Exam 1

100 points total

Multiple choice. As with any test, choose the best answer in each case. Each question is 3 points.

1. The term “internal environment”, as coined by Claude Bernard, is best defined as
   a. the cytosol.
   b. the interstitial fluid.
   c. the blood (or blood plasma).
   d. the air between our clothes and skin.
   e. Two of the above. (b and c)

2. If a system is being regulated, and the rate of efflux from the system increases, then the rate of influx must
   a. decrease.
   b. increase.
   c. remain the same.
   d. become negative.
   e. become infinite.

3. In a positive feedback loop, the signal and the response
   a. must both be positive.
   b. must both be negative.
   c. must have the same sign (positive or negative).
   d. must have opposite signs.
   e. There’s no such thing as a positive feedback loop.

4. Imagine we have two solutions, A and B, separated by a membrane. Solution A is 1.0M sucrose and solution B is 1.0M urea (neither of which is an ion). The membrane is permeable to urea but not to sucrose or water. At equilibrium,
   a. solution A is still 1.0M sucrose and solution B is still 1.0M urea.
   b. solution A is 1M sucrose and has between 0.0 and 0.5M urea, and solution B is between 0.5 and 1.0M urea.
   c. solution A is 1M sucrose and 0.5M urea, and solution B is 0.5M urea.
   d. solution A is 1M sucrose and has between 0.5 and 1.0M urea, and solution B is between 0.0 and 0.5M urea.
   e. solution A is 1.0M sucrose and 1.0M urea, and solution B is just water.
5. Now he have a different set of solutions separated by a membrane. Solution A is 1M sucrose and solution B is 1M urea. A tiny amount of the enzyme sucrase is added to A, which splits each sucrose into a glucose and fructose (also not ions). (We’ll ignore the presence of the sucrase as a solute.) The membrane is permeable to water but not any of the solutes. The result is that

a. water will move from A to B.

b. water will move from B to A.

c. there will be no net movement of water.

d. It’s impossible to say which way the water will move.

e. There aren’t really any other options, are there?

6. Yet another scenario with solutions A and B and a membrane. A contains the solute X and the membrane is permeable to X but not to water. Assuming we know the value of all its variables, we can use the Fick equation to determine the rate of diffusion of X as long as

a. X is not an ion.

b. there is no X on side B.

c. there are no other uncharged solutes on side B.

d. there are no other uncharged solutes on side A.

e. More than one of the above is correct.

7. The main function of Schwann cells is to

a. support neurons.

b. produce the cerebrospinal fluid.

c. insulate axons.

d. release neurotransmitters.

e. form synapses.

8. A good example of a graded potential is

a. an excitatory postsynaptic potential in a dendrite.

b. the hyperpolarization phase of an action potential in an axon.

c. the threshold voltage needed to trigger an action potential.

d. the resting potential of a cell.

e. the equilibrium voltage calculated from the Nernst equation.

9. Consider a cell bathed in a solution mimicking normal ECF. If [K⁺] was raised to 100 mM in the ECF, but everything else about the ECF and the cell stayed the same, we would expect that

a. the membrane potential would fall.

b. the membrane potential would stay the same.

c. the membrane potential would rise.

d. the membrane potential would oscillate slowly.

e. the membrane potential would oscillate rapidly.
10. Which of the following is the correct version of the Nernst equation?

a. \[ E_x = \frac{61mV}{z} \log \left( \frac{[X]_1}{[X]_2} \right) \text{(This one)} \]

b. \[ E_x = \frac{z}{61mV} \log \left( \frac{[X]_1}{[X]_2} \right) \]

c. \[ E_x = \log \left( \frac{61mV [X]_1}{z [X]_2} \right) \]

d. \[ E_x = \log \left( \frac{z [X]_1}{61mV [X]_2} \right) \]

e. \[ E_x = N(e^r)_{n_x,t} \]

11. Action potentials propagate along an axon because

a. each AP alters nearby membrane shape, opening mechanically-gated Na\(^+\) channels in adjacent regions of the axon.

b. each AP alters nearby membrane shape, opening mechanically-gated Ca\(^{2+}\) channels in adjacent regions of the axon.

c. each AP alters nearby membrane potential, opening voltage-gated Na\(^+\) channels in adjacent regions of the axon.

d. each AP alters nearby membrane potential, opening voltage-gated Ca\(^{2+}\) channels in adjacent regions of the axon.

e. they sprinkle fairy dust on them.

12. In postsynaptic neurons, metabotropic receptors

a. always generate depolarization of the cell membrane.

b. act much more quickly than ionotropic receptors.

c. do not amplify the signal they way ionotropic receptors do.

**d. involve the use of a G-protein complex.**

**e. do not bind to neurotransmitter.**

13. For which of the following are all three changes in channel state excitatory?

a. Closing of Na\(^+\) channels, closing of K\(^+\) channels, opening of Ca\(^{2+}\) channels

b. Closing of Na\(^+\) channels, opening of K\(^+\) channels, closing of Ca\(^{2+}\) channels

c. Opening of Na\(^+\) channels, opening of K\(^+\) channels, closing of Ca\(^{2+}\) channels

**d. Opening of Na\(^+\) channels, closing of K\(^+\) channels, opening of Ca\(^{2+}\) channels**

e. Opening of Na\(^+\) channels, opening of K\(^+\) channels, opening of Ca\(^{2+}\) channels
14. Neuron A and neuron B are the only two presynaptic neurons that affect a particular postsynaptic neuron. If a single AP arrives at A, and none at B, the postsynaptic potential increases. If A and B see APs at the same time, the postsynaptic potential increases, but by less than when just A is active. Given this information,

a. neuron B must have effects that are excitatory, and the simultaneous effects of A and B are an example of spatial summation.

b. neuron B must have effects that are inhibitory, and the simultaneous effects of A and B are an example of spatial summation.

c. neuron B must have effects that are excitatory, and the simultaneous effects of A and B are an example of temporal summation.

d. neuron B must have effects that are inhibitory, and the simultaneous effects of A and B are an example of temporal summation.

e. It’s impossible to tell from the information given.

15. What is the benefit of lateral inhibition in the sensory system?

a. It helps us to habituate to constant stimuli so we are not distracted by them.

b. It keeps receptors from being stimulated beyond their dynamic range.

c. It allows sensory cells to have periods of rest to recharge their neurotransmitter stores.

d. It mutes pain perception during periods of danger.

e. It allows us to better detect and localize small changes in stimulus intensity.

16. Which of the following best describes the activation pathway for salt-sensitive taste receptors?

a. Cl⁻ enters the cell and causes it to hyperpolarize.

b. Cl⁻ activates G-protein-coupled receptors.

c. Na⁺ enters the cell and causes it to depolarize.


e. Increased osmotic concentration in the saliva causes the cell to lose water and shrink.

17. About how many different types of olfactory neurons (i.e., different types of receptors) do humans have?

a. Four

b. Five

c. Six

d. 400

e. 4000
18. If a person lacked fluid in his semicircular canals, he would probably have a hard time
   a. telling which way was up (relative to gravity).
   b. hearing high-pitched sounds.
   c. hearing low-pitched sounds.
   d. hearing all sounds.
   e. getting dizzy.

19. When light strikes a photoreceptor, it results in
   a. increased levels of cGMP and increased depolarization.
   b. decreased levels of cGMP and decreased depolarization.
   c. increased levels of cGMP and decreased depolarization.
   d. decreased levels of cGMP and increased depolarization.
   e. the photoreceptor bursting into flame, like an ant under a magnifying glass.

20. A person who lacked rod photoreceptors would
   a. have trouble seeing in the dark.
   b. have trouble seeing red objects in strong light.
   c. have trouble seeing yellow objects in strong light.
   d. have trouble seeing blue objects in strong light.
   e. Two of the above are true.
**Short answer.** Your answers should fit in the space provided (assuming you have reasonably normal sized writing). For some questions, a diagram can save some writing, but needs to be clearly labelled with names, effects, etc. Each question is 8 points.

21. Choose one of the following systems and diagram or describe the negative feedback loop(s) that would be at work, including three effectors in your description.

   Choices: a human who is too warm, a human who is too cold, or a human with low blood Ca²⁺.
22. Describe an example of a primary active transport system and a secondary active transport system, being clear on the difference between the two. For each, be sure to indicate the “target” substance of the process.

23. On the empty graph below, draw a reasonable-looking AP with some approximate time values on the X-axis. Then indicate when the voltage-gated Na⁺ and K⁺ channels (n.b., channels, not gates) open and close. Then note the additional question below.

Tetraethylammonium (TEA) is a neurotoxin that blocks voltage-gated K⁺ channels. Think about how this might affect an otherwise normal AP. Using a dotted line (or some other different format from your first AP), show how the AP might change as a result.
24. Describe the events in a chemical synapse, between the time an AP arrives at the presynaptic axon terminal until the neurotransmitter reaches the postsynaptic receptors. You do not need to describe what happens to the receptors once the NT reaches them.

25. Explain how the cochlea transduces sound waves entering at the oval window into signals that are passed to the afferent neurons leaving the ear. You do not need to describe anything that occurs “upstream” of the oval window.