Directions: Select the one best answer and fill in the space below the corresponding letter on the answer sheet.

Cardiac Physiology Questions

1. Which of the following would most likely increase force development in cardiac muscle?
   - A) A calcium channel blocker
   - B) Lowering of intracellular calcium
   - C) Elevating extracellular calcium
   - D) Increasing the sodium gradient across the sarcolemmal membrane
   - E) Inhibition of calcium binding to troponin C

2. Which of the following is false?
   - A) The directional flow of blood through the heart is maintained by valves that open and close passively in response to pressure gradients.
   - B) The mitral valve opens at the beginning of ventricular isovolumic contraction.
   - C) The aortic valve closes at the beginning of ventricular isovolumic relaxation.
   - D) During the normal cardiac cycle, the aortic valve is closed for a greater length of time than it is open.
   - E) Cardiac output per square meter of body surface area equals the cardiac index.

Use the following list for questions 3-6 (answers may be used once, more than once, or not at all):

   A) End diastolic volume (EDV) only
   B) End systolic volume (ESV) only
   C) Both EDV and ESV
   D) Neither EDV or ESV

3. Norepinephrine increases stroke volume (when supported by an increase in venous return) by lowering ___.

4. Increasing venous return during moderate exercise (with no change in contractility) results in an increase in stroke volume by increasing ___.

5. Elevated arterial blood pressure (with no change in contractility) tends to reduce stroke volume by increasing ___.

6. Changes in stroke volume are affected by changes in ___

7. The minute work (or power) of the heart is enhanced by increases in all of the following except:
   - A) arterial blood pressure
   - B) heart rate
   - C) stroke volume
   - D) end diastolic volume
   - E) end systolic volume
8. During a normal pressure-volume loop for a single ventricular contraction the
   A) filling and ejection phases represent isotonic changes in sarcomere length
   B) pressure is greater at the onset of systole than when the aortic valve opens
   C) mitral valve opens at the end of isovolumetric contraction
   D) aortic valve opens as pressure falls during the ejection phase
   E) pressure is highest when the atria are contracting

9. The curve depicting the relationship between venous return and central venous pressure is shifted downward and to the left when
   A) blood volume is increased
   B) sympathetic stimulation of venous smooth muscle tone is increased
   C) plasma is transfused into the venous compartment
   D) significant blood is lost due to hemorrhage
   E) All of the above are correct

10. In a resting person the aortic oxygen content was 0.22 ml oxygen/ml blood and that in blood returning to the lungs was 0.18 ml oxygen/ml blood. If cardiac output was 5.875 L/min, oxygen consumption was (in ml oxygen/min)
    A) 532
    B) 250
    C) 235
    D) 1,233
    E) 146.875

11. If cardiac output is 5.0 L/min, left atrial pressure is 4 mmHg and pulmonary vascular resistance is 2.0 mmHg L⁻¹ min⁻¹, what is pulmonary artery pressure (in mmHg)?
    A) 15
    B) 24
    C) 14
    D) 1.4
    E) 1.5

12. In the normal cardiac cycle, peak ventricular pressure during systole corresponds to
    A) the P wave of the ECG
    B) the end systolic volume of the left ventricle
    C) closure of the aortic valve
    D) the end diastolic volume of the left ventricle
    E) a period when the aortic valve is open and the mitral valve is closed

13. Pulmonary “capillary wedge pressure”
    A) is obtained from a catheter advanced from the right ventricle into the coronary sinus
    B) reflects the afterload faced by the left ventricle
    C) reflects the right atrial pressure
    D) during diastole when the mitral valve is open, reflects the left ventricular afterload
    E) when elevated will cause fluid to move from the pulmonary vascular space to the lung interstitium
14. In an experimental setting, a catheter containing a pressure transducer was introduced into a peripheral vessel and advanced into the heart of a normal individual. Resting blood pressures were obtained over several cardiac cycles and averaged 18 mmHg during systole and 1 mmHg during diastole. Which of the following most likely describes the series of events that would explain this observation? The catheter was

A) advanced through the right atrium, past the tricuspid valve and into the right ventricle
B) advanced through the aorta, past the aortic valve and into the left ventricle
C) advanced through the aorta, past the aortic valve, into the left ventricle, past the mitral valve and into the left atrium
D) advanced through the right atrium, past the mitral valve, into the right ventricle, through the pulmonic valve and into the pulmonary artery
E) in the right atrium

15. Coronary blood flow to the left ventricle

A) always equals coronary flow to the right ventricle at steady state
B) is maximal during the c wave of the venous pulse tracing
C) is inversely related to myocardial oxygen consumption
D) at rest is about 25% of the total cardiac output
E) must increase to supply more oxygen when needed because oxygen delivery to the myocardium is flow limited

Use the following data to answer question 16; the data were obtained from a patient suspected to have heart disease.

**Pressures (P):**
- Pulmonary artery mean P = 36 mmHg
- Pulmonary capillary wedge P = 30 mmHg
- Aortic mean P = 104 mmHg
- Right atrial mean P = 6 mmHg

- Heart rate = 100 beats/min
- Oxygen consumption = 200 ml oxygen/min
- Pulmonary artery oxygen content = 15 ml oxygen/100 ml blood
- Aortic oxygen content = 20 ml oxygen/100 ml blood

**Angiographic volumes:**
- End diastolic volume = 200 ml
- End systolic volume = 100 ml

16. Based on these data, which of the following statements is **correct**?

A) The forward stroke volume (into the aorta) is 100 ml
B) The ejection fraction is 0.6
C) The patient is likely suffering from aortic stenosis
D) Pulmonary vascular resistance is 1.5 mmHg lit⁻¹ min⁻¹
E) None of the above is correct

17. Which of the following conditions would be expected in congestive heart failure of the left ventricle?

A) A decrease in the inulin space
B) A lowered ejection fraction of the left ventricle
C) A decrease in the pulmonary wedge pressure
D) An increased dP/dT
E) None of the above would be expected

**Circulatory Physiology Questions**
18. Which of the following statements about the circulation is true? Resistance to blood flow

A) can be determined from blood pressure measurements alone
B) of several resistances in series is equal to the sum of the reciprocals of each of the individual resistances
C) of the large veins usually represents less than 10% of the total systemic peripheral resistance
D) is usually expressed in L/min/mmHg
E) of the pulmonary circulation is about equivalent to that of the systemic circulation

19. Which of the following statement is true? Arterial compliance

A) is equal to the systolic pressure minus the diastolic pressure
B) is equal to the change in pressure divided by the change in volume
C) is the primary determinant of cardiac output
D) is the primary determinant of peripheral resistance
E) tends to decrease with age

20. Which of the following conditions is NOT usually associated with an increase in cardiac output?

A) Beriberi
B) Arterio-venous shunt
C) Hypothyroidism
D) Exercise
E) Pregnancy

Use the following data obtained from a patient before and after a therapy to answer question 21.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Arterial Pressure (mmHg)</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td>Cardiac Output (liters/min)</td>
<td>4.2</td>
<td>6</td>
</tr>
<tr>
<td>Heart Rate (beats/min)</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>End-Diastolic Volume (ml)</td>
<td>140</td>
<td>160</td>
</tr>
</tbody>
</table>

21. Which of the following statements about these data is (are) true? The therapy produced:

A) a decreased left ventricular stroke volume
B) an increase in ejection fraction
C) a decrease in total systemic peripheral resistance.
D) an increase in end systolic volume
E) both A and B are correct
F) both C and D are correct

22. Which of the following statements regarding cardiovascular function is true?

A) Veins are able to store large amounts of blood because of their low compliance
B) Capillaries are efficient sites for exchange because of high flow velocity through them.
C) Arterioles are able to efficiently regulate their resistance to flow because of their small wall thickness to internal diameter (WT,ID) ratio
D) Wall tension in capillaries is low due to their small radius.
E) If aortic compliance increases, pulse pressure will also increase.
23. Which of the following is **not** involved in autoregulation of blood flow?

   A) Nitric oxide  
   B) Adenosine  
   C) Stretch sensitive ion channels  
   D) Vasopressin  
   E) H⁺ ions

24. Which of the following would **decrease** net capillary ultrafiltration?

   A) An increase in interstitial protein concentration  
   B) Water deprivation  
   C) Arteriolar dilation  
   D) An increase in the capillary filtration coefficient (Kᵢ)  
   E) An increase in venous pressure

**Use the following two blood pressure tracings to answer question 25.**

![A](image1.png) ![B](image2.png)

25. The changes in arterial pressures depicted in the left (A) and right (B) panel, respectively, could result from which of the following treatments?

   A) Norepinephrine and phenylephrine  
   B) Phenylephrine and norepinephrine  
   C) Norepinephrine and epinephrine  
   D) Epinephrine and norepinephrine  
   E) Phenylephrine and epinephrine  
   F) Epinephrine and phenylephrine

26. A person standing quietly begins to run. After 10 minutes, which of the following will **not** have occurred?

   A) A decrease in cardiac parasympathetic tone  
   B) A decrease in the arterial O₂ – mixed venous O₂ difference  
   C) An increase in oxygen consumption  
   D) An increase heart rate  
   E) A decrease in total peripheral resistance
Use the following graph illustrating autoregulation of blood flow to answer question 27.

![Graph illustrating autoregulation of blood flow](image)

27. Which of the following statements regarding this graph is true?

A) Segment A-B represents an autoregulatory region
B) B represents the area of maximal vasodilation
C) Segment B-C is outside the autoregulatory region
D) C represents the area of maximal vasodilation
E) D represents the area of minimal vasoconstriction

28. A patient responds to a drug with a decrease in total peripheral resistance and an increase in mean arterial pressure. Which of the following best describes the mode of action of the drug? Most likely it produced a

A) vasoconstriction and an increase in cardiac output
B) vasoconstriction and a decrease in cardiac output
C) vasodilation and an increase in cardiac output
D) vasodilation and a decrease in cardiac output
E) decrease in venous return to the heart

Use the following figure to answer question 29.

![Figure illustrating blood flow](image)

29. In the normal situation, which of the following relationships concerning this figure is (are) true?

A) \( P_{\text{transmural}} \), exerted on the wall, is the difference between \( P_{\text{in}} \) and \( P_{\text{out}} \)
B) Wall tension is inversely related to vessel radius and directly related to pressure
C) Thickening of the vessel wall will decrease the wall tension
D) A and B are correct
E) A and C are correct
F) A, B and C are correct
30. The direct effect of stimulation of alpha receptors is (are)

A) increase in heart rate  
B) vasoconstriction in skeletal muscle  
C) increase in cardiac contractility  
D) A, B and C are correct  
E) None of the above is correct

31. Which of the following statements regarding angiotensin II is false? Angiotensin II

A) stimulates the release of antidiuretic hormone  
B) stimulates renin release  
C) stimulates thirst  
D) is a powerful vasoconstrictor  
E) stimulates aldosterone synthesis

32. The carotid sinus baroreceptors

A) are more sensitive to falling pressure than to constant or rising pressure  
B) respond to increased arterial pressure by a decreased rate of firing  
C) serve to decrease parasympathetic tone when their firing rate increases  
D) A, B and C are correct  
E) None of the above are correct

33. Use the following values that were recorded during an experiment to answer question 33.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>capillary hydrostatic pressure</td>
<td>25 mmHg</td>
</tr>
<tr>
<td>capillary oncotic pressure</td>
<td>30 mmHg</td>
</tr>
<tr>
<td>interstitial hydrostatic pressure</td>
<td>3 mmHg</td>
</tr>
<tr>
<td>interstitial oncotic pressure</td>
<td>10 mmHg</td>
</tr>
</tbody>
</table>

33. The net forces favor

A) filtration by 2 mmHg  
B) reabsorption by 2 mmHg  
C) filtration by 12 mmHg  
D) reabsorption by 12 mmHg  
E) filtration by 42 mmHg

34. Use these abbreviations to answer question 34: \( P_c \) = mean capillary hydrostatic pressure; \( \pi_c \) = mean capillary oncotic pressure; \( P_i \) = mean interstitial hydrostatic pressure; and \( \pi_i \) = mean interstitial oncotic pressure.

34. In the lung, which of the following is most responsible for preventing pulmonary edema?

A) \( P_c > P_i \)  
B) \( P_c < \pi_c \)  
C) \( P_c > \pi_i \)  
D) \( \pi_c < \pi_i \)  
E) None of the above

35. Which of the following will not occur as a result of a sustained increase right atrial pressure?

A) An increase in circulating levels of atrial natriuretic peptide  
B) An increase in right ventricular end diastolic volume  
C) An increase in renal sodium excretion  
D) An increase in sympathetic nerve activity  
E) All of these events will occur
36. Which one of the following sequences is the most likely series of events leading to essential hypertension?

A) Inappropriate renal salt and water reabsorption → increased blood volume → increased venous return → increased cardiac output → increased blood pressure → increased total peripheral resistance

B) Increased total peripheral resistance → inappropriate renal salt and water reabsorption → increased blood volume → increased venous return → increased cardiac output → increased blood pressure

C) Increased cardiac output → increased total peripheral resistance → inappropriate renal salt and water reabsorption → increased blood volume → increased venous return → increased blood pressure

D) Inappropriate renal salt and water reabsorption → increased total peripheral resistance → increased blood volume → increased venous return → increased cardiac output → increased blood pressure

E) Inappropriate renal salt and water reabsorption → increased blood volume → increased venous return → increased total peripheral resistance → increased cardiac output → increased blood pressure

ECG/Heart Sounds Questions

Use the following figures to answer question 37. Each panel represents the three standard bipolar limb leads of an ECG with an arrow indicating the vector of cardiac depolarization.

37) If recordings are made from Leads I, II or III in each condition, which of the following statements is correct?

A) In panels 1) and 2), the maximum positive deflection would be in lead III.

B) In panels 3) and 5), lead I would be isoelectric (no deflection)

C) In panels 3) and 4), lead III would be negative

D) In panels 1) and 5), the most negative deflection would be in lead I

E) In panels 1), 2) and 4), lead I would be positive
Use the following figure of the ECG and arrows A-E to answer this question 38.

38. The volume of blood that moves through the mitral valve is normally the greatest around
   A) Arrow A
   B) Arrow B
   C) Arrow C
   D) Arrow D
   E) Arrow E

39. Which of the following best describes the mechanism of increased splitting between the components of the second heart sound during inspiration?
   A) Increased venous return to the right atrium during inspiration leads to delayed emptying of the right ventricle and delayed pulmonic valve closure.
   B) Decreased venous return to the left atrium during inspiration delays left ventricular emptying and delayed aortic valve closure.
   C) Increased air in the chest cavity muffles the transmission of the pulmonic closure sound.
   D) Increased venous return to the right atrium during inspiration causes the tricuspid valve to open prematurely.
   E) Decreased venous return to the right atrium during inspiration delays tricuspid valve closure.

40. Which of the following statements about the cardiac cycle is correct?
   A) The T wave begins immediately after the first heart sound
   B) The QRS complex immediately follows mitral valve closure
   C) The p wave on the ECG just precedes the a wave of the atrial pressure recording.
   D) Peak aortic pressure occurs just after the second heart sound
   E) The second heart sound occurs during late diastole

41. An elderly lady is brought to the emergency room after she complains of severe dizziness. Her pulse is 23 beats per minute. An electrocardiogram shows regularly occurring p waves at a rate of 72 per minute. There are wide QRS complexes at a rate of 23 per minute which bear no regular relationship to the p waves. Which of the following diagnoses best describes this patient’s underlying problem?
   A) Sinus arrest.
   B) Third degree heart block with a junctional escape rhythm.
   C) Accelerated ventricular rhythm.
   D) Sinus bradycardia
   E) Third degree heart block with ventricular escape rhythm.
42. A 23 old man who was not wearing a seat belt is brought to the emergency room following a head on collision during which his chest hit the steering wheel. An emergency cardiac catheterization reveals that the aortic valve has been torn and is leaking. Which of the following findings are you likely to hear on auscultation of the chest?

A) A systolic murmur at the apex.
B) A diastolic murmur at the right second intercostal space
C) An S4 gallop
D) A loud second heart sound
E) Absence of the first heart sound

Hemostasis Questions

43. An experimental drug was administered to an adult participating in a clinical trial and a side effect resulted in a profound bleeding tendency. Lab tests revealed a prolonged bleeding time but a normal prothrombin time. Which of the following are possible actions of the drug?

A) Vitamin K antagonist
B) Inhibitor of the metabolism (breakdown) of serotonin
C) Inhibitor of thrombin
D) Antagonist of the glycoprotein receptor GP Ib-IX on the platelet membrane
E) Stimulator of the synthesis of von Willebrand protein by endothelial cells

44. Which of the following is not characteristic of the normal platelet?

A) Has elements of a contractile cell such as actin, myosin, tropomyosin, calmodulin and troponin
B) Has dense granules that contain ADP, calcium and serotonin
C) Are the smallest of the circulating formed elements with an average diameter of 3-4 microns
D) Energy is provided by ATP derived from anaerobic glycolysis and mitochondrial oxidative metabolism
E) Normal turnover is about 250,000 platelets/µL/day

45. ADP initiates platelet aggregation by

A) binding to the GP IIb-IIIa receptor on the platelet
B) binding to the endothelial cell membrane
C) stimulating the synthesis of prostacyclin (PGI₂)
D) binding to ADP-specific receptors on the platelet
E) stimulating release of intracellular calcium from endothelial cells

46. The coagulation factors circulate in plasma in concentrations ranging from about 0.5 to 150 µg/ml, except for __________, which is much higher at 2.5 mg/ml.

A) Fibrin
B) Fibrinogen
C) Prothrombin
D) High molecular weight kininogen (HMWK)
E) Factor X

47. Normal human plasma was drawn into a test tube containing a calcium-chelating anticoagulant. Upon recalcification, which of the following (when added to the plasma in optimal concentrations) would cause the formation of insoluble fibrin polymer?

A) Thrombin
B) Thrombin plus Factor XIIIa
C) Factor Xa, Factor V plus phospholipid
D) A, B, and C are correct
E) None of the above is correct
48. Vitamin K

A) deficiency, in the absence of malabsorption, only occurs with inadequate oral intake or in the presence of broad spectrum antibiotics
B) is essential for the synthesis of normal Factor V
C) antagonists, such as coumadin, exert their anticoagulant action by chelating extracellular calcium
D) action permits several coagulation factors to bind to plasminogen via calcium bridges
E) action is not a posttranslational event

49. Which of the following statements regarding the action of thrombin on fibrinogen is true?

A) the release of fibrinopeptide B precedes that of fibrinopeptide A
B) thrombin cleaves fibrinogen at the amino terminal end of each alpha and beta chain of fibrinogen
C) thrombin proteolysis of fibrinogen occurs primarily at the distal nodules rather than at the central core
D) once the fibrinopeptides have been cleaved the resulting molecule is termed fibrin polymer
E) none of the above is true

50. With activation of the fibrinolytic system, plasmin-induced degradation of fibrinogen

A) occurs in a sequential fashion yielding fragments of equal molecular weight
B) yields four products X, Y, D and E that are equally inhibitory to fibrin polymerization
C) yields four products of which fragments X and Y are inhibitory to fibrin polymerization
D) results in inhibition of platelet adhesion to subendothelial collagen
E) does not affect the platelet aggregation response to vessel injury

51. A patient with recurrent venous thrombosis received anticoagulant drug therapy that resulted in a normal bleeding time and a normal thrombin time. Based only on this data, which of the following is true? The drug might have been:

A) heparin
B) coumadin administered one hour previously and if the prothrombin time had been measured it would have been prolonged
C) coumadin administered for several days and if the prothrombin time had been measured it would have been prolonged
D) a plasminogen activator
E) none of the above is correct

52. What is the circulating concentration of platelets (in number/µL) if platelet turnover is 10,000 platelets/µL/day and mean survival time is 11 days?

A) 11.0 x 10^5
B) 110,000
C) 1.1 x 10^6
D) 9.09 x 10^2
E) 909,090

53. A qualitative platelet defect

A) but not a quantitative one can be detected by the bleeding time
B) is apparent in classic hemophilia
C) can be either hereditary or acquired
D) is always associated with a decreased platelet count
E) usually occurs with splenomegaly