Solutions to Homework Assignment – Module 5

1. [20 points] Choose the most correct statement AND briefly explain why each of the remaining statements are not correct.

   A. Cardiac muscle cells do not have a t-tubular system.

   This statement is not correct; cardiac muscle cells do have a t-tubule system. See video 1, slides 7 and 8; B&L[7] Figure 13.1.B.

   B. The diameter of cardiac muscle cells is significantly smaller than the diameter of skeletal muscle cells.

   This statement is correct as written. See video 3, slide 1.

   C. With regard to the source(s) of Ca^{2+} for contraction, cardiac muscle is more like skeletal muscle than like smooth muscle.

   This statement is not correct; with regard to the source(s) of Ca^{2+} for contraction cardiac muscle is more like smooth muscle than like skeletal muscle. Cardiac muscle and smooth muscle both source Ca^{2+} for contraction from outside the cell and from the sarcoplasmic reticulum; skeletal muscle sources Ca^{2+} for contraction only from the sarcoplasmic reticulum. See video 3, slide 3; B&L[7] Figure 13.2 (cardiac); B&L[7] Figure 14.10 (smooth).

   D. Cardiac muscle receives its innervation from the somatic nervous system.

   This statement is not correct. Cardiac muscle receives its innervation from the autonomic nervous system. See video 3, slide 2; B&L[7] Figure 11.1.

2. [20 points] Explain why each of the following statements is **incorrect** …

   A. Excitation/contraction coupling in cardiac muscle is similar to excitation/ contraction coupling in skeletal muscle.

   This statement is not correct; excitation/contraction (EC) coupling in cardiac muscle is not similar to EC coupling in skeletal muscle. Rather, EC coupling in cardiac muscle is more similar to EC coupling in smooth muscle. In cardiac muscle an AP on the SL propagates down the T-tubules (so far, similar to skeletal muscle) and opens voltage-gated Ca^{2+} channels in the T-tubular membrane (so much for similarity to skeletal muscle – this step and the following steps do not happen in skeletal muscle). The extracellular Ca^{2+} that enters into the cell (down its electrochemical gradient) can go directly to the myofilament space; it can also trigger an RyR receptor in the SR membrane that opens a Ca^{2+} channel (in the SR membrane) which allows Ca^{2+} from the SR to exit into the myofilament space, moving down its electrochemical gradient (this is referred to as

CICR – calcium induced calcium release). The $3Na^{+}/Ca^{2+}$ antiporter can also play a role in Ca^{2+} entry; the details of this are beyond the scope of this course. See video 2, slide 2.

B. The t-tubular system in cardiac muscle plays a significant role in removing Ca^{2+} from the myofilament space.

This statement is not correct; the t-tubular system in cardiac muscle does not play a significant role in removing Ca^{2+} from the myofilament space in cardiac muscle. See video 2, slide 2; B&L[7] Figure 13.2; Bers DM, Nature 2002 415:198-205.

C. Inositol triphosphate (IP_3) is the trigger for release of Ca^{2+} from myosin light chains in cardiac muscle.

This statement is not correct in that (a) Ca^{2+} does not bind to myosin light chains in cardiac muscle at any time during contraction or relaxation and (b) IP3 does not trigger release of Ca^{2+} from cardiac myosin light chains; see (a).

D. Removal of Ca^{2+} from troponin in cardiac muscle requires the activation of myosin light chain phosphatase.

This statement is not correct; removal of Ca^{2+} from troponin in cardiac muscle does not require the activation of myosin light chain phosphatase. The removal of Ca^{2+} from troponin C (TnC) in cardiac muscle depends on the kinetics of Ca^{2+} binding to troponin; Ca^{2+} begins to come off TnC when $[Ca^{2+}]$ in the myofilament space is on the order of < 1 uM/L.

Rev 0, 10/7/2018 - re-written in proper format - from previous (Spring 2018) version
Rev 1, 9/23/2019 - correct typos; no content changes.