Problem Session #5: Cardiovascular mechanisms
1. Diltiazem (Cardizem®) is a drug that is used to treat many cardiac patients. It changes the function of one group of ion channels.

The top records show ventricular action potentials recorded under control conditions and at three different doses of the drug. The bottom records show the force generated by heart muscle during each action potential.

a. By examining the action potentials shown, can you infer which kind of ion channels are affected by Cardizem? If so, support your answer. If not, tell what additional information you would need in order to make the determination.

b. How does changing channel function change the amount of force produced?
2. Predict what a Lead II EKG would look like under each of the following conditions, supporting your answer with the *one best* reason:

a. Ventricular repolarization follows the same pathway as ventricular depolarization.

b. A person with congestive heart failure takes digitalis to increase cardiac contractility.

c. Voltage-sensitive Na\(^+\) channels are blocked by tetrodotoxin.

d. Coronary atherosclerosis has narrowed the arteries leading to the right atrium sufficiently that it is mildly ischemic. As a result, the sinoatrial node is somewhat hyperexcitable and intermittently depolarizes prematurely.
3. When a heart is transplanted, the original innervation will not regenerate, so the heart remains uninnervated.

   a. Which kinds of nerves would be cut when the heart is transplanted?

   b. Will a transplanted heart require an electrical pacemaker device in order to continue to beat? Why or why not?

   c. Could a transplanted heart respond to increased physical activity by increasing cardiac output? Why or why not?

   d. Do the outputs of the two sides of a transplanted heart have to be balanced, as they must for the person's original heart? Why or why not?
4. The term "blue baby" is typically applied to an infant that is born with a hole in the atrial (or much more rarely, the ventricular) septum.

a. Before technology was available that allowed cardiac surgery on tiny babies, many of these infants died. Why would the condition be life threatening?

b. Some "blue babies" with small holes, survived, but they often developed enlarged hearts. What would cause this change?

c. How would this birth defect affect the EKG?
5. Here is a capillary in the gastrocnemius muscle of a reclining woman who has varicose veins in both legs. The hydrostatic and oncotic pressures are shown.

<table>
<thead>
<tr>
<th>Arterial end</th>
<th>Venous end</th>
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<tbody>
<tr>
<td>$P_{\text{cap}} = 30 \text{ mm Hg}$</td>
<td>$P_{\text{cap}} = 10 \text{ mm Hg}$</td>
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<tr>
<td>$\pi_{\text{cap}} = 25 \text{ mm Hg}$</td>
<td>$\pi_{\text{cap}} = 25 \text{ mm Hg}$</td>
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<tr>
<td>$\pi_{\text{int}} = 10 \text{ mm Hg}$</td>
<td>$P_{\text{int}} = 0 \text{ mm Hg}$</td>
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a. Would you expect net uptake or net loss of fluid through the wall of this capillary? Be as quantitative as you can.

b. If this woman lies down with her feet higher than her heart, will it affect the transfer of fluid across the capillaries in her gastrocnemius muscles? Support your answer with the one best physiological reason.

c. If she stands up, will the transfer of fluid across the capillaries in her gastrocnemius muscles change? Support your answer with the one best physiological reason.

d. If she wraps her legs in elastic bandages before she stands up, will it affect the return of blood to her heart while she is standing up?