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.

As the heart valves stiffen they become narrowed and do not open properly and blood cannot pass easily through the valve. Blood pressure usually increases in the chamber before the stenotic valve and requires a greater force to move the blood to the next chamber. For example, when the opening of the aortic valve becomes narrowed (stenotic), the blood can't be pumped adequately and the pressure in the left ventricle increases. Initially, the left ventricle compensates by thickening its walls (myocardial hypertrophy) in order to maintain adequate pumping pressure. In the later stages, the left ventricle begins to fail.

Stenotic valves would be detected as a heart murmur while listening (auscultation) to the heart.

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

In cardiac muscle tissue there are no antiagonistic muscle groups to extend the cardiac muscle fibers after each contraction. The necessary stretching force is provided by the blood pouring into the heart, aided by the elasticity of the fibrous skeleton. As a result, the amount of blood entering the heart is equal to the amount ejected during the next contraction.

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?

If a coronary artery is obstructed by a clot, the myocardial cells that the artery supplies do not receive sufficient amounts of blood (ischemia). Chest pains (angina pectoris) are usually a symptom of ischemia. When the heart tissue is deprived of oxygen due to ischemia, the affected portion of the heart dies. This is called myocardial infarction (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?

The diagnosis is most likely an insufficient (incompetent) atrioventricular valve. Blood flows back through an insufficient valve in a turbulent fashion, causing a rushing sound after the valve closure.
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?

Anastomosis is the joining of two tubes, usually referring to a connection between two peripheral vessels without an intervening capillary bed. Arterial anastomoses are the interconnections between arteries without a capillary bed in between as seen in the coronary arterial circulation. Because of the interconnected arteries, the blood supply to the cardiac muscle remains relatively constant, regardless of pressure fluctuations within the left and right coronary arteries.

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?

A transplanted heart comes with its own pacemaker but lacks innervation, it adjusts the cardiac output to meet the body’s changing needs by means of both intrinsic control (the Frank-Starling mechanism) and extrinsic hormonal influences, such as the effect of epinephrine on the rate and strength of cardiac contraction.

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?

Trained athlete’s hearts are stronger and can pump blood more efficiently so that the resting stroke volume is larger than in an untrained person. For example, if the resting stroke volume of a strong-hearted athlete is 100 ml, a resting heart rate of only 50 beats/minute produces a normal resting cardiac output of 5000 ml/minute. An untrained individual with a resting stroke volume of 70 ml, in contrast, must have a heart rate of about 70 beats/minute to produce a comparable resting cardiac output.
8. Explain why the beat of the heart is automatic and why the SA node functions as the normal pacemaker.

The term "automatic" refers to the inherent property of myocardial cells to continue beating without the assistance of nerves or hormones. The sinoatrial (SA) region is the pacemaker responsible for initiating each heart beat because the myocardial cells in this region depolarize spontaneously reaching threshold and firing the action potential before other myocardial cells. Since all myocardial cells are connected by gap junctions, SA node depolarization waves spread rapidly along conduction pathways to the other regions of the heart. There are other autorythmic areas of the heart capable of producing pacemaker potentials, but do not because their rate of spontaneous depolarization is slower than that of the SA node. Consequently, the pace of the heart is established by the fastest depolarizing cells in the heart (SA nodal region) while the others fire when stimulated by the arrival of the depolarization wave.

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

A heart murmur is an extra or unusual sound heard during a heartbeat as a result of abnormal turbulent blood flow through the heart. The two types of heart murmurs are innocent (functional) and abnormal.

Innocent heart murmurs aren't caused by heart problems and they don't cause adverse symptoms. Having one doesn't require you to limit your physical activity or do anything else special. They can occur when blood flows more rapidly through the heart as occurs during physical activity, pregnancy, fever, hyperthyroidism, anemia, and aging. These murmurs are common in healthy children and can be simply due to the chest wall being relatively thin making it easier to hear the sounds of the blood flowing through the heart.

Abnormal heart murmurs may have signs or symptoms of heart problems. Most abnormal murmurs in children are caused by congenital heart defects such as a hole between the chambers (septal defect) or valve abnormalities. Congenital defects are problems with the heart's structure that are present at birth. In adults, heart murmurs most often are caused by heart valve disease that develops as the result of another condition. Infections such as rheumatic fever and endocarditis; stenotic (stiff) valves associated with atherosclerosis where the valve doesn't open completely, and insufficient (incompetent) valves that do not close completely and heart changes associated with aging.

Heart murmurs are usually diagnosed by listening to the heart with a stethoscope. A more detailed test includes an Echocardiography (ultrasound), a test that uses sound waves to create pictures of your heart. They are not diagnosed with an ECG.
Part II
A. 6  B. 7  C. 8  D. 9  E. 9  F. 8  G. 1  H. 2
1. SA node
2. AV node
3. AV Bundle (Bundle of His)
4. bundle branches
5. Purkinje fibers
6. pulmonary semilunar valve
7. aortic semilunar valve
8. bicuspid (mitrial) valve
9. tricuspid valve

Part III
1. left atrium
2. left ventricle
3. bicuspid (mitral)
4. chordae tendineae
5. diastole
6. contraction/systole
7. aortic semilunar
8. it is a recording of the electrical changes (action potentials) associated with impulse conduction in the heart.
   Two purposes of ECGs are:
   a. diagnoses of abnormal cardiac rhythms
   b. detection of fetal heartbeat
9. P
10. QRS
11. T
12. pericardial; decrease
13. intercalated; gap

Part IV
1. lumen
2. vasoconstriction
3. vasodilation
4. veins
5. arteries
6. arterioles
7. venules
8. Arteries are high-pressure vessels and do not need valves in their vessels to prevent the backflow of blood. Veins are low-pressure vessels that use valves to prevent backflow of blood.
9. A, B, C, D
10. D
11. C
12. B
13. A, D
14. A, C
15. C
16. electrocardiogram
17. P wave
18. T wave
19. QRS wave
20. bradycardia
21. fibrillation
22. tachycardia
23. heart block
24. angina pectoris
Part V
1. systole
2. diastole
3. lub-dup
4. atrioventricular
5. semilunar
6. ventricles
7. atria
8. atria
9. ventricles
10. murmurs
11. B
12. D
13. C
14. C
15. A
16. B
17. C
18. C
19. A = T; B = F; C = T; D = F; E = F
20. D
21. D
22. D
23. A
24. skip
25. A
26. B
27. D
28. A
29. B, but under certain conditions can also be D
30. B
31. E
32. B
33. thinner
34. lower
35. valves

Part VI
A. 6
B. 9
C. 11
D. 2
E. 7
F. 12
G. 10
H. 3
I. 1
J. 4
K. 8
L. 5
1. right atrium
2. tricuspid valve
3. right ventricle
4. pulmonary semilunar valve
5. pulmonary artery
6. pulmonary capillaries
7. pulmonary vein
8. left atrium
9. mitral valve
10. left ventricle
11. aortic semilunar valve
12. aorta
13. True
14. True
15. False
16. True
17. Diagram

Part VII
1. Cardiac output
2. heart rate
3. stroke volume
4. ~70 beats per minute
5. 70 ml per beat
6. 5250 ml per minute
7. minute
8. stroke volume
9. stretch
10. blood
11. Check
12. Check
13. no
14. check
15. check
16. check
17. no
18. check
19. no
20. check
21. fetal
22. rate of contraction
23. left
24. true
25. true
Part VIII
1. stroke volume and heart rate
2. more
3. greater; Frank-Starling’s; more; increases
4. damaged heart following a myocardial invarction or excessive blood loss, so less blood returns to the heart
5. decreased; decreases
6. systemic regions, such as in neck and ankles; peripheral or systemic
7. difficulty breathing or shortness of breath, which is a sign of pulmonary edema
8. Example
9. increases CO
10. increases SV and increases CO
11. decreases HR and decreases strength of contraction
12. increases SV, increases HR and increases CO
13. decreases HR, decreases strength of heart contraction, decreases SV, and decreases CO
14. increases SV, increases HR and increases CO
15. 1.0; 0.5; insufficient
16. less; 0.8
17. diastole; fills; o.4
18. P; contraction; o.i
19. 0.3; is ejected from; high; QRS; T
20. D
21. E
22. A
23. D
24. D
25. B

Part IX
1. B
2. A
3. B
4. A
5. Na+
6. Ca2+
7. K+
8. Ca2+
9. K+
10. SA node
11. Gap junction
12. AV node
13. AV node
14. SA node
15. His and Purkinje system
16. D
17. Increased; Increased: Greater than before; More than; Increases

Part X
1. Parasympathetic
2. Sympathetic
3. Parasympathetic
4. Parasympathetic
5. Sympathetic
6. Sympathetic
7. Sympathetic
8. Sympathetic
9. Parasympathetic
10. Sympathetic