial-sacral outflow.
 - D. nicotinic and muscarinic receptors on end organs.
 - E. ganglia near the end organ.
40. The region of fastest conduction within the heart is the
- A. S-A node.
 - B. atrium.
 - C. A-V node.
 - D. His-Purkinje system.
 - E. ventricular epicardium.
41. The His-Purkinje system is characterized by all of the following EXCEPT
- A. large cellular size.
 - B. large, complex gap junctions.
 - C. high density of myofibrils.
 - D. large sodium influx during action potential upstroke.
 - E. resting potential of approximately -90mV.
42. In the S-A node, all of the following are correct EXCEPT
- A. action potentials arise from a resting potential of about -60mV.
 - B. action potential upstroke is carried primarily by sodium ions.
 - C. diastolic depolarization is accompanied by a continuing decrease of potassium conductance.
 - D. gap junctions are sparse.
 - E. potassium currents cause repolarization.

43. During coronary occlusion leading to local ischemia, in the ischemic area
- A. resting potential is approximately -90mV .
 - B. action potential duration decreases.
 - C. conduction velocity is increases.
 - D. extracellular potassium decreases.
 - E. intracellular sodium decreases.
44. During sympathetic stimulation to the heart
- A. R-R interval increases.
 - B. action potential duration increases.
 - C. action potential upstroke velocity decreases.
 - D. rate of diastolic depolarization increases.
 - E. resting potential decreases.

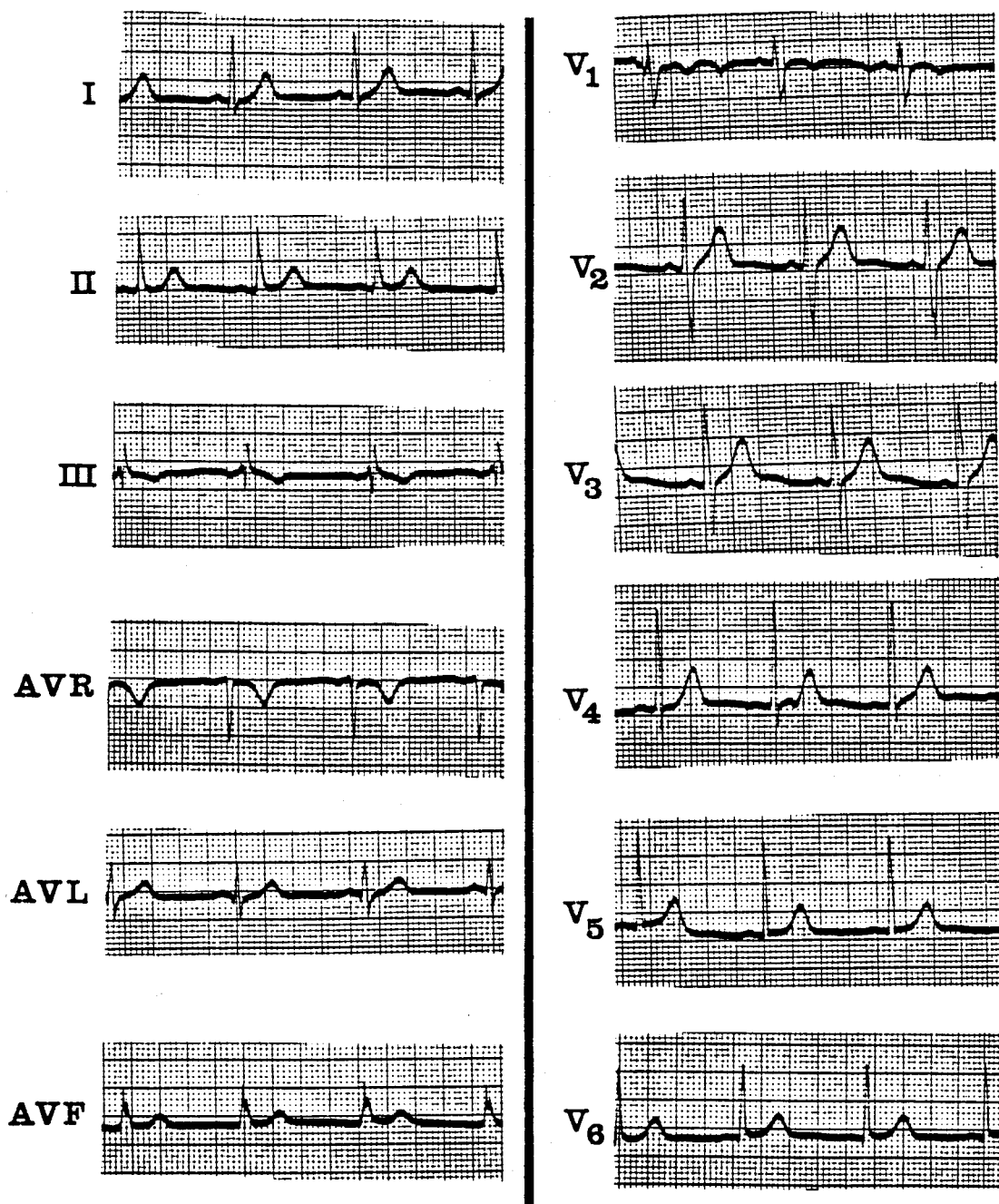
Use the following ECG for questions 45 and 46.



45. In the electrocardiogram shown above, all of the following are correct EXCEPT
- A. the ventricular rhythm is irregular.
 - B. the upward deflections are caused by ventricular excitations.
 - C. each QRS complex is preceded by a P-wave.
 - D. premature ventricular complexes are absent.
 - E. QRS duration is normal.
46. Based on your observations, the patient probably has
- A. ventricular fibrillation.
 - B. A-V block.
 - C. sinus node dysfunction.
 - D. atrial fibrillation.
 - E. ventricular flutter.

47. In ventricular cells
- A. the action potential upstroke velocity depends on the preceding cycle length.
 - B. action potential duration is dependent on the preceding cycle length.
 - C. action potential upstroke velocity depends on calcium current magnitude.
 - D. Na/Ca exchange stops during diastole.
 - E. diastolic depolarization takes place in ventricular cells.
48. Conditions conducive to ventricular fibrillation include all of the following EXCEPT
- A. atrial fibrillation.
 - B. myocardial infarction.
 - C. increased extracellular potassium.
 - D. premature extrasystoles.
 - E. localized conduction block.
49. Select the FALSE statement regarding overdrive suppression.
- A. It is preceded by a period of rapid beating.
 - B. It is related to sodium pump activity.
 - C. It can be observed following acute A-V block.
 - D. It usually resolves spontaneously.
 - E. It is caused by increased calcium channel activity.
50. In an ECG
- A. heart rate is assessed from the P-Q interval.
 - B. ventricular action potential duration is assessed by the Q-T interval.
 - C. presence of 1st degree A-V block is assessed from the R-R interval.
 - D. presence of slow ventricular conduction is assessed from the T-P interval.
 - E. presence of atrial fibrillation is assessed from the T-wave.
51. Compared to ventricular cells, A-V nodal cells have a
- A. higher density of myofibrils.
 - B. similar resting potential.
 - C. similar mechanism of repolarization.
 - D. greater density of gap junctions.
 - E. larger size.

For questions 52 and 53 use the tracings below. A patient comes into the hospital complaining of chest pain. You obtain the following electrocardiogram.



52. What is the patient's heart rate in beats per minute?

- A. 40
- B. 70
- C. 100
- D. 120
- E. 150

53. Based on this electrocardiogram, you must decide whether to admit the patient or send him home. You decide that he
- A. has chronic left ventricular enlargement which should be checked
 - B. has a severe myocardial infarction and should be admitted
 - C. has normal ECG and may be sent home with an anti-gas medication
 - D. is in atrial fibrillation and should be admitted
 - E. is in A-V block and needs a pacemaker
54. Compared with nerve cells, ventricular cells have
- A. a shorter action potential duration.
 - B. a less negative resting membrane potential.
 - C. greater calcium influx during the action potential.
 - D. a shorter refractory period.
 - E. less sodium influx during the action potential upstroke.
55. Identify the FALSE statement about Aminata at the time she was admitted to the local hospital in Mali.
- A. The osmolality of her extracellular and intracellular fluids was equal.
 - B. Her interstitial volume was twice her plasma volume.
 - C. Her plasma osmolality was equal to her interstitial fluid osmolality.
 - D. Her plasma volume was less than normal for her size.
 - E. Her total body potassium content was less than normal.
56. If Aminata had been able to be evacuated to a modern hospital which of the following possible therapies would NOT have been useful?
- A. Intravenous administration of an albumin solution by slow drip.
 - B. Intravenous administration of an isotonic (300 mOsm/L) potassium bicarbonate solution.
 - C. Intravenous administration of an isotonic (300 mOsm/L) sodium chloride and glucose solution.
 - D. Intravenous antibiotic therapy.
 - E. Frequent small feedings of nutritious food.

IT'S OVER. FILL OUT YOUR EVALUATION SHEETS. PLACE YOUR ANSWER SHEETS AND EVALUATION SHEETS IN THE APPROPRIATELY MARKED BOXES THEN PICK UP YOUR NEXT SET OF LECTURE HANDOUTS.

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**REVISED
HUMAN
PHYSIOLOGY**

EXAM #1 - ANSWERS

2/13/95

1. A
2. E
3. D
4. C
5. C
6. C
7. B
8. A
9. C
10. A
11. E
12. C
13. E
14. D
15. E
16. E
17. A
18. B OR E
19. A
20. C
21. A
22. A
23. B
24. D
25. C
26. D
27. B
28. D
29. E
30. E
31. E
32. B
33. A
34. C
35. C
36. E
37. OMITTED

38. D
39. A
40. D
41. C
42. B
43. B
44. D
45. C
46. D
47. B
48. A
49. E
50. B
51. C
52. B
53. C
54. C
55. B
56. B