**POE #5: Hitting the Wall**

**Topic**

Unit 5- Muscular System

The scenario below has been simplified for the purposes of this introductory anatomy and physiology course. As you progress in your academic and professional careers you may learn more extensive details related to this scenario.

**Introduction to the Scenario**

*As you read through the scenario below underline specific facts and information you find important to the situation*

When running a marathon every runner fears of “hitting the wall”. This metaphorical wall generally occurs around mile 20 in the marathon, and it is a point in the race that every runner hopes to avoid. Hitting the wall, also known as “bonking,” refers to the point when a runner experiences extreme exhaustion and energy depletion. When a runner hits the wall, they typically become fatigued, dizzy, weak, and sometimes incapable of finishing the race. The two images below are of runners at mile 20 in their marathon and based on the images it is clear that runner A has hit the wall while runner B is completing her race…strong!



**Runner A**

**Runner B**



**Driving Question**

*How are blood glucose homeostasis, electrolyte balance, neurotransmitter levels, and muscle anatomy and physiology affected when a runner hits the wall in a marathon?*

**Initial Hypotheses/Predictions**

*In the box below, please provide your initial ideas about a possible answer to the driving question above.*

**Relevant Data & Analysis Questions**

***ALL analysis questions are italicized in the pages below***

**Runner Information:**

Each of these runners is healthy, young, and fit with no indications of disease or health problems. Both runners are running the same marathon and the pictures above represent the same mile marker (mile 20) in the race.

|  |  |
| --- | --- |
| **Runner A** | **Runner B** |
| **Blood Glucose**  Pre-Race: 105mg/dl  During Race (Image): 58mg/dl  After Race: 70mg/dl | **Blood Glucose**  Pre-Race: 130mg/dl  During Race (Image): 110mg/dl  After Race: 100mg/dl |
| **Caloric Intake**  Day before race: 2550  Race Morning: 220  During the race: 0 | **Caloric Intake**  Day before race: 3000  Race Morning: 665  During the race: 500 |
| **Water & Electrolyte Intake**  Pre-Race: 6oz. water  During Race: Water only at miles 5, 10, and 15 | **Water & Electrolyte Intake**  Pre-Race: 8oz. water & electrolyte mix  During Race: Water & electrolyte mix at miles 5, 10, and 15 / Water only at miles 3, 6, 12, & 18 |
| **Muscle Glycogen Storage**  Pre-Race: 75%  During Race (Image): 0%  Race  Glycogen  Pre-Race  Glycogen | **Muscle Glycogen Storage**  Pre-Race: 100%  During Race (Image): 50%  Pre-Race  Glycogen  Race  Glycogen |
| **Liver Glycogen Storage**  Pre-Race: 75%  During Race (Image): 0%  Race Glycogen  Pre-Race Glycogen | **Liver Glycogen Storage**  Pre-Race: 100%  During Race (Image): 30%  Race Glycogen  Pre-Race Glycogen |

*Why would low muscle and liver glycogen levels affect blood glucose levels; identify any specific cells, organs, hormones, neurotransmitters, and pathways.*

*Explain how Runner B’s body is maintaining her blood glucose levels; identify any specific cells, organs, hormones, neurotransmitters, and pathways. What would you expect to be different compared to runner A?*

In *POE #2 we learned that Sandy had low blood calcium. How did her low blood calcium affect her synapses and the communication to effectors?*

*Explain how Sandy’s body would work to maintain her blood calcium levels; identify any specific cells, organs, hormones, neurotransmitters, and pathways. Would runner A experience similar muscle issues as Sandy?*

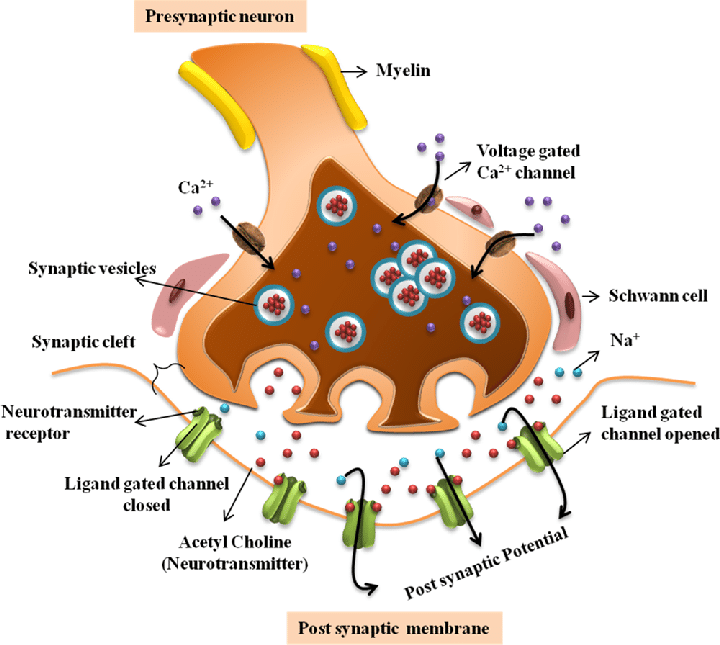
*As a quick refresher,* ***circle*** *answers in the chart below that describe the interconnection of neuron and muscle physiology.*

|  |  |  |
| --- | --- | --- |
|  | At Rest | Depolarization |
| Membrane Potential | POSITIVE / NEGATIVE | POSITIVE / NEGATIVE |
| Na+ Concentration | Inside Cell: HIGH / LOW  Outside Cell: HIGH / LOW | Inside Cell: HIGH / LOW  Outside Cell: HIGH / LOW |
| K+ Concentration | Inside Cell: HIGH / LOW  Outside Cell: HIGH / LOW | Inside Cell: HIGH / LOW  Outside Cell: HIGH / LOW |
| Ca2+ Concentration | Inside Cell: HIGH / LOW  Outside Cell: HIGH / LOW | Inside Cell: HIGH / LOW  Outside Cell: HIGH / LOW |
| Contractile State (Muscle Fiber) | Relaxed / Contracted | Relaxed / Contracted |
| Signal Firing State (Neuron) | Firing/ NOT Firing | Firing/ NOT Firing |
| Action Potentials Occurring | YES / NO | YES / NO |

**Runner Electrolyte Levels**

|  |  |  |
| --- | --- | --- |
| **Electrolytes** | **Runner A** | **Runner B** |
| Na+ | Low | Normal |
| K+ | Low | Normal |
| Ca2+ | Low | Normal |

*Now,* ***CIRCLE*** *the components of the NMJ that would be affected in Runner A due to her low electrolyte levels.*

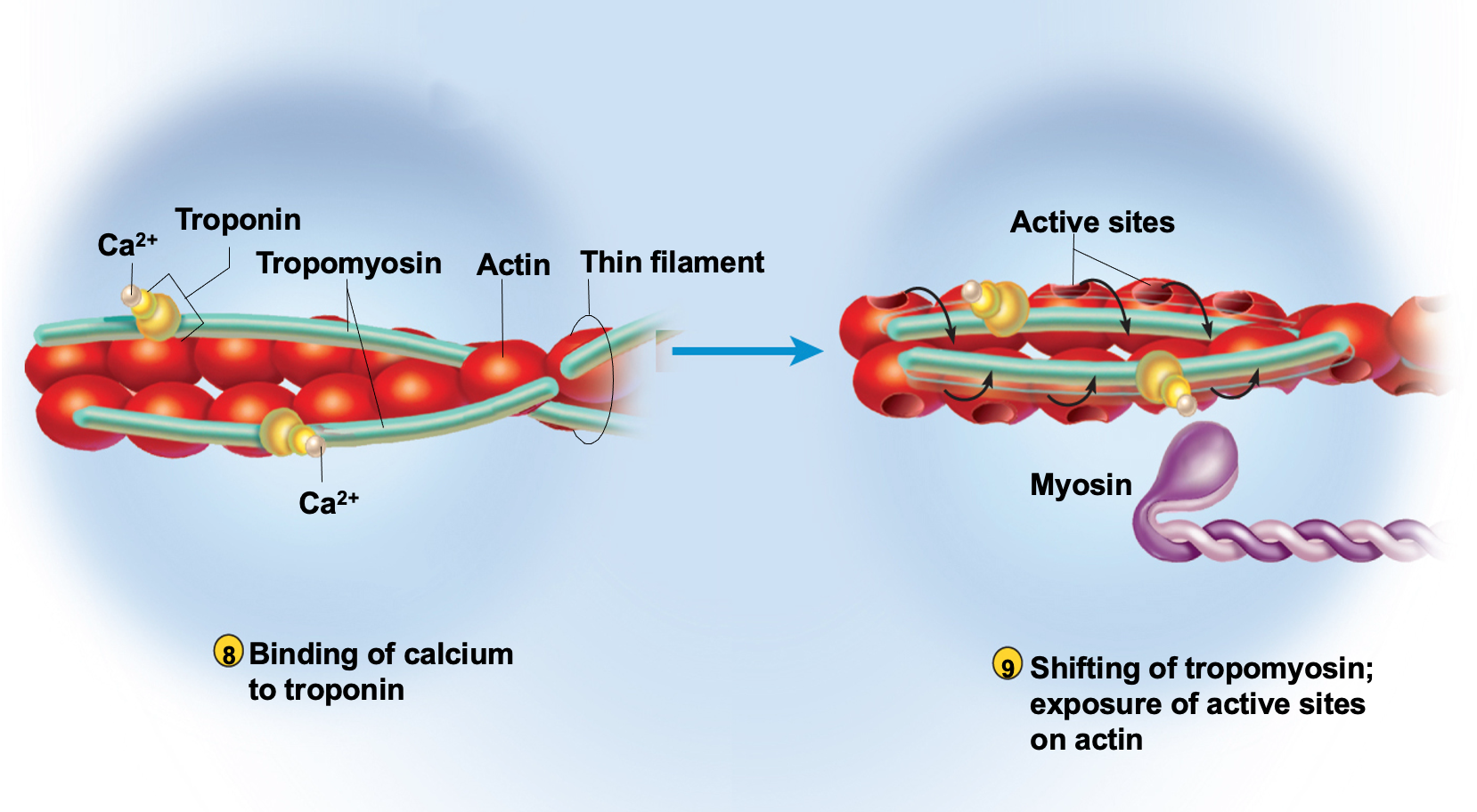


*Explain the role of each ion at the NMJ.*

Na+ 🡪

K+ 🡪

Ca++ 🡪

**Calcium’s Role in Muscle Contraction**

*Explain how the events in steps 8 and 9 would differ between the two runners; identify any specific proteins, cells, organs, hormones, neurotransmitters, and pathways.*

*What other steps in excitation-contraction coupling would be affected in runner A? Identify any specific cells, organs, hormones, neurotransmitters, and pathways. How would these contribute to her hitting the wall?*

*In POE #3, we learned that inhibiting the release of ACh affected the communication at a synapse. Fatigue can reduce the amount of ACh released by motor nerve fibers. Compare and contrast these two scenarios. Then give two examples discussed in class where neurotransmitters, toxins, or receptors are affected and explain the results on the body.*

*Explain different strategies the body uses to remove neurotransmitters from the synapse.*

*From POE #4 we learned that the sympathetic nervous system is responsible for excitatory responses. Complete the graphic below to understand how the SNS plays a role in running a marathon.*

|  |  |
| --- | --- |
| Physiological Process/System | Describe the Response During a Marathon |
| Nervous System Activation |  |
| Heart Rate |  |
| Respiration |  |
| Blood Glucose |  |
| ATP Production |  |
| Blood Flow |  |

**Answer the following questions, connecting as much of the material learned in Units (and POEs) 1-4.**

*List 4 variables that affect muscle force. How might the previous 4 POEs alter each variable.*















*Describe the metabolic pathway used to create ATP in these two women. Which runner would likely have less ATP production? Describe specific processes during muscle contraction that would be affected from low ATP levels.*

*Which muscle fiber type would be dominant in each of these female marathon runners? Which muscle fiber type would be dominant in a sprinter? Before her next marathon, what type of training could runner A work on to improve the performance of this fiber? Give examples and provide an explanation.*

*List and describe 5 variables that affect muscle strength.*















*What are some strategies runner A could have implemented before and during her marathon to prevent her from hitting the wall? (****Hint: Discuss nutrition, electrolyte intake, and training****)*

**Observations**

*After examining the data and answering the analysis questions above, describe interesting observations and patterns you believe are relevant to explaining the scenario. You can include both textual and visual observations in order to help organize the data from above. (Include at least 10 important pieces of data and evidence that will aid in your final explanation of the scenario below)*

**Explanation**

*Based on the data and analysis questions above, please provide an answer to the driving question(s) in the box below. Remember to include data from above as evidence, important ideas from previous units, and the concept of homeostasis in your response.*

**Driving Question(s)**

*How are blood glucose homeostasis, electrolyte balance, neurotransmitter levels, and muscle anatomy and physiology affected when a runner hits the wall in a marathon? Compare Runner A to Runner B in order to explain a normal homeostatic response to exercise (runner B) to an abnormal homeostatic response to exercise (runner A).*