

# **Cardiac and Vascular Physiology — Study Guide with Answers & Explanations**

## Quiz 1

Multiple-Choice (select one best answer)

According to Poiseuille's law, which single change increases flow the most? A. +10% pressure B. -10% viscosity C. +10% vessel diameter D. +10% vessel length

Laplace's law: For a given intraluminal pressure, wall tension... A. decreases as radius increases B. increases as radius increases C. is independent of radius D. is lowest in an aneurysm

Arteriosclerosis with loss of elastin and ↑collagen primarily causes which BP pattern? A. ↓Systolic, ↑Diastolic (↑compliance) B. ↑Systolic, ↓Diastolic (↓compliance) C. Both ↓ D. Both ↑

Which vessel class contributes >60% of total peripheral resistance and provides variable resistance? A. Aorta B. Arterioles C. Capillaries D. Veins

Where is mean blood pressure greatest? A. Capillaries B. Veins C. Aorta D. Vena cavae

Which vessel segment has the slowest blood flow velocity? A. Aorta B. Arteries C. Arterioles D. Capillaries

Which single fluid property in Poiseuille's law is intrinsic to the fluid? A. Density B. Viscosity C. Temperature D. Osmolarity

An acute drop in mean arterial pressure when standing rapidly triggers: A. ↑Parasympathetic, ↓TPR B. ↓Sympathetic, ↓HR C. ↓Parasympathetic, ↑TPR D. No autonomic change

Which statement about capillary exchange is correct? A. Most exchange occurs in arterioles and capillaries B. Exchange with tissues occurs through capillary walls only C. All cells are >100 µm from a capillary D. Veins are the main exchange site

Atherosclerotic stricture causes which pair across/after the narrowing? A. ↓Velocity across, ↑Pressure distal B. ↑Velocity across, ↓Pressure distal C. ↑Velocity across, ↑Pressure distal D. ↓Velocity across, ↓Pressure distal

During exercise in leg muscle, local factors that increase flow include (best answer): A. ↑PO<sub>2</sub>, ↑pH, ↓PCO<sub>2</sub> B. ↓PO<sub>2</sub>, ↓pH, ↑PCO<sub>2</sub> C. ↑PO<sub>2</sub>, ↓pH, ↑PCO<sub>2</sub> D. ↓PO<sub>2</sub>, ↑pH, ↓PCO<sub>2</sub>

Which organ plays no direct role in blood pressure control per these notes? A. Kidneys B. Spleen C. Arterioles D. Medulla oblongata

The largest share (about 1/2–1/3) of circulating blood volume is in the: A. Arteries B. Capillaries C. Veins D. Heart chambers

Which mechanism lowers pulse pressure? A. ↑Stroke volume B. ↑Arterial compliance C. ↓Arterial compliance D. ↑Heart rate with constant SV

Primary distribution of cardiac output to organs is set mainly by: A. Aortic compliance B. Arteriolar resistance C. Venous capacitance D. Capillary permeability

True / False

The relationship between blood volume and blood pressure is roughly linear.

The relationship between blood pressure and blood flow is somewhat non-linear.

“For a given blood pressure, wall tension varies inversely with radius.”

“Blood flow velocity through a stricture is decreased.”

Parasympathetic activity generally lowers arterial pressure by reducing cardiac output.

The baroreceptor stretch receptors are located in the carotid sinus and aortic arch.

Increased baroreceptor stretch increases afferent firing to the medulla and hypothalamus.

Decreased baroreceptor firing stimulates the sympathetic nervous system.

Impairment of renal function tends to lower arterial pressure.

Standing ICP crises (head trauma/meningitis) can provoke a sympathetic-mediated BP surge (Cushing response).

Short Answer / Matching

List two determinants of fluid movement from capillaries into interstitium (Starling/permeability factors).

What single location is the only site for exchange of gases, nutrients, and signaling molecules with tissues?

State the “no cell is farther than” distance from a capillary in these notes.

What does a standard arterial BP reading (e.g., 120/80 mmHg) physically represent?

Name two antihypertensive drug mechanisms targeting the renin–angiotensin system per the notes.

## **Answer Key**

C

B

B

B

C

D

B

C

B

B

B

B

C

B

B

True

True

False ( $T \propto P \cdot r$ ; increases with radius for given P)

False (velocity  $\uparrow$  through a stricture; pressure falls distal)

True

True

True

True

False (renal impairment does not lead to lower BP; often raises it)

True

Any two: capillary hydrostatic pressure; interstitial hydrostatic pressure; plasma (blood) osmotic pressure; interstitial osmotic pressure; capillary permeability characteristics.

Capillaries.

50 micrometers ( $\mu\text{m}$ ).

Force per unit area exerted on walls of larger arteries during systole (120) and diastole (80).

ACE inhibition (block Ang I  $\rightarrow$  Ang II) and AT<sub>1</sub>-receptor blockade (block Ang II receptors).  
(Also acceptable:  $\beta$ -blockers to  $\downarrow$ CO;  $\alpha$ -blockers/ $\alpha$ -antagonists to  $\downarrow$ vasoconstriction.)

## Quiz 2

### # Section A — Ordering & Matching

1. \*\*Put these cardiac-cycle events in the correct order (start anywhere, but keep sequence):\*\*

isovolumic relaxation; opening of AV valves & passive filling; atrial systole; isovolumic contraction; closure of AV valves; opening of semilunar valves; ventricular ejection; closure of semilunar valves

2. \*\*Match the site with its relative rate (fastest → slowest) and refractory period (shortest → longest):\*\*

SA node; AV node; Bundle of His

3. \*\*Match ECG events:\*\*

Atrial depolarization; Ventricular depolarization; AV nodal delay; Ventricular repolarization  
→ P wave; QRS complex; PR interval; T wave

### # Section B — Multiple Choice

4. ***The aortic & pulmonary valves have a smaller cross-sectional area than AV valves. With the \*same\* flow, they produce:***

- A. Lower velocity through semilunar valves
- B. Higher velocity through semilunar valves
- C. No velocity difference
- D. Only pressure, not velocity, changes

5. Massive RBC transfusion with citrate/oxalate most likely causes which acute cardiac change?

- A. ↑Contractility, ↑CO, ↑BP
- B. ↓Contractility, ↓CO, ↓BP
- C. No change in contractility
- D. Reflex tachycardia with ↑contractility

6. ***Parasympathetic slowing of SA node primarily acts by:***

- A.  $\downarrow K^+$  efflux,  $\uparrow Na^+$  influx (funny current)
- B.  $\uparrow K^+$  efflux,  $\downarrow Na^+$  influx (funny current)
- C.  $\uparrow Ca^{2+}$  entry during systole
- D.  $\uparrow Na^+$  entry during late diastole

**7. During the \*\*plateau\*\* phase of ventricular contractile APs:**

- A.  $Ca^{2+}$  exits,  $K^+$  enters
- B.  $Ca^{2+}$  enters,  $K^+$  begins to exit
- C.  $Na^+$  dominates;  $K^+$  closed
- D. Only  $Cl^-$  currents predominate

**8. Most coronary blood flow to myocardium occurs during:**

- A. Early systole
- B. Late systole
- C. Diastole
- D. Equally in all phases

**9. Cardiac output is equal to (choose the \*best\* definition):**

- A. LV stroke volume  $\times$  heart rate
- B. RV stroke volume  $\times$  heart rate
- C. Mitral inflow per minute
- D. Pulmonary artery outflow per minute
- E. All of the above are equal in steady state

**10. According to Starling's law, in steady state CO equals:**

- A. Systemic vascular resistance
- B. Venous return
- C. Arterial compliance
- D. Mean systemic filling pressure

**11. Primary driver of \*\*moment-to-moment\*\* CO variation is:**

- A. Aortic compliance
- B. Oxygen needs of peripheral tissues
- C. Blood viscosity
- D. Spleen contraction

**12. Sympathetic agonists (epi, NE, dopamine, dobutamine) typically: \*(select all that apply)\***

- A. ↑Contractile force of myocytes
- B. ↑Ca<sup>2+</sup> entry during systole
- C. ↑Rate of contraction
- D. ↑Na<sup>+</sup> entry at SA node in late diastole

**13. Aortic stenosis (severe) leads to which \*\*set\*\* of consequences?**

- A. ↓LV systolic pressure vs arterial pressure; ↓work; ↑LV compliance
- B. ↑LV systolic > arterial; ↑work; ↓LV compliance; ↑atrial pressures; LV hypertrophy
- C. No change in refractory periods; ↓atrial pressure; thinner LV
- D. ↑Arterial systolic > LV systolic; ↓atrial pressure

**14. Intercalated discs in myocardium primarily:**

- A. Electrically isolate cells
- B. Transmit mechanical force & allow AP spread (gap junctions)
- C. Store Ca<sup>2+</sup>
- D. Prevent depolarization

**15. The lungs receive the \*\*highest percentage\*\* of cardiac output because:**

- A. Low metabolic rate
- B. They receive entire RV output
- C. They have the highest resistance
- D. They are closest to the heart

**# Section C — True / False**

16. Parasympathetic stimulation lowers cardiac output mainly by reducing heart rate.
17. SA node has the shortest refractory period and greatest  $\text{Na}^+$  influx between beats.
18. Cardiac output = heart rate  $\times$  stroke volume.
19. Coronary flow is greatest during systole.
20. CO in steady state equals flow through any major valve per minute.

#### **# Section D — Calculations / Short Answer**

**21. \*\*Formulas.\*\* Give the formulas for:**

- a) Stroke volume (SV)
- b) Ejection fraction (EF)
- c) Cardiac output (CO)

**22. \*\*CO/EF realistic calc.\*\* A patient has EDV = 120 mL, ESV = 50 mL, HR = 70 bpm.**

- a) SV = ?
- b) EF = ?
- c) CO = ?

**23. \*\*Echocardiogram sanity check.\*\* You're told EDV = 0.035 L and ESV = 0.110 L at HR = 70 bpm.**

- a) Compute SV and CO.
- b) Explain what's wrong (if anything) and how you'd reconcile it.

**24. \*\*Fick principle (pig).\*\*  $\text{VO}_2 = 100 \text{ mL O}_2/\text{min}$ ; arterial  $\text{O}_2$  content = 100 mL/L; mixed venous  $\text{O}_2$  content = 60 mL/L.**

Compute the pig's cardiac output.

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## **## Answer Key**

1. Isovolumic relaxation → AV opening & passive filling → atrial systole → \*\*isovolumic contraction\*\* → AV valve closure → semilunar opening → ventricular ejection → semilunar closure.
2. Rates: \*\*SA > AV > His\*\*. Refractory: \*\*SA < AV < His\*\* (shortest → longest).
3. Atrial depol = \*\*P\*\*; Ventricular depol = \*\*QRS\*\*; AV nodal delay = \*\*PR interval\*\*; Ventricular repol = \*\*T\*\*.
4. \*\*B\*\*
5. \*\*B\*\* (citrate ↓ionized  $\text{Ca}^{2+}$  → ↓contractility → ↓CO, ↓BP)
6. \*\*B\*\* ( $\uparrow \text{K}^+$  efflux,  $\downarrow \text{Na}^+$  funny current → slower phase 4)
7. \*\*B\*\*
8. \*\*C\*\*
9. \*\*E\*\* (all equal in steady state; any single expression is valid)
10. \*\*B\*\*
11. \*\*B\*\*
12. \*\*A, B, C, D\*\*
13. \*\*B\*\*
14. \*\*B\*\*
15. \*\*B\*\*
16. \*\*True\*\*
17. \*\*True\*\*
18. \*\*True\*\*
19. \*\*False\*\* (diastole predominates)
20. \*\*True\*\* (steady state: flows are equal through valves)
21. a) \*\*SV = EDV – ESV\*\*  
b) \*\*EF = SV / EDV\*\*  
c) \*\*CO = SV × HR\*\*
22. a)  $\text{SV} = 120 - 50 = \text{**70 mL**}$

b)  $EF = 70/120 \approx **0.583 (58\%)**$

c)  $CO = 0.07 L \times 70 = **4.9 L/min**$

23. a)  $SV = 0.035 - 0.110 = **-0.075 L**$ ;  $CO = -0.075 \times 70 = **-5.25 L/min**$  (physiologically impossible).

b) Likely the values were \*\*swapped\*\* (EDV must exceed ESV). If  $EDV = 0.110 L$  and  $ESV = 0.035 L \rightarrow SV = 0.075 L$ ;  $CO = 0.075 \times 70 = **5.25 L/min**$ ;  $EF = 0.075/0.110 \approx **68\%**$ .

24.  $**CO = VO_{\text{B}} / (CaO_{\text{B}} - CvO_{\text{B}}) = 100 \text{ mL/min} \div (40 \text{ mL/L}) = 2.5 \text{ L/min.}**$

want me to convert this into a printable worksheet or randomize question order for practice sets?