MCAT Biochemistry and Biology 2 Homework

Passage 1 (Questions 1-5)

Passage Outline

Paragraph 1: Lactotroph adenoma = anterior pituitary tumor; stimulates prolactin

Paragraph 2: Galactorrhea = inappropriate lactation; mass effect = add symptoms due to tumor size

Paragraph 3: Surgical and medicinal treatment of prolactinomas

Q1.

Assess: The method by which the samples are taken is a bit of a distraction from the test-makers. The real question here focuses on identifying actual hormones that would be circulating the body. **Plan:** Elicit- Which of the answer choices are hormones found in the body that would be measured from a sample of blood? Which choice then would we not expect to be measured? **Execute:** Thyroid-stimulating hormone (TSH), Adrenocorticotropic hormone (ACTH), and Follicle-stimulating hormone (FSH) are all hormones that exist within the body (and are all also secreted by the anterior pituitary). There is no such hormone called “Cortisol-releasing hormone,” but rather ACTH would stimulate the release of cortisol from the cortex of the adrenal glands. **Answer:** B

Q2.

Assess: The key concept here is recognizing the difference between incidence and prevalence. **Plan:** Ask the class for an explanation of the difference between incidence and prevalence within a population. Then elicit- If the rate at which new conditions develop is normal, but the total number of individuals with the condition are more than would be expected, what does that mean? **Execute:** Incidence is the risk of developing a condition within a time period and corresponds with the rate at which new cases would be diagnosed within a population. Prevalence refers to the percentage of the population that manifests the condition. If the rate of new diagnoses is within the expected range, but the total number of cases within the population are higher than expected, that means individuals with the condition are remaining part of that total number longer than expected. In other words, people within this population who have this condition are living longer than they would be projected to live. Choose the answer that goes along with this reasoning. **Answer:**C

Q3.

Assess: This problem requires us to consider the effects of mineralocorticoids to draw a conclusion. **Plan:** Elicit- From where are mineralocorticoids secreted? What do they do? What is another effect that large amounts of these hormones would have? **Execute:** Mineralocorticoids are a class of hormone secreted from the cortex of the adrenal glands and they regulate salt and water balance (ie. aldosterone). Specifically, these hormones will increase the amount of solute in the blood, which will

have the osmotic effect of increasing blood volume and therefore blood pressure. Match the answer choice that fits this reasoning. **Answer:** A

Q4.

Assess: The question is asking for us to evaluate which of the presented studies follows sound scientific method for addressing the presented issue, then choose the one that does not. **Plan:** First ask the class what general principles ensure a good scientific study. Then review each of the answer choices to see which match that criteria and also would demonstrate whether people with thyroid tumors are more likely than others to develop pituitary tumors. Remember we are looking for the choice LEAST likely to address this issue. **Execute:** Proper scientific method involves large study groups, clear hypothesis, measurable evidence, and some aspect of controllable variables. When considering each of the answer choices, A, B, and D all describe larger study populations of people with and without thyroid tumors who may or may not develop pituitary tumors. These scenarios would all be able to provide information addressing the question of whether or not patients with thyroid tumors are more likely than those without thyroid tumors to later develop pituitary tumors. Choice C, however, is an observation of only ten cases and focuses solely on people who already have thyroid tumors and were positively diagnosed with pituitary tumors as well. This study would be far too limited and would not answer the question asked. **Answer:** C

Q5.

Assess: This problem requires critical thinking to draw a connection between prolactinomas and effect on physiological function beyond what was specifically described in the passage. **Plan:** Elicit- Where in the passage do we read about mass effect? What is it? Based on where prolactinomas occur, what other hormones secreted there would we expect to be affected? **Execute:** Mass effect is introduced in P2 as additional symptoms due to the increased size of tumor. Since prolactinomas affect cells in the anterior pituitary (see also P1), we would expect other hormones secreted from the anterior pituitary to be affected by the mass effect. Look for the answer choice representing another hormone secreted from the anterior pituitary. **Answer:** B

Passage 2 (Questions 1-6)

Passage Outline

Paragraph 1: MG = neuromuscular dysfunction, autoimmune attack postsynaptic receptors

Paragraph 2: LES = autoimmune attack presynaptic Ca channels

Paragraph 3: Diagnosing MG/LES; acetylcholinesterase aids MG; repetitive nerve stimulation

Figure 1: RNS muscle response for normal, MG, and LES patients

Q1.

Assess: This problems tests understanding of the information provided by the passage about MG and critical thinking ability to make conclusions using that information. **Plan:**Elicit- Where does the passage describe the effects of MG? What does acetylcholinesterase do? How would this relate to what MG does? **Execute:** P1 describes MG as a condition where antibodies attack postsynaptic neurotransmitter receptors. Acetylcholinesterase is the enzyme responsible for degrading the neurotransmitter acetylcholine in order to terminate the signal transmission. If acetylcholinesterase were inhibited, it would result in larger amounts of neurotransmitter that could potentially bind those postsynaptic receptors not affected by MG. Select the answer choice that aligns with this reasoning. **Answer:** B

Q2.

Assess: This is a straightforward question about the effect of presynaptic calcium release. **Plan:** Elicit- What effect does calcium play in the propagation of a signal? What would happen if this action were blocked? **Execute:** The release of calcium triggers the release of neurotransmitter at the presynaptic terminal. Blocking the calcium release also effectively blocks neurotransmitter release. **Answer:** C

Q3.

Assess: Plan: Keeping in mind the process of action potential movement along the axon, review each answer choice and evaluate its effect on this movement. **Execute:** First, choice A- saltatory conduction is the movement of the signal from node to node between myelin sheaths along the axon and is a method of speeding up conduction of action potentials. Choice B is essentially the opposite--without the myelin we would not have saltatory conduction and so the signal would be slowed. This is our answer. Choice C would result in increased signal propagation since there is more sodium available to enter the cell during the depolarization step initiating the action potential down the axon. Choice D is a description of LES (see P2) and affects the presynaptic terminal, not the axon along which the action potential is conducted (which is the specific area about which the question asks). **Answer:** B

Q4.

Assess: Despite the longer question stem, this problem really just asks if we understand the role of a control group in a study. **Plan:** Elicit- What is a control group? If we want to see the effects of the medication, what kind of group would be the best baseline against which to compare the measurements of those taking the drug? **Execute:** Control groups are the groups in studies that do not receive the change or treatment being researched. The results for these groups serve as the baseline measurements for the other test groups so that effects of the change or treatment being researched can be observed. The individuals in a control group should be from the same population as those in the test group. For this particular study, we would want a group of MG patients receiving no other treatment. **Answer:** D

Q5.

Assess: This problem tests ability to draw conclusions from data presented in graphs, charts, or tables. **Plan:** Elicit- What observations can we make looking at this Figure? Does anything in particular really stick out? What does this mean with regards to the strength of a muscle contraction? **Execute:** In comparison with the RNS of the normal state, the strength of the action potentials decreases with repeated stimulation while the actual number of action potentials increases for LES. The most notable change is the decreasing strength of the action potentials for MG. This would also correspond to a decrease in the strength of the muscle contraction with repetitive stimulation. Reviewing the answer choices shows that Choice B matches this interpretation. **Answer:** B

Q6.

Assess: Another straightforward question about action potentials. **Plan:** Elicit- What do we call the reset time that takes place between two action potentials as a result of hyperpolarization? **Execute:** Refractory period. **Answer:** C

Discrete Question Practice (Questions 1-14)

Q1.

Assess: This problem requires an understanding of the function of peptide hormones versus steroid hormones. **Plan:** Elicit- What type of hormone pass through the cell membrane to bind intracellular receptors? **Execute:** Steroid hormones (built from cholesterol precursors). **Answer:** C

Q2.

Assess: The question really just asks which is a hormone secreted from the adrenal medulla. **Plan:** Elicit- What hormones are secreted from the medulla of the adrenal glands?**Execute:** Epinephrine and norepinephrine. **Answer:** D

Q3.

Assess: This question requires a solid grasp on the details and differences of mitosis versus meiosis. **Plan:** Do a very brief review of the stages of mitosis and meiosis, then review the answer choices for the stage in which gametes become haploid. **Execute:** Meiosis I (specifically, anaphase I) **Answer:** B

Q4.

Assess: This problem tests both knowledge of mutations in molecular genetics and ability to consider all information provided by the question stem. **Plan:** Elicit- What type of mutation would result in the early production of a stop codon that halts translation prematurely? How might this mutation occur? Which scenario best fits with all of the information described in the question stem? **Execute:** Changes in amino acid sequence that result in a premature stop codon are called nonsense mutations. This type of mutation can be the result of either base-pair substitution or a frameshift caused by an insertion or deletion. Since the question stem points out that the rest of the protein is substantially altered in terms of the amino acid sequence, the best explanation would be

the frameshift scenario. Of these answer choices, Choice A (an insertion) is the only type of frameshift listed.**Answer:** A

Q5.

Assess: Pay attention to the wording of the question stem. Here we are looking for a "NOT." **Plan:** Notice the double negative --"NOT… decreased…" means we are looking for a mechanism that does increase genetic variability. **Execute:** Point mutation is the only option given whereby genetic variability would be increased. **Answer:** C

Q6.

Assess: Another question where we need to be familiar with the mechanics of mitosis/meiosis. **Plan:** Elicit- Which phase in mitosis are microtubules going to be important?**Execute:** Function of the spindle apparatus during metaphase. **Answer:** B

Q7.

Assess: The true question here is about how mitochondrial DNA is inherited. **Plan:** Elicit- How is mitochondrial DNA passed down generation to generation? **Execute:** Maternally, from mother to child. Only Choice A fits this. You may wonder why not Choice C. A paternal grandmother is the child's father's mother, so the mitochondrial DNA from the grandmother would not pass down further from the father to the child. **Answer:** A

Q8.

Assess: The main point for this problem is knowledge of the branches of the nervous system and what responses are controlled by each. **Plan:** Elicit- In what kind of state is a person typically startled? Which division of the nervous system controls function in this state? **Execute:** People are usually startled when caught unaware, or on low-alert, such as resting or digesting. This is the state which the parasympathetic nervous system controls. **Answer:** C

Q9.

Assess: A fairly direct question regarding summation of action potentials to trigger a response. **Plan:** Ask someone from the class to describe the difference between temporal summation and spatial summation. **Execute:** Threshold potential is the potential each individual neuron must achieve to initiate a single action potential, just as dendritic stimulation is simply the postsynaptic reception of a signal. The two answer choices we should be drawn to are Choices C and D. Temporal summation is where a high frequency of action potentials from a single presynaptic neuron are required to generate a response from a postsynaptic neuron. Spatial summation is where a postsynaptic neuron requires input from multiple presynaptic neurons. **Answer:** D

Q10.

Assess: This problem is testing an understanding of the anaerobic respiration process in humans. **Plan:** Elicit- What happens after glycolysis when undergoing anaerobic

respiration. **Execute:** Pyruvate goes through fermentation and is converted to lactic acid (or ethanol in yeast). **Answer:** B

Q11.

Assess: The question is asking about an effect, not the cause, so there is no need to focus on apoptosis (other than reminding them it is programmed cell death if asked). **Plan:** What role does the mitochondrial membrane play in oxidative phosphorylation? How would the small pores affect this? **Execute:** A key part of the oxidative phosphorylation process is the electrochemical gradient established across the mitochondrial membrane. It is the gradient and the movement of protons through the membrane that drives ATP production. If there were small pores in the membrane, the protons could pass through by means other than the proper ATP-synthase channels and thus the process would not be able to continue. Match the answer that fits this reasoning. **Answer:** C

Q12.

Assess: Emphasize the question stem is asking about an element, not a molecule. **Plan:** Ask the class what the point of taking in nutrients is. Then elicit- Of the three elements (glucose is a tempting answer choice, but the question wants an element, not a molecule), which is going to aid in this purpose? **Execute:** We take in nutrition primarily to provide energy for our bodies. The basic form of energy needed for all processes of the body to function comes from ATP. To build all of this adenosine triphosphate, we need phosphate.**Answer:** D

Q13.

Assess: This problem requires a firm understanding of the steps of the ATP synthesis process. **Plan:** Elicit- What role does ADP play in the process of ATP production? How will Increasing ADP then drive this process forward? **Execute:** ADP may be converted to ATP, but it is not the ADP itself that drives the reaction, but rather the transport of electrons across the mitochondrial membrane. This transport is itself facilitated by the passing of electrons from NADH and $FADH_2$ to O_2. If increased amounts of ADP are available, there will need to be an increase in the production of these electron carriers to drive conversion of the ADP to ATP. Match the answer choice that aligns with this. **Answer:** B

Q14.

Assess: The question stem is pretty open-ended, so we should do a quick preview of the answer choices to guide our approach for reasoning towards an answer. **Plan:** Review the difference between endergonic/exergonic versus endothermic/exothermic. Then consider the process of oxidative phosphorylation and determine which term pair best fits. Lastly, identify which term applies specifically to ATP formation and which applies to electron transport. **Execute:** Endergonic/exergonic is absorbance/release of energy through work, whereas endothermic/exothermic refers to absorbance/release of heat energy. Oxidative phosphorylation is a series of

processes which proceed by energy absorbed/released in the form of work. In considering the individual steps presented, remember that ATP is higher in energy than ADP, so ATP formation must require an input in energy and is therefore endergonic (which also means it is non-spontaneous). Electron transport, on the other hand, requires a release in energy and is therefore exergonic (and spontaneous). Select the answer choice that reflects this reasoning. **Answer:** B