Exam 3 - Key

100 points total

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

1. Which of the following best describes the events that happen when blood reaches the lungs, under normal conditions?
   a. More carbamino compounds are formed in the blood.
   b. The $P_{CO_2}$ of the blood increases.
   c. The oxygen saturation curve of hemoglobin right-shifts.
   d. $H^+$ and $HCO_3^-$ ions form $CO_2$ and $H_2O$.
   e. All of these occur at the lungs.

2. Which of the following factors, by itself, would cause an increase in glomerular filtration rate in the kidneys? (“By itself” means “if nothing else changed except that single variable.”)
   a. Decreased vasoconstriction of the afferent arteriole
   b. Decreased mean arterial pressure
   c. Decreased release of atrial natriuretic factor (ANF)
   d. Decreased permeability of the collecting duct
   e. Decreased aldosterone release

3. In the proximal tubule, glucose enters the epithelial cells on the apical side via __________, and exits the basolateral side via __________.
   a. primary active transport, secondary active transport
   b. secondary active transport, facilitated diffusion
   c. secondary active transport, primary active transport
   d. diffusion, facilitated diffusion
   e. facilitated diffusion, secondary active transport

4. What is the primary purpose of the loop of Henle? (Put another way, what would our kidneys not be able to do if we lacked the loop of Henle?)
   a. Create a hyperosmotic urine
   b. Create an isosmotic urine
   c. Reabsorb urea
   d. Reabsorb NaCl
   e. Regulate pH
5. A drug that activates antidiuretic hormone (ADH) receptors is given to a patient. This would most likely result in
   a. decreased permeability of the collecting duct.
   b. an increased rate of urine production.
   c. increased NaCl secretion.
   d. increased mean arterial pressure.
   e. Two of the above would likely occur.
   [I meant to write “directly result”, but didn’t. “d” would be the initial result, but that could cause “c”, so I’ll accept either “d” or “e” for credit.]

6. Which of the following statements about urea and urine is true?
   a. Urea molecules are too big to enter the urine from the glomerulus.
   b. Urea is part of the urine at formation and is not reabsorbed.
   c. Urea is part of the urine at formation but is fully reabsorbed.
   d. Urea is part of the urine at formation but some is reabsorbed via active transport.
   e. Urea is part of the urine at formation but some is reabsorbed via diffusion.

7. Central venous pressure (CVP) helps to influence mean arterial pressure by affecting
   a. heart rate.
   b. stroke volume.
   c. vasoconstriction of the arterioles.
   d. Two of these are affected by CVP.
   e. All three of these are affected by CVP.
   [Although I didn’t mean to include “directly” this time, not including it did lead to some confusion, so I accepted “c”, “d” or “e” for credit.]

8. On a dare, a not-too-bright freshman drinks a gallon of water. Assuming that he is able to absorb this water without throwing it up, which of the following responses should his body show as it struggles to keep him alive?
   a. Increased sympathetic activity, increased ADH release, increased ANF release
   b. Increased sympathetic activity, increased ADH release, decreased ANF release
   c. Increased sympathetic activity, decreased ADH release, increased ANF release
   d. Decreased sympathetic activity, decreased ADH release, increased ANF release
   e. Decreased sympathetic activity, decreased ADH release, decreased ANF release

9. The mouth contributes, to at least some degree, to
   a. the physical breakdown of food.
   b. the digestion of food.
   c. the absorption of food.
d. Two of these occur in the mouth. [Physical breakdown (mastication) and digestion (amylase)]
e. All three of these occur in the mouth.

10. Which of the following statements about gastric (stomach) acid is true?
   a. It breaks down cellulose into digestible monosaccharides.
   b. It digests fats.
   c. It emulsifies fats so they are easier to digest.
   d. It digests proteins into amino acids.
   e. It denatures proteins so they are easier to digest.

11. A person who did not secrete sufficient mucus in her stomach would probably have
   a. damage to the mucosal layer of her stomach.
   b. trouble digesting lactose.
   c. more pathogens surviving passage through the stomach than normal.
   d. metabolic acidosis.
   e. her own reality TV show.

12. Cholecystokinin (CCK) promotes all of the following except
   a. the appearance of lipase in the small intestine.
   b. the appearance of proteases in the small intestine.
   c. the appearance of amylase in the small intestine.
   d. the appearance of bile in the small intestine.
   e. the appearance of bicarbonate in the small intestine.

13. Trypsinogen is converted to its active form, trypsin, by the action of
   a. disaccharidase.
   b. enterokinase.
   c. segmentation.
   d. the pH in the small intestine.
   e. intestinal mucus.

14. Which of the following shows the correct combinations of agents and their actions in the
    processes occurring during the digestion and absorption of fats?
   a. Bile salts → digestion, lipase → emulsification, chylomicrons → packaging of fats
   b. Bile salts → emulsification, lipase → packaging of fats, chylomicrons → digestion
   c. Bile salts → emulsification, lipase → digestion, chylomicrons → packaging of fats
   d. Bile salts → digestion, lipase → packaging of fats, chylomicrons → emulsification
   e. Bile salts → packaging of fats, lipase → emulsification, chylomicrons → digestion
15. Uh-oh — mass movement in the middle of the exam! What’s your best option that’s under your voluntary control?
   a. Contract your internal anal sphincter
   b. **Contract your external anal sphincter**
   c. Relax your internal anal sphincter
   d. Relax your external anal sphincter
   e. Turn in your test now and run out of the room.

16. The reason we need to keep some energy stored in the form of glycogen rather than fats is that
   a. glycogen is more energy dense than fats.
   b. glycogen can be used to make fats if needed.
   c. fats can only be used for anaerobic respiration.
   d. **some tissues can’t use fats as fuel.**
   e. glycogen can be stored without using water.

17. One challenge with chemotherapy is that it often causes people to lose their appetites. If you’re working on a drug to counteract this problem (for use in states that haven’t legalized medical marijuana), which of the following would be the best approach?
   a. A drug that activates leptin receptors.
   b. **A drug that blocks leptin receptors.**
   c. A drug that activates glucagon receptors.
   d. A drug that blocks glucagon receptors.
   e. Tastier-looking Jello in the hospital lunches.

18. The “turgor,” or swelling, seen during the inflammatory response is due primarily to
   a. **leakage of excess fluid out of the capillaries.**
   b. expansion of macrophages as they engulf pathogens.
   c. rapid reproduction of bacteria or viruses.
   d. leaked contents of dying cells.
   e. gas bubbles resulting from the action of hydrogen peroxide.

19. The action of natural killer T cells is to
   a. phagocytose bacterial cells.
   b. insert perforins into bacterial cells.
   c. phagocytose infected body cells.
   d. **insert perforins into infected body cells.**
   e. try to get themselves renamed to something nicer, like “Hello Kitty T cells.”
20. Which of the following is not a lymphoid tissue?
   a. The appendix  
   b. The bone marrow  
   c. The spleen  
   d. The tonsils  
   e. The pancreas

**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. Diagram or describe the renin-angiotensin-aldosterone system, being sure to give the source of each of the three substances and to indicate what type of substance it is (e.g., a hormone, etc.). As part of your answer, indicate the two specific control pathways that affect the release of renin in the juxtaglomerular apparatus. (This is in addition to telling me what variables the system in helping to regulate.)

*In addition to the main diagram or description (see Fig. 20-13 in the textbook), you should have labelled substances as:*
  
  Renin = enzyme  
  Angiotensinogen = prohormone  
  Angiotensin I & II and aldosterone = hormones  

*Pathways that control renin release are input from the sympathetic nervous system to the granular cells (based on MAP and coming from the CNS), local control by the granular cells (based on BP in the afferent arteriole), and control of the granular cells by the macula dense (via paracrine agents) based on [Na⁺] in the distal tubule.*
22. Answer the next set of questions based on the graph below. The black line is the oxygen saturation curve for hemoglobin (Hb), while the gray line is the saturation curve for myoglobin (Mb).

![Graph of Oxygen Saturation Curve]

a. What is the HbO₂ for blood (Hb) at Po₂ = 35 torr? **About 72%**

b. What Po₂ is required to saturate Hb to 40%? **About 23 torr**

c. A mountain climber at high altitude has an alveolar Po₂ of 50 torr and a tissue Po₂ of 15 torr. How much oxygen (in units of %HbO₂) gets delivered by the blood under these circumstances? **82% - 22% = 60%**

d. Relative to Hb, does Mb have a higher or lower affinity for oxygen? **Higher**

e. One function of Mb is to act as a reservoir of O₂ for muscles if O₂ consumption rates increase rapidly and blood flow has not yet increased enough to meet the new demand. Based on the information from the graph above, why does Mb function effectively for this task? Think about what the conditions are in a resting muscle, and then what will happen as Po₂ levels in muscles drop below resting levels.

*The Mb will hold onto O₂ until Po₂ in the tissues drops below about 20 torr, meaning that it only starts giving up O₂ once any the blood has already given up most of its O₂. As we go below 20 torr, Mb can continue to offload O₂ in addition to that provided by the Hb.*
23. Two related questions:

a. During a metabolic acidosis, what are the acute and longer term responses, and how do they help the problem?

*You should have discussed both respiratory and renal responses since this is a metabolic acidosis.*

*Increased ventilation will reduce CO₂, which will pull the bicarbonate buffering equation to the left, reducing H⁺ (and HCO₃⁻), meaning reduced acidity.*

*The renal response will be to secrete H⁺ into the urine and reabsorb HCO₃⁻ into the ECF.*

b. Breath-hold divers often hyperventilate (breath heavily and rapidly) immediately before taking a final deep breath for a dive. Given what you know about gas transport and ventilatory control, what is the reason for this?

*Based on the discuss of blood gases and ventilation, I was looking for you to figure out two things.*

*First, increasing Po₂ will not significantly increase the O₂ concentration in the blood, because Hb is ~saturated at normal Po₂. It will slightly increase the amount of O₂ stored in the lungs, but this is a relatively minor effect, so the hyperventilation is not about O₂.*

*Second, increasing ventilation reduces [H⁺] (or drives up pH), and thus makes it take longer until [H⁺] gets to critically high concentrations than if no hyperventilation had happened. Thus, the dive time is increased. (Or if you prefer to think about is solely in terms of CO₂, it drives down CO₂ in the blood, so it takes longer until CO₂ becomes too high.)*
24. For each of the following locations, describe the events that are taking place during the post-absorptive phase and what hormonal level(s) is/are controlling those events. What is the source of each of the hormones you listed above?

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Events</th>
<th>Due to</th>
</tr>
</thead>
<tbody>
<tr>
<td>General tissues</td>
<td><strong>Fatty acids (or fats) are used for fuel</strong></td>
<td>This is triggered by low insulin levels [in response to the low blood glucose].</td>
</tr>
<tr>
<td>Liver</td>
<td><strong>The liver is releasing glucose [for use by the N.S.] through glycogenolysis and gluconeogenesis.</strong></td>
<td>This is triggered by high glucagon levels [in response to the low blood glucose]</td>
</tr>
<tr>
<td>Adipose tissue</td>
<td><strong>Fat cells are releasing fatty acids (or fats) [for use by most tissues].</strong></td>
<td>This is probably triggered by high glucagon levels [but maybe by low insulin].</td>
</tr>
</tbody>
</table>

Both hormones come from the islets of Langerhans in the pancreas, with insulin being produces by the beta cells and glucagon by the alpha cells.
25. Describe the events that would take place in the activation of the humoral portion of the acquired immune response to a bacterial infection. You do not need to describe the inflammatory response beyond any elements important in activating humoral immunity, nor do you need to explain what would happen if a second infection by the same bacterium occurred.

The humoral system involves B cells. Activation of these cells generally requires two stimuli:

1. A B cell with a receptor (immunoglobulin) that matches an antigen from the bacteria (living or dead) needs to encounter that antigen, and

2. Cytokines such as IL-2 should be present. These are released by activated helper T cells. To activate helper T’s, a macrophage (or other phagocyte) needs to ingest a bacterium and then present antigen in its MHC II complex. Release of IL-1 and TNF by the macrophage also promotes activation. A helper T with a matching receptor can then be activated by the macrophage.

Once activated by antigen and cytokines, the B cell begins dividing, producing plasma cells and memory B cells. The plasma cells release antibodies that match the receptor activated by the antigen, so those antibodies will bind to the antigen, helping to kill, disable, or mark the bacteria for destruction.