**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**BI231 Action Potential Graphing Exercise**

1. Na+ is critical for action potential formation in neurons. Much of our understanding of the ionic basis of action potentials has come from experimental alteration of Na+ and K+ concentrations in vitro. The graphs provided on Page 3 illustrate the action potentials generated as the extracellular concentration of Na+ was altered. Study the three graphs then answer a-c below. Basis

a. Describe the changes observed due to changes in [Na+].

b. Provide an explanation for the changes.

c. While clinically you would not see such dramatic changes (normal range 135 mEq/L-145 mEq/L) in extracellular Na+ levels, sodium values can change and are routinely monitored in blood samples. Under what physiological conditions could you image seeing modest changes in Na+ levels?

2. In question #1 above the changes in action potentials were due to changing [Na+]. There is a toxin tetrodotoxin (TTX) produced by puffer fish that results in similar effects on the neuron by blocking voltage gated Na+ channels. There is also a toxin tetraethylammonia (TEA) that has long been known to block voltage gated K+ channels in neuron axons.

In the space below draw a graph of an action potential generated in the presence of TEA (assume 50% of the K+ channels are blocked)

3. What would happen to the membrane potential if both Na+ and K+ channels opened at the same time making the membrane equally permeable to both? The membrane potential would: *(select your answer then provide support for your selection)*

A. Show no change.

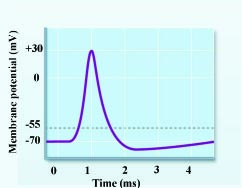
B. The membrane potential would be lower because a new K+ equilibrium potential was established.

C. The membrane potential would be higher because a new Na+ equilibrium potential was established.

D. The membrane potential would approach a value between Na+ and K+ potentials.

Support your answer

4. If the concentration of K+ in the cytoplasm of an axon was experimentally reduced by half (normal range 3.5-5.0 mEq/L; a condition known as hypokalemia) the membrane potential would be affected. On the action potential graph below draw a line indicating what the membrane potential might be under this condition.



5. With hypokalemia would a patient be hyperreflexive (overactive or overresponsive reflexes) or hyporeflexive. *Support your answer.*

**A**

**70% [Na+]**

**0**

**50% [Na+]**

**Normal [Na+]**

**Membrane potential (mV)**

**Membrane potential (mV)**

**Membrane potential (mV)**

**Time (ms)**

**Time (ms)**

**Time (ms)**

**33% [Na+]**

**Normal [Na+]**

**Normal [Na+]**

**Resting Membrane Potential**

**B**

**Resting Membrane Potential**

**0**

**C**

**Resting Membrane Potential**

**0**

**Case Study**

74-year-old woman admitted to emergency department

**Chief Complaint:** Increasing shortness of breath and peripheral edema.

**History:** Martha Wilmington, a 74-year-old woman with a history of rheumatic fever while in her twenties, presented to her physician with complaints of increasing shortness of breath ("dyspnea") upon exertion. She also noted that the typical swelling she's had in her ankles for years has started to get worse over the past two months, making it especially difficult to get her shoes on toward the end of the day. In the past week, she's had a decreased appetite, some nausea and vomiting, and tenderness in the right upper quadrant of the abdomen.

Additional history includes: Diabetes Mellitus II (DMII); Hypertension (HTN) and Chronic Kidney Disease (CKD)

Note: Diabetes mellitus exacerbates the process of atherosclerosis (vessel narrowing) leading to HTN and CKD

Medications: Metformin (an oral medication for DMII); Minipress (Prazosin) (an oral medication for high blood pressure); Spironolactone (a diuretic medication for fluid build-up related to heart failure)

Note: Spironolactone is a potassium-sparing diuretic

**Labs** return for Martha. Her K+ is 6.1 mEq/L normal range is 3.5 – 5.0 mEq/L

6. Martha’s deep tendon reflex is tested (e.g. rubber mallet tapping the patella tendon)

With hyperkalemia would Martha exhibit hyperreflexia (overactive or over-responsive reflexes) or hyporeflexia. *Support your answer.*

7. What pathology may be contributing to Martha’s hyperkalemia?