Solutions to Homework Assignment – Module 9

1. [20 points] Which of the following statements about the autonomic nervous system is the most correct? Re-write the choices that, as written now, are wrong so that they will be correct once you change them.

   A. Sympathetic preganglionic nerves are ~~longer~~ shorter than parasympathetic preganglionic nerves. See video 2, slides 2, 3.

   Alternative: Parasympathetic preganglionic nerves are longer than ~~para~~sympathetic preganglionic nerves. See video 1, slides 2, 3.

   Alternative: Sympathetic post~~pre~~ganglionic nerves are longer than parasympathetic post~~pre~~ganglionic nerves. See video 1, slides 2, 3.

   B. ACh is the preganglionic neurotransmitter for the sympathetic and for the parasympathetic branches of the autonomic nervous system.

   Correct as written.

   C. Parasympathetic postganglionic neurons arise from ~~the paravertebral~~ ganglia close to/on/in the organ/tissue that they innervate. See video 1, slide 2.

   Alternative: ~~Paras~~Sympathetic postganglionic neurons arise from the paravertebral ganglia.

   D. The parasympathetic postganglionic neurotransmitter is ~~epinephrine~~ acetylcholine (ACh). See video 1, slide 3.

   Alternative: The ~~para~~sympathetic postganglionic neurotransmitter is norepinephrine. See video 1, slide 3.

   Alternative: The parasympathetic post/preganglionic neurotransmitter is ~~epinephrine~~ acetylcholine (ACh). See video 1, slide 3.

2. [20 points] Heart rate varies with respiration, being higher during inspiration than expiration. Describe/discuss/explain the mechanism(s) involved.

   During inspiration
   - ✦ Intrathoracic pressure decreases …

Rev 2, 3/31/17 - adapted from Rev 1, with changes to Response 2
Rev 3, 4/3/17 - correct numbering for problem 3
Rev 4, 10/23/17 - add refs B&L[7] as needed; no change to content
Rev 5, 11/8/17 - Revise Response 3; no other changes
Rev 6, 11/6/18 - update to 601; no content changes

- Lungs inflate, triggering pulmonary stretch receptors →inhibit cardiac controller in medulla → heart rate increases
- Increased venous return → triggers atrial stretch receptors → triggers Bainbridge reflex → heart rate increases

- Increased venous return → increased cardiac output (Frank – Starling curve) → increased arterial pressure → heart rate decreases (baroreceptor reflex)

✦ Respiratory controller (medulla) → inhibits cardiac controller (medulla) → heart rate increases

During expiration

✦ Vagal neural activity increases → heart rate decreases

Net result is that heart rate increases during inspiration and decreases during expiration.

See B&L[6+], Figures 18-6 and 18-8 and pages 373-374; B&L[7], Figures 18.6 and 18.8 and page 380.

3. [20 points] In video 3 of this Module there was a brief mention of atrial stretch receptors, but no details were provided. So – describe the several physiological consequences of stimulating (stretching) the atrial stretch receptors and briefly discuss whether (or not) the physiological consequences are consistent with the original stimulus.

Stimulating the atrial stretch receptors triggers the Bainbridge reflex, resulting in an increase in heart rate. If the atrial receptors were stimulated by an increase in atrial volume (perhaps secondary to increased venous return) then an increase in heart rate makes physiological sense in that an increased heart rate will reduce atrial filling time, thus reducing atrial volume, thus reducing the drive to the atrial stretch receptors – seems like a reasonable negative feedback loop.

If you think about stimulating the atrial stretch receptors by increasing atrial volume (as above) you must consider that some of the increased atrial volume will be pushed into the ventricle when the atria contract, resulting in an increased ventricular end-diastolic volume, that in turn results in an increased cardiac output (Frank-starling curve), which will increase arterial pressure. That will trigger the baroreceptor reflex, which will reduce heart rate. A reduced heart rate leads to increased filling time, which will increase atrial filling (thus increasing atrial volume) and thus increase stretch on the atrial stretch receptors. This doesn't immediately appear to make physiological sense, since the initial

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stimulus was to increase stretch of the atrial stretch receptors; this appears to be a positive feedback loop.

So - it appears that stimulating atrial stretch receptors evokes a “push-pull” response that will fine tune the heart rate and arterial pressure (B&L[6+], Figures 18-6 and 18-8 and pages 372 - 373; B&L[7], Figures 18.6 and 18.8 and pages 388 - 390).

NOTE that there are other effects of stimulating atrial stretch receptors (i.e., modulation of vasopressin and ANP levels, both of which affect renal function) – we have not covered that material.

Rev 2, 3/31/17 - adapted from Rev 1, with changes to Response 2
Rev 3, 4/3/17 - correct numbering for problem 3
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Rev 5, 11/8/17 - Revise Response 3; no other changes
Rev 6, 11/6/18 - update to 601; no content changes