Final Exam

200 points

When suitable, diagrams may be used in answer but must be accompanied by appropriate labels, explanatory phrases, etc, as needed. Also, be sure to use full names rather than just abbreviations at least once in your answers unless otherwise indicated.

1. Provide an example of a positive feedback loop that occurs in humans. Be sure to indicate the factor(s) that ultimately cause the positive feedback cycle to end. (6 points)

2. For each of the following substances, circle the pathway(s) that it can use to cross a cell’s plasma membrane. If the substance moves via both channel and carrier proteins, circle both. (6 points)

   Na⁺: Simple diffusion only  Channel proteins  Carrier proteins
   Glucose: Simple diffusion only  Channel proteins  Carrier proteins
   Water: Simple diffusion only  Channel proteins  Carrier proteins
   CO₂: Simple diffusion only  Channel proteins  Carrier proteins

3. Which of the following statements is false? (3 points)
   a. Water moves from hypotonic to hypertonic regions by osmosis.
   b. The diffusion rate of solutes will always be determined by the concentration difference.
   c. The dissociation of molecules can result in osmotic concentrations that differ from the molar concentration of a compound.
   d. If everything else stays the same, diffusion will occur more slowly across a thicker membrane than a thinner one.
4. For each of the following events during an action potential, indicate what changes in the state (open or closed) of the voltage-gated Na\textsuperscript{+} and K\textsuperscript{+} channels cause the change in membrane potential ($V_m$) and what further events result from the change in $V_m$. (Note that some events may have only a cause or a result, not both.) (8 points)

$V_m$ reaching threshold voltage:

Depolarization:

Repolarization & hyperpolarization:

Return to resting $V_m$:

5. Provide a list of the events that take place in an axon terminal upon arrival of an action potential. You do not need to discuss the events after the initial release of neurotransmitter. (6 points)
6. What precisely is meant by the term excitatory postsynaptic potential? How does this differ from an inhibitory postsynaptic potential? (4 points)

7. The combination of rod photoreceptors and cone photoreceptors represents an example of what is known as range fractionation. Explain what this is and how it relates to the concept of dynamic range in receptors. (5 points)

8. Explain how a rod photoreceptor transduces the energy from photons into varying levels of neurotransmitter release. (8 points)
9. Name three lipophilic hormones. (3 points)

10. What does the term “tropic” mean as it refers to hormones? (3 points)

11. Describe or diagram the pathways controlling the release of the thyroid hormones. Be sure to give the full names of all hormones, including the two hormones released by the thyroid gland. You do not need to discuss the specific effects of thyroid hormone on body tissues. (6 points)

12. Describe or graph the change in the force produced by the sarcomere as its length changes, and explain the reasons the force changes. (6 points)
13. In general, how do the variables associated with muscle shortening change as the muscle is required to lift heavier and heavier weights? (6 points)

14. Choose among the following terms to complete the paragraph below. Terms may be used more than once: Arteries, veins, capillaries (5 points)

Blood is at its highest pressure in the _________________ and its lowest pressure in the _________________. The vessel walls are thickest in the ________________ and thinnest in the _________________. Blood velocity is lowest in the _________________.

15. How is blood flow through the circulatory system maintained during ventricular diastole? (4 points)

16. Choose among the following terms to complete the paragraph below that describes conditions during ventilation seen in a resting individual. Terms may be used more than once: Positive, negative, zero (6 points)

During the middle of an inhalation, pressure in the intrapleural fluid is ________________, and pressure in the alveoli is ________________. Between the end of inhalation and the start of exhalation, pressure in the intrapleural fluid is ________________, and pressure in the alveoli is ________________. During the middle of an exhalation, pressure in the intrapleural fluid is ________________, and pressure in the alveoli is ________________.
17. A number of mechanisms help to deliver increased amounts of oxygen to very metabolically active tissues, like contracting muscles. Describe three different ways that working muscles end up receiving more oxygen than resting muscles. (6 points)

18. Describe or graph the effects of changing CO₂ levels and changing O₂ levels in the arterial blood on ventilation rates. (6 points)

19. Explain how the nephron’s loop of Henle functions. What is the major purpose of the actions that occur in the loop? (8 points)
20. Describe or diagram the renal regulatory pathway that controls the permeability of the nephron’s collecting duct. (6 points)

21. The effect of aldosterone on the kidney is to (3 points)
   a. increase the reabsorption of Na⁺.
   b. increase the secretion of Na⁺.
   c. increase the rate of glomerular filtration.
   d. decrease the rate of glomerular filtration.

22. Why is central venous pressure important to blood pressure (MAP) regulation, and what are some of the factors that influence CVP? (6 points)

23. The enzyme(s) that digest complex carbohydrates is/are known as ______________________ and are produced in largest quantities by the ______________________. The enzyme(s) that digest proteins is/are known as ______________________ and are produced in significant quantities by the ______________________ and ______________________. The enzyme(s) that digest fats is/are known as ______________________ and are produced in largest quantities by the ______________________. The enzymes that digest fats are aided by the detergent-like action of ______________________ released by the ______________________. (6 points)
24. Diagram or describe the main hormonal pathway that helps to regulate the pH in the small intestine. (6 points)

25. Explain how fats get digested and move into the epithelium of the intestinal wall. You do not need to describe what happens after they cross the apical membrane. (6 points)

26. List the effects of increased levels of insulin and of increased levels of glucagon in the blood. Be specific about the type of tissues that show each response. (8 points)
27. How does erection of the penis occur? (4 points)

28. Describe the process of spermatogenesis, from spermatogonia to mature spermatozoa. Indicate where different events take place and any support cells involved. You do not need to describe the hormonal pathways involved. (6 points)

29. Provide a number to fill in each of the blanks below. (Looking for ballpark figures here.)

Healthy young men make about ____________ sperm per day and release about ____________ during an ejaculation. A woman, on the other hand, may only ovulate about ____________ oocytes over her lifetime, at the normal rate of ____________ per month during her reproductive years. (4 points)
30. Diagram or describe the hormonal pathway (including short loop feedback) that controls the release of sex hormones in women during the early-to-mid luteal phase of the menstrual cycle. (5 points)

31. On the graph below, draw in lines representing the approximate levels of progesterone, estrogen and luteinizing hormone across the standard 28 menstrual cycle of a woman. Also indicate (in whatever way is most convenient) the time or periods (no pun intended) at which each of the events below occurs. (8 points)

   a. Ovulation
   b. Beginning of follicular development
   c. Appearance of the dominant follicle
   d. Menstruation
   e. Luteal phase
32. What is chorionic gonadotropin and what does it do? Why is it no longer needed after about the third month of a pregnancy? (5 points)

33. List and briefly describe the events that take place as part of the inflammatory response. (8 points)

34. Interferon helps combat viral infections by (3 points)
   a. digesting the protein coat of live viruses.
   b. serving as a decoy attachment site for viruses.
   c. preventing viruses from binding to cells.
   d. shutting down the protein synthesis pathways used to make additional viruses.

35. Antibodies binding to antigens results in all of the following except (3 points)
   a. activation of apoptosis (programmed cell death) of infected cells.
   b. activation of components of the complement system.
   c. agglutination by sticking together clumps of antigen.
   d. opsonization of antigens to make them more attractive to phagocytes.
36. Explain how the cell-mediated (T cell) component of the acquired immune response could be activated by and respond to a viral pathogen. (8 points)

37. True / False  After the initial infection by a pathogen, large numbers of pathogen-specific plasma cells are still active even months after the infection has ended. (2 points)

Extra Credit: Write your own physiology question and answer it below. Like figure skating, more points are awarded for higher levels of difficulty and creativity. (6 points possible)