Part I. Clinical Applications

1. After a bout with bacterial endocarditis, scar tissue often stiffens (stenosis) the edges of the heart valves. Describe what is happening with the valves and how this would be picked up in a routine examination.

2. Unlike the situation in skeletal muscle, cardiac muscle contraction is an active process, but relaxation is entirely passive. Why?

3. After a vigorous tennis match, Ted complains of chest pains. He was advised to see his doctor who immediately ordered an ECG. An evaluation of the ECG showed a slight irregular wave pattern. The physician ordered a PET scan, which showed an obstruction due to an embolus (clot) in a branch of a coronary artery. What is the relationship between chest pains and the possibility of a heart attack?

4. You are responsible for conducting a clinical evaluation of a patient who has previously been diagnosed as having a heart murmur. While auscultating the patient you detect a rushing swirling sound immediately after the first heart sound. What is your diagnosis and what is causing the abnormal sound?
5. You are listening to a lecture on the importance of coronary circulation to the overall functional efficiency of the heart. Part of this efficiency is due to the presence of arterial anastomoses. What are arterial anastomoses and why are they important in coronary circulation?

6. Through what regulatory mechanisms can a transplanted heart, which does not have any innervation, adjust cardiac output to meet the body’s changing needs?

7. Trained athletes usually have lower resting heart rates than normal (for example, 50 beats/min in an athlete compared to 70 beats/min in a sedentary individual). Considering that the resting cardiac output is 5000 ml/min in both trained athletes and sedentary people, what is responsible for the bradycardia of trained athletes?
8. Explain why the beat of the heart is automatic and why the SA node functions as the normal pacemaker.

9. Explain what a heart murmur is and describe the difference between an innocent and abnormal heart murmur. How is a heart murmur diagnosed?
Part II

Follow the instructions below to complete this exercise.

First, draw arrows to indicate the direction of blood flow through the heart. Draw the pathway of the oxygen-rich blood with red arrows, and trace the pathway of oxygen-poor blood with blue arrows.

Second, identify each of the elements of the intrinsic conduction system (numbers 1–5 on the figure) by inserting the appropriate terms in the blanks left of the figure. Then, indicate with green arrows the pathway that impulses take through this system.

Third, correctly identify each of the heart valves (numbers 6–9 on the figure) by inserting the appropriate terms in the blanks left of the figure, and draw in and identify by name the cordlike structures that anchor the flaps of the atrioventricular (AV) valves.

Fourth, use the numbers from the figure to identify the structures described below. Place the numbers in the lettered answer blanks.

_____ A. _____ B. Prevent backflow into the ventricles when the heart is relaxed

_____ C. _____ D. Prevent backflow into the atria when the ventricles are contracting

_____ E. AV valve with three flaps

_____ F. AV valve with two flaps

_____ G. The pacemaker of the intrinsic conduction system

_____ H. The point in the intrinsic conduction system where the impulse is temporarily delayed

1. Superior vena cava

2. Aorta

3. Pulmonary trunk

4. Left atrium

5. Wall of left ventricle

6. Superior vena cava

7. Inferior vena cava
Post III

Where necessary, complete the statements by inserting the missing word(s) in the answer blanks.

1. Your journey starts in the pulmonary vein and includes a trip to part of the systemic circulation and a special circulation.

2. You ready your equipment and prepare to be miniaturized and injected into your host.

3. Almost immediately after injection, you find yourself swept into a good-sized chamber, the (1). However, you do not stop in this chamber but continue to plunge downward into a larger chamber below. You land with a big splash and examine your surroundings. All about you are huge white cords, hanging limply from two flaps of endothelial tissue far above you. You report that you are sitting in the (2) chamber of the heart, seeing the flaps of the (3) valve above you. The valve is open, and its anchoring cords, the (4), are lax. Because this valve is open, you conclude that the heart is in the (5) phase of the cardiac cycle.

Gradually you notice that the chamber walls seem to be closing in. You hear a thundering boom, and the whole chamber vibrates as the valve slams shut above you. The cords, now rigid and strained, form a cage about you, and you feel extreme external pressure. Obviously, the heart is in a full-fledged (6). Then, high above on the right, the “roof” opens, and you are forced through this (7) valve. A fraction of a second later, you hear another tremendous boom that sends shock waves through the whole area. Out of the corner of your eye, you see that the valve below you is closed, and it looks rather like a pie cut into three wedges.

8. What do the letters ECG (or EKG) stand for? ______________ An ECG is a recording of ______________. State two purposes of ECGs.

9. Match the answers in the box with descriptions of parts of the ECG below.

<table>
<thead>
<tr>
<th>P. P wave</th>
<th>QRS. QRS complex</th>
<th>T. T wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Related to depolarization and contraction of atria</td>
<td>11 Related to repolarization and relaxation of ventricles</td>
</tr>
<tr>
<td>10</td>
<td>Related to depolarization and contraction of ventricles</td>
<td></td>
</tr>
</tbody>
</table>

12 The thin film of serous fluid located in the pericardial cavity is known as the (common). Its function is to (increase? decrease?) friction between the membranes as the heart beats.

13 Cardiac muscle fibers are in physical contact with neighboring fibers via transverse thickenings of the sarcolemma called ______________ discs. Within the discs are ______________ junctions that allow the action potential to spread from one fiber to another.
Part IV

Complete the following statements concerning blood vessels.

1. The central cavity of a blood vessel is called the (1). Reduction of the diameter of this cavity is called (2), and enlargement of the vessel diameter is called (3). Blood is carried to the heart by (4) and away from the heart by (5). Capillary beds are supplied by (6) and drained by (7).

2. Briefly explain in the space provided the need for valves in veins but not in arteries.

9. The fibrous skeleton of the heart:
   A. supports valves
   B. anchors vessels
   C. provides electrical insulation to separate the atrial mass from the ventricular mass
   D. anchors cardiac muscle fibers

10. Freshly oxygenated blood is first received by the:
    A. right ventricle
    B. left ventricle
    C. right atrium
    D. left atrium

11. Atrial repolarization coincides in time with the:
    A. P wave
    B. T wave
    C. QRS wave
    D. P-Q interval

12. The thickest layer of the heart wall is:
    A. endocardium
    B. myocardium
    C. epicardium
    D. fibrous pericardium

13. Atrioventricular valves are held closed by:
    A. papillary muscles
    B. trabeculae carneae
    C. pectinate muscles
    D. chordae tendineae

14. Soon after the onset of ventricular systole the:
    A. AV valves close
    B. semilunar valves open
    C. first heart sound is heard
    D. aortic pressure increases

15. Which of the following depolarizes next after the AV node?
    A. Atrial myocardium
    B. Ventricular myocardium
    C. Bundle branches
    D. Purkinje fibers
Match the terms provided in Column B with the statements given in Column A. Place the correct term in the answer blanks.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. A recording of the electrical activity of the heart</td>
<td>Angina pectoris</td>
</tr>
<tr>
<td>17. The period when the atria are depolarizing</td>
<td>Bradycardia</td>
</tr>
<tr>
<td>18. The period when the ventricles are repolarizing</td>
<td>Electrocardiogram</td>
</tr>
<tr>
<td>19. The period during which the ventricles are depolarizing, which precedes their contraction</td>
<td>Fibrillation</td>
</tr>
<tr>
<td>20. An abnormally slow heartbeat, that is, slower than 60 beats per minute</td>
<td>Heart block</td>
</tr>
<tr>
<td>21. A condition in which the heart is uncoordinated and useless as a pump</td>
<td>P wave</td>
</tr>
<tr>
<td>22. An abnormally rapid heartbeat, that is, faster than 100 beats per minute</td>
<td>QRS wave</td>
</tr>
<tr>
<td>23. Damage to the AV node, totally or partially releasing the ventricles from the control of the sinoatrial (SA) node</td>
<td>T wave</td>
</tr>
<tr>
<td>24. Chest pain, resulting from ischemia of the myocardium</td>
<td>Tachycardia</td>
</tr>
</tbody>
</table>

Part V

The events of one complete heartbeat are referred to as the cardiac cycle. Complete the following statements that describe these events. Insert your answers in the answer blanks.

1. The contraction of the ventricles is referred to as _{(1)}_, and the period of ventricular relaxation is called _{(2)}_. The monosyllables describing heart sounds during the cardiac cycle are _{(3)}_. The first heart sound is a result of closure of the _{(4)}_ valves; the second heart sound is caused by closure of the _{(5)}_ valves. The heart chambers that have just been filled when you hear the first heart sound are the _{(6)}_ , and the chambers that have just emptied are the _{(7)}_. Immediately after the second heart sound, the _{(8)}_ are filling with blood, and the _{(9)}_ are empty. Abnormal heart sounds, or _{(10)}_, usually indicate valve problems.

9. 

10. 

8. 
The P wave of a normal electrocardiogram indicates:
   a. atrial repolarization
   b. atrial depolarization
   c. ventricular repolarization
   d. ventricular depolarization

The QRS complex of the ECG appears as the:
   a. atria depolarize
   b. atria repolarize
   c. ventricles repolarize
   d. ventricles depolarize

The "lubb-dubb" sounds of the heart have practical clinical value because they provide information concerning:
   a. the strength of ventricular contraction
   b. the strength of the pulse
   c. the efficiency of heart valves
   d. the relative time the heart spends in systole and diastole

When a chamber of the heart fills with blood and prepares for the start of the next cardiac cycle the heart is in:
   a. systole
   b. ventricular ejection
   c. diastole
   d. isovolumetric contraction

During ventricular diastole, when the pressure in the left ventricle rises above that in the left atrium:
   a. the left AV valve closes
   b. the left AV valve opens
   c. the aortic valve closes
   d. all the valves close

During ventricular systole, the blood volume in the atria is ____________, and the volume in the ventricle is ____________.
   a. decreasing; increasing
   b. increasing; decreasing
   c. increasing; increasing
   d. decreasing; decreasing

The correct sequential path of a normal action potential in the heart is:
   a. SA node → AV bundle → AV node → Purkinje fibers
   b. AV node → SA node → AV bundle → bundle of His
   c. SA node → AV node → bundle of His → bundle branches → Purkinje fibers
   d. SA node → AV node → bundle branches → AV bundle → Purkinje fibers

Valvular stenosis refers to:
   a. the inability of a valve to seal tightly
   b. the growth of scar tissue on the valve
   c. excessive narrowing of a valve
   d. an abnormal increase of blood volume

---

**Answer (T) True or (F) False to the following questions.**

A ______ A narrowing of a valve is called a stenosis.

B ______ The bicuspid (mitral) valve is located between the right atrium and right ventricle.

C ______ In atrial flutter the atrial rhythm averages about 300 beats per minute.

D ______ Opening of the semilunar valves is responsible for the durrp portion of the heart sound.

E ______ Blood ejected from the left ventricle enters the pulmonary trunk.
Choose the one best answer to the following questions.

20. The thickest layer of the heart wall is the
   A. pericardium   D. myocardium
   B. epicardium   E. none of the
   C. endocardium above are correct

21. The space between the parietal and visceral layers of the serous pericardium is filled with
   A. fat   D. serous fluid
   B. mucous   E. cartilage
   C. water

22. The foramen ovale directs blood, in the fetal heart, from the
   A. left atrium to the right atrium
   B. right ventricle to the left ventricle
   C. right ventricle to the right atrium
   D. right atrium to the left atrium
   E. pulmonary trunk to the aorta

23. Which valve closes when the left ventricle is relaxing?
   A. aortic semilunar   D. bicuspid
   B. mitral   E. B and C are both correct answers
   C. tricuspid

24. Blood ejected from the right ventricle passes through the ________________ valve.
   A. mitral   C. tricuspid
   B. pulmonary semilunar   D. bicuspid
   E. aortic semilunar

25. The chordae tendineae attach from the
   A. wall of the atria to the atrioventricular valves
   B. interventricular septum to the semilunar valves
   C. left atrium to the right atrium via the foramen ovale
   D. tips of the atrioventricular valves to the papillary muscles
   E. atrioventricular valves to the semilunar valves

26. The first heart sound is produced by the
   A. closure of the atrioventricular valves
   B. closure of the semilunar valves
   C. opening of the atrioventricular valves
   D. opening of the semilunar valves
   E. A and C are correct

27. The backflow of blood from the left ventricle to the left atrium could be caused by
   A. aortic stenosis   D. mitral stenosis
   B. mitral valve insufficiency   E. tricuspid valve prolapse
   C. aortic insufficiency

28. Chest pain resulting from ischemia of the myocardium is called ________________.
   A. myocardial infarction   D. cardiac tamponade
   B. angina pectoris   E. heart block
   C. myocarditis

29. An irregular surface of ridges and folds of the myocardium covered by endocardium in the ventricles is known as the
   A. papillary muscles   C. intercardial muscles
   B. pectinate muscles   D. pectina papillae
   E. trabeculae carneae

30. The thin layer of endothelium that lines the inside of the heart is called the
   A. pericardium   D. myocardium
   B. endocardium   E. B and C are both correct
   C. epicardium

31. The tunica media of veins is much (thinner? thicker?) than that of accompanying arteries.

32. The blood pressure in veins is (lower? higher?) than that in arteries.

33. The structures located in veins, especially those of the limbs, that prevent the backflow of blood are called ________________.
Part III

You are a red blood cell entering the heart from the superior vena cava! Test your understanding of cardiac structures by tracing your route through the entire heart, past the valves, and into the aorta—numbering the following structures on the left in proper sequence. On the right side of the page, write the name of the structure you have passed in the space provided, again in proper sequence, from structures 1 through 12. The last one has been done for you. Notice that the pulmonary circulation is included.

<p>| | | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>aorta</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IV. Cardiac Cycle and Heart Sounds

**Perspective:** The two atria fill with blood and then contract simultaneously. This is then followed by simultaneous contraction of both ventricles, which sends blood through the pulmonary and systemic circulations. Contraction of the ventricles closes the AV valves and opens the semilunar valves; relaxation of the ventricles closes the semilunar valves and opens the AV valves. The closing of first the AV valves and then the semilunar valves produces the “lub-dub” sounds heard with a stethoscope.

**True or False/Edit**

13. The muscular wall, or septum, prevents the mixture of blood between the left and right sides of the heart.

14. The myocardial cells of the atria and ventricles are structurally and functionally separated from each other.

15. The work performed by the right ventricle is five to seven times greater than that performed by the left ventricle.

16. The cardiac valves open and close due to changes in pressure on either side of the valves.

17. A portion of an electrocardiogram is shown in Figure. On the figure identify the QRS complex, the P wave, and the T wave. Then, using a red pencil, bracket a portion of the recording equivalent to the length of one cardiac cycle. Using a blue pencil, bracket a portion of the recording in which the ventricles would be in diastole.
Part VII

Complete the following statements relating to cardiac output by writing the missing terms in the answer blanks.

1. In the relationship CO = HR x SV, CO stands for \( (1) \), HR stands for \( (2) \), and SV stands for \( (3) \). For the normal resting heart, the value of HR is \( (4) \), and the value of SV is \( (5) \). The normal average adult cardiac output, therefore, is \( (6) \). The time for the entire blood supply to pass through the body is once each \( (7) \).

2. According to Starling's law of the heart, the critical factor that determines force of heartbeat, or \( (8) \), is the degree of \( (9) \) of the cardiac muscle just before it contracts. Consequently, the force of heartbeat can be increased by increasing the amount of \( (10) \) returned to the heart.

3. \( (11) \). Epinephrine  16. Activation of the sympathetic nervous system

4. \( (12) \). Thyroxine  17. Activation of the vagus nerves

5. \( (13) \). Hemorrhage  18. Low blood pressure

6. \( (14) \). Fear  19. High blood pressure

7. \( (15) \). Exercise  20. Fever

Check (✓) all factors that lead to an increase in cardiac output by influencing either heart rate or stroke volume.

For each of the following statements that is true, write T in the answer blank. For any false statements, correct the underlined term by writing the correct term in the answer blank.

21. The resting heart rate is fastest in \( \underline{\text{adult\ life}} \). The

22. Because the heart of the highly trained athlete hypertrophies, its \( \underline{\text{stroke volume}} \) decreases.

23. If the \( \underline{\text{right}} \) side of the heart fails, pulmonary congestion occurs.

24. In \( \underline{\text{peripheral}} \) congestion, the feet, ankles, and fingers become edematous.

25. The pumping action of the healthy heart ordinarily maintains a balance between cardiac output and \( \underline{\text{venous return}} \).
Part VIII

1. The two major factors (shown in Checkpoint E1) that control cardiac output (CO) are ______________________ and ______________________. Do this activity about stroke volume (SV).

2. During exercise, muscles surrounding blood vessels, especially in the legs, squeeze more blood back toward the heart. This increased blood returning to the heart stretches the myocardium cells of the heart wall (more? less?).

3. Within limits, a stretched muscle contracts with (greater? less?) force than a muscle that is only slightly stretched. This is a statement of ______________________'s law of the heart. As a result, during exercise the ventricles of the normal heart contract (more? less?) forcefully, and stroke volume (increases? decreases?).

4. State two or more reasons why stroke volume may be decreased abnormally.

A clinical challenge. Do this exercise about Ms. S, who has congestive heart failure (CHF).

5. Her weakened heart becomes overstretched much like a balloon (except much thicker!) that has been expanded 5000 times. Now her heart myofibers are stretched beyond the optimum length according to the Frank-Starling’s law. As a result, the force of her heart is ________-creased, and its stroke volume ________-creases (opposite of Checkpoint E2b).

6. Ms. S. has right-sided heart failure, so her blood is likely to back up, distending vessels in (lungs? systemic regions, such as in neck and ankles?); thus ______________________ edema results, with signs such as swollen hands and feet.

7. Write a sign or symptom of left-sided heart failure.

Summarize normal effects of factors below upon heart rate (HR), stroke volume (SV), cardiac output (CO), and blood pressure (BP) by completing arrows: ↑ (for increase) or ↓ (for decrease). The first one is done for you.

8. ↑ exercise → ↑ return of blood to the heart → ↑ SV

9. ↑ SV (if HR stays the same) → ________ CO

10. ↑ heart contractility → ________ SV and ________ CO

11. ↓ body temperature (hypothermia) → ________ HR and ________ strength of contraction

12. ↑ sympathetic nerve impulses → ________ SV, ________ HR, and ________ CO

13. Vagus (parasympathetic) nerve impulses to the heart → ________ HR, ________ strength of heart contraction, ________ SV, and ________ CO

14. Epinephrine → ________ SV, ________ HR, and ________ CO
15. If your heart beats at 60 beats/minute, each heart beat (or cardiac cycle) takes ______ sec. If your pulse rate increases to 120 beats/minute, the duration of each cardiac cycle is about ______ sec. In fact, extremely rapid heart rates (such as 200–400 beats/minute) provide (too much? insufficient?) time for events of the cardiac cycle to take place adequately.

16. If your heart beats at 75 beats/minute, each heart beat (or cardiac cycle) requires slightly (more? less?) than one minute, or about ______ sec. This is the length of a typical cardiac cycle.

17. In the relaxation phase, all four chambers of the heart are in (systole? diastole?). During this time, blood (fills? is ejected from?) the heart. This phase takes about ______ sec. (With very rapid heart rates, this phase is reduced so much that the heart cannot properly fill with blood.)

18. The start of atrial systole is marked by the (P? QRS? T?) wave. Systole refers to myocardial (contraction? relaxation) that pushes more blood from atria to ventricles. Atrial systole requires ______ sec.

19. During ventricular systole (______ sec.), blood (fills? is ejected from?) the ventricles due to the (high? low?) pressure in those chambers. The (P? QRS? T?) wave occurs at the start of this phase. The (P? QRS? T?) wave signals the end of ventricular systole and the start of the relaxation phase of a new cardiac cycle.

20. During normal ventricular contraction, what fraction of the end-diastolic volume is ejected as the stroke volume?
   a. one-fourth
   b. one-third
   c. one-half
   d. two-thirds
   e. three-fourths

21. The sinoatrial (SA) node is the normal pacemaker of the heart because this region
   a. demonstrates spontaneous electrical activity
   b. depolarizes to threshold before other regions
   c. has Ca++ diffusing through ... fast Ca++ channels
   d. develops pacemaker potentials during diastole
   e. All of these are correct.

22. Which statement about ECG tracings is false?
   a. The T wave represents depolarization of the atria.
   b. The QRS represents depolarization of the ventricles.
   c. The repolarization of the atria is hidden by the QRS.
   d. The P wave occurs shortly before the QRS wave.
   e. All of these are true.

23. The second heart sound (S2) on the ECG recording is heard approximately
   a. at the P wave
   b. at the P-R interval
   c. at the QRS wave
   d. at the T wave
   e. after the T wave

24. Action potentials in myocardial cells have a characteristic plateau phase, which is caused primarily by the
   a. slow outward diffusion of Na+
   b. fast inward diffusion of Na+
   c. fast outward diffusion of Ca++
   d. slow inward diffusion of Ca++

25. How many liters of blood does the adult heart pump per minute?
   a. three
   b. five
   c. seven
   d. nine
   e. twelve
Part IX
Indicate which valve abnormality is being described using the answer code below
   A = valvular stenosis
   B = valvular insufficiency

1. produces a “gurgling” murmur
2. produces a “whistling” murmur
3. valve does not close completely
4. valve does not open completely

Indicate which ion is involved in each event begin described by using the following.
   K+ Na+ Ca2+

5. Explosive increase in membrane permeability to ____ bring about the rapidly rising phase of
   the action potential in contractile cardiac cells.
6. Slow inward diffusion of ______ is largely responsible for the plateau portion of the cardiac
   action potential.
7. The rapid falling phase of the cardiac action potential is brought about primarily by the outward
   diffusion of ____________
8. changes in cytosolic ______ concentration bring about changes in the strength of cardiac
   contraction.
9. Parasympathetic stimulation increases the permeability of the SA node to ______, which will
   cause a decrease in heart rate.

Use the following answers to label the descriptions:
   SA node    AV node    His and Purkinje system    Gap junction

10. Has the fastest rate of pacemaker activity
11. allows impulses to spread from cell to cell
12. delays conduction of the impulse
13. only point of electrical contact between the atria and ventricles
14. normal pacemaker of the heart
15. rapidly conducts the impulse down the ventricular septum and throughout much of the
   ventricular musculature.

16. This cardiac complication can be caused by prolonged pumping against a chronically increased
    afterload.
    A. myocardial infarction
    B. myocardial ischemia
    C. valvular stenosis
    D. congestive heart failure

17. Frank-Starling Law of the heart. Complete the following by circling the correct phrase within the
    parentheses.

    If the venous return increases, at the end of diastole the ventricular volume will be (increased,
    decreased, the same as before). Therefore, the length of the cardiac muscle cells will be (increased,
    decreased, the same as before). Consequently, during the next contraction the tension developed by
    the heart will be (greater than before, less than before, the same as before). The amount of blood
    pumped out as a result of this contraction will be (more than, less than, the same as) the amount
    pumped out by the contraction prior to the increase in venous return. Therefore, as venous return to
    the heart increases, the stroke volume ejected by the heart (increases, decreases, remains
    unchanged).
Part X

Match the division of the autonomic nervous system to the effect it exerts on the heart or structure that influence the heart. Indicate either Sympathetic or Parasympathetic.

1. Has no effect on the adrenal medulla.
2. Increases contractility of the atrial muscle and strengthens contraction.
3. Decreases excitability; increases AV nodal delay.
4. Has no effect on the ventricular conduction pathway.
5. Increases rate of depolarization to threshold of SA node; increases heart rate.
6. Promotes adrenomedullary secretion of epinephrine.
7. Increases contractility of the ventricular muscle; strengthens contraction.
8. Increases venous return.
10. Increases excitability; decreases AV nodal delay.