Breathing and Exchange of Gases

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The primary site of exchange of gases in the lungs is the:

(a) trachea **(b)** larynx **(c)** bronchi **(d)** alveoli

2. A person has tidal volume 450 mL, inspiratory reserve volume 3,000 mL, expiratory reserve volume 1,100 mL and residual volume 1,200 mL. Their vital capacity is:

(a) 4,550 mL **(b)** 3,450 mL **(c)** 1,550 mL **(d)** 2,300 mL

3. A person breathes 12 times a minute with a tidal volume of 450 mL. The volume of air breathed in each minute is:

(a) 10,800 mL **(b)** 462 mL **(c)** 4,500 mL **(d)** 5,400 mL

4. About how much oxygen is delivered to the tissues by 200 mL of oxygenated blood?

(a) 10 mL **(b)** 8 mL **(c)** 100 mL **(d)** 40 mL

5. In which direction does O_2 diffuse between the deoxygenated blood and the tissues? (pO_2: 40 and 40 mm Hg)

(a) Both ways at different rates

(b) Neither: there is no gradient

(c) From the deoxygenated blood to the tissues

(d) From the tissues to the deoxygenated blood

6. The diaphragm:

(a) a double membrane round the lungs, with fluid that reduces friction

(b) next to the rhythm centre, sensitive to CO_2 and H^+

(c) a dome-shaped muscle whose contraction enlarges the thoracic cavity

(d) an enzyme in red cells that speeds up $CO_2 + H_2O \rightleftharpoons H_2CO_3$

7. What fraction of the CO_2 carried by blood travels as as bicarbonate?

(a) about 70% **(b)** about 23% **(c)** about 97% **(d)** about 3%

8. Assertion (A): With tidal volume 450 mL, IRV 2,800 mL and ERV 1,100 mL, the vital capacity is 5,550 mL.
Reason (R): Vital capacity is the greatest volume that can be breathed out after a forced inspiration: ERV + TV + IRV.

(a) Both A and R are true, and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. What is the difference between breathing and respiration?

10. A person has tidal volume 450 mL, inspiratory reserve volume 2,800 mL, expiratory reserve volume 1,100 mL and residual volume 1,200 mL. Find their vital capacity and total lung capacity.

11. A person breathes 16 times a minute with a tidal volume of 550 mL. How many litres of air do they breathe in 30 minutes?

12. How much oxygen does 1,200 mL of oxygenated blood deliver to the tissues, and how much CO_2 does the same volume of deoxygenated blood deliver to the alveoli?

13. What is the CO_2 partial-pressure gradient between the oxygenated blood and the atmospheric air, and which way would the gas diffuse?

14. Name the structure: a straight tube, supported by incomplete cartilaginous rings, that divides into the primary bronchi.

15. Each haemoglobin molecule can carry up to four O_2 molecules. How many O_2 molecules can 47 haemoglobin molecules carry, and how many when they are only half saturated?

16. Name the disorder: inflammation and fibrosis of the lungs from long exposure to dust.

Section C — Word problems — 4 × 4 = 16 marks

17. Describe the mechanism of breathing.

18. A person has tidal volume 450 mL, inspiratory reserve volume 3,000 mL, expiratory reserve volume 1,050 mL and residual volume 1,150 mL. Find (a) the inspiratory capacity, (b) the expiratory capacity, (c) the functional residual capacity, (d) the vital capacity and (e) the total lung capacity.

19. Using pO_2 and pCO_2 values (mm Hg) — alveoli: 104 and 40; oxygenated blood: 95 and 40 — explain the direction in which each gas would move between the alveoli and the oxygenated blood, and give each gradient.

20. A person breathes 18 times a minute with a tidal volume of 450 mL, and their heart pumps 4 litres of blood a minute. (a) Find the air breathed in per minute. (b) How much O_2 do the tissues receive per minute? (c) How much CO_2 reaches the lungs per minute? (Take 5 mL of O_2 and 4 mL of CO_2 per 100 mL of blood.)

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Answer key

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Q	Answer	Working
1	**(d) alveoli**	—
2	**(a) 4,550 mL**	vital capacity = ERV + TV + IRV
3	**(d) 5,400 mL**	450 × 12
4	**(a) 10 mL**	about 5 mL per 100 mL of blood
5	**(b) Neither: there is no gradient**	gases diffuse from high to low partial pressure
6	**(c) a dome-shaped muscle whose contraction enlarges the thoracic cavity**	—
7	**(a) about 70%**	—
8	**(d) A is false, but R is true.**	A is false: 1,100 + 450 + 2,800 = 4,350. R is true.
9	**Breathing is the exchange of air between the atmosphere and the lungs (inspiration and expiration). Respiration also includes the exchange of gases at the alveoli and tissues and the use of oxygen in cells to release energy.**	—
10	**vital capacity = ERV + TV + IRV = 4,350 mL; total lung capacity = VC + RV = 5,550 mL**	—
11	**264 L**	550 × 16 × 30 mL
12	**60 mL O_2; 48 mL CO_2**	about 5 mL O_2 and 4 mL CO_2 per 100 mL of blood
13	**39.7 mm Hg; from the oxygenated blood to the atmospheric air**	pCO_2: 40 and 0.3 mm Hg
14	**Trachea**	—
15	**188; 94**	47 × 4
16	**Occupational respiratory disorders**	—

Q	Answer	Working
17	**Inspiration: the diaphragm contracts and the external intercostal muscles lift the ribs and sternum, increasing the volume of the thoracic cavity in both directions; the lungs expand, the pressure inside falls below atmospheric and air enters. Expiration: the diaphragm and intercostal muscles relax, the volume decreases, the pressure in the lungs rises above atmospheric and air leaves. Abdominal muscles help in forced breathing.**	—
18	**(a) TV + IRV = 3,450 mL; (b) TV + ERV = 1,500 mL; (c) ERV + RV = 2,200 mL; (d) ERV + TV + IRV = 4,500 mL; (e) VC + RV = 5,650 mL**	—
19	**O_2 moves from the alveoli to the oxygenated blood (gradient 9 mm Hg); CO_2: no gradient, no net movement. Gases diffuse from high to low partial pressure; CO_2 is 20–25 times more soluble, so a small gradient is enough.**	—
20	**(a) 8,100 mL; (b) 200 mL; (c) 160 mL**	450 × 18; 4000 mL × 5/100; × 4/100