"I pledge my honor that I have abided by the Stevens Honor System."

Name: Ch 382 - Biological Systems – Exam #1

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Answer the short answers in the space provided.
Circle either TRUE or FALSE. If false, CORRECT the FALSE statement.

1. (True/False) Most of the water in the human body is found in the interstitial fluid compartment.
   - Intracellular fluid

2. Give the approximate % of total body water normally found in different compartments.
   - 66% intracellular
   - 33% extracellular

3. (True/False) The majority of homeostatic control systems are regulated by a positive-feedback control system.
   - Negative feedback

4. Draw a flow chart showing the components of such a homeostatic control system.

5. Suppose in the hottest day of the summer in August when it is 101°F you are on the beach and suddenly start shivering! You go inside, turn off the air conditioning and put on the heaviest sweaters you can possibly find! Explain the mechanism behind this behavior.
   - This mechanism occurs during a set point within the human body.
   - Essentially, here, the body has adjusted the set point of your body temperature from 98.6°F to 101°F. Therefore, if it desires to warm itself to whatever that temperature may be.

6. (True/False) Some athletes have knee injuries that result in damage to their anterior cruciate ligament (ACL). ACL repair is possible by using different types of muscle tissue.
   - The ACL is connective tissue, not muscle tissue. Therefore, connective tissue would be needed to repair it.
   - Though, the outcome of such surgeries are generally dubious and signal the end of an athletic career.
7. The photograph on the cover of your textbook (Vander’s Physiology-11th ed.) represents:
   a. What type of cell? epithelial
   b. What type of tissue? alveoli
   c. Which organ? respiratory
   d. Which biological system? respiratory

8. (True/False) Afferent neurons have their cell bodies in the dorsal root ganglion and the central axon terminal in the spinal cord.

9. (True/False) Myelinated nerve fibers have a hydrophilic glycoprotein coat on their axons.

10. What is the function of a myelin sheath around axons?

11. (True/False) The resting membrane potential of an excitable membrane, such as nerve and muscle, is closer to the sodium equilibrium potential.

12. (True/False) Graded potentials are all-or-none.

13. What is an action potential? Draw a curve showing a typical tracing from an excitable tissue. Label and give the proper units. Explain what causes the changes in the shape of this tracing.

An action potential is the propagation of an electrical current down an axon. To begin, a neuron is at $E_{rest} \approx -70 \text{ mV}$. A change, sometimes chemical, then causes the nerve to change conformation opening sodium channels ($Na^+$) resulting in $Na^+$ flowing into the cell activating other $Na^+$ channels to open. This causes $E_{Na^+}$ to toward 60mV. Depolarization. The $Na^+$ leaks close & $K^+$ open during this time, dropping $E$ back down. This drops $E$ to below $E_{rest} \approx -90 \text{ mV}$, which is hyperpolarization. During this time, $K^+ / Na^+$-ATPase pumps active, bringing the curve back to $-70 \text{ mV}$. 

[Diagram of action potential]
14. If the extracellular chloride concentration is 110 mmol/L, and a particular neuron maintains an intracellular chloride concentration of 4 mmol/L, at what membrane potential would chloride be closest to electrochemical equilibrium in that cell? Show your calculations. State any assumptions that you are making. Give the proper units. Circle your answer.

\[ E = -\frac{61}{1} \log \left( \frac{110 \text{ mmol/L}}{4 \text{ mmol/L}} \right) \]

Currently, \( E = -61 \frac{1}{1} \log \left( \frac{110 \text{ mmol/L}}{4 \text{ mmol/L}} \right) \) the

implies that \( E \leq 0 \text{ mV} \) and there is a potential. However, at equilibrium \( E = 0 \), since concentration would be equal on both the inter and extracellular sides.

\[ E = -\frac{61}{1} \log \left( \frac{57 \text{ mmol/L}}{57 \text{ mmol/L}} \right) = 0 \text{ mV} \]

therefore, making \( E = 0 \text{ mV} \).

15. Neurotransmitters can be excitatory or inhibitory. Explain what this means in terms of their effects on membranes. Show on a graph and explain what happens.

An excitatory neurotransmitter would encourage opening of Na+ gates, raising the E of the nerve toward threshold; EPSPs cause depolarization. Inhibitory synapses may open Cl- channels or encourage K+ leakage, hyperpolarizing the membrane.

16. Name the neurotransmitter that is released at the synapse of a somatic efferent neuron onto a skeletal muscle cell. **Acetylcholine**

17. Amino acid can give rise to neurotransmitters.
   a. Name such an amino acid. **Tyrosine**
   b. Name such a neurotransmitter. **Dopamine**

18. Name the parts of the central nervous system.
   **Brain, brainstem, spinal cord**
19. Give an example of a cranial nerve. Explain its function.

I: olfactory: afferent; facilitate transmission of scent stimuli to olfactory center of brain.

20. What does EEG stand for? electroencephalogram

21. What is the difference between alpha and beta rhythm?

- Alpha waves tend to be released by the brain during times of concentration and thought, have a higher Hz.
- Beta waves are released by the brain at rest, tend to have smaller Hz.

22. What is needed for a skeletal muscle to contract? List the key players and give a brief description of its role.

ATP - provides energy for Ca^2+ reuptake, as well as crosslink formation between myosin + actin
Ca^2+ - binds to troponin to allow tropomyosin to be removed from crossbridge binding site
Myosin - has "feet" on it which cross and join to actin, allowing the two muscles to slide past each other
Actin - joins to myosin to allow it to "pull" against it and create contraction
Tropomyosin - works with Ca^2+ to move tropomyosin away from crossbridge linkage site

23. List two (2) key players in smooth muscle contraction different from those in skeletal muscle contraction.

Calmodulin - an acceptor for Ca^2+, needed to bind to myosin light chain kinase - an enzyme activated by Ca^2+ - calmodulin complex causes cross bridge linking from myosin to actin by joining ATP to head
24. Spring will be here soon and we will be searching for some bug-sprays! The active ingredient in certain pesticides is organophosphates that inhibit the enzyme acetylcholinesterase (AChE).
   a. What is the function of AChE?
      AChE is an enzyme found between a motor nerve and the connection site of a muscle. Serve to break down ACh (acetylcholine).
   b. What will be the physiological consequences of AChE-inhibitors on the bugs? Explain.
      Without AChE, ACh will build at receptor sites, inducing unstoppable muscle contraction. Once all receptors are bound, the muscle will be unable to relax, causing asphyxiation.

25. The functional contractile unit in skeletal muscle is called ___________.

26. What is the definition of a motor unit?
   A motor unit is a group of muscle fibers used to facilitate movement.

27. Give an example of an:
   a. Isotonic skeletal muscle contraction
      Lifting a dumbbell
   b. Isometric skeletal muscle contraction
      Standing still

28. (True/False) Each thick myosin filament is surrounded by six thin actin filaments.

29. List the conditions that will produce maximum tension in a skeletal muscle.
   Maximum tension is exerted by a muscle (skeletal) at the point where the muscle's length is 100% of the normal length. Thus allowing maximum actin-myosin stroking, and ___________.
30. In the lab you recorded EMG. What does EMG stand for?

31. What is recorded in an EMG? What did the trace(s) look like? What did they represent?

32. An increase in hand-dynamometer pressure was produced by
   a. Activation of more motor neurons
   b. Activation of more motor units
   c. Contraction of more muscle fibers
   d. All of the above
   e. None of the above

33. List and compare five (5) characteristics of the majority of the skeletal muscle fibers involved in the following sports activities. Give a brief functional role of each characteristic.

   Marathon Runner
   - More myoglobin
   - Large use of glycolysis
   - Small glycogen stores
   - Thinner muscle fibers
   - Mainly slow oxidative fibers

   Weight Lifter
   - Less myoglobin
   - Large use of glycolysis
   - Large glycogen stores
   - Thicker fibers (Hypertrophy)
   - Mainly fast glycolytic fibers
   - Fast glycolytic fibers make use of glycogen to provide energy rapidly

34. Suppose you are holding your 5lb-laptop in your hand! Your forearm is bent making a 90° angle at the elbow. Assume the forearm is 30cm long and the biceps muscle is attached 5cm from the elbow. Draw a sketch and show the mechanical equilibrium of forces acting on the forearm while supporting the 5lb-load. Calculate the tension generated by the biceps muscle.