



Hemoglobin & Oxygen Content

Q1

A healthy adult male has a hemoglobin concentration of 15 g/dL. What is the **maximum oxygen content** of his arterial blood?

- A. 0.3 ml O₂/dL
- B. 5 ml O₂/dL
- C. 15 ml O₂/dL
- D. 20 ml O₂/dL
- E. 30 ml O₂/dL

Q2

Which of the following contributes **directly** to the arterial partial pressure of oxygen (PaO₂)?

- A. Oxygen bound to hemoglobin
- B. Total oxygen content
- C. Dissolved oxygen in plasma
- D. Number of red blood cells
- E. Hemoglobin saturation

 **Hb–O₂ Dissociation Curve****Q3**

A patient's arterial PO₂ decreases from 100 mmHg to 60 mmHg. What is the expected change in hemoglobin saturation?

- A. Decrease of ~2%
- B. Decrease of ~8–10%
- C. Decrease of ~25%
- D. Decrease of ~50%
- E. Near complete desaturation

Q4

Which of the following best explains why PaO₂ is normally ~95 mmHg rather than 100 mmHg?

- A. Increased diffusion distance in alveoli
- B. High affinity of hemoglobin for oxygen
- C. Plateau phase of the Hb–O₂ dissociation curve
- D. Low inspired oxygen tension
- E. Increased CO₂ production



Venous Admixture & V/Q

Q5

A small amount of deoxygenated blood normally mixes with oxygenated pulmonary venous blood. This phenomenon is best described as:

- A. Dead space ventilation
- B. Shunt physiology
- C. Venous admixture
- D. Diffusion limitation
- E. Ventilation-perfusion mismatch

Q6

Which of the following conditions corresponds to $V/Q = 0$?

- A. Pulmonary embolism
- B. Hyperventilated alveoli
- C. Airway obstruction
- D. High altitude exposure
- E. Increased cardiac output

Q7

In an alveolus with $V/Q = \infty$, which of the following alveolar gas values is most likely?

- A. $PO_2 \approx 40 \text{ mmHg}$, $PCO_2 \approx 45 \text{ mmHg}$
- B. $PO_2 \approx 100 \text{ mmHg}$, $PCO_2 \approx 40 \text{ mmHg}$
- C. $PO_2 \approx 130 \text{ mmHg}$, $PCO_2 \approx 30 \text{ mmHg}$
- D. $PO_2 \approx 150 \text{ mmHg}$, $PCO_2 \approx 0 \text{ mmHg}$
- E. $PO_2 \approx 95 \text{ mmHg}$, $PCO_2 \approx 40 \text{ mmHg}$

Diffusing Capacity

Q8

Which factor would **increase** the diffusing capacity (DL) of the respiratory membrane?

- A. Increased membrane thickness
- B. Decreased surface area
- C. Increased molecular weight of gas
- D. Increased gas solubility
- E. Decreased pressure gradient

Q9

The average diffusing capacity for oxygen ($DL O_2$) at rest in a healthy young adult is approximately:

- A. 5 ml/min/mmHg
- B. 11 ml/min/mmHg
- C. 17 ml/min/mmHg
- D. 21 ml/min/mmHg
- E. 250 ml/min/mmHg

肺 CO Method & Partial Pressure

Q10

Carbon monoxide is used to measure lung diffusing capacity because:

- A. It is highly soluble in plasma
- B. It diffuses slower than oxygen
- C. Its partial pressure in blood is essentially zero
- D. It does not bind hemoglobin
- E. It reflects total oxygen content

Q11

Which statement regarding gas partial pressure in blood is **correct**?

- A. It reflects total gas content
- B. It depends on hemoglobin-bound gas
- C. It is determined only by dissolved gas
- D. It increases with hemoglobin saturation
- E. It is higher for CO than O_2 in blood



Q1 → D

$15 \times 1.34 \approx 20 \text{ ml O}_2/\text{dL}$

Q2 → C

يعتمد فقط على الأوكسجين المذاب.

Q3 → B

من 100 → 60 mmHg 8–10% التسريع ينزل فقط.

Q4 → C

الـ plateau يمنع المناطق المهدّأة زيادة تعوّض بالدم.

Q5 → C

تعريف .venous admixture

Q6 → C

$V/Q = 0$ = perfusion بدون ventilation.

Q7 → D

تهوية بدون تروية → غازات قريبة من الهواء المستنشق.

Q8 → D

$DL \propto$ solubility.

Q9 → D

ال الطبيعي.

Q10 → C

$CO \approx$ صفر $Hb \rightarrow PCO$ يرتبط بقوّة بـ.

Q11 → C

فقط الغاز المذاب يحدد partial pressure

Question 1

A healthy adult has a PaO_2 of 100 mmHg and hemoglobin concentration of 15 g/dL. Which of the following best represents the **major contributor** to oxygen content in arterial blood?

- A) Oxygen dissolved in plasma
- B) Oxygen bound to hemoglobin
- C) Carbon dioxide bound to hemoglobin
- D) Oxygen bound to methemoglobin
- E) Bicarbonate ions

 Correct answer: B

 Explanation:

~98.5% من الأكسجين مرتبط بالهيموغلوبين، بينما فقط 1.5% مذاب بالبلازما.

Question 2

An anemic patient has a hemoglobin concentration of 7.5 g/dL. Arterial blood gas analysis shows $\text{PaO}_2 = 100$ mmHg and $\text{SaO}_2 = 98\%$.

What is the most likely arterial oxygen content?

- A) 20 mL O_2/dL
- B) 18 mL O_2/dL
- C) 15 mL O_2/dL
- D) 10 mL O_2/dL
- E) 5 mL O_2/dL

 Correct answer: D

 Explanation:

رغم PaO_2 و SaO_2 الطبيعيين، نقص Hb يقلل oxygen content للنصف.

Question 3

At which partial pressure of oxygen is hemoglobin 50% saturated?

- A) 100 mmHg
- B) 60 mmHg
- C) 40 mmHg
- D) 26 mmHg
- E) 20 mmHg

 Correct answer: D

 Explanation:

هذا هو P_{50} → مؤشر ال�يموغلوبين للأكسجين.

Question 4

A resting tissue extracts approximately how much oxygen from each deciliter of blood?

- A) 2 mL O₂/dL
- B) 5 mL O₂/dL
- C) 10 mL O₂/dL
- D) 15 mL O₂/dL
- E) 20 mL O₂/dL

 Correct answer: B

 Explanation:

الاستخلاص الطبيعي بالراحة .mL O₂/dL 5 → %25 ≈

Q. Question 5

Which of the following conditions causes a **rightward shift** of the oxyhemoglobin dissociation curve?

- A) Decreased temperature
- B) Decreased CO₂
- C) Decreased H⁺ concentration
- D) Increased 2,3-BPG
- E) Fetal hemoglobin

 **Correct answer: D**

 **Explanation:**

↑ 2,3-BPG ↓ affinity → Right shift → تسلیم O₂ للأنسجة.

Q. Question 6

During intense exercise, which of the following changes facilitates increased oxygen delivery to tissues?

- A) Left shift of oxyhemoglobin curve
- B) Decreased P50
- C) Increased hemoglobin affinity
- D) Increased temperature
- E) Decreased hydrogen ion concentration

 **Correct answer: D**

 **Explanation:**

↑ Temperature = Right shift = ↑ unloading.

Question 7

A patient has elevated levels of methemoglobin. Which of the following best explains the impaired oxygen transport?

- A) Reduced PaO_2
- B) Decreased hemoglobin concentration
- C) Iron in the ferric (Fe^{3+}) state
- D) Increased oxygen solubility
- E) Decreased alveolar ventilation

 Correct answer: C

Explanation:

Fe^{3+} cannot bind oxygen.

Question 8

Why is fetal hemoglobin able to extract oxygen efficiently from maternal blood?

- A) Higher PaO_2 in fetal circulation
- B) Increased hemoglobin concentration
- C) Reduced affinity for oxygen
- D) Reduced binding of 2,3-BPG
- E) Increased carbon dioxide levels

 Correct answer: D

Explanation:

γ chains 2,3 بـPG \rightarrow \uparrow affinity \rightarrow Left shift.

Q Question 9

An increase in PaO_2 from 100 mmHg to 600 mmHg primarily increases:

- A) Hemoglobin-bound oxygen
- B) Oxygen extraction by tissues
- C) Oxygen dissolved in plasma
- D) Hemoglobin saturation
- E) P50 value

 Correct answer: C

Explanation:

Hb مشبع أصلًا → الزيادة فقط بالمذاب.

Q Question 10

Which parameter is the **best indicator** of adequate oxygen delivery to tissues?

- A) PaO_2
- B) SaO_2
- C) Hemoglobin concentration
- D) Oxygen content of blood
- E) Alveolar ventilation

 Correct answer: D

Explanation:

[O_2] يعكس $\text{Hb} + \text{saturation} + \text{PaO}_2$.

A healthy person begins intense exercise. Which of the following changes is primarily responsible for the increase in the diffusing capacity of oxygen?

- A. Increased thickness of the alveolar membrane
- B. Increased hemoglobin concentration
- C. Recruitment of pulmonary capillaries
- D. Increased alveolar PO_2
- E. Increased PaCO_2

 **Answer: C**

Explanation:

During exercise, previously closed pulmonary capillaries open \rightarrow \uparrow surface area \rightarrow \uparrow DL O_2 .
 $\text{DL} \propto \text{Area}$.

Question 2

A patient has an arterial PO_2 of 100 mmHg and an oxygen content of 20 mL O_2/dL . If 50% of his red blood cells are removed acutely, what will be his new arterial PO_2 ?

- A. 30 mmHg
- B. 50 mmHg
- C. 60 mmHg
- D. 80 mmHg
- E. 100 mmHg

 **Answer: E**

Explanation:

PaO_2 depends on lung function, not hemoglobin.
 O_2 content decreases, but PaO_2 remains normal (anemia-like state).

 **Question 3**

A person breathes from a tank containing 45% oxygen at sea level. Assuming $\text{PaCO}_2 = 40$ mmHg and $R = 0.8$, what is the alveolar PO_2 ?

- A. 149 mmHg
- B. 250 mmHg
- C. 270 mmHg
- D. 320 mmHg
- E. 340 mmHg

 **Answer: C**

Explanation:

$$\begin{aligned}\text{PAO}_2 &= \text{FiO}_2 \times (760 - 47) - \text{PaCO}_2/R \\ &= 0.45 \times 713 - 40/0.8 \approx 270 \text{ mmHg}\end{aligned}$$

 **Question 4**

A patient has hemoglobin concentration of 10 g/dL and an arterial oxygen content of 6.5 mL O_2 /dL. What is the arterial oxygen saturation?

- A. 25%
- B. 50%
- C. 75%
- D. 90%
- E. 100%

 **Answer: B**

Explanation:

$$\begin{aligned}6.5 &= 10 \times 1.34 \times \text{SaO}_2 \\ \text{SaO}_2 &\approx 0.5 \rightarrow 50\%\end{aligned}$$

 **Question 5**

A patient with carbon monoxide poisoning presents with headache and dizziness. Which of the following best explains the normal arterial PO_2 despite severe hypoxia?

- A. Increased dissolved oxygen
- B. Increased alveolar ventilation
- C. CO does not affect oxygen diffusion into plasma
- D. Increased hemoglobin affinity for oxygen
- E. Decreased oxygen extraction by tissues

 **Answer: C**

Explanation:

CO affects **hemoglobin binding**, not dissolved $\text{O}_2 \rightarrow \text{PaO}_2$ remains normal.

 **Question 6**

Which of the following changes is most responsible for the reduced oxygen content in carbon monoxide poisoning?

- A. Decreased PaO_2
- B. Decreased solubility of oxygen
- C. Reduced functional hemoglobin
- D. Reduced alveolar ventilation
- E. Increased oxygen consumption

 **Answer: C**

Explanation:

CO binds Hb $\rightarrow \downarrow$ available binding sites $\rightarrow \downarrow \text{SaO}_2 \rightarrow \downarrow \text{O}_2$ content.

 **Question 7**

An increase in tissue metabolic activity with constant blood flow will have which effect on venous PO_2 ?

- A. Increase PvO_2
- B. No change in PvO_2
- C. Decrease PvO_2
- D. Increase PaO_2
- E. Decrease PaCO_2

 **Answer: C**

Explanation:

Higher metabolism \rightarrow higher O_2 extraction \rightarrow $\downarrow \text{PvO}_2$.

 **Question 8**

Which muscle fiber type is best adapted for endurance exercise?

- A. White fibers with high glycolytic capacity
- B. Fibers with low myoglobin content
- C. Fibers with low mitochondrial density
- D. Red fibers with abundant mitochondria
- E. Fibers that rely on anaerobic metabolism

 **Answer: D**

Explanation:

Red fibers \rightarrow \uparrow myoglobin + \uparrow mitochondria \rightarrow sustained aerobic ATP production.

 **Question 9**

Which factor is the primary physiological limit to VO_2 max in healthy individuals?

- A. Pulmonary diffusion capacity
- B. Hemoglobin saturation
- C. Muscle mitochondrial density
- D. Cardiac output
- E. Alveolar ventilation

 **Answer: D**

Explanation:

Max oxygen delivery is limited by how much blood the heart can pump.

 **Question 10**

Which form accounts for the majority of CO_2 transport in blood?

- A. Dissolved CO_2
- B. Carbaminohemoglobin
- C. Carbonic acid
- D. Bicarbonate
- E. CO_2 bound to plasma proteins

 **Answer: D**

Explanation:

~60% of CO_2 transported as HCO_3^- via carbonic anhydrase.

 **Question 11**

The Haldane effect refers to which of the following?

- A. Increased CO₂ binding to oxygenated hemoglobin
- B. Release of CO₂ from hemoglobin upon oxygenation
- C. Increased oxygen affinity in acidic conditions
- D. Increased bicarbonate formation in lungs
- E. Increased chloride shift in tissues

 **Answer: B**

Explanation:

Oxygenation of Hb in lungs \rightarrow \downarrow CO₂ affinity \rightarrow CO₂ released.

 **Question 12**

Carbonic anhydrase is most important for which step in CO₂ transport?

- A. Diffusion of CO₂ into alveoli
- B. Binding of CO₂ to hemoglobin
- C. Conversion of CO₂ to bicarbonate in RBCs
- D. Transport of dissolved CO₂
- E. Buffering of hydrogen ions in plasma

 **Answer: C**

Q1

A healthy adult voluntarily holds his breath for as long as possible. After some time, he is forced to breathe involuntarily. What is the primary mechanism responsible for terminating voluntary breath-holding?

- A) Decreased PaO_2 stimulating carotid bodies
- B) Increased PaCO_2 causing direct inhibition of DRG
- C) Increased H^+ concentration stimulating central chemoreceptors
- D) Decreased ATP levels in respiratory neurons
- E) Activation of apneustic center

 Answer: C

 Explanation:

CO_2 diffuses into CSF \rightarrow converted to H^+ \rightarrow stimulates chemosensitive area \rightarrow activates DRG \rightarrow overrides cortical inhibition.

Q2

Which of the following arterial blood gas changes will most strongly stimulate ventilation in a healthy individual?

- A) PaO_2 decreases from 100 to 80 mmHg
- B) PaO_2 increases from 100 to 120 mmHg
- C) PaCO_2 decreases from 40 to 35 mmHg
- D) PaCO_2 increases from 40 to 45 mmHg
- E) pH increases from 7.40 to 7.45

 Answer: D

 Explanation:

CO_2 has **bidirectional, linear control** of ventilation and is the **strongest stimulus**.

Q3

Alveolar ventilation is increased while CO₂ production remains constant. What happens to arterial CO₂ tension?

- A) Increases
- B) Decreases
- C) Remains unchanged
- D) Fluctuates unpredictably
- E) Initially increases then decreases

 Answer: B

 Explanation:

$$\text{PACO}_2 = (\dot{V}\text{CO}_2 / \dot{V}\text{A}) \times 0.862$$

↑ ventilation → ↓ PaCO₂

Q4

A patient with chronic obstructive pulmonary disease (COPD) receives high-flow oxygen. Shortly after, he develops respiratory depression. What is the most likely explanation?

- A) Increased PaCO₂ stimulates central chemoreceptors
- B) Loss of hypoxic ventilatory drive
- C) Direct inhibition of pneumotaxic center
- D) Increased bicarbonate excretion
- E) Increased oxygen toxicity

 Answer: B

 Explanation:

In chronic CO₂ retention → ventilation depends on hypoxia (PaO₂ < 60). Giving high O₂ removes the hypoxic drive → ↓ ventilation → CO₂ retention.

Q5

Which structure primarily terminates inspiration?

- A) Dorsal respiratory group
- B) Ventral respiratory group
- C) Apneustic center
- D) Pneumotaxic center
- E) Nucleus tractus solitarius



Answer: D

Explanation:

Pneumotaxic center (upper pons) **suppresses DRG** → ends inspiration.

Q6

At what arterial oxygen tension does oxygen begin to significantly stimulate ventilation?

- A) 100 mmHg
- B) 80 mmHg
- C) 70 mmHg
- D) 60 mmHg
- E) 40 mmHg



Answer: D

Explanation:

O_2 only becomes a stimulus when $\text{PaO}_2 < 60 \text{ mmHg}$.

Q7

Which of the following best explains why CO₂ is considered a "self-compensatory gas"?

- A) It has a sigmoidal dissociation curve
- B) It diffuses slowly across alveoli
- C) It has a linear dissociation curve
- D) It binds hemoglobin irreversibly
- E) It does not stimulate ventilation

 **Answer:** C

 **Explanation:**

Linear CO₂ dissociation curve → mixing blood corrects regional differences.

Q8

Which nerve transmits signals from the carotid bodies to the respiratory center?

- A) Vagus nerve
- B) Phrenic nerve
- C) Hypoglossal nerve
- D) Glossopharyngeal nerve
- E) Trigeminal nerve

 **Answer:** D

 **Explanation:**

Carotid bodies → CN IX

Aortic bodies → CN X

Q9

During exercise, arterial blood gases remain normal despite increased ventilation. What is the primary stimulus for increased ventilation?

- A) Increased PaCO_2
- B) Decreased PaO_2
- C) Increased H^+
- D) Muscle and joint receptors
- E) Central chemoreceptors



Answer: D



Explanation:

Ventilation \uparrow proportionally with $\text{VO}_2 \rightarrow$ ABGs unchanged \rightarrow driven by mechanoreceptors.

Q10

Which of the following best describes hyperventilation?

- A) Increased tidal volume during exercise
- B) Increased respiratory rate with normal PaCO_2
- C) Ventilation exceeding CO_2 production
- D) Ventilation matching metabolic demand
- E) Increased oxygen consumption



Answer: C



Explanation:

Hyperventilation \rightarrow hypocapnia, not just fast breathing.

- هو الملك  : أقوى وأسرع محفّز للتنفس CO_2
- تأثيره ضعيف إلا تحت O_2 60.
- COPD = hypoxic drive
- يوقف الشهيق Pneumotaxic
- Central chemoreceptors = CO_2/H^+
- Peripheral = O_2 (Carotid bodies)