Discussion Week 4

Animal Physiology
Discussion Questions and Reading Assignments

Heart overview Skim HWA pp.688-696, read box 25.1. Withers pp. 715-718 Myogenic and neurogenic hearts, depolarization of the heart, cardiac output. HWA is in the shared Google Drive under "Supplemental_Textbooks". https://tinyurl.com/2cpyxvct

Heart Function

1. The heart is basically a big muscle (modified skeletal muscle). How are cardiac muscle fibers modified relative to skeletal muscle fibers? and how does this design promote a coordinated, forceful contraction? Look at box 25.1. What would happen if it the signal propagation were less coordinated?

2. Describe how the electrical signal in the vertebrate heart is propagated -- where does it start, and through which cells/fibers does it spread? How does the timing of the depolarizations through the SA node, AV node, Purkinje fibers, and through the ventricles relate to the ECG, and what his happening with regard to blood filling/being ejected from the atria and ventricles? (see Fig. 14-41)

3. What is the Frank-Starling Effect and what causes it? How is it helpful?

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Withers fig. 6-32. Basic description of transmission of action potential at a chemical synapse Read Withers 353-355 sympathetic and parasympathetic branch of the autonomic nervous system.Skim: Skim Withers 239-243 for list of neurotransmitters: Acetycholine, Epinephrine, Serotonin, GABA.

Chemical Synapse

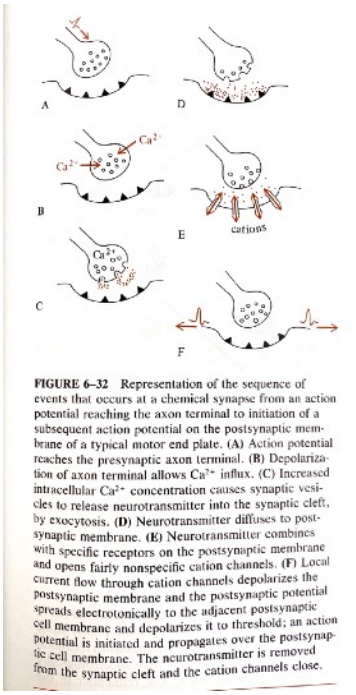

FIGURE 6–32 Representation of the sequence of events that occurs at a chemical synapse from an action potential reaching the axon terminal to initiation of a subsequent action potential on the postsynaptic membrane of a typical motor end plate. **(A)** Action potential reaches the presynaptic axon terminal. **(B)** Depolarization of axon terminal allows Ca^{2+} influx. **(C)** Increased intracellular Ca^{2+} concentration causes synaptic vesicles to release neurotransmitter into the synaptic cleft, by exocytosis. **(D)** Neurotransmitter diffuses to postsynaptic membrane. **(E)** Neurotransmitter combines with specific receptors on the postsynaptic membrane and opens fairly nonspecific cation channels. **(F)** Local current flow through cation channels depolarizes the postsynaptic membrane and the postsynaptic potential spreads electrotonically to the adjacent postsynaptic cell membrane and depolarizes it to threshold; an action potential is initiated and propagates over the postsynaptic cell membrane. The neurotransmitter is removed from the synaptic cleft and the cation channels close.

1. Study fig. 6-32. Draw it and describe the steps involved in transmitting nervous information (an action potential) from one neuron to another via a chemical synapse and how they contribute to control. What is the role of the neurotransmitter?

Heart Regulation

2. The most important control on heart rate is by the autonomic nervous system from the medulla oblongata in the brain stem and negative feedback control mechanisms. Sympathetic fibers synapse with the heart at the SA node, AV node, and ventricular cardiac muscle. Parasympathetic fibers reach the SA and AV nodes via the vagus nerve. Which neurotransmitters are involved with the sympathetic ("fight or flight") and which with the parasympathetic ("rest and digest") responses? What advantages might chemical synapses provide over using electrical synapses to regulate cardiac output?

3. At rest, the usual heart rate for humans is 60-80 bpm. It has been observed that the intrinsic rate of discharge of the pacemaker (SA node) is greater than resting heart rate. What does that tell you about which is dominant at rest, sympathetic or parasympathetic influence? Why?