Name:_____ Student Number:_____

BIOLOGY 2A03 TEST #1

February 3, 2017 **Dr. Graham Scott**
50 minutes **Ms. Sinah Lee**

Special Instructions:

- This test contains 8 pages and 40 questions
- Mark the letter of the one fully correct answer on the scan sheet.
- One mark per questions. 40 marks total (there is no penalty for incorrect answers)
- Only the McMaster Standard Calculator (Casio FX-991) is permitted

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THE FOLLOWING EQUATIONS MAY BE NEEDED TO ANSWER SOME OF THE QUESTIONS ON THE QUIZ:

$$V = \frac{[S] \cdot V_{max}}{K_m + [S]}$$

$$F = \frac{K_p \cdot A}{T} \cdot ([X]_{out} - [X]_{in})$$

$$E_{ion} = \frac{61}{z} \log\left(\frac{[ion]_{out}}{[ion]_{in}}\right)$$

1. Which of the following statement(s) is/are true of homeostasis?
   a) Internal conditions are regulated so that they match external conditions.
   b) The stability of the internal environment depends on negative feedback.
   c) Regulatory systems maintain the stability of the internal environment.
   d) B and C
   e) All of the above

2. Which of the following statements is TRUE in regards to the hierarchical organization of the body?
   a) All cells in the body can be classified into 3 different types: neural, muscle, and epithelial cells.
   b) An organ system refers to the function of one organ working in isolation.
   c) Organs are intact structures composed of a single cell type.
   d) Blood cells are classified as a type of epithelial cell.
   e) None of the above.

3. What distinguishes the terms “extracellular fluid” and “interstitial fluid”?
   a) The interstitial fluid does not include plasma.
   b) The interstitial fluid is inside cells, while the extracellular fluid is outside cells.
   c) Together, the two types of fluid represent all of the water in the body.
   d) A and B
   e) None of the above.

4. Referring to the Michaelis-Menten equation of enzyme kinetics, a high K_m:
   a) represents the effect of increasing substrate concentration on reaction rate
   b) is caused by an increase in enzyme concentration
   c) is characteristic of enzymes with a low affinity for substrate
   d) has no effect on the rate of enzyme reactions
   e) is used to calculate the effect of substrate concentration on V_{max}

5. Oxidative phosphorylation
   a) occurs in the cytosol
   b) requires high amounts of ATP to occur
   c) requires a proton gradient across the inner mitochondrial membrane
   d) generates reducing equivalents that can be used to make ATP in the Krebs cycle
   e) C and D

6. Enzymes reduce the _____ and, thereby, increase the speed of biochemical reactions.
   a) transformation state
   b) mass action
   c) chemical equilibrium constant
   d) activation energy barrier
   e) rate of catalysis

7. In Fick's Law, a substance's permeability constant for diffusion across a membrane is affected by
   a) the area of the membrane
   b) the substance's solubility in lipid bilayers
   c) the temperature
   d) B and C
   e) All of the above

8. When an uncharged solute diffuses across a membrane, the net flux
   a) can be described by Fick's law
   b) always occurs down the concentration gradient for that solute
   c) is independent of membrane potential
   d) All of the above
   e) None of the above

9. When a charged solute diffuses across a membrane, the net flux
   a) can be described by Fick's law
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   c) is independent of membrane potential
   d) All of the above
   e) None of the above

10. Which of the following is NOT true for all three of these transport mechanisms: facilitated diffusion, primary active transport, and secondary active transport?
    a) All three transport mechanisms require energy
    b) All three transport mechanisms can show specificity for a particular solute
    c) All three transport mechanisms involve a membrane protein
    d) The rate of transport can be increased for all three mechanisms by increasing the number of transport molecules in the plasma membrane
    e) All of the above are true

11. The passive movement of water across a membrane is called
    a) osmolarity
    b) symport
    c) osmosis
    d) facilitated diffusion
    e) antiport

12. If there is a difference in osmolarity between a cell and its environment, water will move _____.
    a) in the direction of higher osmolarity
    b) into a hypotonic environment
    c) by active transport
    d) in order to keep cell size constant
    e) A and B

13. Which of the following about lipophilic messengers is true?
    a) They bind receptors on the cell surface
    b) They can regulate the transcription of genes
    c) They can activate G proteins
    d) They are released into the blood from vesicles
    e) All of the above

14. Membrane-bound receptors
    a) can act as ligand-gated ion channels
    b) can activate second messenger pathways when they are bound by a ligand
    c) can catalyze biochemical reactions
    d) can produce graded potentials in post-synaptic neurons
    e) All of the above

15. The central nervous system receives sensory information from _____ and sends information to effector cells *via* _____.
    a) visceral receptors; astrocytes
    b) sympathetic neurons; multipolar neurons
    c) efferent neurons; afferent neurons
    d) afferent neurons; efferent neurons
    e) myelin; microglia

16. _____ branch from the cell body and receive input from other neurons at specialized junctions called _____.
    a) Somas; synapses
    b) Dendrites; cell bodies
    c) Dendrites; axon hillocks
    d) Dendrites; synapses
    e) Axon hillocks; dendrites

17. What type of cell enhances the speed of action potential propagation along an axon in the central nervous system?
    a) oligodendrocyte
    b) Schwann cell
    c) astrocyte
    d) ependymal cell
    e) microglia

18. In a resting neuron, chemical driving forces tend to cause Na^+ to diffuse _____ and Cl^- to diffuse _____.
    a) outward; outward
    b) inward; inward
    c) inward; outward
    d) outward; inward
    e) none of the above

19. In a resting neuron, electrical driving forces tend to cause Na^+ to diffuse _____ and Cl^- to diffuse _____.
    a) outward; outward
    b) inward; inward
    c) inward; outward
    d) outward; inward
    e) none of the above

20. If the membrane potential is -70 mV and the equilibrium potential for a negatively charged ion is -90 mV, what are the directions of the electrical driving force and the electrochemical driving force for that ion?
    a) outward; outward
    b) inward; inward
    c) inward; outward
    d) outward; inward

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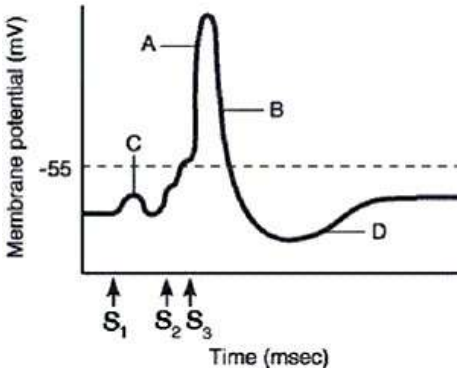
21. What is the equilibrium potential for Ca^{2+}? The concentration of Ca^{2+} in the intracellular fluid is 0.001 mM and in the extracellular fluid is 1.8 mM.
    a) 99 mV
    b) 199 mV
    c) 60 mV
    d) -94 mV
    e) None of the above

The following figure illustrates the changes in membrane potential during an action potential in a neuron. Use the figure to answer questions 22 and 23.



22. What is the best term to describe the event indicated by the letter "D" in the above figure?
    a) Threshold
    b) Depolarization
    c) Repolarization
    d) After-hyperpolarization
    e) Absolute refractory period

23. Which statement best describes the event indicated by the letter "A" in the above figure, and how is that event is initiated?
    a) It is the depolarization phase of an action potential, and it is caused by the closing of potassium channels.
    b) It is the depolarization phase of an action potential, and it is caused by the opening of sodium channels.
    c) It is a hyperpolarization of the membrane, and it is caused by the outward movement of potassium ions.
    d) It is a suprathreshold graded potential resulting from the opening of sodium channels.
    e) It is a subthreshold graded potential that represents an action potential.

24. Which of the following is <u>not</u> a mechanism whereby neurotransmitters are removed from the synaptic cleft?
    a) diffusion out of the cleft
    b) degradation by enzymes
    c) active reuptake across the presynaptic membrane
    d) binding to the receptor
    e) none – all of the above are valid mechanisms

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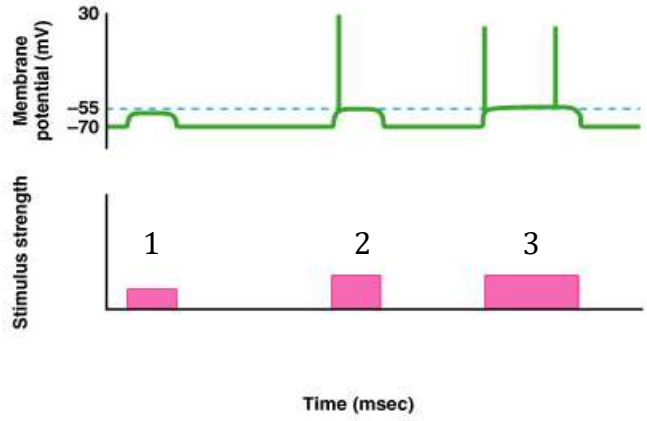
25. The binding of a neurotransmitter to its receptor at an inhibitory synapse can lead to the _____ of _____ channels.
    a) opening : potassium
    b) closing : potassium
    c) opening : sodium
    d) closing : chloride
    e) opening : calcium

The following figure shows the responses of a neuron to three different stimuli. Use the figure to answer questions 26 and 27.



26. Which of the following is true regarding the stimulus depicted at point 1?
    a) It causes an excitatory graded potential.
    b) It is sufficient to elicit an action potential.
    c) It likely caused K^+ channels to open.
    d) Both A and C are true.
    e) None of the above are true.

27. Which of the following is true regarding the stimulus depicted at point 3?
    a) It is strong enough to bring the membrane to threshold.
    b) It lasts longer than the relative refractory period.
    c) It does not last as long as the absolute refractory period.
    d) It is below threshold.
    e) Both A and B.

28. Which of the following is false in regards to sensory systems?
    a) Sensory receptors can be specialized endings of afferent neurons.
    b) One sensory unit comprises multiple afferent neurons and a single receptor cell.
    c) Information about stimulus intensity is encoded by action potential frequency.
    d) Receptor potentials can decrease over time, even if stimulus strength is constant.
    e) Sensory systems are important for maintaining homeostasis.

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29. Why does eating chili peppers feel hot?
    a) They reduce action potential firing in cold thermoreceptors.
    b) They initiate thermal signals that are transmitted to the thalamus.
    c) They contain a substance that binds to TRP ion channels.
    d) B and C.
    e) All of the above.

30. The sympathetic nervous system _____; the parasympathetic nervous system _____.
    a) innervates the heart; does not innervate the heart
    b) is active during intense activity; is active at rest
    c) contains only pre-ganglionic fibres; contains only post-ganglionic fibres
    d) uses acetylcholine as a neurotransmitter; uses epinephrine as a neurotransmitter
    e) inhibits the cardiovascular system; inhibits the digestive system

31. Where in the central nervous system do the preganglionic neurons of the parasympathetic nervous system originate?
    a) Primarily in the thoracic region of the spinal cord
    b) Only in the sacral region of the spinal cord
    c) Only in the lumbar region of the spinal cord
    d) Only in the thoracic and lumbar regions of the spinal cord
    e) Primarily in the brainstem

32. Which of the following describes the skeletal muscle sarcomere?
    a) The region of a myofibril between 2 adjacent Z-lines.
    b) The region of a myofibril between an M-line and an I-band.
    c) The protein structure that connects a transverse tubule with a lateral sac of the sarcoplasmic reticulum.
    d) The connection between myosin and actin during muscle shortening.
    e) A tendon that connects skeletal muscle to bone.

33. Which of the following is an accurate description of the sliding filament model of muscle contraction:
    a) Contraction occurs as adjacent thick filaments slide past each other.
    b) Muscle shortening occurs as myosin and tropomyosin slide past each other.
    c) Muscle shortening occurs when thin filaments overlap each other.
    d) Muscle shortening causes the H-zone between thin filaments to shorten.
    e) None of the above.

34. During the cross bridge cycle in skeletal muscle, the power stroke refers to the step when:
    a) ATP binds.
    b) ATP is hydrolyzed.
    c) Actin gets pulled towards the middle of the sarcomere.
    d) Ca^{2+} binds to troponin.
    e) None of the above.

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35. Excitation-contraction coupling in skeletal muscle depends upon:
    a) The association of troponin and myosin.
    b) The release of calcium from the sarcoplasmic reticulum.
    c) The physical coupling of DHP and ryanodine receptors.
    d) B and C.
    e) All of the above.

36. Which of the following statements is false:
    a) Actin is the main ATP consumer in contracting skeletal muscle.
    b) Muscle relaxation occurs when Ca^{2+}-ATPase removes excess Ca^{2+} from the cytosol.
    c) A single twitch is reproducible in magnitude and shape.
    d) During the muscle contraction phase, cytosolic [Ca^{2+}] is rising.
    e) None of the above.

37. Identify which of the following statement(s) is/are true:
    a) Large muscle fibres are recruited to contract before small fibres.
    b) Fast glycolytic fibres tend to be recruited before slow oxidative fibres.
    c) Each motor neuron innervates only one muscle fibre.
    d) Recruitment order relates to the size of the cell bodies of motor neurons.
    e) C and D.

38. Type I fibres have many _____, are _____ contracting, and tend to be recruited _____ at the onset of contraction.
    a) Mitochondria; fast; first.
    b) Mitochondria; fast; last.
    c) Mitochondria; slow; first.
    d) Glycolytic enzymes; fast; last.
    e) Glycolytic enzymes; slow; last.

39. During flight, hummingbirds increase power output by the flight muscles by
    a) increasing wingbeat frequency
    b) increasing stroke amplitude
    c) recruiting motor units composed of fast glycolytic fibres
    d) recruiting more motor units composed of different fibre types
    e) none of the above

40. Having more subsarcolemmal mitochondrial is beneficial in a low oxygen environment because
    a) ATP is produced closer to myofibrils
    b) the mitochondria are closer to capillaries
    c) the mitochondria require less oxygen
    d) the mitochondria are smaller
    e) all of the above