1. Which of the following lung volumes or capacities can be measured by spirometry?

(A) Functional residual capacity (FRC)
(B) Physiologic dead space
(C) Residual volume (RV)
(D) Total lung capacity (TLC)
(E) Vital capacity (VC)

2. An infant born prematurely in gestational week 25 has neonatal respiratory distress syndrome. Which of the following would be expected in this infant?

(A) Arterial PO₂ of 100 mm Hg
(B) Collapse of the small alveoli
(C) Increased lung compliance
(D) Normal breathing rate
(E) Lecithin:sphingomyelin ratio of greater than 2:1 in amniotic fluid

3. In which vascular bed does hypoxia cause vasoconstriction?

(A) Coronary
(B) Pulmonary
(C) Cerebral
(D) Muscle
(E) Skin

Questions 4 and 5
A 12-year-old boy has a severe asthmatic attack with wheezing. He experiences rapid breathing and becomes cyanotic. His arterial PO₂ is 60 mm Hg and his PCO₂ is 30 mm Hg.

4. Which of the following statements about this patient is most likely to be true?

(A) Forced expiratory volume/forced vital capacity (FEV₁/FVC) is increased
(B) Ventilation/perfusion (V/Q) ratio is increased in the affected areas of his lungs
(C) His arterial PCO₂ is higher than normal because of inadequate gas exchange
(D) His arterial PCO₂ is lower than normal because hypoxemia is causing him to hyperventilate
(E) His residual volume (RV) is decreased

5. To treat this patient, the physician should administer

(A) an α₁-adrenergic antagonist
(B) a β₁-adrenergic antagonist
(C) a β₂-adrenergic agonist
(D) a muscarinic agonist
(E) a nicotinic agonist

6. Which of the following is true during inspiration?

(A) Intrapleural pressure is positive
(B) The volume in the lungs is less than the functional residual capacity (FRC)
(C) Alveolar pressure equals atmospheric pressure
(D) Alveolar pressure is higher than atmospheric pressure
(E) Intrapleural pressure is more negative than it is during expiration

7. Which volume remains in the lungs after a tidal volume (TV) is expired?

(A) Tidal volume (TV)
(B) Vital capacity (VC)
(C) Expiratory reserve volume (ERV)
(D) Residual volume (RV)
(E) Functional residual capacity (FRC)
(F) Inspiratory capacity
(G) Total lung capacity

8. A 35-year-old man has a vital capacity (VC) of 5 L, a tidal volume (TV) of 0.5 L, an inspiratory capacity of 3.5 L, and a functional residual capacity (FRC) of 2.5 L. What is his expiratory reserve volume (ERV)?

(A) 4.5 L
(B) 3.9 L
(C) 3.6 L
(D) 3.0 L
(E) 2.5 L
(F) 2.0 L
(G) 1.5 L

9. When a person is standing, blood flow in the lungs is

(A) equal at the apex and the base
(B) highest at the apex owing to the effects of gravity on arterial pressure
(C) highest at the base because that is where the difference between arterial and venous pressure is greatest
(D) lowest at the base because that is where alveolar pressure is greater than arterial pressure

10. Which of the following is illustrated in the graph showing volume versus pressure in the lung–chest wall system?

(A) The slope of each of the curves is resistance
(B) The compliance of the lungs alone is less than the compliance of the lungs plus chest wall
(C) The compliance of the chest wall alone is less than the compliance of the lungs plus chest wall
(D) When airway pressure is zero (atmospheric), the volume of the combined system is the functional residual capacity (FRC)
(E) When airway pressure is zero (atmospheric), intrapleural pressure is zero

11. Which of the following is the site of highest airway resistance?

(A) Trachea
(B) Largest bronchi
(C) Medium-sized bronchi
(D) Smallest bronchi
(E) Alveoli

12. A 49-year-old man has a pulmonary embolism that completely blocks blood flow to his left lung. As a result, which of the following will occur?

(A) Ventilation/perfusion (V/Q) ratio in the left lung will be zero
(B) Systemic arterial PO₂ will be elevated
(C) V/Q ratio in the left lung will be lower than in the right lung
(D) Alveolar PO₂ in the left lung will be approximately equal to the PO₂ in inspired air
(E) Alveolar PO₂ in the right lung will be approximately equal to the PO₂ in venous blood

Questions 13 and 14

13. In the hemoglobin–O₂ dissociation curves shown above, the shift from curve A to curve B could be caused by

(A) increased pH
(B) decreased 2,3-diphosphoglycerate (DPG) concentration
(C) strenuous exercise
(D) fetal hemoglobin (HbF)
(E) carbon monoxide (CO) poisoning

14. The shift from curve A to curve B is associated with

(A) increased P50
(B) increased affinity of hemoglobin for O₂
(C) impaired ability to unload O₂ in the tissues
(D) increased O₂-carrying capacity of hemoglobin
(E) decreased O₂-carrying capacity of hemoglobin

15. Which volume remains in the lungs after a maximal expiration?

(A) Tidal volume (TV)
(B) Vital capacity (VC)
(C) Expiratory reserve volume (ERV)
(D) Residual volume (RV)
(E) Functional residual capacity (FRC)
16. Compared with the systemic circulation, the pulmonary circulation has a
(A) higher blood flow
(B) lower resistance
(C) higher arterial pressure
(D) higher capillary pressure
(E) higher cardiac output

17. A healthy 65-year-old man with a tidal volume (TV) of 0.45 L has a breathing frequency of 16 breaths/min. His arterial $P_{CO_2}$ is 41 mm Hg, and the $P_{CO_2}$ of his expired air is 35 mm Hg. What is his alveolar ventilation?
(A) 0.066 L/min
(B) 0.38 L/min
(C) 5.0 L/min
(D) 6.14 L/min
(E) 8.25 L/min

18. Compared with the apex of the lung, the base of the lung has
(A) a higher pulmonary capillary $P_{O_2}$
(B) a higher pulmonary capillary $P_{CO_2}$
(C) a higher ventilation/perfusion (V/Q) ratio
(D) the same V/Q ratio

19. Hypoxemia produces hyperventilation by a direct effect on the
(A) phrenic nerve
(B) J receptors
(C) lung stretch receptors
(D) medullary chemoreceptors
(E) carotid and aortic body chemoreceptors

20. Which of the following changes occurs during strenuous exercise?
(A) Ventilation rate and $O_2$ consumption increase to the same extent
(B) Systemic arterial $P_{O_2}$ decreases to about 70 mm Hg
(C) Systemic arterial $P_{CO_2}$ increases to about 60 mm Hg
(D) Systemic venous $P_{CO_2}$ decreases to about 20 mm Hg
(E) Pulmonary blood flow decreases at the expense of systemic blood flow

21. If an area of the lung is not ventilated because of bronchial obstruction, the pulmonary capillary blood serving that area will have a $P_{O_2}$ that is
(A) equal to atmospheric $P_{O_2}$
(B) equal to mixed venous $P_{O_2}$
(C) equal to normal systemic arterial $P_{O_2}$
(D) higher than inspired $P_{O_2}$
(E) lower than mixed venous $P_{O_2}$

22. In the transport of $CO_2$ from the tissues to the lungs, which of the following occurs in venous blood?
(A) Conversion of $CO_2$ and $H_2O$ to $H^+$ and $HCO_3^-$ in the red blood cells (RBCs)
(B) Buffering of $H^+$ by oxyhemoglobin
(C) Shifting of $HCO_3^-$ into the RBCs from plasma in exchange for $Cl^-$
(D) Binding of $HCO_3^-$ to hemoglobin
(E) Alkalinization of the RBCs

23. Which of the following causes of hypoxia is characterized by a decreased arterial $P_{O_2}$ and an increased A–a gradient?
(A) Hypoventilation
(B) Right-to-left cardiac shunt
(C) Anemia
(D) Carbon monoxide poisoning
(E) Ascent to high altitude

24. A 42-year-old woman with severe pulmonary fibrosis is evaluated by her physician and has the following arterial blood gases: $pH = 7.48$, $P_{O_2} = 55$ mm Hg, and $P_{CO_2} = 32$ mm Hg. Which statement best explains the observed value of $P_{CO_2}$?
(A) The increased $pH$ stimulates breathing via peripheral chemoreceptors
(B) The increased $pH$ stimulates breathing via central chemoreceptors
(C) The decreased $P_{O_2}$ inhibits breathing via peripheral chemoreceptors
(D) The decreased $P_{O_2}$ stimulates breathing via peripheral chemoreceptors
(E) The decreased $P_{O_2}$ stimulates breathing via central chemoreceptors

25. A 38-year-old woman moves with her family from New York City (sea level) to Leadville Colorado (10,200 feet above sea level). Which of the following will occur as a result of residing at high altitude?
(A) Hypoventilation
(B) Arterial $P_{O_2}$ greater than 100 mm Hg
(C) Decreased 2,3-diphosphoglycerate (DPG) concentration
26. The pH of venous blood is only slightly more acidic than the pH of arterial blood because
   (A) CO₂ is a weak base
   (B) there is no carbonic anhydrase in venous blood
   (C) the H⁺ generated from CO₂ and H₂O is buffered by HCO₃⁻ in venous blood
   (D) the H⁺ generated from CO₂ and H₂O is buffered by deoxyhemoglobin in venous blood
   (E) oxyhemoglobin is a better buffer for H⁺ than is deoxyhemoglobin

27. In a maximal expiration, the total volume expired is
   (A) tidal volume (TV)
   (B) vital capacity (VC)
   (C) expiratory reserve volume (ERV)
   (D) residual volume (RV)
   (E) functional residual capacity (FRC)
   (F) inspiratory capacity
   (G) total lung capacity

28. A person with a ventilation/perfusion (V/Q) defect has hypoxemia and is treated with supplemental O₂. The supplemental O₂ will be most helpful if the person's predominant V/Q defect is
   (A) dead space
   (B) shunt
   (C) high V/Q
   (D) low V/Q
   (E) V/Q = 0
   (F) V/Q = x

29. Which person would be expected to have the largest A–a gradient?
   (A) Person with pulmonary fibrosis
   (B) Person who is hypoventilating due to morphine overdose
   (C) Person at 12,000 feet above sea level
   (D) Person with normal lungs breathing 50% O₂
   (E) Person with normal lungs breathing 100% O₂