Solutions to Homework Assignment – Module 4

1. [20 points] From the statements below regarding smooth muscle choose the most correct statement AND briefly explain why each of the incorrect statements is incorrect.

   A. Phosphorylation of ATP bound to myosin light chains depends on the binding of Ca^{2+} to calmodulin; this binding is potentiated by myosin light chain kinase.

   Choice A is not correct because (1) ATP does not become phosphorylated at any time during SMC contraction/relaxation, (2) ATP does not bind to MLCs, and (3) the binding of Ca^{2+} to calmodulin is not potentiated by MLCK. Refer to video 3, slide 3; VSL[14], section 9.9; B&L[7], Figure 14.7 and associated text.

   B. The formation of crossbridges that can continue to cycle requires that myosin phosphatase be activated by an elevated intracellular concentration of Ca^{2+}.

   Choice B is not correct because the formation of crossbridges that can continue to cycle requires that myosin light chain kinase (not myosin phosphatase) be activated by an elevated intracellular concentration of Ca^{2+}. Refer to video 3, slide 5.

   C. The velocity of unloaded shortening (V_0) is proportional to the percentage of crossbridges with phosphorylated light chains.

   Choice C is correct as written. Refer to video 3, slide 1.

   D. In response to a sustained (in time) stimulation most crossbridges become, and remain, phosphorylated.

   Choice D is not correct because in response to a sustained (in time) stimulation most crossbridges become, but do not remain, phosphorylated. Rather, after an initial burst during which most crossbridges become phosphorylated, as time goes forward some of the phosphorylated cross bridge become dephosphorylated until most of the crossbridges are NOT phosphorylated. Refer to video 3, slide 4.

2. [20 points] From the statements below regarding Ca^{2+} handling in smooth muscle choose the one that is most correct AND briefly explain why each of the incorrect statements are incorrect.

   A. Ca^{2+} is released from the sarcoplasmic reticulum in response to an action potential coupled from the sarcolemma to the sarcoplasmic reticulum by the caveolae.

   Choice A is not correct because (1) Ca^{2+} is NOT released from the sarcoplasmic reticulum in response to an action potential coupled from the sarcolemma to the sarcoplasmic reticulum and (2) caveolae do not couple action potentials from the sarcolemma to the sarcoplasmic reticulum. Refer to video 3, slide 6.

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B. In response to a ligand binding to a receptor on the sarcolemma an ATP-powered pump drives extracellular Ca^{2+} across the sarcolemma and into the myofilament space.

Choice B is not correct because in response to a ligand binding to a receptor on the sarcolemma extracellular Ca^{2+} can enter the myofilament space by moving (through a receptor-activated Ca^{2+} channel) down its concentration gradient ($[Ca^{2+}]_o >> [Ca^{2+}]_i$; no ATP-powered pump is needed). Refer to video 3, slide 6.

C. An increase in the concentration of intracellular Ca^{2+} reduces the activity of myosin light chain kinase.

Choice C is not correct; an increase in $[Ca^{2+}]_i$ increases (not reduces) the activity of myosin light chain kinase. Alternatively, Choice C is not correct because a decrease (not an increase) in $[Ca^{2+}]_i$ reduces the activity of myosin light chain kinase.

D. To enable relaxation, Ca^{2+} can be removed from the myofilament space by re-accumulation into the sarcoplasmic reticulum and by extrusion across the sarcolemma; both of these require energy.

Choice D is correct as written.

3. [20 points] Indicate which of the following statements regarding smooth muscle is ***not*** correct AND briefly explain why it is incorrect.

A. Activator Ca^{2+} (for contraction) can enter the myofilament space across the sarcolemma in response to a stimulus that does not alter the sarcolemma's membrane potential.

This statement is correct as written.

B. Crossbridges in the "latch" state go through (finish, if they are attached) their cycle more slowly than crossbridges that are phosphorylated.

This statement is correct as written.

C. Single-unit smooth muscle is more densely innervated than is multi-unit smooth muscle.

Choice C is not correct because single-unit smooth muscle is less (not more) densely innervated than is multi-unit smooth muscle. Alternatively, multi-unit (not single unit) smooth muscle is more densely innervated than is single unit (not multi-unit) smooth muscle. Refer to video 4, slides 2 - 5.

D. Ca^{2+} in the myofilament space can be extruded across the sarcolemma *via* a secondary active transport mechanism.

This statement is correct as written.

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