Cardiac Physiology Questions

1. Which one 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) None of the above is false.

2. Which one of the following models most closely resembles the intact beating heart?
   A) a preloaded tonic contraction
   B) an afterloaded isotonic contraction
   C) a purely isometric contraction
   D) a purely isotonic contraction

3. A normal heart with a normal end diastolic volume has an arbitrary radius of 1. On the other hand, an enlarged heart, operating at an elevated end diastolic volume has an arbitrary radius of 2. Assuming an equal wall thickness for both hearts, if the pressure necessary to open the aortic valve is 100 mmHg, the Law of LaPlace predicts that the
   A) enlarged heart will develop one-half the tension of the normal heart
   B) enlarged heart will develop twice the tension of the normal heart
   C) enlarged heart cannot develop enough pressure to open the aortic valve
   D) normal heart has a lower preload than the enlarged heart
   E) tension in the ventricular wall of the normal heart will equal one-tenth of that in the enlarged heart

For questions 4-8, use the following answers (answers can be used once, more than once, or not at all). Questions relate to a pump-perfused, isolated heart (i.e., all variables are held constant except for the one specified in the question).

   A) stroke volume
   B) end diastolic volume
   C) end systolic volume
   D) both A and B
   E) both A and C

4. Increases with norepinephrine infusion.
5. Decreases with increases in afterload.
6. Decreases with increases in contractility.
7. Increases with increases in afterload.
8. Increases with small (10%) increases in preload.
9. Reductions in afterload are helpful in reducing the oxygen requirements for left ventricular stroke work because with reduced afterload
   A) more “pressure work” is done than is “volume work”
   B) the end systolic volume is higher than with increases in afterload
   C) more “volume work” is done than is “pressure work”
   D) the pressure-volume loop is taller and narrower than with increases in afterload
   E) none of the above

10. The minute work of the heart can be increased by increasing
    A) arterial blood pressure
    B) heart rate
    C) end diastolic volume
    D) A and B
    E) A, B and C

Use the following patient data to answer question 11:
    Heart Rate = 100 bpm
    Oxygen consumption = 200 ml O\textsubscript{2} / min
    Pulmonary artery oxygen content = 15 ml O\textsubscript{2} / 100 ml of blood
    Aorta oxygen content = 20 ml O\textsubscript{2} / 100 ml of blood
    Angiographic volumes of the left ventricle:
        EDV = 200 ml
        ESV = 100 ml

11. Which one of the following is true?
    A) The regurgitant fraction of the total left ventricular output is 70%.
    B) The fraction of total left ventricular output entering the aorta is 40%.
    C) Regurgitant flow is 10 L/min.
    D) Forward flow into the aorta is 10 L/min.
    E) Total output of the left ventricle is 4 L/min.

12. In a normal beating heart at the time of mitral valve opening,
    A) one would hear the first heart sound
    B) the aortic valve is open
    C) left ventricular volume is at its highest level
    D) aortic blood flow greatly exceeds that occurring at the time of mitral valve closure
    E) none of the above

13. Which one of the following is true regarding central venous pressure (Pcv) and the central venous pool?
    A) The central venous pool equals the volume of blood in the great veins in the thorax.
    B) When peripheral venous pressure (Ppv) and venous vascular resistance are constant, venous return is lower at lower values of Pcv than at higher values of Pcv.
    C) When venous return and cardiac output are temporarily out of balance, a change in Pcv must occur.
    D) Both A and B
    E) Both A and C
14. 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) is affected by changes in aortic diastolic blood pressure

Use the following graph for questions 15-17. The figure indicates two cardiac function curves in an adult and transitions in end diastolic pressure and stroke work at a constant heart rate of 60 beats/min.

15. The transition from A to B could be due to:
   A) a transient response to a change in posture from lying to standing
   B) an infusion of a positive inotropic agent
   C) a transient response to a change in posture from standing to lying
   D) a sudden increase in systemic arterial pressure
   E) a decrease in afterload

For questions 16-17 assume the following values for end diastolic volume (EDV) and stroke volume (SV) for each of the points on the figure:
   \[ \text{EDV}_A = 180 \text{ ml}; \text{SV}_A = 70 \text{ ml} \]
   \[ \text{EDV}_B = 200 \text{ ml}; \text{SV}_B = 80 \text{ ml} \]
   \[ \text{EDV}_C = 190 \text{ ml}; \text{SV}_C = 90 \text{ ml} \]

16. Which one of the points on the curve represents the highest and lowest values for end systolic volume (ESV), respectively?
   A) A and B
   B) B and C
   C) C and B
   D) A and C
   E) None of the above; ESV is the same for all points.

17. Which one of the following is true? The
   A) ejection fraction is highest at point B
   B) cardiac output at point B exceeds that at point C
   C) ejection fraction is lowest at point C
   D) cardiac output at point C is 4.8 L/min
Circulatory Physiology Questions

18. Which one of the following statements is false concerning flow through a single vessel in the arterial system?

A) Volume flow is reduced in response to lengthening of the vessel.
B) Volume flow increases in response to a decrease in the viscosity of the blood.
C) Dilation of the vessel to double its original diameter results in a doubling in flow.
D) Flow is increased by an increase in the pressure gradient across the length of the vessel.
E) Pouisille’s equation applies to laminar (streamlined), but not to turbulent flow.

19. In an isolated microvascular bed perfused at a constant pressure, an increase in the arteriolar resistance (i.e. increased arteriolar tone) is associated with

A) An increase in flow through the bed.
B) A decrease in capillary hydrostatic pressure.
C) A decreased activation of alpha-adrenergic receptors on the arteriolar smooth muscle.
D) An increased rate of ultra-filtration in capillaries.
E) A lowering of the oncotic pressure inside the capillary.

20. When a healthy individual runs at a moderate pace on a treadmill

A) systolic and diastolic pressure decrease.
B) heart rate and stroke volume decrease.
C) total peripheral vascular resistance decreases.
D) brain blood flow doubles.
E) blood flow through the pulmonary circulation decreases.

21. Blood flow through the cerebral circulation is

A) decreased by a reduction in arterial oxygen tension from 95 to 45 mm Hg.
B) increased proportionately in response to increases in carbon dioxide tension.
C) regulated primarily by the sympathetic nervous system.
D) reduced during exercise due to decreased total peripheral resistance.
E) unaffected by quick changes in posture (e.g. lying to standing position).

22. An increase in the volume of interstitial fluid space in a given tissue (edema) might be due to each of the following conditions, except:

A) increased intracapillary colloid osmotic pressure with no change in hydrostatic pressure.
B) increased colloid osmotic pressure in the interstitial space with no change in capillary hydrostatic pressure.
C) increased arterial blood pressure (195/120 mmHg).
D) increased capillary hydrostatic pressure with no change in capillary oncotic pressure.
E) increased hydrostatic pressure in the venules with no change in capillary oncotic pressure.

23. During a hypertensive crisis (very rapid and excessive increase in arterial pressure to 240/180 mmHg)

A) the correct clinical response is to lower the pressure as quickly as possible to 120/80 mmHg.
B) the fluid balance in the capillaries in the brain is likely to be disrupted and result in cerebral edema.
C) the patient is not in immediate danger.
D) carotid baroreceptor activity is reduced.
E) the cerebral blood flow autoregulation curve will shift to the left.

24. In the normal pulmonary circulation
A) blood flow is highest at the top of the upright lung.
B) blood flow is highest in regions of the lung where oxygen tension is lowest.
C) the mean cardiac output is less than that in the system circulation.
D) the compliance of the pulmonary artery is higher than that of the aorta.
E) the mean pressure in the pulmonary artery is essentially identical to that measured in the aorta.

25. Which one of the following statements is correct?

A) Oxygen moves across endothelial cells by active transport mechanisms.
B) An increase in cardiac output coupled with a proportional decrease in total peripheral resistance (TPR) is the cause of the marked increase in MAP during exercise.
C) A decrease in central venous pressure reduces venous return.
D) The velocity of blood flow is highest in the capillaries.
E) The magnitude of the arterial pulse pressure is inversely related to arterial compliance.

26. An increase in arteriolar smooth muscle tone is most likely due to

A) decreased level of adenosine.
B) decreased level of endothelin.
C) reduced sympathetic nerve activity.
D) inhibition of angiotension converting enzyme (ACE).
E) an increase in nitric oxide level.

27. The rapid loss of half the total blood volume due to hemorrhage results in

A) a progressive increase in carotid sinus baroreceptor activity.
B) increased total peripheral resistance.
C) edema in most tissues.
D) increased mean arterial pressure (MAP).
E) increased perfusion of resting skeletal muscle.

28. Which one of the following statements is incorrect?

A) Mean arterial pressure is generally higher in older individuals (60 yrs) compared to young individuals (20 yrs).
B) Precapillary sphincters regulate flow within individual capillary beds.
C) Proteins do not routinely diffuse through clefts in the normal capillary wall.
D) Mean arterial pressure is inversely related to total peripheral resistance at a constant cardiac output.
E) The vascular segment with the largest cross-sectional area is the capillary.

29. Which one of the following statements concerning the pressor area in the brain is correct?

A) Stimulation of the pressor area usually results in a reduced heart rate.
B) Activation of the pressor area results from decreased neural input from the carotid baroreceptors.
C) Stimulation of the pressor area leads to a reduction in mean arterial pressure.
D) Pressor area activity is reduced during hemorrhage.
E) A reduction in pressor area activity results in an increase in cardiac output.

30. An increase in sympathetic nerve stimulation of the peripheral venous system (veno-constriction)

A) results in a decrease in the blood volume stored in the peripheral venous system.
B) results in an increased compliance of the venous system.
C) results in a reduction in venous return from the peripheral to the central venous pool.
D) leads to a reduced cardiac output.
E) causes a decrease in venous pressure.
Use the following figures marked A-E to answer questions 31-34 (the oval point represents the steady-state set point of the system). Answers may be used once, more than once, or not at all. The x axis is BP (mean arterial blood pressure) and the y axis is the response indicated in each question.

31. Which figure most closely describes blood flow to the brain?

32. Which figure most closely describes carotid sinus nerve activity?

33. Which figure most closely describes sympathetic output from the medullary blood pressure center?

34. Which figure most closely describes parasympathetic output from the medullary blood pressure center?

35. Use the following data obtained from a skeletal muscle capillary to answer this question:

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure in the capillary</td>
<td>35 mmHg</td>
</tr>
<tr>
<td>Hydrostatic pressure in the interstitial fluid space</td>
<td>5 mmHg</td>
</tr>
<tr>
<td>Colloid osmotic pressure in the capillary</td>
<td>20 mmHg</td>
</tr>
<tr>
<td>Colloid osmotic pressure in the interstitial fluid space</td>
<td>5 mmHg</td>
</tr>
</tbody>
</table>

A) There is a net filtration force of 5 mmHg  
B) There is a net filtration force of 10 mmHg  
C) There is a net filtration force of 15 mmHg  
D) There is a net reabsorption force of 5 mmHg  
E) There is a net reabsorption force of 10 mmHg
For questions 36-38, select the best term to answer the question. Answers may be used once, more than once, or not at all.

A) α adrenergic receptor
B) β₁ adrenergic receptor
C) β₂ adrenergic receptor
D) Ach receptor

36. This receptor mediates the arterial smooth muscle vasodilator response to catecholamines

37. This receptor mediates increases in ventricular contractility

38. This receptor mediates increases in total peripheral resistance in essential hypertension

Use the following figure illustrating decreases in blood pressure across the circulation to answer questions 39-40.

39. Compared with control, curve A or B represents a situation in which there is increased constriction of the arterioles.

40. Compared with control, curve A or B represents a situation that would result in net reabsorption of water (assume oncotic and tissue pressures are the same as control).

**ECG Questions**

41. During the normal conduction sequence in the heart, which depolarization follows the A-V node?

A) Atria
B) Sinus node.
42. A patient has an ECG in which normal appearing P waves, at a rate of 72 beats per minute, are each followed by a normal appearing QRS complex and T wave. However, there is an abnormally long interval between the P wave and the QRS complex. This prolonged P-R interval might occur in which of the following clinical scenarios:

A) A stab wound to the chest that lacerates the right atrium.
B) A myocardial infarction damaging the apex of the left ventricle.
C) A tumor infiltrating the right ventricle.
D) An occlusion of the AV nodal branch of the right coronary artery, leading to infarction of the A-V node.
E) An overdose of a drug which suppresses the rate of sinus node depolarization.

43. If a patient with a previously normal sinus rhythm at 80 bpm developed a ventricular tachycardia at 180 bpm, what would be the relationship between P waves and QRS complexes on the ECG?

A) P waves would precede each QRS complex with an abnormally short P-R interval.
B) P waves would precede each QRS complex with an abnormally long P-R interval.
C) P waves would precede every other QRS complex.
D) P waves would not occur.
E) P waves would be seen but there would be no relationship between P waves and QRS complexes.

44. A driver who was not wearing her seatbelt is rushed to the emergency room after a head on automobile collision. On examination, she is awake and alert and complains only of chest soreness. On examining her chest, you hear a loud murmur that begins with the second heart sound and continues up to the first heart sound. Which of the following is a possible cause of the murmur?

A) Laceration of a mitral valve leaflet with a resultant valve leak.
B) Laceration of the anterior wall of the right ventricle with leakage of blood into the pericardium.
C) Injury to the aorta with obstruction of the aortic valve by a large blood clot.
D) Tear in one of the aortic valve cusps.
E) Ejection of blood through a right ventricular laceration during right ventricular contraction.

45. The first heart sound is associated with which of the following:

A) Pulmonic closure.
B) Aortic opening.
C) Aortic closure.
D) Mitral valve opening.
E) Mitral valve closure.

46. Which of the following statements about the cardiac cycle is correct?

A) The onset of the T wave is the electrical event follows the first heart sound.
B) The P wave occurs after atrial systole.
C) Left atrial contraction normally precedes right atrial contraction.
D) A third heart sound, if heard, is generated during atrial contraction.
E) Aortic flow is greatest during ventricular ejection.

47. Regarding heart sounds,

A) the aortic component of S2 normally occurs before the pulmonic component.
B) the normal splitting of the second heart sound is accentuated by breath holding.
C) S1 results from mitral and tricuspid valve opening.
D) a systolic murmur will begin with S2.
E) the tricuspid component of S1 should occur slightly before the mitral component.
Hemostasis Questions  

Use the following letters A-J to answer questions 48-53. Answers may be used once, more than once, or not at all.

A) PGI₂ (prostacyclin)  
B) ADP (adenosine diphosphate)  
C) vWF (vonWillebrand factor or protein)  
D) collagen  
E) thrombin  
F) cyclooxygenase  
G) GP IIb-IIIa (platelet membrane glycoprotein IIb-IIIa)  
H) GP Ib-IX  
I) Thromboxane A₂

48. Following platelet adhesion, this substance is the primary stimulus for platelet aggregation.

49. Circulates as a multimolecular complex with Factor VIII.

50. Hereditary absence of this receptor results in defective platelet adhesion.

51. In addition to its vasoconstrictor activity, this substance mobilizes intracellular stores of platelet Ca²⁺.

52. Acetylation of this substance results in the accumulation of arachidonate in platelets exposed to subendothelium.

53. deleted

54. A patient with a bleeding disorder had a normal thrombin time, a normal prothrombin time and a platelet count of 275,000 platelets/µL. Which of the following defects can be ruled out (i.e. is not possible)?

   A) Mutation of the GP Ib-IX receptor in platelets  
   B) Factor XIII defect  
   C) Hypoprothrombinemia  
   D) Factor IX defect  
   E) Classic hemophilia

55. A drug used in the treatment of arterial thrombosis prolonged the bleeding time but did not affect the platelet count or any other tests of hemostatic function. Which of the following is a possible action of the drug?

   A) Inhibition of tissue plasminogen activator (tPA).  
   B) Irradiation of bone marrow.  
   C) Inhibition of the binding of vWF to GP IIb-IIIa on the platelet membrane.  
   D) Inhibition of thromboxane synthase.  
   E) Enhanced production of platelet phospholipase A₂.

56. Anticoagulation by Coumadin:

   A) Requires the presence of normal plasma levels of antithrombin.  
   B) Is much faster in onset than heparin.  
   C) Can be monitored by the degree of prolongation of the bleeding time.  
   D) Is accompanied by a prolongation of the thrombin time.  
   E) None of the above.

57. Activation of plasminogen to free plasin in plasma would most likely result in:
A) Inhibition of platelet aggregation.
B) Formation of fibrinogen degradation products X, Y, D and E.
C) Inhibition of fibrin polymerization.
D) A and B
E) A, B and C.

58. As compared to arterial thrombosis, venous thrombosis:
   A) Would be more likely to be alleviated by a Vitamin K deficiency.
   B) More frequently occurs on or around an abnormal vessel wall.
   C) Is more effectively treated with antiplatelet therapies.
   D) Does not affect fibrinogen turnover.
   E) None of the above.

59. Bleeding due to a severe Vitamin K deficiency could be differentiated from classic hemophilia by which of the following tests of hemostatic function?
   A) Prothrombin time
   B) Platelet count and bleeding time
   C) Partial thromboplastin time
   D) Clot solubility
   E) Thrombin time

For question 60 use the following laboratory findings:
   Platelet turnover = 8 x 10^4 platelets/µL/day
   Fibrinogen survival time = 1.33 days
   Platelet count = 2 x 10^5 platelets/µL
   Plasma fibrinogen level = 2.0 mg/ml

60. Which of the following is true?
   A) Platelet survival time is about 2.5 days.
   B) Fibrinogen turnover is about 1.5 mg/ml/day.
   C) The person most likely has ongoing venous thrombosis.
   D) A and B.
   E) A, B and C.

61. All of the following tend to limit intravascular coagulation except
   A) Activation of plasminogen to plasmin
   B) Antithrombin
   C) Endothelial cell production of prostacyclin (PGI₂)
   D) Static blood flow
   E) Fibrinogen degradation fragments X and Y

62. Which one of the following is true? The Factor VIII:C molecule
   A) Is produced in the same location as Factor VIII:vWF
   B) Has an X-linked recessive mode of inheritance
   C) Is produced in the endothelial cell
   D) Synthesis is normal in classic hemophilia
   E) Is necessary for normal platelet adhesion

63. Heparin
   A) Anticoagulant action requires antitrypsin, a co-factor in plasma
   B) Is orally effective as an anticoagulant
C) Will not anticoagulate whole blood drawn into a test tube
D) Injection results in the defective synthesis of Factors II, VII, IX and X
E) None of the above

Answers exam a:
1b 2b 3b 4a 5a 6c 7c 8d 9e 10e 11b 12e 13c 14e 15c 16b 17e 18c 19b 20c 21b 22a 23b 24d 25e 26a 27b 28d 29b 30a 31c 32a 33b 34a 35c 36c 37b 38a 39a 40a 41c 42d 43e 44d 45e 46e 47a 48b 49c 50h 51i 52f 53x 54c 55d 56e 57e 58a 59a 60e 61d 62b 63e