Final Exam

Provide a concise answer to each of the following questions. Your answers should fit in the spaces provided. Diagrams are welcome but must be accompanied by written explanations. 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, indicate the pathway(s) that it can use to cross a cell’s plasma membrane. More than one answer applies in some cases. Choose from: Simple diffusion / Channel protein / Carrier protein (6 points)

   Na⁺:

   Glucose:

   Testosterone:

   CO₂:
3. For each of the following events during an action potential, indicate what changes in the state (open or closed) of the voltage-gated Na\(^+\) and K\(^+\) channels cause the change in membrane potential (\(V_m\)) and what changes 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 \(V_m\):

4. What is meant by the term excitatory postsynaptic potential? How does this differ from an inhibitory postsynaptic potential? (6 points)

5. 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. (6 points)
6. Explain how the cochlea of the ear converts sounds into action potentials. You do not need to explain how different volumes or frequencies of sound are detected. (8 points)

7. Which type of hormone receptor responds to hydrophilic hormones, and which to lipophilic ones? In general terms, how does each of these two types of receptors affect cellular activity? (6 points)

8. Cushing’s disease is a condition in which levels of cortisol in the blood are chronically elevated. Levels of adrenocorticotropic hormone are also high, but levels of corticotropin releasing hormone are low. Speculate about possible explanations for this pattern. You do not need to discuss the effects of cortisol. (6 points)
9. Describe the general structure of a sarcomere. How does this structure explain the fact that a sarcomere produces less force if it starts contracting when it is longer than its ideal, intermediate length? (6 points)

10. In general, how do the variables associated with muscle shortening change as the muscle is required to lift heavier and heavier weights? (6 points)

11. Choose among the following terms to complete the paragraph below. Terms may be used more than once: Arteries, veins, capillaries (6 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 ___________________.

12. How is blood flow through the circulatory system maintained during ventricular diastole? (6 points)
13. 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 ________________.

14. 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)

15. What regulatory functions do the kidneys help carry out? (6 points)
16. Describe the modifications to the urine that take place in the proximal tubule of the nephron, including brief explanations of how substances are moved. Focus on $\text{Na}^+$, glucose, water and urea. (8 points)

17. What important function does the loop of Henle serve in terms of the overall function of the nephron? (6 points)

18. How is the final concentration of the urine controlled as it passes through the collecting duct? You should discuss the mechanism involved as well as the hormone that controls the process, but you do not need to discuss the pathways that control release of the hormone. (6 points)
19. Diagram or describe the pathways involved in the renin-angiotensin-aldosterone system. You do not need to describe all the details of the juxtaglomerular apparatus. (8 points)

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

21. 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)
22. Diagram or describe the main hormonal pathway that helps to control the pH in the small intestine. (6 points)

23. How does glucose get from the lumen of the small intestine into the bloodstream? (6 points)

24. Describe the process of defecation. (6 points)
25. For liver and fat cells, list the events that occur during the absorptive and post-absorptive phases with regard to the storage, creation, conversion and/or release of glucose and fats. (6 points)

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<tr>
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<th>Absorptive phase</th>
<th>Post-absorptive phase</th>
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<tr>
<td>Liver cells</td>
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<tr>
<td>Fat cells</td>
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26. (6 points) During the absorptive phase, high levels of _________________________ in the blood cause the release of the hormone _________________________ from the gland known as the _______________________. In response, cells throughout the body generally start using _________________________ as their predominant source of fuel. During the post-absorptive phase, the level of this hormone drops, resulting in a switch to _________________________ as the main source of fuel by most body cells. The hormone _________________________ shows increased release from the gland during this period.

27. Describe the process of emission, or the formation of semen, that occurs just prior to ejaculation. What components are contributed by which parts of the reproductive system? (6 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.

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. (6 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? (6 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. (8 points possible)