Physiology Final Material Test Bank

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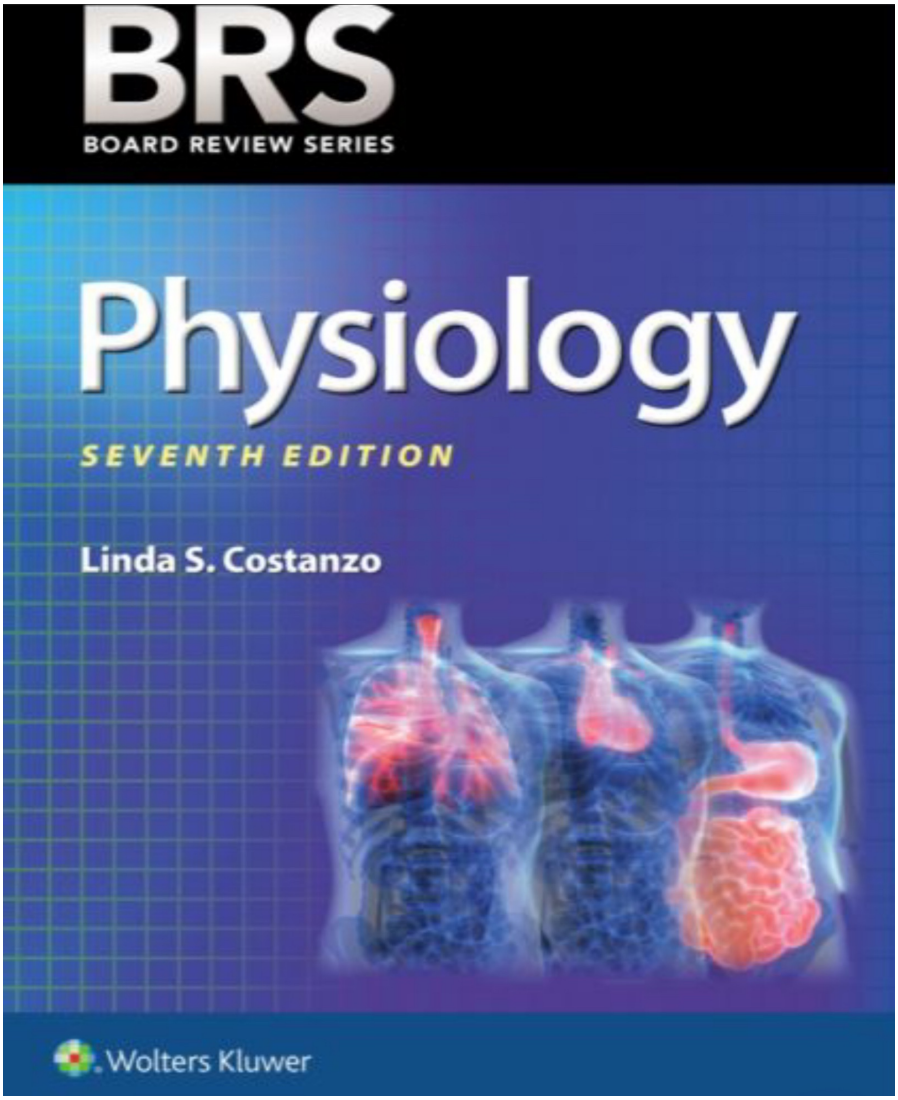


1. A 53-year-old woman is found, by arteriography, to have 50% narrowing of her left renal artery. What is the expected change in blood flow through the stenotic artery?
(A) Decrease to 1⁄2
(B) Decrease to 1⁄4
(C) Decrease to 1⁄8
(D) Decrease to 1⁄16
(E) No change

2. When a person moves from a supine position to a standing position, which of the following compensatory changes occurs?
(A) Decreased heart rate
(B) Increased contractility
(C) Decreased total peripheral resistance (TPR)
(D) Decreased cardiac output
(E) Increased PR intervals

3. At which site is systolic blood pressure the highest?
(A) Aorta
(B) Central vein
(C) Pulmonary artery
(D) Right atrium
(E) Renal artery
(F) Renal vein

Questions 4 and 5
An electrocardiogram (ECG) on a person shows ventricular extrasystoles.

4. The extrasystolic beat would produce
(A) increased pulse pressure because contractility is increased
(B) increased pulse pressure because heart rate is increased
(C) decreased pulse pressure because ventricular filling time is increased
(D) decreased pulse pressure because stroke volume is decreased
(E) decreased pulse pressure because the PR interval is increased

5. After an extrasystole, the next “normal” ventricular contraction produces (A) increased pulse pressure because the contractility of the ventricle is increased
(B) increased pulse pressure because total peripheral resistance (TPR) is decreased
(C) increased pulse pressure because compliance of the veins is decreased
(D) decreased pulse pressure because the contractility of the ventricle is increased
(E) decreased pulse pressure because TPR is decreased

Questions 6 and 7
In a capillary,Pc is 30mmHg, Pi is–2mmHg, πc is 25mmHg, and πi is 2mm Hg.

6. What is the direction of fluid movement and the net driving force?
(A) Absorption; 6 mm Hg
(B) Absorption; 9 mm Hg
(C) Filtration; 6 mm Hg
(D) Filtration; 9 mm Hg
(E) There is no net fluid movement

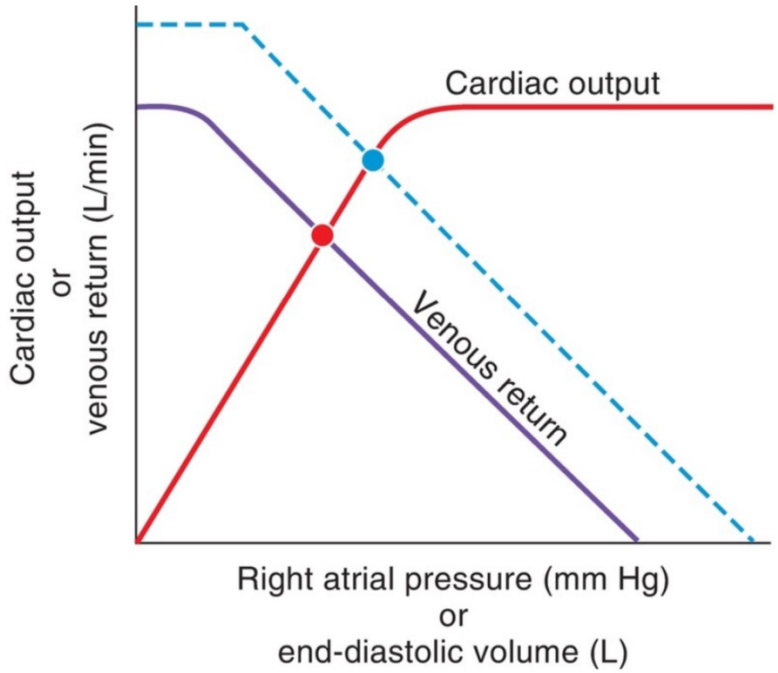
7. If Kf is 0.5 mL/min/mm Hg, what is the rate of water flow across the capillary wall?
(A) 0.06 mL/min
(B) 0.45 mL/min
(C) 4.50 mL/min
(D) 9.00 mL/min
(E) 18.00 mL/min

8. The tendency for blood flow to be turbulent is increased by (A) increased viscosity
(B) increased hematocrit
(C) partial occlusion of a blood vessel
(D) decreased velocity of blood flow

9. A 66-year-old man, who has had a sympathectomy, experiences a greater- than-normal fall in arterial pressure upon standing up. The explanation for this occurrence is
(A) an exaggerated response of the renin–angiotensin–aldosterone system
(B) a suppressed response of the renin–angiotensin–aldosterone system
(C) an exaggerated response of the baroreceptor mechanism
(D) a suppressed response of the baroreceptor mechanism

10. In which of the following situations is pulmonary blood flow greater than aortic blood flow?
(A) Normal adult
(B) Fetus
(C) Left-to-right ventricular shunt
(D) Right-to-left ventricular shunt
(E) Right ventricular failure
(F) Administration of a positive inotropic agent

11. The change indicated by the dashed lines on the cardiac output/venous return curves shows



(A) decreased cardiac output in the “new” steady state
(B) decreased venous return in the “new” steady state
(C) increased mean systemic filling pressure
(D) decreased blood volume
(E) increased myocardial contractility

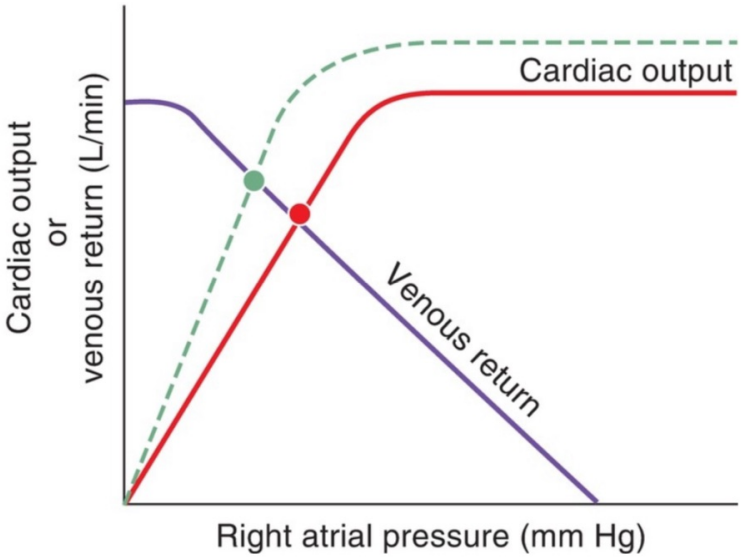
12. An acute decrease in arterial blood pressure elicits which of the following compensatory changes?
(A) Decreased firing rate of the carotid sinus nerve
(B) Increased parasympathetic outflow to the heart
(C) Decreased heart rate
(D) Decreased contractility
(E) Decreased mean systemic filling pressure

13. The tendency for edema to occur will be increased by
(A) arteriolar constriction
(B) increased venous pressure
(C) increased plasma protein concentration
(D) muscular activity

14. During exercise, total peripheral resistance (TPR) decreases because of the effect of
(A) the sympathetic nervous system on splanchnic arterioles
(B) the parasympathetic nervous system on skeletal muscle arterioles
(C) local metabolites on skeletal muscle arterioles
(D) local metabolites on cerebral arterioles
(E) histamine on skeletal muscle arterioles

15. An increase in arteriolar resistance, without a change in any other component of the cardiovascular system, will produce
(A) a decrease in total peripheral resistance (TPR)
(B) an increase in capillary filtration
(C) an increase in arterial pressure

Questions 17 and 18



16. The dashed line in the figure illustrates the effect of (A) increased total peripheral resistance (TPR)
(B) increased blood volume
(C) increased contractility
(D) a negative inotropic agent
(E) increased mean systemic filling pressure

17. The x-axis in the figure could have been labeled (A) end-systolic volume
(B) end-diastolic volume
(C) pulse pressure
(D) mean systemic filling pressure (E) heart rate

18. Which of the following is an effect of histamine? (A) Decreased capillary filtration
(B) Vasodilation of the arterioles
(C) Vasodilation of the veins
(D) Decreased Pc
(E) Interaction with the muscarinic receptors on the blood vessels

19. Carbon dioxide (CO_2) regulates blood flow to which one of the following organs? (A) Heart
(B) Skin
(C) Brain
(D) Skeletal muscle at rest
(E) Skeletal muscle during exercise

20. Blood flow to which organ is controlled primarily by the sympathetic nervous system rather than by local metabolites?
(A) Skin
(B) Heart
(C) Brain
(D) Skeletal muscle during exercise

21. Which of the following parameters is decreased during moderate exercise? (A) Arteriovenous O_2 difference
(B) Heart rate
(C) Cardiac output
(D) Pulse pressure
(E) Total peripheral resistance (TPR)

22. Which of the following changes will cause an increase in myocardial O_2 consumption?
(A) Decreased aortic pressure
(B) Decreased heart rate
(C) Decreased contractility
(D) Increased size of the heart
(E) Increased influx of Na^+ during the upstroke of the action potential

23. A 24-year-old woman presents to the emergency department with severe diarrhea. When she is supine (lying down), her blood pressure is 90/60 mm Hg (decreased) and her heart rate is 100 beats/min (increased). When she is moved to a standing position, her heart rate further increases to 120 beats/min. Which of the following accounts for the further increase in heart rate upon standing?

(A) Decreased total peripheral resistance (B) Increased venoconstriction
(C) Increased contractility
(D) Increased afterload
(E) Decreased venous return

24. A 60-year-old businessman is evaluated by his physician, who determines that his blood pressure is significantly elevated at 185/130 mm Hg. Laboratory tests reveal an increase in plasma renin activity, plasma aldosterone level, and left renal vein renin level. His right renal vein renin level is decreased. What is the most likely cause of the patient's hypertension?

(A) Aldosterone-secreting tumor
(B) Adrenal adenoma secreting aldosterone and cortisol
(C) Pheochromocytoma
(D) Left renal artery stenosis
(E) Right renal artery stenosis

25. A 38-year-old woman has a bout of "intestinal flu," with vomiting and diarrhea for several days. Although she is feeling better, when she stands up quickly, she feels faint and light-headed. Which of the following explains why she is light-headed?

(A) Decreased blood volume, decreased preload, decreased cardiac output
(B) Increased heart rate, increased cardiac output
(C) Increased sympathetic output, increased total peripheral resistance, increased arterial pressure
(D) Increased renin levels, increased angiotensin II levels, increased aldosterone levels
(E) Decreased atrial natriuretic peptide levels, decreased Na+ reabsorption

1. The answer is D.
If the radius of the artery decreased by 50% (1/2), then resistance would increase by 24, or 16 ($R = 8\eta l/\pi r4$). Because blood flow is
inversely proportional to resistance ($Q = \Delta P/R$), flow will decrease to 1/16 of the original value.

2. The answer is B.
When a person moves to a standing position, blood pools in the leg veins, causing decreased venous return to the heart, decreased cardiac output, and decreased arterial pressure. The baroreceptors detect the decrease in arterial pressure, and the vasomotor center is activated to increase sympathetic outflow and decrease parasympathetic outflow. There is an increase in heart rate (resulting in a decreased PR interval), contractility, and total peripheral resistance (TPR). Because both heart rate and contractility are increased, cardiac output will increase toward normal.

3. The answer is E.
Pressures on the venous side of the circulation (e.g., central vein, right atrium, renal vein) are lower than pressures on the arterial side. Pressure in the pulmonary artery (and all pressures on the right side of the heart) is much lower than their counterparts on the left side of the heart. In the systemic circulation, systolic pressure is actually slightly higher in the downstream arteries (e.g., renal artery) than in the aorta because of the reflection of pressure waves at branch points.

4. The answer is D
On the extrasystolic beat, pulse pressure decreases because there is inadequate ventricular filling time—the ventricle beats "too soon." As a result, stroke volume decreases.

5. The answer is A
The postextrasystolic contraction produces
increased pulse pressure because contractility is increased. Extra Ca2+ enters the cell during the extrasystolic beat. Contractility is directly related to the amount of intracellular Ca2+ available for binding to troponin C.

6. The answer is D
The net driving force can be calculated with the Starling equation

$$\begin{aligned}\text{Net pressure} &= (P_c - P_i) - (\pi_c - \pi_i)\\ &= \left[(30-(-2))-(25-2)\right]\text{mm Hg}\\ &= 32\text{ mm Hg} - 23\text{ mm Hg}\\ &= +9\text{ mm Hg}\end{aligned}$$

Because the net pressure is positive, filtration out of the capillary will occur.

7. The answer is C
Kf is the filtration coefficient for the capillary and describes the intrinsic water permeability.

$$\begin{aligned}\text{Water flow} &= K_f \times \text{Net pressure} \\ &= 0.5\ \text{mL/min/mm Hg} \times 9\ \text{mm Hg} \\ &= 4.5\ \text{mL/min}\end{aligned}$$

8. The answer is C
Turbulent flow is predicted when the Reynolds number is increased. Factors that increase the Reynolds number and produce turbulent flow are decreased viscosity (hematocrit) and increased velocity. Partial occlusion of a blood vessel increases the Reynolds number (and turbulence) because the decrease in cross-sectional area results in increased blood velocity (v = Q/A).

9. The answer is D
Orthostatic hypotension is a decrease in arterial pressure that occurs when a person moves from a supine to a standing position. A person with a normal baroreceptor mechanism responds to a decrease in arterial pressure through the vasomotor center by increasing sympathetic outflow and decreasing parasympathetic outflow. The sympathetic component helps to restore blood pressure by increasing heart rate, contractility, total peripheral resistance (TPR), and mean systemic filling pressure. In a patient who has undergone a sympathectomy, the sympathetic component of the baroreceptor mechanism is absent.

10. The answer is C
In a left-to-right ventricular shunt, a defect in the ventricular septum allows blood to flow from the left ventricle to the right ventricle instead of being ejected into the aorta. The "shunted" fraction of the left ventricular output is therefore added to the output of the right ventricle, making pulmonary blood flow (the cardiac output of the right ventricle) higher than systemic blood flow (the cardiac output of the left ventricle). In normal adults, the outputs of both ventricles are equal in the steady state. In the fetus, pulmonary blood flow is near zero. Right ventricular failure results in decreased pulmonary blood flow. Administration of a positive inotropic agent should have
the same effect on contractility and cardiac output in both ventricles.

11. The answer is C
The shift in the venous return curve to the right is consistent with an increase in blood volume and, as a consequence, mean systemic filling pressure. Both cardiac output and venous return are increased in the new steady state (and are equal to each other). Contractility is unaffected.

12. The answer is A
A decrease in blood pressure causes decreased stretch of the carotid sinus baroreceptors and decreased firing of the carotid sinus nerve. In an attempt to restore blood pressure, the parasympathetic outflow to the heart is decreased and sympathetic outflow is increased. As a result, heart rate and contractility will be increased. Mean systemic filling pressure will increase because of increased sympathetic tone of the veins (and a shift of blood to the arteries).

13. The answer is B
Edema occurs when more fluid is filtered out of the capillaries than can be returned to the circulation by the lymphatics. Filtration is increased by changes that increase Pc or decrease πc.
Arteriolar constriction would decrease Pc and decrease filtration. Dehydration would increase plasma protein concentration (by hemoconcentration) and thereby increase πc and decrease filtration. Increased venous pressure would increase Pc and filtration.

14. The answer is C
During exercise, local metabolites accumulate in the exercising muscle and cause local vasodilation and decreased arteriolar resistance of the skeletal muscle. Because muscle mass is large, it contributes a large fraction of the total peripheral resistance (TPR). Therefore, the skeletal muscle vasodilation results in an overall decrease in TPR, even though there is sympathetic vasoconstriction in other vascular beds.

15. The answer is C
An increase in arteriolar resistance will increase total peripheral resistance (TPR). Arterial pressure = cardiac output × TPR, so arterial pressure will also increase. Capillary filtration decreases when there is arteriolar constriction because Pc decreases. Afterload of the heart would be increased by an increase in TPR.

16. The answer is C
An upward shift of the cardiac output curve is consistent with an increase in myocardial contractility; for any right atrial pressure (sarcomere length), the force of contraction is increased. Such a change causes an increase in stroke volume and cardiac output. Increased blood volume and increased mean systemic filling pressure are related and would cause a rightward shift in the venous return curve. A negative inotropic agent would cause a decrease in contractility and a downward shift of the cardiac output curve.

17. The answer is B
End-diastolic volume and right atrial pressure are related and can be used interchangeably.

18. The answer is B
Histamine causes vasodilation of the arterioles, which increases Pc and capillary filtration. It also causes constriction
of the veins, which contributes to the increase in Pc. Acetylcholine (ACh) interacts with muscarinic receptors (although these are not present on vascular smooth muscle).

19. The answer is C
Blood flow to the brain is autoregulated by the PCO_2. If metabolism increases (or arterial pressure decreases), the PCO_2 will increase and cause cerebral vasodilation. Blood flow to the heart and to skeletal muscle during exercise is also regulated metabolically, but adenosine and hypoxia are the most important vasodilators for the heart. Adenosine, lactate, and K^+ are the most important vasodilators for exercising skeletal muscle. Blood flow to the skin is regulated by the sympathetic nervous system rather than by local metabolites.

20. The answer is A.
Circulation of the skin is controlled primarily by the sympathetic nerves. The coronary and cerebral circulations are primarily regulated by local metabolic factors. Skeletal muscle circulation is regulated by metabolic factors (local metabolites) during exercise, although at rest it is controlled by the sympathetic nerves.

21. The answer is E
In anticipation of exercise, the central command increases sympathetic outflow to the heart and blood vessels, causing an increase in heart rate and contractility. Venous return is increased by muscular activity and contributes to an increase in cardiac output by the Frank-Starling mechanism. Pulse pressure is increased because stroke volume is increased. Although increased sympathetic outflow to the blood vessels might be expected to increase total peripheral resistance (TPR), it does not because there is an overriding vasodilation of the skeletal muscle arterioles as a result of the buildup of vasodilator metabolites (lactate, K^+ adenosine). Because this vasodilation improves the delivery of O_2, more O_2 can be extracted and used by the
contracting muscle.

22. The answer is D

Myocardial O_2 consumption is determined by the amount of tension developed by the heart. It increases when there are increases in aortic pressure (increased afterload), when there is increased heart rate or stroke volume (which increases cardiac output), or when the size (radius) of the heart is increased ($T = P \times r$). Influx of Na^+ ions during an action potential is a purely passive process, driven by the electrochemical driving forces on Na^+ ions. Of course, maintenance of the inwardly directed Na^+ gradient over the long term requires the Na^+–K^+ pump, which is energized by adenosine triphosphate (ATP).

23. The answer is E

Diarrhea causes a loss of extracellular fluid volume, which produces a decrease in arterial pressure. The decrease in arterial pressure activates the baroreceptor mechanism, which produces an increase in heart rate when the patient is supine. When she stands up, blood pools in her leg veins and produces a decrease in venous return, a decrease in cardiac output (by the Frank-Starling mechanism), and a further decrease in arterial pressure. The further decrease in arterial pressure causes further activation of the baroreceptor mechanism and a further increase in heart rate.

24. The answer is D

In this patient, hypertension is most likely caused by left renal artery stenosis, which led to increased renin secretion by the left kidney. The increased plasma renin activity causes an increased secretion of aldosterone, which increases Na^+ reabsorption by the renal distal tubule. The increased Na^+ reabsorption leads to increased blood volume and blood pressure. The right kidney to the increase in blood pressure by decreasing its renin secretion. Right renal artery stenosis causes a similar pattern of results, except that renin secretion from the right kidney, not the left kidney, is increased. Aldosterone-secreting tumors cause increased levels of aldosterone but decreased plasma renin activity (as a result of decreased renin secretion by both kidneys). Pheochromocytoma is associated with increased circulating levels of catecholamines, which increase blood pressure by their effects on the heart (increased heart rate and contractility) and blood vessels (vasoconstriction); the increase in blood pressure is sensed by the kidneys and results in decreased plasma renin activity and aldosterone levels.

25. The answer is A

The woman has significant loss of extracellular fluid (and blood) volume due to vomiting and diarrhea. Decreased blood volume leads to decreased venous return, decreased preload, and decreased cardiac output by the Frank-Starling mechanism; the decrease in cardiac output causes decreased arterial pressure (Pa) and decreased cerebral blood flow, which is responsible for the feeling of light-headedness. The decrease in Pa will activate both the baroreceptor mechanism and the renin–angiotensin II–aldosterone system, but the results of turning on these mechanisms (increased sympathetic output, increased total peripheral resistance, increased heart rate, and compensatory increase in Pa toward normal) are secondary to the decrease in Pa; they are not causes of the light-headedness. Likewise, decreased atrial natriuretic peptide levels and decreased Na^+ reabsorption can occur secondary to the decrease in Pa but are not causes of the light-headedness.