

BMED 3100: Systems Physiology
Quiz 1, January 21, 2009

_____ Last Name

Honor Pledge

All students are required, when requested, to attach the following statement to any material turned in for a grade in any course at Georgia Institute of Technology:

On my honor, I pledge that I have neither given nor received inappropriate aid in the preparation of this assignment.

Signature

Name (Printed)

Be brief in your answers.

Write clearly.

Backs of pages will not be graded. 1.

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Multiple Choice: Write the *best* answer on the line to the right. (2 pts each)

1. The internal environment _____ **E** _____
 - A. refers to the intracellular fluid compartment of the body.
 - B. is regulated to remain relatively constant by the specialized activities of many of the body's cells.
 - C. is the medium for exchange of nutrients and wastes for the body's cells.
 - D. Both refers to the intracellular fluid compartment of the body and is regulated to remain relatively constant by the specialized activities of many of the body's cells are correct.
 - E. Both is regulated to remain relatively constant by the specialized activities of many of the body's cells and is the medium for exchange of nutrients and wastes for the body's cells are correct.

2. If a person begins to sweat upon entering a hot room but continued sweating is able to keep the body temperature constant, the person is _____ **C** _____
 - A. in equilibrium.
 - B. not using energy to maintain a constant temperature.
 - C. in steady state.
 - D. using a positive feedback mechanism.

3. The steady state value for a variable that the body attempts to maintain is the _____ **A** _____
 - A. set point.
 - B. equilibrium potential.
 - C. error signal.
 - D. reflex arc.
 - E. median value.

4. Feedforward regulatory processes _____ **E** _____
 - A. work in anticipation of changes in regulated variables.
 - B. work in conjunction with negative feedback processes.
 - C. lead to instability of the regulated variable.
 - D. maximize fluctuations in the regulated variable.
 - E. Both work in anticipation of changes in regulated variables and work in conjunction with negative feedback processes are correct.

5. Which organelles would you expect to be especially numerous in cells that expend a great deal of energy in the form of ATP? _____ **E** _____
 - A. peroxisomes
 - B. endosomes
 - C. lysosomes
 - D. ribosomes
 - E. mitochondria

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6. A certain protein receptor is capable of binding the neurotransmitter epinephrine but does not bind to the neurotransmitters dopamine, glutamate, or serotonin.

This is because the receptor displays

___ **C** ___

- A. saturation.
- B. inhibition.
- C. specificity.
- D. acclimatization.
- E. All of the choices are correct.

7. The net flux of a penetrating solute into a cell will increase if the

___ **E** ___

- A. permeability constant for that solute increases.
- B. temperature increases.
- C. concentration of that solute in the extracellular fluid increases.
- D. Both permeability constant for that solute increases and concentration of that solute in the extracellular fluid increases are correct.
- E. All of the choices are correct.

8. Which of the following statements regarding the movement of molecules across cell membranes is correct?

___ **E** ___

- A. The diffusion of molecules across a cell membrane occurs at a rate that is influenced by the surface area of the membrane and the magnitude of the concentration difference across it.
- B. The net flux of molecules that cross cell membranes by diffusion is always from regions of lower concentration to regions of higher concentration.
- C. Molecules that enter a cell by diffusion must directly permeate the lipid portion of the plasma membrane, whereas those that enter by facilitated diffusion utilize membrane-bound proteins.
- D. Both the diffusion of molecules across a cell membrane occurs at a rate that is influenced by the surface area of the membrane and the magnitude of the concentration difference across it and the net flux of molecules that cross cell membranes by diffusion is always from regions of lower concentration to regions of higher concentration are correct.
- E. Both the diffusion of molecules across a cell membrane occurs at a rate that is influenced by the surface area of the membrane and the magnitude of the concentration difference across it and molecules that enter a cell by diffusion must directly permeate the lipid portion of the plasma membrane, whereas those that enter by facilitated diffusion utilize membrane-bound proteins are correct.

9. Carrier-mediated transport

___ **A** ___

- A. involves a specific membrane protein that functions as a carrier molecule.
- B. always involves the movement of substances against a concentration gradient.
- C. always requires the direct expenditure of energy.
- D. Both involves a specific membrane protein that functions as a carrier molecule and always involves the movement of substances against a concentration gradient are correct.
- E. All of the choices are correct.

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10. Which of the following is a feature that distinguishes active transport from facilitated diffusion?

___ **E** ___

- A. saturability
- B. requirement for a carrier molecule
- C. specificity
- D. presence of a transport maximum
- E. requirement for metabolic energy

11. If the ATP-generating mechanisms in a cell are poisoned and the cell has depleted its ATP reserves,

___ **E** ___

- A. primary active transport of molecules would cease immediately.
- B. secondary active transport of molecules would cease immediately.
- C. eventually there will be no potential difference across the membrane.
- D. primary active transport of molecules would cease immediately and secondary active transport of molecules would cease immediately are correct.
- E. primary active transport of molecules would cease immediately and eventually there will be no potential difference across the membrane are correct.

12. If pure water and a solution containing a nonpenetrating solute are separated by a membrane that is permeable only to water,

___ **C** ___

- A. water will diffuse by osmosis until the water concentrations in the two compartments become equal.
- 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 by osmosis until stopped by opposing hydrostatic pressure.
- D. no movement will occur between the compartments.
- E. none of the choices will occur.

13. If all other conditions remain the same and the concentration of a nonpenetrating solute increases inside a cell,

___ **A** ___

- A. water will tend to enter the cell because the interior has an increased osmolarity.
- B. water will tend to leave the cell because the interior has an increased osmolarity.
- C. water will tend to enter the cell because the interior has a decreased osmolarity.
- D. water will tend to leave the cell because the interior has a decreased osmolarity.
- E. the non-penetrating solute will diffuse across the membrane until its concentration is equal on both sides of the membrane.

14. If a cell is placed in a hypotonic solution, it

___ **A** ___

- A. will swell.
- B. will shrink.
- C. will stay the same size.
- D. may swell, shrink, or stay the same size, depending upon the concentration of penetrating and nonpenetrating solutes in the solution.

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15. If a cell is placed in a hyperosmotic solution, it _____ **D** _____
A. will swell.
B. will shrink.
C. will stay the same size.
D. may swell, shrink, or stay the same size, depending upon the concentration of penetrating and nonpenetrating solutes in the solution.
16. If a cell is placed into an unknown solution and it shrinks, what can be concluded about the unknown solution? _____ **A** _____
A. Its nonpenetrating solute concentration was greater than that of the cell.
B. Its nonpenetrating solute concentration was less than that of the cell.
C. Its nonpenetrating solute concentration was equal to that of the cell.
D. Any of the choices are possible.
17. The reason solutions for injection or infusion into people normally contain either 150 mM NaCl or 300 mM glucose is that these _____ **D** _____
A. solutes are necessary for metabolism.
B. solutions are hypertonic to the blood and cells.
C. solutions are hypoosmotic to the blood and cells.
D. solutions are isotonic to the blood and cells.
E. solutions contain penetrating solutes.
18. An example of a hypertonic solution is _____ **A** _____
A. 200 mM NaCl.
B. 300 mM glucose.
C. 100 mM MgCl₂.
D. 400 mM urea.
E. None of the choices are correct.
19. Which of the following solutions is *not* isotonic to human cells? _____ **B** _____
A. 300 mM glucose
B. 300 mM urea
C. 100 mM MgCl₂
D. 300 mOsm NaCl
20. Regarding the tonicity and osmolarity of solutions, which of the following statements is *not* true? _____ **C** _____
A. The term "tonicity" refers to the effect that a solution has on the degree of stretch or shrinking of the cell membrane.
B. The term "osmolarity" refers to the osmotic properties of a solution, regardless of its tonicity.
C. Isotonic solutions are always isoosmotic.
D. Hypoosmotic solutions are always hypotonic.
E. Hypertonic solutions are always hyperosmotic.

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True or False: Write the correct answer on the line to the right. (2 pts each)

21. Organs are generally composed of only one kind of tissue. _____ **F** _____
22. An important function of organ systems is to regulate the external environment of the body. _____ **F** _____
23. The respiratory system is primarily responsible for transporting blood to the body's tissues. _____ **F** _____
24. Homeostasis refers to the relative constancy of the external environment. _____ **F** _____
25. The composition of the fluid bathing the cells of the body is essentially the same as that within the cells. _____ **F** _____
26. Intracellular fluid is defined as the fluid in the cytoplasm. _____ **T** _____
27. The major lipids in cellular membranes are phospholipids. _____ **T** _____
28. More ATP is generated from glycolytic reactions under aerobic than under anaerobic conditions. _____ **T** _____

29. Name Cannon's Postulates. (6 pts)

1. The autonomic nervous system plays a key role in maintaining homeostasis
2. Physiologic activity can have tonic levels of control
3. Antagonistic controls exist to maintain homeostatic control
4. Chemicals signals can have different effects in different tissues

30. Name the different tissue types and indicate which ones are excitable tissues. (6 pts)

1. Epithelial
2. Connective
3. Muscle (excitable)
4. Nervous (excitable)

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31. The urea concentration of blood is 10 mg/dl. The urea concentration in a portion of the tubular part of the nephron is 20 mg/dl. If the permeability to urea is 1×10^{-5} cm/sec and the surface area is 100 cm^2 , what are the magnitude and direction of the urea flux? (8 pts).

$$1 \text{ ml} = 1 \text{ cm}^3$$
$$1 \text{ dl} = 0.01 \text{ cm}^3$$

$$J = -PA (C_1 - C_2)$$

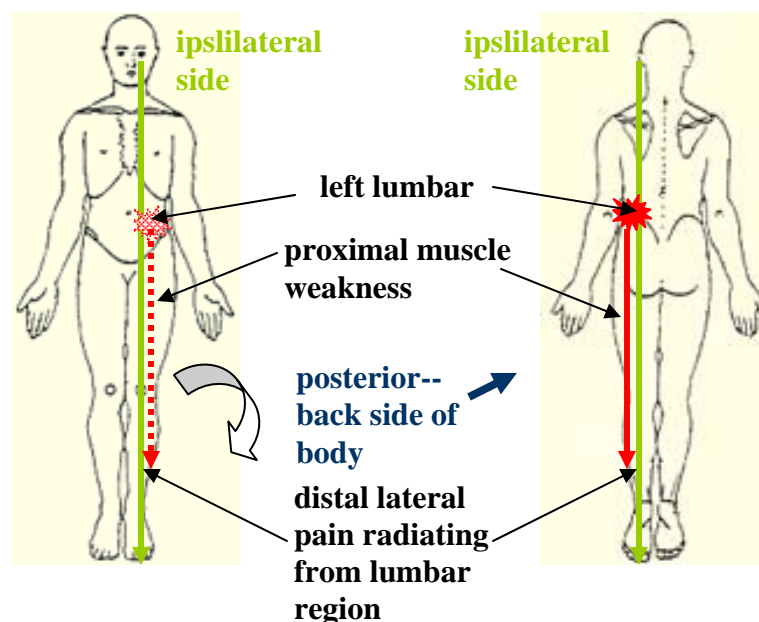
$$J = 1 \times 10^{-5} \text{ cm/sec} * 100 \text{ cm}^2 (0.2 \text{ mg/ml} - 0.1 \text{ mg/ml})$$

$$J = 1 \times 10^{-5} \text{ cm/sec} * 100 \text{ cm}^2 (0.1 \text{ mg/cm}^3)$$

$$J = 1 \times 10^{-4} \text{ mg/sec from lumen to blood (high to low concentration)}$$

32. A patient presented to his physician with pain in the left lumbar region with ipsilateral leg pain. The pain was felt in the posterior portion and radiated to the distal lateral portion of the extremity. There was also some proximal muscle weakness reported in the affected leg. Draw this patient in the anatomical position and indicate where the pain and weakness are located. (8 pts)

2 points for left lumbar, 2 points for ipsilateral, 1 point for posterior, 1 point for distal/lateral, 2 points for proximal muscle weakness



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33. Following an occlusion in blood flow in a coronary artery, a reperfusion injury may occur, leading to a myocardial infarction. (8 pts)

- rewrite this sentence in layman's terms
- indicate the mechanism of damage and cellular consequences following reperfusion
- assume the cell directly affected die. describe what happens to them.
- the surviving cells need to replace some of the function lost. what type of adaptation will likely occur to accomplish this?

- There sometimes is a block in a blood vessels that go to the heart, and when blood flow returns to the region, the heart tissue can die, impeding or stopping heart function.
- Following reperfusion the cell (which has already been without or with low oxygen) get a rapid flow of oxygen and the production of free radicals are highly likely.
- They will likely die by necrosis. The main features are denaturation of proteins and enzymatic breakdown of the cell. Necrosis also includes influx of calcium (and general loss of ion homeostasis and energy stores), protein breakdown, breakdown of cell organelles, membrane degradation, and lysis.
- Hypertrophy

34. You have never walked on a balance beam before, but you decide to try it. Draw a feed back loop that will adjust your balance as you move from one end to the other. Assume you do not fall off. Identify all the parts of the control loop and, where appropriate, which corresponding anatomical feature is involved. (8 pts)

Components of feedback loop (input, sensor, controller, command, plant, output, feedback, comparator) (3 pts)

Physiological components (input to visual system, vestibular system, joint position, other sensory systems – pressure, touch, brain / spinal cord, voluntary muscle control of legs / torso, arms, visual input to controller, better balance with practice / learning) (3 pts)

Identify as parametric feedback, Ability to control system, system learns, more inputs (2 pts)
E.g.:

