C) 0.09 sec
D) 0.13 sec
E) 0.17 sec

29. What is the resting membrane potential of the sinus nodal fibers?
A) −100 mV
B) −90 mV
C) −80 mV
D) −55 mV
E) −20 mV

30. If the Purkinje fibers, situated distal to the A-V junction, become the pacemaker of the heart, what is the expected heart rate?
A) 30/min
B) 50/min
C) 60/min
D) 70/min
E) 80/min

31. Sympathetic stimulation of the heart normally causes which of the following conditions?
A) Acetylcholine release at the sympathetic endings
B) Decreased heart rate
C) Decreased rate of conduction of the cardiac impulse
D) Decreased force of contraction of the atria
E) Increased force of contraction of the ventricles

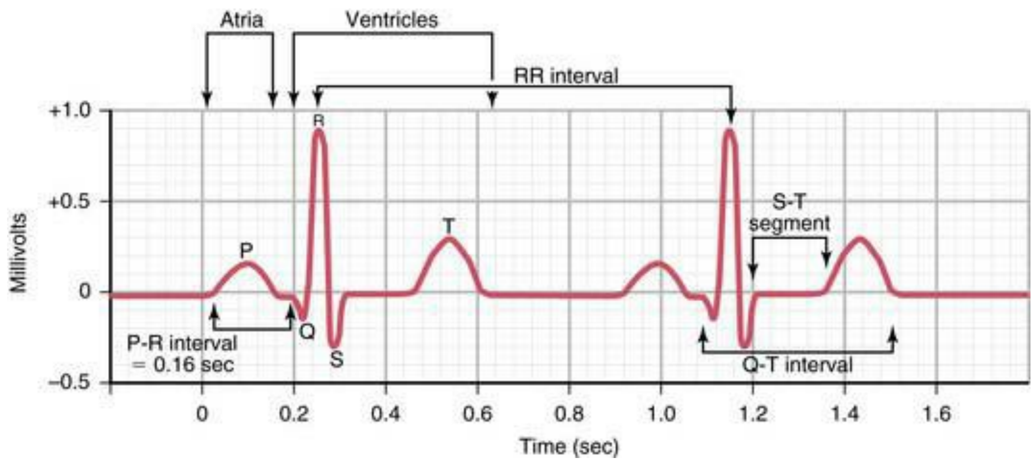
32. When recording lead I on an EKG, the right arm is the negative electrode, and the positive electrode is the
A) left arm
B) left leg
C) right leg
D) left arm + left leg
E) right arm + left leg

33. When recording lead aVL on an EKG, the positive electrode is the
A) left arm
B) left leg
C) right leg
D) left arm + left leg
E) right arm + left leg

34. A 70-year-old man was had the following EKG during his annual physical exam. What is his Q-T interval?
A) 0.12 sec
B) 0.16 sec
C) 0.22 sec

D) 0.30 sec
E) 0.40 sec

35. What is the heart rate in the following EKG?



A) 64
B) 70
C) 88
D) 94
E) 104

36. What is the normal QT interval?
A) 0.03 seconds
B) 0.13 seconds
C) 0.16 seconds
D) 0.20 seconds
E) 0.35 seconds

37. When recording lead II on an EKG, the positive electrode is the
A) left arm
B) left leg
C) right leg
D) left arm + left leg
E) right arm + left leg

38. When recording lead III on an EKG, the negative electrode is the
A) left arm
B) left leg
C) right leg
D) left arm + left leg
E) right arm + left leg

39. A 65-year-old man had an EKG recorded at a local emergency room following a biking accident. His weight was 80 kg and his aortic blood pressure was 160/90 mm Hg. The QRS voltage was 0.5 mV in

lead I and 1.5 mV in lead III. What is the QRS voltage in lead II?

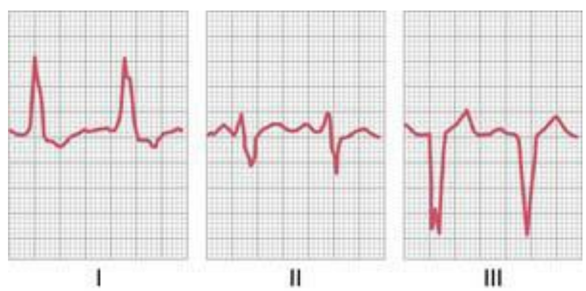
A) 0.5 mV
B) 1.0 mV
C) 1.5 mV
D) 2.0 mV
E) 2.5 mV

40. A ventricular depolarization wave when traveling −90° in the frontal plane will cause a large negative deflection in which lead?

A) aVR
B) aVL
C) Lead II
D) Lead III
E) aVF

Questions 41-43

A 60-year-old woman had the following EKG recorded at a local emergency room following an automobile accident. Her weight was 70 kg and her aortic blood pressure was 140/80 mm Hg.



41. What is the mean electrical axis calculated from standard leads I, II, and III shown in her EKG?

A) −90°
B) −50°
C) −12°
D) +100°
E) +170°

42. What is the heart rate using lead I for the calculation?

A) 70
B) 88
C) 100
D) 112
E) 148

43. What is her likely diagnosis?

A) Mitral valve stenosis
B) Left bundle branch block
C) Pulmonary valve stenosis

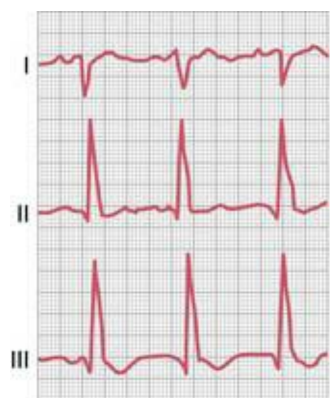
D) Right bundle branch block
E) Left ventricular hypertrophy

44. Which of the following conditions will usually result in right axis deviation in an EKG?
A) Systemic hypertension
B) Aortic valve stenosis
C) Aortic valve regurgitation
D) Excess abdominal fat
E) Pulmonary hypertension

45. A ventricular depolarization wave when traveling 60° in the frontal plane will cause a large positive deflection in which of the following leads?
A) aVR
B) aVL
C) Lead I
D) Lead II
E) aVF

Questions 46 and 47

A male long-term smoker who is 62 years old weighs 250 lb. He had the following EKG recorded at his local hospital.



46. Which of the following is the mean electrical axis calculated from standard leads I, II, and III shown in his EKG?
A) −110°
B) −20°
C) +90°
D) +105°
E) +180°

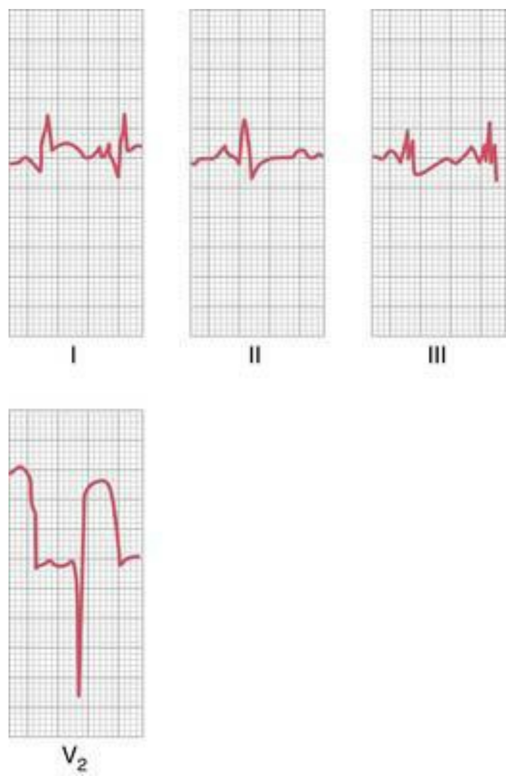
47. Which of the following is the likely diagnosis?
A) Left ventricular hypertrophy
B) Left bundle branch block
C) Tricuspid stenosis
D) Right bundle branch block

E) Right ventricular hypertrophy

48. A 60-year-old woman has lost some ability to perform normal household tasks and is not feeling well. An EKG shows a QRS complex with a width of 0.20 sec, the T wave is inverted in lead I, and the R wave has a large negative deflection in lead III. Which of the following is the likely diagnosis?

A) Right ventricular hypertrophy
B) Left bundle branch block
C) Pulmonary valve stenosis
D) Right bundle branch block
E) Left ventricular hypertrophy

49. A 70-year-old woman sought assistance at a hospital emergency department because she is experiencing chest pain. Based on the following EKG tracing, which of the following is the likely diagnosis?



A) Acute anterior infarction in the left ventricle of the heart
B) Acute anterior infarction in the right ventricle of the heart
C) Acute posterior infarction in the left ventricle of the heart
D) Acute posterior infarction in the right ventricle of the heart
E) Right ventricular hypertrophy

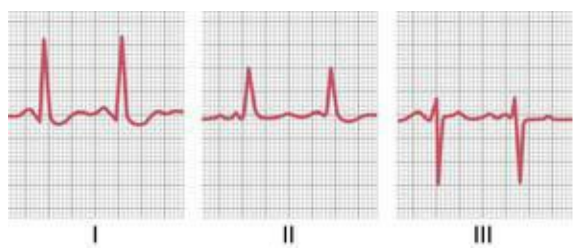
50. A 30-year-old man had his EKG measured at his physician's office, but his records were lost. The EKG technician remembered that the QRS deflection was large and positive in lead aVF and 0 in lead I. What is the mean electrical axis in the frontal plane?

A) 90°
B) 60°

C) 0°
D) −60°
E) −90°

51. Which of the following is most likely at the "J point" in an EKG of a patient with a damaged cardiac muscle?
A) Entire heart is depolarized
B) All the heart is depolarized except for the damaged cardiac muscle
C) About half the heart is depolarized
D) All of the heart is repolarized
E) All of the heart is repolarized except for the damaged cardiac muscle

52. A 50-year-old man is a new employee at ABC Software. The EKG shown here was recorded during a routine physical examination. His likely diagnosis is which of the following?



A) Chronic systemic hypertension
B) Chronic pulmonary hypertension
C) Second-degree heart block
D) Paroxysmal tachycardia
E) Tricuspid valve stenosis

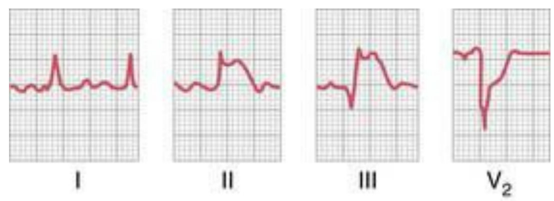
53. A 55-year-old man had his EKG measured at an annual physical, and his net deflection (R wave minus Q or S wave) in standard limb lead I is −1.2 mV. Standard limb lead II has a net deflection of +1.2 mV. What is the mean electrical axis of his QRS?
A) −30°
B) +30°
C) +60°
D) +120°
E) −120°

54. A 65-year-old patient with a heart murmur has a mean QRS axis of 120°, and the QRS complex lasts 0.18 sec. Which of the following is the likely diagnosis?
A) Aortic valve stenosis
B) Aortic valve regurgitation
C) Pulmonary valve stenosis
D) Right bundle branch block
E) Left bundle branch block

55. A 60-year-old woman tires easily. Her EKG shows a QRS complex that is positive in the aVF lead and negative in standard limb lead I. A likely cause of this condition is which of the following?

A) Chronic systemic hypertension
B) Pulmonary hypertension
C) Aortic valve stenosis
D) Aortic valve regurgitation

56. A 60-year-old woman came to the hospital emergency department and complained of chest pain. Based on the EKG tracing shown here, which of the following is the most likely diagnosis?



A) Acute anterior infarction in the base of the heart
B) Acute anterior infarction in the apex of the heart
C) Acute posterior infarction in the base of the heart
D) Acute posterior infarction in the apex of the heart
E) Right ventricular hypertrophy

57. A 50-year-old man has a blood pressure of 140/85 and weighs 200 lb. He reports that he is not feeling well, his EKG has no P-waves, he has a heart rate of 46, and the QRS complexes occur regularly. What is his likely condition?

A) First-degree heart block
B) Second-degree heart block
C) Third-degree heart block
D) Sinoatrial heart block
E) Sinus bradycardia

58. An 80-year-old man had an EKG taken at his local doctor's office, and the diagnosis was atrial fibrillation. Which of the following statements are likely conditions in someone with atrial fibrillation?

A) Ventricular fibrillation normally accompanies atrial fibrillation
B) P waves of the EKG are strong
C) Rate of ventricular contraction is irregular and fast
D) Atrial "a" wave is normal
E) Atria have a smaller volume than normal

59. Circus movements in the ventricle can lead to ventricular fibrillation. Which of the following conditions in the ventricular muscle will increase the tendency for circus movements?

A) Decreased refractory period
B) Low extracellular potassium concentration
C) Increased refractory period
D) Shorter conduction pathway (decreased ventricular volume)

E) Increase in parasympathetic impulses to the heart

60. A 75-year-old man goes to the hospital emergency department and faints. Five minutes later he is alert. An EKG shows 75 P waves per minute and 35 QRS waves per minute with a normal QRS width. Which of the following is the likely diagnosis?

A) First-degree A-V block
B) Stokes-Adams syndrome
C) Atrial paroxysmal tachycardia
D) Electrical alternans
E) Atrial premature contractions

61. A 60-year-old man weighing 220 lb had the following EKG, which shows the standard lead II. What is his diagnosis?

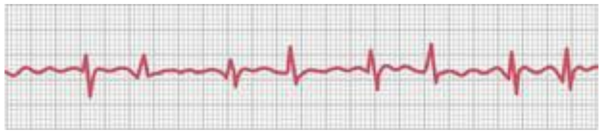
A) A-V nodal rhythm
B) First-degree A-V heart block
C) Second-degree A-V heart block
D) Third-degree A-V heart block
E) Atrial flutter

62. A 35-year-old woman had unusual sensations in her chest after she smoked a cigarette. Her EKG is shown here. Which of the following is the likely diagnosis?

A) Premature contraction originating in the atrium
B) Premature contraction originating high in the A-V node
C) Premature contraction originating low in the A-V node
D) Premature contraction originating in the apex of the ventricle
E) Premature contraction originating in the base of the ventricle

Questions 63 and 64

A 55-year-old man had the following EKG recorded at his doctor's office during a routine physical examination.



63. What is his diagnosis?
A) Normal EKG
B) Atrial flutter
C) High A-V junctional pacemaker
D) Middle A-V junctional pacemaker
E) Low A-V junctional pacemaker

64. What is his ventricular heart rate in beats per minute?
A) 37.5
B) 60
C) 75
D) 100
E) 120

65. A 60-year-old woman has been diagnosed with atrial fibrillation. Which of the following statements best describe this condition?
A) Ventricular rate of contraction is 140 beats/min
B) P waves of the EKG are pronounced
C) Ventricular contractions occur at regular intervals
D) QRS waves are more pronounced than normal
E) Atria are smaller than normal

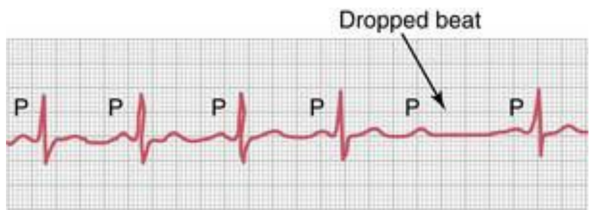
66. Which of the following is most characteristic of atrial fibrillation?
A) Occurs less frequently in patients with atrial enlargement
B) Ventricular heart rate is about 40 beats per min
C) Efficiency of ventricular pumping is decreased 20 to 30 percent
D) Ventricular beat is regular
E) Atrial P wave is easily seen

67. A 65-year-old woman who had a myocardial infarction 10 days ago returns to her family physician's office and reports that her pulse rate may be rapid. Based on the above EKG, which of the following is the likely diagnosis?

A) Stokes-Adams syndrome

B) Atrial fibrillation
C) A-V nodal tachycardia
D) Atrial paroxysmal tachycardia
E) Ventricular paroxysmal tachycardia

68. A 65-year-old man had the EKG shown here recorded at his annual physical examination. Which of the following is the likely diagnosis?



A) Atrial paroxysmal tachycardia
B) First-degree A-V block
C) Second-degree A-V block
D) Third-degree A-V block
E) Atrial flutter

69. Which of the following decreases the risk of ventricular fibrillation?
A) Dilated heart
B) Increased ventricular refractory period
C) Decreased electrical conduction velocity
D) Exposure of the heart to 60-cycle alternating current
E) Epinephrine administration

70. Which of the following occurs after the heart is stimulated with a 60-cycle alternating current?
A) Velocity of conduction through the heart muscle decreases
B) Longer ventricular refractory period
C) Decreased tendency for circus movements
D) Decreased tendency for ventricular fibrillation

71. Which of the following statements best describes a patient with premature atrial contraction?
A) Pulse taken from the radial artery immediately following the premature contraction will be weak
B) Stroke volume immediately following the premature contraction will be increased
C) P wave is never seen
D) Probability of these premature contractions occurring is decreased in people with a large caffeine intake
E) Causes the QRS interval to be lengthened

Questions 72 and 73

A male patient had a myocardial infarction at age 55. He is now 63 years old. Standard limb lead I is shown here.

72. What is his heart rate?
   A) 40 beats/min
   B) 50 beats/min
   C) 75 beats/min
   D) 100 beats/min
   E) 150 beats/min

73. What is his current diagnosis?
   A) Sinus tachycardia
   B) First-degree heart block
   C) Second-degree heart block
   D) ST segment depression
   E) Third-degree heart block

74. A 55-year-old man has been diagnosed with Stokes-Adams syndrome. Two minutes after the syndrome starts to cause active blockade of the cardiac impulse, which of the following is the pacemaker of the heart?
   A) Sinus node
   B) A-V node
   C) Purkinje fibers
   D) Cardiac septum
   E) Left atrium

75. If the origin of the stimulus that causes atrial paroxysmal tachycardia is near the A-V node, which of the following statements about the P-wave in standard limb lead I is most accurate?
   A) P wave will originate in the sinus node
   B) It will be upright
   C) It will be inverted
   D) P wave will be missing

76. A 45-year-old man had the EKG below recorded at his annual physical. Which of the following is the likely diagnosis?

   A) Atrial paroxysmal tachycardia
   B) First-degree A-V block

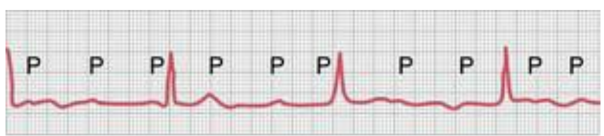
C) Second-degree A-V block
D) Ventricular paroxysmal tachycardia
E) Atrial flutter

77. A 60-year-old woman sees her physician for her annual physical examination. The physician orders an EKG, which is shown below. Which of the following is the likely diagnosis?

A) First-degree A-V block
B) Second-degree A-V block
C) Third-degree A-V block
D) Atrial paroxysmal tachycardia
E) Atrial fibrillation

Questions 78 and 79

An 80-year-old man went to his family physician for his annual checkup, and his EKG tracing is shown here.



78. What is his heart rate?
A) 105
B) 95
C) 85
D) 75
E) 40

79. Which of the following is the likely diagnosis?
A) Left bundle branch block
B) First-degree A-V block
C) Second-degree A-V block
D) Electrical alternans
E) Complete A-V block

Answers

1.E) This patient has a heart rate of 70 beats/, and you can determine the cardiac output by using the following formula: cardiac output = heart rate × stroke volume. The stroke volume can be determined from the figure, which is 100 ml, the volume change during the C-D segment. Using this you can determine

that the cardiac output is 7000 ml/min.
TMP12 109

2.A) During the ejection phase, the aortic and pulmonary valves open and blood flows into the aorta and pulmonary artery. The ejection phase is between C and D, so the aortic and pulmonary valves open at C and then close at D. The closing of these valves causes the second heart sound.
TMP12 105

3.B) Between points A and B is the period of ventricular filling. The vibration of the ventricular walls makes this sound after sufficient blood has entered the ventricular chambers.
TMP12 105

4.D) The ejection fraction is the stroke volume/end diastolic volume. Stroke volume is 100 ml, and the end systolic volume at point D is 150 ml. This gives you an ejection fraction of 0.667 or in terms of percentage 66.7%.
TMP12 109

5.D) During phase 3 of the ventricular muscle action potential, the potassium permeability of ventricular muscle greatly increases, which causes a more negative membrane potential.
TMP12 102

6.D) The typical ejection fraction is 60%, and lower values are indicative of a weakened heart.
TMP12 109

7.D) The end diastolic volume is always greater than the end systolic volume. Multiplication of the ejection fraction by the end diastolic volume gives you the stroke volume, which is 50 ml in this problem. Therefore, the end diastolic volume is 50 ml greater than the end systolic volume and has a value of 200 ml.
TMP12 109

8.B) The cardiac muscle stores much more calcium in its tubular system than skeletal muscle and is much more dependent on extracellular calcium than the skeletal muscle. An abundance of calcium is bound by the mucopolysaccharides inside the T-tubule. This calcium is necessary for contraction of cardiac muscle, and its strength of contraction depends on the calcium concentration surrounding the cardiac myocytes. At the initiation of the action potential, the fast sodium channels open first, followed later by the opening of the slow calcium channels.
TMP12 102–103

9.A) Heart rate is determined by the formula 60/R-R interval, and the heart rate for this patient is 109 beats/min. This is a fast heart rate, which would occur during fever. A trained athlete has a low heart rate. Excess parasympathetic stimulation and hyperpolarization of the S-A node both decrease heart rate.
TMP12 112

10.E) The heart goes into spastic contraction following a large increase in the calcium ion concentration surrounding the cardiac myofibrils, and this occurs if extracellular fluid calcium ion concentration increases too much. An excess potassium concentration in the extracellular fluids causes the heart to become dilated because of the more positive resting membrane potential of the cardiac muscle fibers.

TMP12 112

11.E) At the end of ventricular ejection, both the aortic valves and the pulmonary valves close. This is followed by the period of isovolumic relaxation.

TMP12 108

12.E) Immediately after the QRS wave, the ventricles begin to contract and the first phase that occurs is isovolumic contraction. This occurs before the ejection phase and increases the ventricular pressure enough to mechanically open the aortic and pulmonary valves.

TMP12 108

13.B) Excess potassium ions in the blood and extracellular fluid cause the heart to become dilated and flaccid as well as slowing the heart. This effect is important due to a more positive resting membrane potential in the cardiac muscle fibers. As the membrane potential becomes more positive, the intensity of the action potential decreases, which makes the contraction of the heart progressively weaker. Excess calcium ions in the blood and sympathetic stimulation and increased norepinephrine concentration of the blood all cause the heart to contract vigorously.

TMP12 112

14.E) The normal plateau level of the cardiac output function curve is 13 L/min. This level decreases in any kind of cardiac failure and increases markedly during sympathetic stimulation.

TMP12 111

15.E) As seen in Chapter 9, the first heart sound by definition occurs just after the ventricular pressure exceeds the atrial pressure. This causes the A-V valves to mechanically close. The second heart sound occurs when the aortic and pulmonary valves close.

TMP12 105

16.D) The increase in potassium permeability causes a hyperpolarization of the A-V node, and this will decrease the heart rate. Increases in sodium permeability will actually partially depolarize the A-V node, and an increase in norepinephrine levels increases the heart rate.

TMP12 102

17.D) Increased sympathetic stimulation of the heart increases heart rate, atrial contractility, and ventricular contractility and also increases norepinephrine release at the ventricular sympathetic nerve endings. It does not release acetylcholine. It does cause an increased sodium permeability of the A-V node, which increases the rate of upward drift of the membrane potential to the threshold level for self-excitation, thus increasing heart rate.

TMP12 111 and 120

18.D) The impulse from the S-A node travels rapidly through the internodal pathways and arrives at the A-V node at 0.03 sec, at the A-V bundle at 0.12 sec and at the ventricular septum at 0.16 sec. The total delay is thus 0.13 sec.

TMP12 118

19.D) During sympathetic stimulation, the permeabilities of the S-A node and the A-V node increase. Also, the permeability of cardiac muscle to calcium increases resulting in an increased contractile strength. In addition, there is an upward drift of the resting membrane potential of the S-A node. Increased permeability of the S-A node to potassium does not occur during sympathetic stimulation.

TMP12 120

20.C) The atrial and ventricular muscles have a relatively rapid rate of conduction of the cardiac action potential, and the anterior internodal pathway also has fairly rapid conduction of the impulse. However, the A-V bundle myofibrils have a slow rate of conduction because their sizes are considerably smaller than the sizes of the normal atrial and ventricular muscle. Also, their slow conduction is partly caused by diminished numbers of gap junctions between successive muscle cells in the conducting pathway, causing a great resistance to conduction of the excitatory ions from one cell to the next.

TMP12 117

21.A) After the S-A node discharges, the action potential travels through the atria, through the A-V bundle system and finally to the ventricular septum and throughout the ventricle. The last place that the impulse arrives is at the epicardial surface at the base of the left ventricle, which requires a transit time of 0.22 sec.

TMP12 118

22.D) The action potential arrives at the A-V bundle at 0.12 sec. It arrives at the A-V node at 0.03 sec and is delayed 0.09 sec in the A-V node, which results in an arrival time at the bundle of His of 0.12 sec.

TMP12 118

23.D) Increases in sodium and calcium permeability at the S-A node result in an increased heart rate. An increased potassium permeability causes a hyperpolarization of the S-A node, which causes the heart rate to decrease.

TMP12 120

24.A) Acetylcholine does not depolarize the A-V node or increase permeability of the cardiac muscle to calcium ions but causes hyperpolarization of the S-A node and the A-V node by increasing permeability to potassium ions. This results in a decreased heart rate.

TMP12 120

25.A) The normal resting membrane potential of the S-A node is −55 mV. As the sodium leaks into the membrane an upward drift of the membrane potential occurs until it reaches −40 mV. This is the threshold level that initiates the action potential at the S-A node.

TMP12 116

26.D) An increase in potassium permeability causes a decrease in the membrane potential of the A-V node. Thus, it will be extremely hyperpolarized, making it much more difficult for the membrane potential to reach its threshold level for conduction. This results in a decrease in heart rate. Increases in sodium and calcium permeability and norepinephrine levels increase the membrane potential, causing a tendency to increase the heart rate.

TMP12 120

27.A) If there is a failure in conduction of the S-A nodal impulse to the A-V node or if the S-A node stops firing, the A-V node will take over as the pacemaker of the heart. The intrinsic rhythmical rate of the A-V node is 40 to 60 times per minute. If the Purkinje fibers take over as pacemakers, the heart rate will be between 15 and 40 beats/min.
TMP12 119

28.D) The impulse coming from the S-A node to the A-V node arrives at 0.03 sec. Then there is a total delay of 0.13 sec in the A-V node and bundle system allowing the impulse to arrive at the ventricular septum at 0.16 sec.
TMP12 118

29.D) The resting membrane potential of the sinus nodal fibers is −55 mV, and this is in contrast with the −85 to −90 mV membrane potential of cardiac muscle. Other major differences between the sinus nodal fibers and ventricular muscle fibers are that the sinus fibers exhibit self-excitation from inward leaking of sodium ions.
TMP12 116

30.A) If the Purkinje fibers are the pacemaker of the heart, the heart rate ranges between 15 and 40 beats/min. In contrast, the rate of firing of the A-V nodal fibers are 40 to 60 times a minute, and the sinus node fires at 70 to 80 times per minute. If the sinus node is blocked for some reason, the A-V node will take over as the pacemaker; and if the A-V node is blocked, the Purkinje fibers will take over as the pacemaker of the heart.
TMP12 119

31.E) Sympathetic stimulation of the heart normally causes an increased heart rate, increased rate of conduction of the cardiac impulse and increased force of contraction in the atria and ventricles. However, it does not cause acetylcholine release at the sympathetic endings because they contain norepinephrine. Parasympathetic stimulation causes acetylcholine release. The sympathetic nervous system firing increases the permeability of the cardiac muscle fibers, the S-A node, and the A-V node to sodium and calcium.
TMP12 120

32.A) By convention, the left arm is the positive electrode for lead I of an EKG.
TMP12 125

33.A) By convention, the left arm is the positive electrode for lead aVL of an EKG.
TMP12 126

34.E) The contraction of the ventricles lasts almost from the beginning of the Q wave and continues to the end of the T wave. This interval is called the Q-T interval and ordinarily lasts about 0.35 sec. In this particular example the Q-T interval is a little bit longer than average and equals 0.40 sec.
TMP12 123

35.B) The heart rate can be calculated by 60 divided by the R-R interval, which is 0.86 sec. This results in a heart rate of 70 beats/min.
TMP12 121, 123

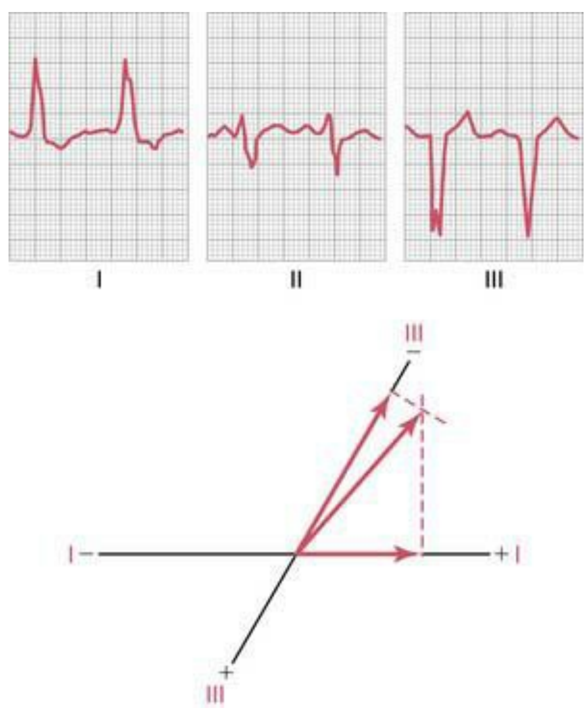
36.E) The contraction of the ventricles lasts almost from the beginning of the Q wave and continues to the end of the T wave. This interval is called the Q-T interval and ordinarily lasts about 0.35 sec.
TMP12 123

37.B) By convention, the left leg is the positive electrode for lead II of an EKG.
TMP12 125

38.A) By convention, the left arm is the negative electrode for lead III of an EKG.
TMP12 125

39.D) Einthoven's law states that the voltage in lead I plus the voltage in lead III is equal to the voltage in lead II, which in this case is 2.0 mV.
TMP12 125

40.E) As can be seen in Figure 12-3 (TMP12), the positive portion of lead aVF has an axis of 90° and the negative part of this lead has an axis of −90°. Note the difference between the positive and the negative ends of this vector is 180°.
TMP12 130



41.B) The mean electrical axis can be determined plotting the resultant voltage of the QRS for leads I, II, and III. The result is as is shown above and has a value of −50°.
TMP12 134

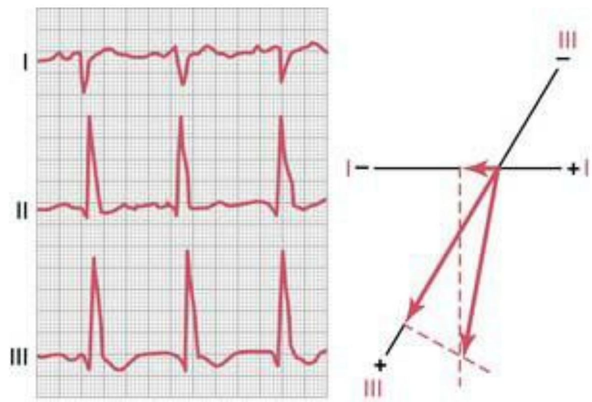
42.A) The heart rate can be calculated by 60 divided by the R-R interval, which is 0.68 sec. This results in a heart rate of 88 beats/min.
TMP12 123

43.B) Note in Figure 12-14 (TMP12), which is shown above, that there is a QRS width greater than

0.12 sec. This indicates a bundle branch block. There is also a left axis deviation, which is consistent with a left bundle branch block.
TMP12 136

44.E) Systemic hypertension results in a left axis deviation because of the enlargement of the left ventricle. Aortic valve stenosis and aortic valve regurgitation also result in a large left ventricle and left axis deviation. Excessive abdominal fat, because of the mechanical pressure of the fat, causes a rotation of the heart to the left resulting in a leftward shift of the mean electrical axis. Pulmonary hypertension causes enlargement of the right heart and thus causes right axis deviation.
TMP12 136

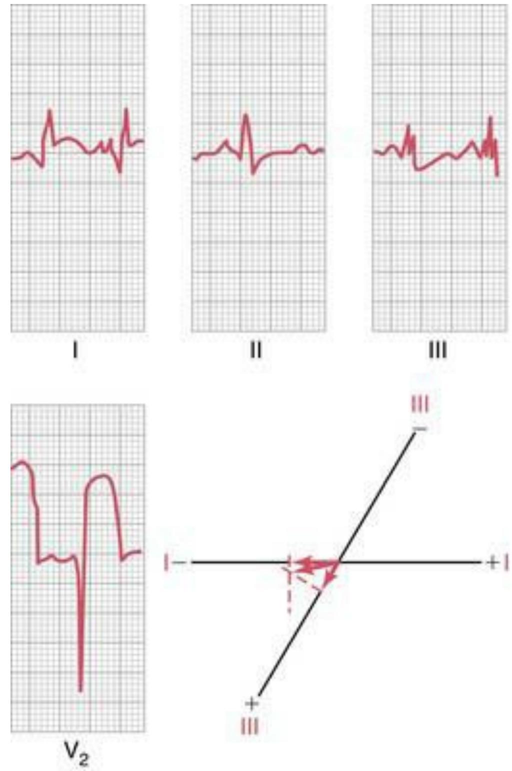
45.D) Lead II has a positive vector at the 60° angle. The positive end of lead II is at −120°.
TMP12 130



46.D) Note that lead III has the strongest vector, therefore the mean electrical axis will be closer to this lead than to leads I or II. The angle of lead III is 120°, and the resultant vector (mean electrical axis) is close to that lead and has a value of +105°.
TMP12 134

47.D) The diagnosis is right bundle branch block. This can be determined by a rightward shift in mean electrical axis as well as the greatly prolonged QRS complex. In right ventricular hypertrophy, the QRS complex is only moderately prolonged.
TMP12 137

48.D) The patient has a left axis deviation because of the large negative deflection of the R wave in lead III. Also, her T wave was inverted in lead I, which means that it is in the opposite direction of the QRS complex. This is characteristic of bundle branch block. Also, the QRS complex had a width of 0.20 sec, a very prolonged QRS complex. A QRS complex that has a width greater than 0.12 sec is normally caused by a conduction block. All these factors indicate that this patient has a left bundle branch block.
TMP12 136



49.A) This patient has an acute anterior infarction in the left ventricle of the heart. This can be determined by plotting the currents of injury from the different leads. The limb leads are used to determine whether the infarction is coming from the left or right side of the heart and from the base or apex of the heart. The chest leads are used to determine whether it is an anterior or posterior infarct. When we analyze the currents of injury, a negative potential, caused by the current of injury, occurs in lead I and a positive potential, caused by the current of injury, occurs in lead III. This is determined by subtracting the J point from the TP segment. The negative end of the resultant vector originates in the ischemic area, which is therefore the left side of the heart. In lead V_2, the chest lead, the electrode is in a field of very negative potential, which occurs in patients with an anterior lesion.

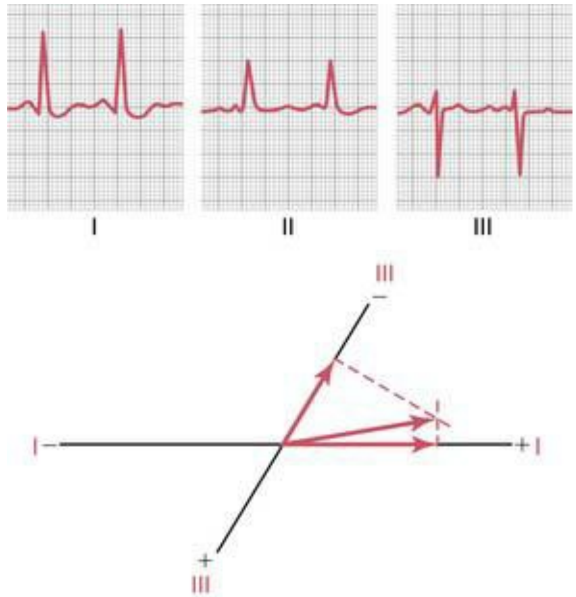
TMP12 140

50.A) Since the deflection in this EKG is 0 in lead I, the axis has to be 90° away from this lead. Therefore, the mean electrical axis has to be +90° or −90°. Since the aVF lead has a positive deflection, the mean electrical axis must be at +90°.

TMP12 134

51.A) At the J point the entire heart is depolarized in a patient with a damaged cardiac muscle or a patient with a normal cardiac muscle. The area of the heart that is damaged will not repolarize, but remains depolarized at all times.

TMP12 139



52.A) Note that the QRS complex has a positive deflection in lead I and a negative in lead III, which indicates that there is a leftward axis deviation. This occurs during chronic systemic hypertension. Pulmonary hypertension increases the ventricular mass on the right side of the heart, which gives a right axis deviation.

TMP12 135

53.D) The QRS wave plotted on lead I was −1.2 mV and lead II was +1.2 mV so the absolute value of the deflections were the same. Therefore, the mean electrical axis has to be exactly halfway in between these two leads, which is halfway between the lead II axis of 60° and the lead I negative axis of 180°, resulting in a value of 120°.

TMP12 134

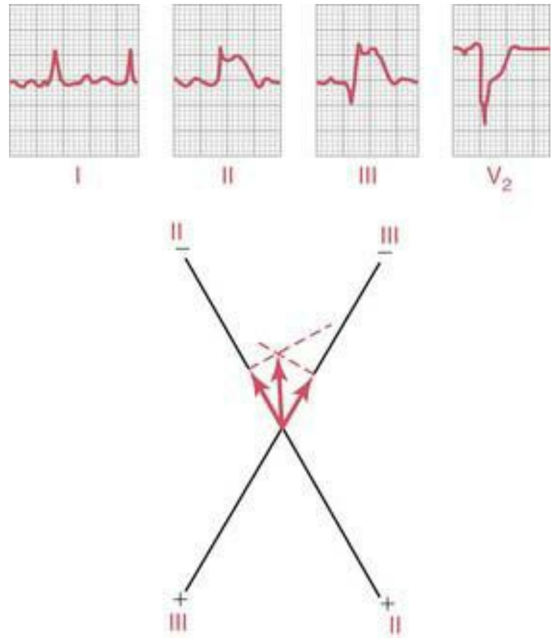
54.D) A QRS axis of 120° indicates a rightward shift. Since the QRS complex is 0.18 sec, this indicates a conduction block. Therefore, this EKG, which fits with these characteristics, is a right bundle branch block.

TMP12 137

55.B) The EKG from this patient has a positive deflection in aVF and a negative deflection in standard limb lead I. Therefore, the mean electrical axis is between 90° and 180°, which is a rightward shift in the EKG mean electrical axis. Systemic hypertension, aortic valve stenosis, and aortic valve regurgitation cause hypertrophy of the left ventricle and thus a leftward shift in the mean electrical axis. Pulmonary hypertension causes a rightward shift in the axis, and is therefore characterized by this EKG.

TMP12 136

56.D) Note in the following figure that the current of injury is plotted on the graph at the bottom. This is not a plot of the QRS voltages but the current of injury voltages. They are plotted for leads II and III, which are both negative, and the resultant vector is nearly vertical. The negative end of the vector points to where the current of injury originated, which is in the apex of the heart. The elevation of the TP segment above the J point indicates a posterior lesion. Therefore, the EKG is consistent with acute posterior infarction in the apex of the heart.



TMP12 140

57.D) When a patient has no P waves and a low heart rate, it is likely that the impulse leaving the sinus node is totally blocked before entering the atrial muscle. This is called sinoatrial block. The ventricles pick up the new rhythm usually initiated in the A-V node at this point, which results in a heart rate of 40 to 60 beats/min. In contrast, during sinus bradycardia you still have P waves associated with each QRS complex. In first-, second-, and third-degree heart block, you have P waves in each of these instances, although some are not associated with QRS complex.
TMP12 144

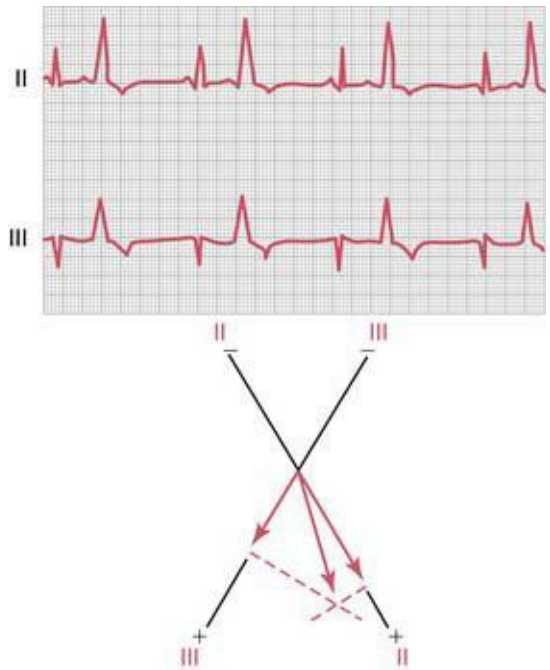
58.C) Atrial fibrillation has a rapid irregular heart rate. The P waves are missing or are very weak. The atria exhibit circus movements, and atrial volume is often increased, causing the atrial fibrillation.
TMP12 151–152

59.A) Circus movements occur in ventricular muscle particularly if you have a dilated heart or decreases in conduction velocity. High extracellular potassium and sympathetic stimulation, not parasympathetic stimulation, increase the tendency for circus movements. A longer refractory period tends to prevent circus movements of the heart, because when the impulses travel around the heart and contact the area of ventricular muscle that has a longer refractory period, the action potential stops at this point.
TMP12 150

60.B) A sudden onset of A-V block that comes and goes is called the Stokes-Adams syndrome. The patient depicted here has about 75 P-waves/min, which means that the atria are contracting normally. But the A-V block that occurs allows only 35 QRS waves to occur each minute.
TMP12 145

61.D) By definition, first-degree A-V heart block occurs when the P-R interval exceeds a value of 0.20 sec, but without any dropped QRS waves. In the following figure, the P-R interval is about 0.30 sec, which is considerably prolonged. However, there are no dropped QRS waves. During second-degree A-

V block or third-degree A-V block, QRS waves are dropped.



TMP12 144

62.E) Note that the premature ventricular contractions (PVCs) have wide and tall QRS waves in the EKG. The mean electrical axis of the premature contraction can be determined by plotting these large QRS complexes on the standard limb leads. The PVC originates at the negative end of the resultant mean electrical axis, which is at the base of the ventricle. Note that the QRS of the PVC is wider and much taller than the normal QRS waves in this EKG.

TMP12 147

63.B) This patient has atrial flutter characterized by several P waves for each QRS complex. In this EKG, you see some areas that have two P waves for every QRS and other areas that have three P waves for each QRS. Note the rapid heart rate, which is characteristic of atrial flutter, and the irregular R-R intervals.

TMP12 152

64.E) The average ventricular rate is 120 beats/min in this EKG, which is typical of atrial flutter. Once again, note that the heart rate is irregular due to the inability of the impulses to quickly pass through the A-V node because of its refractory period.

TMP12 123

65.A) Atrial fibrillation has a rapid irregular heart rate. The P waves are missing or are very weak. The atria exhibit circus movements, and often are very enlarged, causing the atrial fibrillation.

TMP12 151–152

66.C) Atrial fibrillation occurs often with patients with an atrial enlargement. This causes an increased tendency for circus movements to occur. The ventricular beat is irregular because impulses are rapidly arriving at the A-V node; however, many times the A-V node is in a refractory period. Therefore the A-V

node will not pass a second impulse until about 0.35 sec elapses after the previous one. There is also a variable interval between when the atrial impulses reach the A-V node. This results in a very irregular heartbeat but one that is very rapid with a rate of 125 to 150 beats/min.
TMP12 151–152

67.E) The term paroxysmal means that the heart rate becomes rapid in paroxysms, with the paroxysm beginning suddenly and lasting for a few seconds, a few minutes, a few hours, or much longer. Then the paroxysm usually ends as suddenly as it began and the pacemaker shifts back to the S-A node. The mechanism by which this is believed to occur is by a re-entrant circus movement feedback pathway that sets up an area of local repeated self-re-excitation. The EKG shown is ventricular paroxysmal tachycardia. That the origin is in the ventricles can be determined because of the changes in the QRS complex that have high voltages and look much different than the preceding normal QRS complexes. This is very characteristic of a ventricular irritable locus.
TMP12 149

68.C) Note in this EKG that a P wave precedes each of the first four QRS complexes. After that we see a P wave but a dropped QRS wave. This is characteristic of second-degree A-V block.
TMP12 145

69.B) A dilated heart increases the risk of occurrence of ventricular fibrillation because of an increase in likelihood of circus movements. Also, if the conduction velocity decreases, it will take longer for the impulse to travel around the heart, which decreases the risk of ventricular fibrillation. Exposure of the heart to 60-cycle alternating current or epinephrine administration increases the irritability of the heart. If the refractory period is long, the likelihood of the re-entrant type of pathways decreases, because when the impulse travels around the heart, the ventricles remain in a refractory period.
TMP12 149

70.A) The risk of occurrence of ventricular fibrillation increases in a heart exposed to a 60-cycle alternating current. A shortened ventricular refractory period and a decreased conduction through the heart muscle occur, which increases the probability of re-entrant pathways. Therefore, when the electrical stimulus travels around the heart and reaches the ventricular muscle that was again initially stimulated, the risk of ventricular fibrillation increases if this muscle has a short refractory period.
TMP12 150

71.A) The heartbeat immediately following a premature atrial contraction weakens because the diastolic period is very short in this condition. Therefore, the ventricular filling time is very short, and thus the stroke volume decreases. The P wave is usually visible in this arrhythmia unless it coincides with the QRS complex. The probability of these premature contractions increases in people with toxic irritation of the heart and local ischemic areas.
TMP12 146

72.E) The heart rate can be determined by 60 divided by the R-R interval, which gives you a value of 150 beats/min. This is tachycardia, defined as a heart rate greater than 100 beats/min.
TMP12 123

73.A) The relationship between the P waves and the QRS complexes appears to be normal and there are no missing beats. Therefore, this patient has a sinus rhythm, and there is no heart block. There is also no ST segment depression in this patient. Since we have normal P and QRS and T waves, this condition is sinus tachycardia.

TMP12 143

74.B) During a Stokes-Adams syndrome attack total A-V block suddenly begins, and the duration of the block may be a few seconds or even several weeks. The new pacemaker of the heart is distal to the point of blockade but is usually the A-V node or the A-V bundle.

TMP12 143

75.C) During atrial paroxysmal tachycardia the impulse is initiated by an ectopic focus somewhere in the atria. If the point of initiation is near the A-V node the P wave travels backward toward the S-A node and then forward into the ventricles at the same time. Therefore, the P wave will be inverted.

TMP12 146

76.A) This EKG has characteristics of atrial paroxysmal tachycardia. This means the tachycardia may come and go at random times. The basic shape of the QRS complex and its magnitude are virtually unchanged from the normal QRS complexes, which eliminates the possibility of ventricular paroxysmal tachycardia. This EKG is not characteristic of atrial flutter since there is only one P wave for each QRS complex.

TMP12 148

77.E) First-, second-, and third-degree heart blocks as well as atrial paroxysmal tachycardia all have P waves in the EKG. However, there are usually no evident P waves during atrial fibrillation, and the heart rate is irregular. Therefore, this EKG is characteristic of atrial fibrillation.

TMP12 151-152

78.E) This patient’s heart rate is 40 beats/min, which can be determined by dividing 60 by the R-R interval. This is characteristic of some type of A-V block.

TMP12 123

79.E) This EKG is characteristic of complete A-V block, which is also called third-degree A-V block. The P waves seem to be totally dissociated from the QRS complexes, since sometimes there are three P waves and sometimes two P waves between QRS complexes. First-degree A-V block causes a lengthened P-R interval, and second-degree A-V block has long P-R intervals with dropped beats. However, this does not seem to be occurring in this EKG, since there is no relationship between the ORS waves and the P waves.

TMP12 145

The circulation

1. A healthy 28-year-old woman stands up from a supine position. Which of the following sets of cardiovascular changes is most likely to occur?

	Heart rate	Renal blood flow	Total peripheral resistance
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

2. A healthy 25-year-old male medical student has an exercise stress test at a local health club. Which of the following sets of physiological changes is most likely to occur in this man's skeletal muscles during exercise?

	Arteriolar resistance	Adenosine concentration	Vascular conductance
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

3. A 60-year-old woman has experienced dizziness for the past 6 months when getting out of bed in the morning and when standing up. Her mean arterial pressure is 130/90 mm Hg lying down and 95/60 sitting. Which of the following sets of physiological changes would be expected in response to moving from a supine to an upright position?

	Parasympathetic nerve activity	Plasma renin activity	Sympathetic activity
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

4. Which of the following sets of physiological changes would be expected to occur in response to an increase in atrial natriuretic peptide?

	Angiotensin II	Aldosterone	Sodium excretion
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

5. Listed below are the hydrostatic and oncotic pressures within a microcirculatory bed:

Plasma colloid osmotic pressure = 25 mm Hg
Capillary hydrostatic pressure = 25 mm Hg
Venous hydrostatic pressure = 5 mm Hg
Arterial pressure = 80 mm Hg
Interstitial fluid hydrostatic pressure = −5 mm Hg
Interstitial colloid osmotic pressure = 10 mm Hg
Capillary filtration coefficient = 10 ml/min/mm Hg
What is the rate of net fluid movement across the capillary wall?
A) 25 ml/min
B) 50 ml/min
C) 100 ml/min
D) 150 ml/min
E) 200 ml/min

6. Listed below are the hydrostatic and oncotic pressures and filtration rate across a muscle capillary wall:

Capillary hydrostatic pressure (Pc) = 25 mm Hg
Plasma colloid osmotic pressure (Πp) = 25 mm Hg
Interstitial colloid osmotic pressure (Π_I) = 10 mm Hg

Interstitial hydrostatic pressure (P_I) = −5 mm Hg
Capillary filtration rate = 150 ml/min
What is the capillary filtration coefficient?
A) 0
B) 5
C) 10
D) 15
E) 20

7. Administration of a drug decreases the diameter of arterioles in the muscle bed of an experimental animal. Which of the following sets of physiological changes would be expected to occur in response to the decrease in diameter?

	Vascular conductance	Capillary filtration	Blood flow
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

8. A 35-year-old woman visits her family practitioner for an examination. She has a blood pressure of 160/75 mm Hg and a heart rate of 74 beats/min. Further tests by a cardiologist reveal that the patient has moderate aortic regurgitation. Which of the following sets of changes would be expected in this patient?

	Pulse pressure	Systolic pressure	Stroke volume
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

9. A 65-year-old man with a 5-year history of congestive heart failure is being treated with an angiotensin-converting enzyme (ACE) inhibitor. Which of the following sets of changes would be expected to occur in response to the ACE inhibitor drug therapy?

	Arterial pressure	Angiotensin II	Total peripheral resistance
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

10. Cognitive stimuli such as reading, problem solving, and talking all result in significant increases in cerebral blood flow. Which of the following changes in cerebral tissue concentrations is the most likely explanation for the increase in cerebral blood flow?

	Carbon dioxide	pH	Adenosine
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

11. A 55-year-old man with a history of normal health visits his physician for a checkup. The physical examination reveals that his blood pressure is 170/98 mm Hg. Further tests indicate that he has renovascular hypertension as a result of stenosis in the left kidney. Which of the following sets of findings would be expected in this man with renovascular hypertension?

	Total peripheral resistance	Plasma renin activity	Plasma aldosterone concentration
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

12. Histamine is infused into the brachial artery. Which of the following sets of microcirculatory

changes would be expected in the infused arm?

	Capillary water permeability	Capillary hydrostatic pressure	Capillary filtration rate
A)	↑	↑	↑
B)	↑	↑	↓
C)	↑	↓	↓
D)	↑	↓	↑
E)	↓	↓	↓
F)	↓	↓	↑
G)	↓	↑	↑
H)	↓	↑	↓

13. Bradykinin is infused into the brachial artery of a 22-year-old man. Which of the following sets of microcirculatory changes would be expected in the infused arm?

	Capillary hydrostatic pressure	Interstitial hydrostatic pressure	Lymph flow
A)	↑	↑	↑
B)	↑	↑	↓
C)	↑	↓	↓
D)	↑	↓	↑
E)	↓	↓	↓
F)	↓	↓	↑
G)	↓	↑	↑
H)	↓	↑	↓

14. An increase in shear stress in a blood vessel results in which of the following changes?

A) Decreased endothelin production
B) Decreased cyclic guanosine monophosphate production
C) Increased nitric oxide release
D) Increased renin production
E) Decreased prostacyclin production

15. A 72-year-old man had surgery to remove an abdominal tumor. Pathohistologic studies reveal that the tumor mass contains a large number of blood vessels. An increase in which of the following is the most likely stimulus for the growth of vessels in a solid tumor?

A) Growth hormone
B) Plasma glucose concentration
C) Angiostatin growth factor
D) Tissue oxygen concentration
E) Vascular endothelial growth factor

16. The diameter of a precapillary arteriole is increased in a muscle vascular bed. A decrease in which

of the following would be expected?

A) Capillary filtration rate
B) Vascular conductance
C) Capillary blood flow
D) Capillary hydrostatic pressure
E) Arteriolar resistance

17. Under control conditions, flow through a blood vessel is 100 ml/min with a pressure gradient of 50 mm Hg. What would be the approximate flow through the vessel after increasing the vessel diameter by 50%, assuming the pressure gradient is maintained at 100 mm Hg?

A) 100 ml/min
B) 150 ml/min
C) 300 ml/min
D) 500 ml/min
E) 700 ml/min

18. A 24-year-old woman delivers a 6-lb, 8-oz female baby. The newborn is diagnosed as having patent ductus arteriosus. Which of the following sets of changes would be expected in this baby?

	Pulse pressure	Stroke volume	Systolic pressure
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

19. Which of the following sets of changes would be expected to cause the greatest increase in the net movement of sodium across a muscle capillary wall?

	Wall permeability to sodium	Wall surface area	Concentration difference across wall
A)	↑	↑	↑
B)	↑	↑	↓
C)	↑	↓	↓
D)	↑	↓	↑
E)	↓	↓	↓
F)	↓	↓	↑
G)	↓	↑	↑
H)	↓	↑	↓

20. A 60-year-old man visits his family practitioner for an annual examination. He has a mean blood pressure of 130 mm Hg and a heart rate of 78 beats/min. His plasma cholesterol level is in the upper 25th percentile, and he is diagnosed as having atherosclerosis. Which of the following sets of changes would be expected in this patient?

	Pulse pressure	Arterial compliance	Systolic pressure
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

21. While participating in a cardiovascular physiology laboratory, a medical student isolates the carotid artery of an animal and partially constricts the artery with a tie around the vessel. Which of the following sets of changes would be expected to occur in response to constriction of the carotid artery?

	Sympathetic nerve activity	Renal blood flow	Total peripheral resistance
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

22. A balloon catheter is advanced from the superior vena cava into the heart and inflated to increase atrial pressure by 5 mm Hg. An increase in which of the following would be expected to occur in response to the elevated atrial pressure?

A) Atrial natriuretic peptide
B) Angiotensin II
C) Aldosterone
D) Renal sympathetic nerve activity

23. The diameter of a precapillary arteriole is decreased in a muscle vascular bed. Which of the following changes in the microcirculation would be expected?

A) Decreased capillary filtration rate
B) Increased interstitial volume

C) Increased lymph flow
D) Increased capillary hydrostatic pressure
E) Decreased arteriolar resistance

24. A 50-year-old man has a 3-year history of hypertension. He complains of fatigue and occasional muscle cramps. There is no family history of hypertension. The patient has not had any other significant medical problems in the past. Examination reveals a blood pressure of 168/104 mm Hg. Additional laboratory tests indicate that the patient has primary hyperaldosteronism. Which of the following sets of findings would be expected in this man with primary hyperaldosteronism hypertension?

	Extracellular fluid volume	Plasma renin activity	Plasma potassium concentration
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

25. A 72-year-old man had surgery to remove an abdominal tumor. Pathohistologic studies revealed that the tumor mass contained a large number of vessels. A decrease in which of the following is the most likely stimulus for the growth of vessels in a solid tumor?
A) Growth hormone
B) Plasma glucose concentration
C) Angiostatin growth factor
D) Vascular endothelial growth factor
E) Tissue oxygen concentration

26. Under control conditions, flow through a blood vessel is 100 ml/min under a pressure gradient of 50 mm Hg. What would be the approximate flow through the vessel after increasing the vessel diameter to four times normal, assuming that the pressure gradient was maintained at 50 mm Hg?
A) 300 ml/min
B) 1600 ml/min
C) 1000 ml/min
D) 16,000 ml/min
E) 25,600 ml/min

27. While participating in a cardiovascular physiology laboratory, a medical student isolates an animal’s carotid artery proximal to the carotid bifurcation and partially constricts the artery with a tie around the vessel. Which of the following sets of changes would be expected to occur in response to constriction of the carotid artery?

	Mean carotid sinus nerve impulses	Parasympathetic nerve activity	Total peripheral resistance
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

28. A 22-year-old man enters the hospital emergency room after severing a major artery in a motorcycle accident. It is estimated that he has lost approximately 700 ml of blood. His blood pressure is 90/55 mm Hg. Which of the following sets of changes would be expected in response to hemorrhage in this man?

	Heart rate flow	Sympathetic nerve activity	Total peripheral resistance
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

29. A 22-year-old man has a muscle blood flow of 250 ml/min and a hematocrit of 50. He has a mean arterial pressure of 130 mm Hg, a muscle venous pressure of 5 mm Hg, and a heart rate of 80 beats/min. Which of the following is the approximate vascular resistance in the muscle of this man?

A) 0.10 mm Hg/ml/min
B) 0.20 mm Hg/ml/min
C) 0.50 mm Hg/ml/min
D) 1.00 mm Hg/ml/min
E) 2.50 mm Hg/ml/min

30. A healthy 28-year-old woman stands up from a supine position. Moving from a supine to a standing position results in a transient decrease in arterial pressure that is detected by arterial baroreceptors located in the aortic arch and carotid sinuses. Which of the following sets of cardiovascular changes is most likely to occur in response to activation of the baroreceptors?

	Mean circulatory filling pressure	Strength of cardiac contraction	Sympathetic nerve activity
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

31. A 35-year-old woman visits her family practice physician for an examination. She has a mean arterial blood pressure of 105 mm Hg and a heart rate of 74 beats/min. Further tests by a cardiologist reveal that the patient has moderate aortic valve stenosis. Which of the following sets of changes would be expected in this patient?

	Pulse pressure	Stroke volume	Systolic pressure
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

32. A 25-year-old man enters the hospital emergency room after severing a major artery during a farm accident. It is estimated that the patient has lost approximately 800 ml of blood. His mean blood pressure is 65 mm Hg, and his heart rate is elevated as a result of activation of the chemoreceptor reflex. Which of the following sets of changes in plasma concentration would be expected to cause the greatest activation of the chemoreceptor reflex?

	Oxygen	Carbon dioxide	Hydrogen
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

33. An increase in which of the following would tend to increase lymph flow?

A) Hydraulic conductivity of the capillary wall
B) Plasma colloid osmotic pressure
C) Capillary hydrostatic pressure
D) Arteriolar resistance
E) A and C

34. Under normal physiological conditions, blood flow to the skeletal muscles is determined mainly by which of the following?
A) Sympathetic nerves
B) Angiotensin II
C) Vasopressin
D) Metabolic needs
E) Capillary osmotic pressure

35. Which of the following substances in plasma is the major factor that contributes to plasma colloid osmotic pressure?
A) Sodium chloride
B) Glucose
C) Albumin
D) Cholesterol
E) Potassium

36. A healthy 22-year-old female medical student has an exercise stress test at a local health club. An increase in which of the following is most likely to occur in this woman's skeletal muscles during exercise?
A) Vascular conductance
B) Blood flow
C) Carbon dioxide concentration
D) Arteriolar diameter
E) All of the above

37. Assuming that vessels A to D are the same length, which one has the greatest flow?

Blood vessel	Pressure gradient	Radius	Viscosity
A)	100	1	10
B)	50	2	5
C)	25	4	2
D)	10	6	1

38. Which blood vessel has the highest vascular resistance?

Blood vessel	Blood flow (ml/min)	Pressure gradient (mm Hg)
A)	1000	100
B)	1200	60
C)	1400	20
D)	1600	80
E)	1800	40

39. A twofold increase in which of the following would result in the greatest increase in the transport of oxygen across the capillary wall?
   A) Capillary hydrostatic pressure
   B) Intercellular clefts in the capillary wall
   C) Oxygen concentration gradient
   D) Plasma colloid osmotic pressure
   E) Capillary wall hydraulic permeability

40. Which of the following vessels has the greatest total cross-sectional area in the circulatory system?
   A) Aorta
   B) Small arteries
   C) Capillaries
   D) Venules
   E) Vena cava

41. Which of the following components of the circulatory system contains the largest percentage of the total blood volume?
   A) Arteries
   B) Capillaries

C) Veins
D) Pulmonary circulation
E) Heart

42. An increase in which of the following would be expected to decrease blood flow in a vessel?
A) Pressure gradient across the vessel
B) Radius of the vessel
C) Plasma colloid osmotic pressure
D) Viscosity of the blood
E) Plasma sodium concentration

43. Which of the following segments of the circulatory system has the highest velocity of blood flow?
A) Aorta
B) Arteries
C) Capillaries
D) Venules
E) Veins

44. A decrease in which of the following tends to increase pulse pressure?
A) Systolic pressure
B) Stroke volume
C) Arterial compliance
D) Venous return
E) Plasma volume

45. An increase in which of the following tends to decrease capillary filtration rate?
A) Capillary hydrostatic pressure
B) Plasma colloid osmotic pressure
C) Interstitial colloid osmotic pressure
D) Venous hydrostatic pressure
E) Arteriolar diameter

46. An increase in which of the following tends to increase capillary filtration rate?
A) Capillary wall hydraulic conductivity
B) Arteriolar resistance
C) Plasma colloid osmotic pressure
D) Interstitial hydrostatic pressure
E) Plasma sodium concentration

47. A decrease in which of the following tends to increase lymph flow?
A) Capillary hydrostatic pressure
B) Interstitial hydrostatic pressure
C) Plasma colloid osmotic pressure
D) Lymphatic pump activity
E) Arteriolar diameter

48. Which of the following capillaries has the lowest capillary permeability to plasma molecules?
A) Glomerular
B) Liver
C) Muscle
D) Intestinal
E) Brain

49. Which of the following tends to increase the net movement of glucose across a capillary wall?
A) Increase in plasma sodium concentration
B) Increase in the concentration difference of glucose across the wall
C) Decrease in wall permeability to glucose
D) Decrease in wall surface area without an increase in the number of pores
E) Decrease in plasma potassium concentration

50. A 65-year-old man is suffering from congestive heart failure. He has a cardiac output of 4 L/min, arterial pressure of 115/85 mm Hg, and a heart rate of 90 beats/min. Further tests by a cardiologist reveal that the patient has a right atrial pressure of 10 mm Hg. An increase in which of the following would be expected in this patient?
A) Plasma colloid osmotic pressure
B) Interstitial colloid osmotic pressure
C) Arterial pressure
D) Cardiac output
E) Vena cava hydrostatic pressure

51. Which of the following parts of the circulation has the highest compliance?
A) Capillaries
B) Large arteries
C) Veins
D) Aorta
E) Small arteries

52. Using the following data, calculate the filtration coefficient for the capillary bed:
Plasma colloid osmotic pressure = 30 mm Hg
Capillary hydrostatic pressure = 40 mm Hg
Interstitial hydrostatic pressure = 5 mm Hg
Interstitial colloid osmotic pressure = 5 mm Hg
Filtration rate = 150 ml/min
Venous hydrostatic pressure = 10 mm Hg
A) 10 ml/min/mm Hg
B) 15 ml/min/mm Hg
C) 20 ml/min/mm Hg
D) 25 ml/min/mm Hg
E) 30 ml/min/mm Hg

53. Which of the following sets of physiological changes would be expected to occur in a person who stands up from a supine position?

	Venous hydrostatic pressure in legs	Heart rate	Renal blood flow
A)	↑	↑	↑
B)	↑	↑	↓
C)	↑	↓	↓
D)	↓	↓	↓
E)	↓	↓	↑
F)	↓	↑	↑

54. Blood flow to a tissue remains relatively constant despite a reduction in arterial pressure (autoregulation). Which of the following would be expected to occur in response to the reduction in arterial pressure?

A) Decreased conductance
B) Decreased tissue carbon dioxide concentration
C) Increased tissue oxygen concentration
D) Decreased vascular resistance
E) Decreased arteriolar diameter

55. The tendency for turbulent flow is greatest in which of the following?

A) Arterioles
B) Capillaries
C) Small arterioles
D) Aorta

56. Autoregulation of tissue blood flow in response to an increase in arterial pressure occurs as a result of which of the following?

A) Decrease in vascular resistance
B) Initial decrease in vascular wall tension
C) Excess delivery of nutrients such as oxygen to the tissues
D) Decrease in tissue metabolism

57. Which of the following pressures is normally negative in a muscle capillary bed in the lower extremities?

A) Plasma colloid osmotic pressure
B) Capillary hydrostatic pressure
C) Interstitial hydrostatic pressure
D) Interstitial colloid osmotic pressure
E) Venous hydrostatic pressure

58. Which of the following would decrease venous hydrostatic pressure in the legs?

A) Increase in right atrial pressure
B) Pregnancy
C) Movement of leg muscles
D) Presence of ascitic fluid in the abdomen

59. Movement of solutes such as Na^+ across the capillary walls occurs primarily by which of the following processes?

A) Filtration
B) Active transport
C) Vesicular transport
D) Diffusion

60. Which of the following has the fastest rate of movement across the capillary wall?

A) Sodium
B) Albumin
C) Glucose
D) Oxygen

61. A decrease in which of the following would be expected to occur in response to a direct increase in renal arterial pressure?

A) Water excretion
B) Sodium excretion
C) Extracellular fluid volume
D) Glomerular filtration rate
E) Inrushing of blood into the ventricles in the early to middle part of diastole

62. Excess production of which of the following would most likely result in chronic hypertension?

A) Atrial natriuretic peptide
B) Prostacyclin
C) Angiotensin II
D) Nitric oxide

63. A decrease in which of the following would be expected to occur in response to an increase in sodium intake?

A) Angiotensin II
B) Nitric oxide
C) Sodium excretion
D) Atrial natriuretic peptide

64. Which of the following would be expected to occur in response to constriction of the renal artery?

A) Increase in sodium excretion
B) Decrease in arterial pressure
C) Decrease in renin release
D) Increase angiotensin II

65. An increase in atrial pressure results in which of the following?

A) Decrease in plasma atrial natriuretic peptide
B) Increase in plasma angiotensin II concentration
C) Increase in plasma aldosterone concentration
D) Increase in heart rate

66. Which of the following would be expected to occur during a Cushing reaction caused by brain ischemia?

A) Increase in parasympathetic activity
B) Decrease in arterial pressure
C) Decrease in heart rate
D) Increase in sympathetic activity

67. Which of the following often occurs in decompensated heart failure?

A) Increased renal loss of sodium and water
B) Decreased mean systemic filling pressure
C) Increased norepinephrine in cardiac sympathetic nerves
D) Orthopnea
E) Weight loss

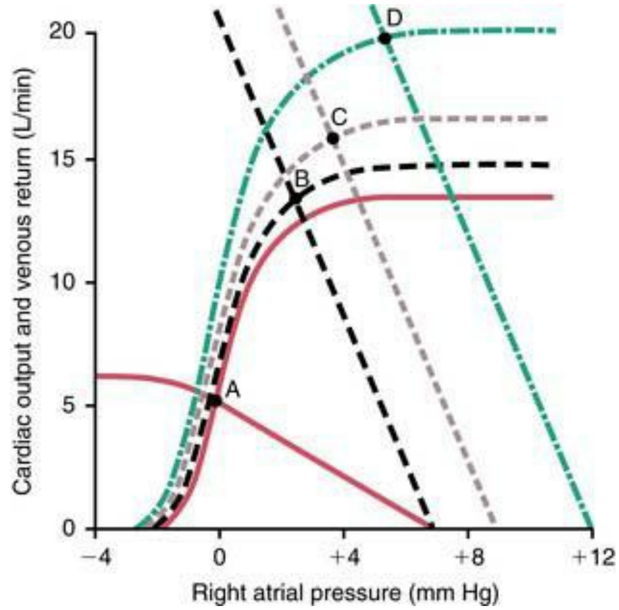
68. An angiotensin-converting enzyme inhibitor is administered to a 65-year-old man with a 20-year history of hypertension. The drug lowers arterial pressure and increases plasma levels of renin and bradykinin. Which of the following would best explain the elevation in plasma bradykinin?

A) Inhibition of preprobradykinin
B) Decreased conversion of angiotensin I to angiotensin II
C) Increased formation of angiotensin II
D) Increased formation of kallikrein
E) Inhibition of kininases

69. A 60-year-old man has a mean arterial blood pressure of 130 mm Hg, a heart rate of 78 beats/min, a right atrial pressure of 0 mm Hg, and a cardiac output of 3.5 L/min. He also has a pulse pressure of 35 mm Hg and a hematocrit of 40. What is the approximate total peripheral vascular resistance in this man?

A) 17 mm Hg/L/min
B) 1.3 mm Hg/L/min
C) 13 mm Hg/L/min
D) 27 mm Hg/L/min
E) 37 mm Hg/L/min

70. In the following graph, for the cardiac output and venous return curves defined by the solid red lines (with the equilibrium at A), which of the following is true?



A) Mean systemic filling pressure is 12 mm Hg
B) Right atrial pressure is 2 mm Hg
C) Resistance to venous return is 1.4 mm Hg/L/min
D) Pulmonary arterial flow is approximately 7 L/min
E) Resistance to venous return is 0.71 mm Hg/L/min

71. A 30-year-old male is resting, and his sympathetic output increases to maximal values. Which of the following sets of changes would be expected in response to this increased sympathetic output?

	Resistance to venous return	Mean systemic filling pressure	Venous return
A)	↑	↑	↑
B)	↑	↓	↑
C)	↑	↓	↓
D)	↑	↑	↓
E)	↓	↓	↓
F)	↓	↑	↓
G)	↓	↑	↑
H)	↓	↓	↑

72. If a patient has an oxygen consumption of 240 ml/min, a pulmonary vein oxygen concentration of 180 ml/L of blood and a pulmonary artery oxygen concentration of 160 ml/L of blood units, what is cardiac output in liters per minute?

A) 8
B) 10
C) 12
D) 16
E) 20

73. If the thorax of a normal person is surgically opened, what will happen to the cardiac output curve?

A) It shifts to the left 2 mm Hg
B) It shifts to the left 4 mm Hg
C) It shifts to the right 2 mm Hg
D) It shifts to the right 4 mm Hg
E) It does not shift

74. Which of the following normally cause the cardiac output curve to shift to the left along the right atrial pressure axis?
A) Surgically opening the chest
B) Severe cardiac tamponade
C) Breathing against a negative pressure
D) Playing a trumpet
E) Positive pressure breathing

75. Which of the following will elevate the plateau of the cardiac output curve?
A) Surgically opening the thoracic cage
B) Placing a patient on a mechanical ventilator
C) Cardiac tamponade
D) Increasing parasympathetic stimulation of the heart
E) Increasing sympathetic stimulation of the heart

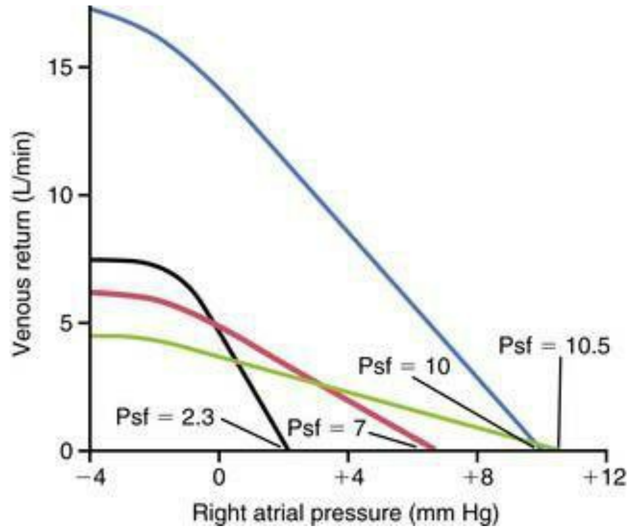
76. Which of the following normally cause the cardiac output curve to shift to the right along the right atrial pressure axis?
A) Decreasing intrapleural pressure to -6 mm Hg
B) Increasing mean systemic filling pressure
C) Taking a patient off a mechanical ventilator and allowing normal respiration
D) Surgically opening the chest
E) Breathing against a negative pressure

77. Which of the following conditions would be expected to decrease mean systemic filling pressure?
A) Norepinephrine administration
B) Increased blood volume
C) Increased sympathetic stimulation
D) Increased venous compliance
E) Skeletal muscle contraction

78. Which of the following is normally associated with an increased venous return of blood to the heart?
A) Decreased mean systemic filling pressure
B) Acute large vein dilation
C) Decreased sympathetic tone
D) Increased venous compliance
E) Increased blood volume

79. Which of the curves in the following graph (redrawn from Guyton AC, Jones CE, Coleman TB: *Circulatory Physiology: Cardiac Output and Its Regulation*, 2nd ed., Philadelphia: WB Saunders,

1973) has the highest resistance to venous return?



A) Blue line with mean systemic pressure (Psf) = 10
B) Green line with Psf = 10.5
C) Black line with Psf = 2.3
D) Red line with Psf = 7

80. Which of the following is normally associated with an increased cardiac output?
A) Increased venous compliance
B) Cardiac tamponade
C) Surgically opening the chest
D) Moderate anemia
E) Severe aortic stenosis

81. In which of the following conditions would you normally expect to find a decreased cardiac output?
A) Hyperthyroidism
B) Beriberi
C) A-V fistula
D) Anemia
E) Acute myocardial infarction

82. At the onset of exercise, which of the following normally occur?
A) Decreased cerebral blood flow
B) Increased venous constriction
C) Decreased coronary blood flow
D) Decreased mean systemic filling pressure
E) Increased parasympathetic impulses to the heart

83. Which of the following will usually increase the plateau level of the cardiac output curve?
A) Myocarditis
B) Severe cardiac tamponade
C) Decreased parasympathetic stimulation of the heart

D) Myocardial infarction
E) Mitral stenosis

84. If a person has been exercising for 1 hr, which of the following organs will experience the smallest decrease in blood flow?
A) Brain
B) Intestines
C) Kidneys
D) Non-exercising skeletal muscle
E) Pancreas

85. Which of the following increase the risk of adverse cardiac events?
A) Decreased blood levels of LDL
B) Decreased blood levels of HDL
C) Female gender
D) Moderate hypotension
E) Decreased blood triglycerides

86. Which of the following vasoactive agents is usually the most important controller of coronary blood flow?
A) Adenosine
B) Bradykinin
C) Prostaglandins
D) Carbon dioxide
E) Potassium ions

87. During mild exertion, a 70-year-old man experiences an ischemia-induced myocardial infarction and dies from ventricular fibrillation. In this patient, what factor was most likely to increase the tendency of the heart to fibrillate after the infarction?
A) Increased parasympathetic stimulation of the heart
B) A decrease in ventricular diameter
C) Low potassium concentration in the heart extracellular fluid
D) A more negative ventricular membrane potential
E) Current of injury from the damaged area

88. Which of the following statements about coronary blood flow is most accurate?
A) Normal resting coronary blood flow is 500 ml/min
B) The majority of flow occurs during systole
C) During systole the percentage decrease in subendocardial flow is greater than the percentage decrease in epicardial flow
D) Adenosine release will normally decrease coronary flow

89. Which of the following conditions normally cause arteriolar vasodilation during exercise?
A) Decreased plasma potassium ion concentration
B) Increased histamine release
C) Decreased plasma nitric oxide concentration

D) Increased plasma adenosine concentration
E) Decreased plasma osmolality

90. Which of the following vascular beds experiences the most vasoconstriction in a person near the end of a 10-km run?
A) Cerebral
B) Coronary
C) Exercising muscle
D) Intestinal
E) Skin

91. Which of the following blood vessels is responsible for transporting the majority of venous blood flow that leaves the ventricular heart muscle?
A) Anterior cardiac veins
B) Coronary sinus
C) Bronchial veins
D) Azygos vein
E) Thebesian veins

92. A 70-year-old man with a weight of 100 kg and a blood pressure of 160/90 has been told by his doctor that he has angina pain caused by myocardial ischemia. Which of the following treatments would be beneficial to this man?
A) Increased dietary calcium
B) Isometric exercise
C) Give a beta-1 receptor stimulator
D) Angiotensin II infusion
E) Nitroglycerin

93. Which of the following events normally occur during exercise?
A) Arteriolar dilation in non-exercising muscle
B) Decreased sympathetic output
C) Venoconstriction
D) Decreased release of epinephrine by the adrenals
E) Decreased release of norepinephrine by the adrenals

94. Which of the following is the most frequent cause of decreased coronary blood flow in patients with ischemic heart disease?
A) Increased adenosine release
B) Atherosclerosis
C) Coronary artery spasm
D) Increased sympathetic tone of the coronary arteries
E) Occlusion of the coronary sinus

95. Which of the following is an acceptable treatment for patients with an acute myocardial infarction?
A) Daily exercise
B) Beta receptor stimulation

C) Discontinue nitroglycerin intake
D) Discontinue aspirin intake
E) Coronary angioplasty

96. Which of the following would be recommended for a patient with myocardial ischemia?
A) Use of alpha receptor stimulation
B) Discontinue high blood pressure medication
C) Lose excess body weight
D) Angiotensin II infusion
E) Isometric exercise

97. Which of the following is one of the major causes of death after myocardial infarction?
A) Increased cardiac output
B) A decrease in pulmonary interstitial volume
C) Fibrillation of the heart
D) Increased cardiac contractility

98. Which of the following statements about the results of sympathetic stimulation is most accurate?
A) Epicardial flow increases
B) Venous resistance decreases
C) Arteriolar resistance decreases
D) Heart rate decreases
E) Venous reservoirs vasoconstrict

99. Which of the following is normally associated with the chronic stages of compensated heart failure? Assume that the patient is resting.
A) Dyspnea
B) Decreased right atrial pressure
C) Decreased heart rate
D) Sweating
E) Increased mean systemic filling pressure

100. Which of the following normally occur in unilateral right heart failure?
A) Increased pulmonary artery pressure
B) Increased left atrial pressure
C) Increased right atrial pressure
D) Pulmonary edema
E) Increased mean pulmonary filling pressure

101. Which of the following normally causes either renal sodium or water retention during compensated heart failure?
A) Decreased angiotensin II formation
B) Decreased aldosterone formation
C) Sympathetic vasodilation of the afferent arterioles
D) Increased glomerular filtration rate
E) Increased ADH formation

C) Infusion of a balanced electrolyte solution
D) Infusion of a sympathomimetic drug
E) Administration of a glucocorticoid

Answers

1.B) Moving from a supine to a standing position causes an acute fall in arterial pressure that is sensed by arterial baroreceptors located in the carotid bifurcation and aortic arch. Activation of the arterial baroreceptors leads to an increase in sympathetic outflow to the heart, peripheral vasculature, and the kidneys and a decrease in parasympathetic outflow to the heart. The increase in sympathetic activity to peripheral vessels results in an increase in total peripheral resistance. The increase in sympathetic activity and decrease in parasympathetic outflow to the heart result in an increase in heart rate. The increase in renal sympathetic nerve activity results in a decrease in renal blood flow.

TMP12 205–207

2. G)The increase in local metabolism during exercise causes cells to release vasodilator substances such as adenosine. The increase in tissue adenosine concentration decreases arteriolar resistance and increases vascular conductance and blood flow to skeletal muscles.

TMP12 191–195

3.G) Moving from a supine to a standing position causes an acute fall in arterial pressure that is sensed by arterial baroreceptors located in the carotid sinuses and aortic arch. Activation of the baroreceptors results in a decrease in parasympathetic activity (or vagal tone) and an increase in sympathetic activity, which leads to an increase in plasma renin activity (or renin release).

TMP12 205–207

4.H) Atrial natriuretic peptide (ANP) inhibits renin release (and angiotensin II formation). ANP also inhibits aldosterone production, which leads to an increase in sodium excretion.

TMP12 208

5.D) The rate of net fluid movement across a capillary wall is calculated as capillary filtration coefficient × net filtration pressure. Net filtration pressure = capillary hydrostatic pressure − plasma colloid osmotic pressure + interstitial colloid osmotic pressure − interstitial hydrostatic pressure. Thus, the rate of net fluid movement across the capillary wall is 150 ml/min.

Filtration rate = Capillary filtration coefficient (K_f) × Net filtration pressure

Filtration rate = $K_f \times [Pc - \Pi c + \Pi i - P_I]$

Filtration rate = 10 ml/min/mm Hg × [25 − 25 + 10 − (−5)]

Filtration rate = 10 × 15 = 150 ml/min

TMP12 181–182

6.C) Filtration rate (FR) is the product of the filtration coefficient (Kf) and the net pressure (NP) across the capillary wall. Thus, the filtration coefficient is equal to filtration rate divided by the net pressure. The net pressure for fluid movement across a capillary wall = capillary hydrostatic pressure − plasma colloid osmotic pressure + interstitial colloid osmotic pressure − interstitial hydrostatic pressure. The net pressure in this question calculates to be 15 mm Hg and the filtration is 150. Thus, the Kf is 150/15 or 10 ml/min/mm Hg.

$NP = [Pc - \Pi p + \Pi_I - P_I]$
$NP = [25 - 25 + 10 - (-5)]$
$NP = 15$
$Kf = 150/15 = 10$ ml/min/mm Hg
TMP12 181–182

7.E) Administration of a drug that decreases the diameter of arterioles in a muscle bed increases the vascular resistance. The increased vascular resistance decreases vascular conductance and blood flow. The reduction in arteriolar diameter also leads to a decrease in capillary hydrostatic pressure and capillary filtration rate.
TMP12 163–164, 181–182

8.A) The difference between systolic pressure and diastolic pressure is the pulse pressure. The two major factors that affect pulse pressure are the stroke volume output of the heart and the compliance of the arterial tree. In patients with moderate aortic regurgitation (due to incomplete closure of aortic valve), the blood that is pumped into the aorta immediately flows back into the left ventricle. The backflow of blood into the left ventricle increases stroke volume and systolic pressure. The rapid backflow of blood also results in a decrease in diastolic pressure. Thus, patients with moderate aortic regurgitation have high systolic pressure, low diastolic pressure, and high pulse pressure.
TMP12 168–169

9.E) Angiotensin II is a powerful vasoconstrictor. Angiotensin I is formed by an enzyme (renin) acting on a substrate called angiotensinogen. Angiotensin I is converted to angiotensin II by a converting enzyme. Angiotensin II is a powerful vasoconstrictor and sodium-retaining hormone that increases arterial pressure. Administration of an ACE inhibitor would be expected to decrease angiotensin II formation, total peripheral resistance, and arterial pressure.
TMP12 220–223

10.B) Cognitive stimuli increase cerebral blood flow by decreasing cerebral vascular resistance. The diameter of cerebral vessels is decreased by various metabolic factors in response to cognitive stimuli. Metabolic factors that enhance cerebral blood flow include increases in carbon dioxide, hydrogen ion (decreased pH), and adenosine.
TMP12 191–194

11.A) Stenosis of one kidney results in the release of renin and the formation of angiotensin II from the affected kidney. Angiotensin II stimulates aldosterone production and increases total peripheral resistance by constricting most of the blood vessels in the body.
TMP12 222–224

12.A) Histamine is a vasodilator that is typically released by mast cells and basophils. Infusion of histamine into a brachial artery would decrease arteriolar resistance and increase water permeability of the capillary wall. The decrease in arteriolar resistance would also increase capillary hydrostatic pressure. The increase in capillary hydrostatic pressure and water permeability leads to an increase in capillary filtration rate.
TMP12 163–164, 181–182

13.A) Bradykinin is a vasodilator that is believed to play a role in regulating blood flow and capillary leakage in inflamed tissue. Infusion of bradykinin into the brachial artery would increase arteriolar diameter and decrease arteriolar resistance. The decrease in arteriolar resistance would also result in an increase in capillary hydrostatic pressure and filtration rate. The increase in filtration rate leads to an increase in interstitial hydrostatic pressure and lymph flow.

TMP12 163–164, 181–182, 187–188

14.C) An increase in shear stress in blood vessels is one of the major stimuli for the release of nitric oxide by endothelial cells. Nitric oxide increases blood flow by increasing cyclic guanosine monophosphate.

TMP12 195–196

15.E) Solid tumors are metabolically active tissues that need increased quantities of oxygen and other nutrients. When metabolism in a tissue is increased for a prolonged period, the vascularity of the tissue also increases. One of the important factors that increase growth of new blood vessels is vascular endothelial growth factor (VEGF). Presumably, a deficiency of tissue oxygen or other nutrients, or both, leads to the formation of VEGF.

TMP12 198

16.E) An increase in the diameter of a precapillary arteriole would decrease arteriolar resistance. The decrease in arteriolar resistance would lead to an increase in vascular conductance and capillary blood flow, hydrostatic pressure, and filtration rate.

TMP12 163–164, 181–182

17.D) Blood flow in a vessel is directly proportional to the fourth power of the vessel radius. Increasing vessel diameter by 50% (1.5 times control) would increase blood flow 1.5 to the fourth power × normal blood flow (100 ml/min). Thus, blood flow would increase to 100 ml/min × 5.06, or approximately 500 ml/min.

TMP12 163–164

18.A) In patent ductus arteriosus, a large quantity of the blood pumped into the aorta by the left ventricle immediately flows backward into the pulmonary artery and then into the lung and left atrium. The shunting of blood from the aorta results in a low diastolic pressure, while the increased inflow of blood into the left atrium and ventricle increases stroke volume and systolic pressure. The combined increase in systolic pressure and decrease in diastolic pressure results in an increase in pulse pressure.

TMP12 169

19.A) The net movement of sodium across a capillary wall is directly proportional to the wall permeability to sodium, wall surface area, and concentration gradient across the capillary wall. Thus, increases in permeability to sodium, surface area, and sodium concentration gradient wall would all increase the net movement of sodium across the capillary wall.

TMP12 178–180

20.B) A person with atherosclerosis would be expected to have decreased arterial compliance. The decrease in arterial compliance would lead to an increase in systolic pressure and pulse pressure.

TMP12 168–169

21.B) Constriction of the carotid artery reduces blood pressure at the carotid bifurcation where the arterial baroreceptors are located. The decrease in arterial pressure activates baroreceptors, which in turn leads to an increase in sympathetic activity and a decrease in parasympathetic activity (or vagal tone). The enhanced sympathetic activity results in constriction of peripheral blood vessels including the kidneys. The enhanced sympathetic activity leads to an increase in total peripheral resistance and decrease in renal blood flow. The combination of enhanced sympathetic activity and decreased vagal tone also leads to an increase in heart rate.

TMP12 205–207

22.A) Atrial natriuretic peptide is released from myocytes in the atria in response to increases in atrial pressure.

TMP12 208

23.A) A decrease in the diameter of a precapillary arteriole increases arteriolar resistance while decreasing vascular conductance and capillary blood flow, hydrostatic pressure, filtration rate, interstitial volume, and interstitial hydrostatic pressure.

TMP12 163–164, 181–182

24.C) Excess secretion of aldosterone results in enhanced tubular reabsorption of sodium and secretion of potassium. The increased reabsorption of sodium and water leads to an increase in extracellular fluid volume, which in turn suppresses renin release by the kidney. The increase in potassium secretion leads to a decrease in plasma potassium concentration, or hypokalemia.

TMP12 221–222

25.E) A decrease in tissue oxygen tension is thought to be an important stimulus for vascular endothelial growth factor and the growth of blood vessels in solid tumors.

TMP12 198

26.E) According to Poiseuille's law, flow through a vessel increases in proportion to the fourth power of the radius. A fourfold increase in vessel diameter (or radius) would increase 4 to the fourth power, or 256 times normal. Thus, flow through the vessel after increasing the vessel four times normal would increase from 100 to 25,600 ml/min.

TMP11 163–164

27.H) Constriction of the carotid artery decreases blood pressure at the level of the carotid sinus. A decrease in carotid sinus pressure leads to a decrease in carotid sinus nerve impulses to the vasomotor center, which in turn leads to enhanced sympathetic nervous activity and decreased parasympathetic nerve activity. The increase in sympathetic nerve activity results in peripheral vasoconstriction and an increase in total peripheral resistance.

TMP12 205–208

28.A) The arterial baroreceptors are activated in response to a fall in arterial pressure. During hemorrhage, the fall in arterial pressure at the level of the baroreceptors results in enhanced sympathetic outflow from the vasomotor center and a decrease in parasympathetic nerve activity. The increase in sympathetic nerve activity leads to constriction of peripheral blood vessels, increased total peripheral resistance, and a return of blood pressure toward normal. The decrease in parasympathetic nerve activity

and sympathetic outflow would result in an increase in heart rate.
TMP12 205–208

29.C) Vascular resistance = arterial pressure − venous pressure ÷ blood flow. In this example, arterial pressure is 130 mm Hg, venous pressure is 5 mm Hg, and blood flow is 250 ml/min. Thus, vascular resistance = 125 ÷ 250, or 0.50 mm Hg/ml/min.
TMP12 162–163

30.A) Activation of the baroreceptors leads to an increase in sympathetic activity, which in turn increases heart rate, strength of cardiac contraction, and constriction of arterioles and veins. The increase in venous constriction results in an increase in mean circulatory filling pressure, venous return, and cardiac output.
TMP12 205–208

31.E) Pulse pressure is the difference between systolic pressure and diastolic pressure. The two major factors that affect pulse pressure are the stroke volume output of the heart and the compliance of the arterial tree. An increase in stroke volume increases systolic and pulse pressure, while an increase in compliance of the arterial tree decreases pulse pressure. Moderate aortic valve stenosis results in a decrease in stroke volume, which leads to a decrease in systolic pressure and pulse pressure.
TMP12 168–169

32.G) When blood pressure falls below 80 mm Hg, carotid and aortic chemoreceptors are activated to elicit a neural reflex to minimize the fall in blood pressure. The chemoreceptors are chemosensitive cells that are sensitive to oxygen lack, carbon dioxide excess, or hydrogen ion excess (or fall in pH). The signals transmitted from the chemoreceptors into the vasomotor center excite the vasomotor center to increase arterial pressure.
TMP12 208

33.E) The two main factors that increase lymph flow are an increase in capillary filtration rate and an increase in lymphatic pump activity. An increase in plasma colloid osmotic pressure decreases capillary filtration rate, interstitial volume and hydrostatic pressure, and lymph flow. In contrast, an increase in hydraulic conductivity of the capillary wall and capillary hydrostatic pressure increase capillary filtration rate, interstitial volume and pressure, and lymph flow. An increase arteriole resistance would decrease capillary hydrostatic pressure, capillary filtration rate, interstitial volume and pressure, and lymph flow.
TMP12 181–187

34.D) Although sympathetic nerves, angiotensin II, and vasopressin are powerful vasoconstrictors, blood flow to skeletal muscles under normal physiological conditions is mainly determined by local metabolic needs.
TMP12 194–196

35.C) Those molecules or ions that fail to pass through the pores of the capillary wall exert osmotic pressure. The capillary wall is highly permeable to sodium chloride, glucose, cholesterol, and potassium but relatively impermeable to albumin. Thus, albumin in the plasma is the major contributor to plasma colloid osmotic pressure.
TMP12 184

36.E) During exercise, tissue levels of carbon dioxide and lactic acid increase. These metabolites dilate blood vessels, decrease arteriolar resistance, and enhance vascular conductance and blood flow.
TMP12 194–195

37.D) The flow in a vessel is directly proportional to the pressure gradient across the vessel and to the fourth power of the radius of the vessel. In contrast, blood flow is inversely proportional to the viscosity of the blood. Because blood flow is proportional to the fourth power of the vessel radius, the vessel with the largest radius (vessel D) would have the greatest flow.
TMP12 163

38.A) Resistance of a vessel = pressure gradient ÷ blood flow of the vessel. In this example, vessel A has the highest vascular resistance (100 mm Hg/1000 ml/min, or 0.1 mm Hg/ml/min).
TMP12 162–163

39.C) The transport of oxygen across a capillary wall is proportional to the capillary surface area, capillary wall permeability to oxygen, and oxygen gradient across the capillary wall. Thus, a twofold increase in the oxygen concentration gradient would result in the greatest increase in the transport of oxygen across the capillary wall. A twofold increase in intercellular clefts in the capillary wall would not significantly impact oxygen transport, because oxygen can permeate the endothelial cell wall.
TMP12 179–180

40.C) The capillaries have the largest total cross-sectional area of all vessels of the circulatory system. The venules also have a relatively large total cross-sectional area, but not as great as the capillaries, which explains the large storage of blood in the venous system compared with that in the arterial system.
TMP12 160–161

41.C) The percentage of total blood volume in the veins is approximately 64%.
TMP12 157

42.D) The rate of blood flow is directly proportional to the fourth power of the vessel radius and to the pressure gradient across the vessel. In contrast, the rate of blood flow is inversely proportional to the viscosity of the blood. Thus, an increase in blood viscosity would decrease blood flow in a vessel.
TMP12 163–164

43.A) The velocity of blood flow within each segment of the circulatory system is inversely proportional to the total cross-sectional area of the segment. Because the aorta has the smallest total cross-sectional area of all circulatory segments, it has the highest velocity of blood flow.
TMP12 161–162

44.C) The difference between systolic pressure and diastolic pressure is called the pulse pressure. The two main factors that affect pulse pressure are stroke volume and arterial compliance. Pulse pressure is directly proportional to the stroke volume and inversely proportional to the arterial compliance. Thus, a decrease in arterial compliance would tend to increase pulse pressure.
TMP11 168–169

45.B) An increase in plasma colloid osmotic pressure would reduce net filtration pressure and capillary filtration rate. Increases in capillary hydrostatic pressure and interstitial colloid osmotic pressure would also favor capillary filtration. An increase in venous hydrostatic pressure and arteriolar diameter would tend to increase capillary hydrostatic pressure and capillary filtration rate.

TMP12 181–185

46.A) An increase in capillary wall permeability to water would increase capillary filtration rate, whereas increases in arteriolar resistance, plasma colloid osmotic pressure, and interstitial hydrostatic pressure would all decrease filtration rate. Plasma sodium concentration would have no effect on filtration.

TMP12 181–186

47.C) The rate of lymph flow increases in proportion to the interstitial hydrostatic pressure and the lymphatic pump activity. A decrease in plasma colloid osmotic pressure would increase filtration rate, interstitial volume, interstitial hydrostatic pressure, and lymph flow. A decrease in arteriolar diameter would decrease capillary hydrostatic pressure, capillary filtration, and lymph flow.

TMP12 181–188

48.E) The brain has tight junctions between capillary endothelial cells that allow only extremely small molecules such as water, oxygen, and carbon dioxide to pass in or out of the brain tissues.

TMP12 178

49.B) The factors that determine the net movement of glucose across a capillary wall include the wall permeability to glucose, the glucose concentration gradient across the wall, and the capillary wall surface area. Thus, an increase in the concentration difference of glucose across the wall would enhance the net movement of glucose.

TMP12 179–180

50.E) An increase in atrial pressure of 10 mm Hg would tend to decrease venous return to the heart and increase vena cava hydrostatic pressure. Plasma colloid osmotic pressure, interstitial colloid osmotic pressure, arterial pressure, and cardiac output would generally be low to normal in this patient.

TMP12 172–173

51.C) The vascular compliance is proportional to the vascular distensibility and vascular volume of any given segment of the circulation. The compliance of a systemic vein is 24 times that of its corresponding artery because it is about 8 times as distensible and it has a volume about 3 times as great.

TMP12 167

52.B) Filtration coefficient (K_f) = filtration rate ÷ net filtration pressure. Net filtration pressure = capillary hydrostatic pressure − plasma colloid osmotic pressure + interstitial colloid osmotic pressure − interstitial hydrostatic pressure. The net filtration pressure in this example is 10 mm Hg. Thus, K_f = 150 ml/min ÷ 10 mm Hg, or 15 ml/min/mm Hg.

TMP12 181–186

53.B) Moving from a supine to a standing position results in pooling of blood in the lower extremities and a fall in blood pressure. The pooling of blood in the legs increases venous hydrostatic pressure. The fall in arterial pressure activates the arterial baroreceptors, which in turn increases sympathetic nerve activity and decreases parasympathetic nerve activity. The increase in sympathetic activity constricts renal vessels and reduces renal blood flow. The heart rate also increases.

TMP12 205–207

54.D) Reduction in perfusion pressure to a tissue leads to a decrease in tissue oxygen concentration and an increase in tissue carbon dioxide concentration. Both events lead to an increase in arteriolar diameter, decreased vascular resistance, and increased vascular conductance.

TMP12 194–196

55.D) The largest portion of the arterial pressure is at the site of greatest vascular resistance, which is the arteriolar–capillary juncture.

TMP12 158

56.D) The tendency for turbulent flow occurs at vascular sites where the velocity of blood flow is high. The aorta has the highest velocity of blood flow.

TMP12 161–162

57.C) An increase in perfusion pressure to a tissue results in excessive delivery of nutrients such as oxygen to a tissue. The increase in tissue oxygen concentration constricts arterioles and returns blood flow and nutrient delivery toward normal levels.

TMP12 194–195

58.C) Interstitial hydrostatic pressure in a muscle capillary bed is normally negative (−3 mm Hg). Pumping by the lymphatic system is the basic cause of the negative pressure.

TMP12 183–184

59.C) Movement of the leg muscles causes blood to flow toward the vena cava, which reduces venous hydrostatic pressure. An increase in right atrial pressure would decrease venous return and increase venous hydrostatic pressure. Pregnancy and the presence of ascitic fluid in the abdomen would tend to compress the vena cava and increase venous hydrostatic pressure in the legs.

TMP12 172–173

60.D) The primary mechanism whereby solutes move across a capillary wall is simple diffusion.

TMP12 179

61.D) Because oxygen is lipid soluble and can cross the capillary wall with ease, it has the fastest rate of movement across the capillary wall.

TMP12 179

62.C) An increase in renal arterial pressure results in pressure natriuresis and diuresis. The loss of sodium and water tends to decrease extracellular fluid volume. Glomerular filtration rate would be normal or slightly increased in response to an increase in renal artery pressure.

TMP12 213–215

63.C) Nitric oxide and prostacyclin are potent vasodilator and natriuretic substances. In addition, atrial natriuretic peptide is natriuretic and antihypertensive. In contrast, angiotensin II is a powerful vasoconstrictor, antinatriuretic, and hypertensive hormone.

TMP12 195–196

64.A) An increase in sodium intake would result in an increase in sodium excretion to maintain sodium balance. Angiotensin II decreases in response to a chronic elevation in sodium intake while nitric oxide and atrial natriuretic peptide increase.

TMP12 217–222

65.D) Constriction of the renal artery increases renin release, angiotensin II formation, and arterial pressure. Sodium excretion decreases, but only transiently, because as arterial pressure increases, sodium excretion returns to normal levels via a pressure natriuresis mechanism.

TMP12 223–225

66.D) An increase in atrial pressure causes an increase in heart rate by a nervous reflex called the Bainbridge reflex. The stretch receptors of the atria that elicit the Bainbridge reflex transmit their afferent signals through the vagus nerves to the medulla of the brain. The efferent signals are transmitted back via vagal and sympathetic nerves to increase the heart rate. An increase in atrial pressure would also increase plasma levels of atrial natriuretic peptide, which in turn would decrease plasma levels of angiotensin II and aldosterone.

TMP12 208–209

67.D) The Cushing reaction is a special type of central nervous system (CNS) ischemic response that results from increased pressure of the cerebrospinal fluid around the brain in the cranial vault. When the cerebrospinal fluid pressure rises, it decreases the blood supply to the brain and elicits a CNS ischemic response. The CNS ischemic response includes enhanced sympathetic activity; decreased parasympathetic activity; and increased heart rate, arterial pressure, and total peripheral resistance.

TMP12 209–210

68.E) The conversion of angiotensin I to angiotensin II is catalyzed by a converting enzyme that is present in the endothelium of the lung vessels and in the kidneys. The converting enzyme also serves as a kininase that degrades bradykinin. Thus, a converting enzyme inhibitor not only decreases the formation of angiotensin II but also inhibits kininases and the breakdown of bradykinin.

TMP12 220

69.E) Total peripheral vascular resistance = arterial pressure − right atrial pressure ÷ cardiac output. In this example, total peripheral vascular resistance = 130 mm Hg ÷ 3.5 L/min, or approximately 37 mm Hg/L/min.

TMP12 162-163

70.C) The formula for resistance to venous return is mean systemic filling pressure − right atrial pressure/cardiac output. In this example the mean systemic filling pressure is 7 mm Hg and the right atrial pressure is 0 mm Hg. The cardiac output is 5 L/min. Using these values in the previous formula indicates that the resistance to venous return is 1.4 mm Hg/L/min. Note that this formula only applies to the linear portion of the venous return curve.

TMP12 238–239

71.A) During increases in sympathetic output to maximal values, several changes occur. First, the mean systemic filling pressure increases markedly, but at the same time the resistance to venous return increases. Venous return is determined by the formula: mean systemic filling pressure – right atrial pressure/resistance to venous return. During maximal sympathetic output, the increase in systemic filling pressure is greater than the increase in resistance to venous return. Therefore, in this formula the numerator has a much greater increase than the denominator. This results in an increase in the venous return.

TMP12 238–239

72.C) This problem concerns the Fick principle for determining cardiac output. The formula for cardiac output is oxygen absorbed per minute by the lungs divided by the arterial-venous oxygen difference. In this problem, oxygen consumption of the body is 240 ml/min, and in a steady-state condition this would exactly equal the oxygen absorbed by the lungs. Therefore, by inserting these values into the equation we see that the cardiac output will equal 12 L/min.

TMP12 240

73.D) The normal intrapleural pressure is -4 mm Hg. When the thorax is surgically opened, all pressures inside the chest will immediately have a value of 0 mm Hg, which is the atmospheric pressure. This increased pressure in the chest tends to collapse the atria and decreases the transmural pressure across each of the atria. In particular, the right atrial transmural pressure gradient decreases about 4 mm Hg. Therefore, the cardiac output curve will shift to the right by 4 mm Hg.

TMP12 234

74.C) Several factors can cause the cardiac output to shift to the right or to the left. These factors include surgically opening the chest, which makes the cardiac output curve shift 4 mm Hg to the right, and severe cardiac tamponade, which increases the pressure inside the pericardium, thus tending to collapse the heart, particularly the atria. Playing a trumpet or positive pressure breathing tremendously increases the interpleural pressure, thus collapsing the atria and shifting the cardiac output curve to the right. Breathing against a negative pressure will shift the cardiac output curve to the left.

TMP12 234

75.E) The plateau level of the cardiac output curve, which is one measure of cardiac contractility, decreases in several circumstances. Some of these include severe cardiac tamponade that increases the pressure in the pericardial space and increasing parasympathetic stimulation of the heart. Increased sympathetic stimulation of the heart increases the level of the cardiac output curve by increasing heart rate and contractility.

TMP12 231

76.D) Several factors can cause the cardiac output to shift to the right or to the left. These factors include surgically opening the chest, which makes the cardiac output curve shift 4 mm Hg to the right, and severe cardiac tamponade, which increases the pressure inside the pericardium, thus tending to collapse the heart, particularly the atria. Playing a trumpet or positive pressure breathing including being on a mechanical ventilator tremendously increases the interpleural pressure, thus collapsing the atria and shifting the cardiac output curve to the right.

TMP12 234

77.D) Mean systemic filling pressure is a measure of the tightness of fit of the blood in the circulation.

Mean systemic filling pressure is increased by factors which increase blood volume and by factors that decrease the vascular compliance. Therefore, a decreased venous compliance, not an increased compliance, would cause an increase in mean systemic filling pressure. Norepinephrine administration and sympathetic stimulation cause arteriolar vasoconstriction and decreased vascular compliance resulting in an increase in mean systemic filling pressure. Increased blood volume and skeletal muscle contraction, which cause a contraction of the vasculature, also increase this filling pressure.

TMP12 236

78.E) Venous return of the heart is equal to the mean systemic filling pressure minus the right atrial pressure divided by the resistance to venous return. Therefore, decreased mean systemic filling pressure will decrease the venous return to the heart. Factors that will decrease the systemic filling pressure include large vein dilation, decreased sympathetic tone, increased venous compliance and increased blood volume.

TMP12 236–237

79.B) The resistance to venous return is the inverse of the slope of the linear portion of the venous return curve. Therefore, the curve with the lowest slope will have the highest resistance to venous return.

TMP12 238

80.D) Decreased cardiac output can result from a weakened heart or from a decrease in venous return. Increased venous compliance decreases the venous return of blood to the heart. Cardiac tamponade, surgically opening the chest and severe aortic stenosis will effectively weaken the heart and thus decrease cardiac output. Moderate anemia will cause an arteriolar vasodilation, which increases venous return of blood back to the heart thus increasing cardiac output.

TMP12 239

81.E) Cardiac output increases in several conditions because of increased venous return. Cardiac output increases in hyperthyroidism because of the increased oxygen use by the peripheral tissues resulting in arteriolar vasodilation and thus increased venous return. Beriberi causes increased cardiac output because a lack of the vitamin thiamine results in peripheral vasodilation. A-V fistulae also cause a decreased resistance to venous return thus increasing cardiac output. Anemia, because of the decreased oxygen delivery to the tissues, causes an increase in venous return to the heart and thus an increase in cardiac output. Cardiac output decreases in patients with myocardial infarction.

TMP12 232–233

82.B) During exercise there is very little change in cerebral blood flow and coronary blood flow increases. Because of the increased sympathetic output, mean systemic filling pressure increases and the veins constrict. During exercise there is also a decrease in parasympathetic impulses to the heart.

TMP12 238–239

83.C) The plateau level of the cardiac output curve, which is one measure of cardiac contractility, decreases in several circumstances. Some of these include myocarditis, severe cardiac tamponade that increases the pressure in the pericardial space, myocardial infarction and various valvular diseases such as mitral stenosis. Decreased parasympathetic stimulation of the heart actually moderately increases the level of the cardiac output curve by increasing heart rate.

TMP12 231

84.A) During increases in sympathetic output the main two organs to maintain their blood flow are the brain and the heart. During exercise for 1 hour, the intestinal flow decreases significantly as will the renal and pancreatic blood flows. The skeletal muscle blood flow to non-exercising muscles also decreases at this time. Therefore, the cerebral blood flow remains close to its control value.

TMP12 244

85.B) There are several factors that decrease the risk of adverse cardiac events, including decreased blood levels of LDL, female gender, moderate hypotension, and decreased blood triglycerides. Decreased blood levels of HDL will increase cardiac risks, since HDL is a protective cholesterol.

TMP12 248–249

86.A) Bradykinin, prostaglandins, carbon dioxide, and potassium ions serve as vasodilators for the coronary artery system. However, the major controller of coronary blood flow is adenosine. Adenosine is formed as ATP degrades to adenosine monophosphate. Then, small portions of the adenosine monophosphate are further degraded to release adenosine into the tissue fluids of the heart muscle, and this adenosine vasodilates the coronary arteries.

TMP12 247

87.E) An acute loss of blood supply to a cardiac muscle causes depletion of potassium from the cardiac myocytes. This locally increases the extracellular potassium concentration. In turn, this increases the irritability of the cardiac musculature and therefore its likelihood for fibrillating. Therefore, a decreased potassium ion concentration in the extracellular fluids of the heart does not lead to fibrillation. Powerful sympathetic and not parasympathetic reflexes also increase the irritability of the cardiac muscle and predispose it to fibrillation. A more negative membrane potential protects the heart from fibrillation, and a current of injury allows electrical current flow from an ischemic area of the heart to a normal area and can elicit fibrillation.

TMP12 250–251

88.C) The normal resting coronary blood flow is approximately 225 ml/min. Infusion of adenosine or local release of adenosine normally increases the coronary blood flow. The contraction of the cardiac muscle around the vasculature, particularly in the subendocardial vessels, causes a decrease in blood flow. Therefore, during the systolic phase of the cardiac cycle the subendocardial flow clearly decreases while the decrease in epicardial flow is relatively minor.

TMP12 247

89.D) There are several factors that cause arteriolar vasodilation during exercise including increases in potassium ion concentration, plasma nitric oxide concentration, plasma adenosine concentration and plasma osmolality. Although histamine causes arteriolar vasodilation, histamine release does not normally occur during exercise.

TMP12 243

90.D) The vascular beds that are spared from vasoconstriction due to increased sympathetic output during exercise include the cerebral and coronary vascular beds. In exercising muscle the metabolic vasodilatory response overcomes the sympathetic nervous system resulting in vasodilation. In the skin vasculature, vasoconstriction occurs only at the beginning of exercise, and when the body heats up, the skin arterioles dilate. The intestinal vasculature significantly constricts during long-term exercise.

TMP12 244

91.B) The anterior cardiac veins and the thebesian veins both drain venous blood from the heart. However, 75% of the total coronary flow drains from the heart by the coronary sinus.
TMP12 246

92.E) Several drugs have proven to be helpful to patients with myocardial ischemia. Beta receptor blockers (not stimulators) inhibit the sympathetic effects on the heart and are very helpful. Angiotensin converting enzyme inhibition prevents the production of angiotensin II and thus decreases the afterload effect on the heart. Nitroglycerin causes nitric oxide release resulting in coronary vasodilation. Isometric exercise increases blood pressure markedly and can be harmful, and increased dietary calcium would be of little benefit.
TMP12 252

93.C) During exercise the sympathetic output increases markedly which causes arteriolar constriction in many places of the body including non-exercising muscle. The increased sympathetic output also causes venoconstriction throughout the body. During exercise there also is an increased release of norepinephrine and epinephrine by the adrenal glands.
TMP12 244–245

94.B) Several factors contribute to decreased coronary flow in patients with ischemic heart disease. Some patients will have spasm of the coronary arteries which acutely decreases coronary flow. However, the major cause of decreased coronary flow is an atherosclerotic narrowing of the lumen of the coronary arteries.
TMP12 248

95.E) There are a several acceptable treatments for patients with myocardial ischemia. Many patients take a daily dose of aspirin to prevent coronary thrombosis. Angioplasty with placement of stents or coronary by-pass surgery effectively increases the coronary blood flow. Lowering of blood pressure, angiotensin converting enzyme inhibitors, or beta receptor blockade are also effective treatments. However, beta receptor stimulation or exercise would be detrimental to a patient with ischemia.
TMP12 252–253

96.C) In a patient with myocardial ischemia, factors which increase stress on the heart must be minimized. This can be done with the use of beta sympathetic blockers, which inhibit the effects of excess sympathetic output on the heart. It is also important to maintain a normal body weight and a normal arterial pressure, which prevent excess stress on the heart. And in conditions of acute myocardial ischemia, nitroglycerin can be taken. Isometric exercise should be avoided because of the large increase in arterial pressure that occurs.
TMP12 252

97.C) The major causes of death after myocardial infarction include a decrease in cardiac output that prevents tissues of the body from receiving adequate nutrition and oxygen delivery and prevents removal of waste materials. Other causes of death are pulmonary edema, which reduces the oxygenation of the blood, fibrillation of the heart, and rupture of the heart. Cardiac contractility decreases after a myocardial infarction.

TMP12 250

98.E) During sympathetic stimulation venous reservoirs constrict, venous vascular resistance also increases, arterioles constrict which increases their resistance, and heart rate increases. The epicardial coronary vessels have a large number of alpha receptors but the subendocardial vessels have more beta receptors. Therefore, sympathetic stimulation causes at least a slight constriction of the epicardial vessels. This results in a slight decrease in epicardial flow.

TMP12 244–245, 247

99.E) Several factors change during compensated heart failure to stabilize the circulatory system. Because of increased sympathetic output the heart rate increases during compensated heart failure. The kidneys retain sodium and water which increases blood volume and thus right atrial pressure. The increased blood volume that results causes an increase in mean systemic filling pressure, which will help to increase the cardiac output. Dyspnea usually will occur only in the early stages of compensated failure.

TMP12 255–256

100.C) In acute right heart failure the kidneys retain sodium and water, and the systemic but not the pulmonary veins become congested. Therefore, mean pulmonary filling pressure and left atrial pressure do not increase, but right atrial pressure increases and edema of the lower extremities including the feet and ankles occurs.

TMP12 259

101.E) In compensated heart failure the sympathetic output increases. One of the results is a sympathetic vasoconstriction of the afferent arterioles of the kidney. This decreases the glomerular hydrostatic pressure and thus the glomerular filtration rate, resulting in an increase in sodium and water retention in the body. An increased release of angiotensin II also occurs which causes direct renal sodium retention and also stimulates aldosterone secretion which will, in turn, cause further increases in sodium retention in the kidney. The excess sodium in the body will increase osmolality and this increases the release of antidiuretic hormone which causes renal water retention.

TMP12 260

102.C) During acute pulmonary edema, the increased fluid in the lungs diminishes the O_2 content in the blood. This decreased oxygen weakens the heart even further and also causes arteriolar dilation in the body. This results in increases in venous return of blood to the heart which cause further leakage of the fluid in the lungs and further decreases in oxygen content in the blood. It is important to interrupt this vicious circle to save a patient's life. This can be done by placing tourniquets on all four limbs which effectively removes blood volume from the chest. The patient can also breathe oxygen and you can give a bronchodilator. Furosemide can be given to reduce some of the fluid volume in the body and especially in the lungs. One thing that you do not want to do is infuse whole blood or an electrolyte solution in this patient as it may exacerbate the pulmonary edema that is already present.

TMP12 261

103.D) Cardiogenic shock results from a weakening of the cardiac muscle many times following coronary thrombosis. This can result in a vicious circle because of low cardiac output resulting in a low diastolic pressure. This causes a decrease in coronary flow which decreases the cardiac strength even more. Therefore, arterial pressure, particularly diastolic pressure, must be increased in patients with