1. Define the following terms:
   a. Automaticity: the ability to do something without occupying the mind with low-level details required, allowing it to become an automatic response pattern or habit.
   b. Rhythmicity: a spontaneous event that occurs in a regular continuous rhythm.

2. Explain the anatomical differences between frog and human hearts.
   The frog heart has 2 atria and one ventricle, which is separated by the common arterial trunk. The ventricle delivers oxygenated blood to the systemic and pharyngeal arteries. The human heart has 4 chambers: 2 atria and 2 ventricles.

3. Define the following terms:
   a. Intrinsic heart control: stimuli that comes from within the heart itself, such as starting at the SA node.
   b. Extrinsic heart control: stimuli comes from outside of the heart, such as adrenaline from the adrenal gland.

4. Why is it necessary to keep the frog heart moistened with Ringer’s solution?
   This fluid imitates the body fluids of the frog and keeps the heart able to function. It is an isotonic solution without which spontaneous cardiac APs would not occur.

5. Define extrasystole: this is a prematurely occurring beat at one of the chambers of the heart that leads to premature arrhythmia but leaves the fundamental rhythm unchanged.

6. Refer to the exercise to answer the following questions:
   a. What was the effect of stimulating the heart during ventricular contraction?
      No reaction.
   b. During ventricular relaxation?
      This is the period of time where it is possible to create a extrasystole.
   c. During the pause interval?
      No reaction.
   d. What does this information indicate about the refractory period of cardiac muscle?
      The refractory period of cardiac muscle is much longer than that of skeletal muscle. This is important for the cardiac muscle cells to have more time, because if it were shorter, the heart would enter the tonic contraction which would result in death.
   e. Can cardiac muscle be tetanized? Why or why not?
      No because relaxation must complete before the next contraction can begin due to the long absolute refractory period.

7. What was the effect of vagal stimulation on heart rate?
   This stimulus slowed the heart rate and created a vagal escape and then started beating again.

8. What is vagal escape?
   This is when the heart stops momentarily and then begins to beat again.
   A heart rate by continue vagal stimulation due to parasympathetic rhythm initiation.
9. Why is the vagal escape valuable in maintaining homeostasis?

   Vagal escape reduces blood pressure, so if heart rate and pressure are too high, this can stabilize it all.

10. Describe the effects of thermal factors on the frog heart:

   a. Cold: This decreased heart rate.
   b. Heat: This increased heart rate.

11. a. Which of the following factors caused the same, or very similar, heart rate-reducing effects: epinephrine, atropine, pilocarpine, digitalis, potassium ions?

   b. Pilocarpine, digitalis, and K⁺ shared similar heart rate-reducing effects.

   b. Which of the factors listed above would reverse or antagonize vagal effects?

   Epinephrine and atropine.

12. Did administering any of the following produce any changes in force of contraction (shown by peaks of increasing or decreasing height)? If so, explain the mechanism.

   a. Epinephrine: Yes, the peaks increased because the heart is pumping harder to pump more blood quickly.
   b. Calcium ions: Yes, the peaks increased. The heart rate slowed down due to the Calcium so the heart had to pump more to get blood flowing.

13. Excessive amounts of each of the following ions would most likely interfere with normal heart activity. Explain the type of changes caused in each case:

   a. K⁺: Reduces heart rate and strength of contractions, because due to an influx of K⁺, Calcium ion channels close, resulting in decreased heart rate. Excess K⁺ decreases PM potential.
   b. Ca²⁺: An influx of Ca²⁺ would raise the heart rate & increase contractions. Calcium is required for contraction of cardiac muscle so an excessive amount would increase it.
   c. Na⁺: Results in depression of cardiac function, the heart rate is affected by the slow sodium channels in the pacemaker.

14. Define the following:

   a. Parasympathomimetic: something that produces the effects similar to those resulting from stimulation of the parasympathetic nervous system.
   b. Ectopic pacemaker: an excited group of cells that causes a premature heart beat outside the normal functioning.

15. Explain how digitalis works:

   It contains chemicals that can increase the strength of heart muscle contractions, change heart rate, & increase heart blood output.
   - Inhibits Na⁺/K⁺ pump, to Ca²⁺ entry into cardiac cells
Experiment Results

Predict Question:
Predict Question 1: When you increase the frequency of the stimulation, what do you think will happen to the amplitude (height) of the ventricular systole wave?
Your answer: c. The amplitude will not change.

Predict Question 2: If you deliver multiple stimuli (20 stimuli per second) to the heart, what do you think will happen?
Your answer: a. wave summation

Stop & Think Questions:
1. Watch the contractile activity from the frog heart on the oscilloscope.

Enter the number of ventricular contractions per minute (from the heart rate display) in the field below and then click Submit Data to record your answer in the lab report.
You answered: 60 beats/min

Which of the following statements about the contractile activity is true?
You did not answer this question.
Correct answer: a. The smaller waves represent the contraction of the atria.

During which portion of the cardiac muscle contraction is it possible to induce an extrasystole?
You correctly answered: d. during relaxation

Experiment Data:

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<td>Time (sec)</td>
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Experiment: Modifiers of Heart Rate

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<th>Solution</th>
<th>Heart Rate</th>
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<tbody>
<tr>
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<td>51</td>
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<tr>
<td>32 deg. Ringer's</td>
<td>71</td>
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<tr>
<td>Pilocarpine</td>
<td>46</td>
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<td>Atropine</td>
<td>71</td>
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<tr>
<td>Epinephrine</td>
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<td>21 &lt; 57 &lt; 70  spastic increase</td>
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<tr>
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<tr>
<td>Potassium Ions  all  60</td>
<td>21 &lt; 56 &lt; 70  reduction in strength and rate</td>
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