Respiratory Study Questions 2016: Courtesy of Dr. HN Mayrovitz: Answers and Explanations can be obtained from notes, lectures and required text. Answers are not generally provided although some may be discussed in sessions and otherwise. A certain % of the MC study questions may appear on the exam as is or slightly modified!

Please note that these Study Questions and MC Questions provided by Dr. HN Mayrovitz are offered as study aids and should not be viewed as inclusive of material that will be covered or tested in conjunction with any course. There are two parts PART 1 = "One-Liners" = 80 questions and PART 2 = MC questions = 150

**PART 1. Some Basic “One-Liner” Study Questions**

1. If lung compliance decreases, what is the effect on the work of inspiration?
2. Which alveolar cell types produce lung surfactant?
3. If surfactant production is low or absent, what will be the effect on Alveolar surface tension? Lung compliance? work of inspiration?
4. Do the effects of lung surfactant depend on lung volume?
5. What is the name given to lung volume at the end of quiet inspiration?
6. By what method can most lung volumes be determined?
7. If your TV was 600 ml, what RR would you need to achieve a total ventilation of 6 liters per minute?
8. Approximately what breathing rate would you need to achieve an alveolar ventilation of 400 ml per minute?
   (Hint you need to include your personal dead space volume).
9. What would happen to the oxygen tension in your trachea if you were on top of Mt. Everest?
10. Normal PCO2 of blood entering pulmonary capillaries is about ___________?
11. Normal PO2 of blood exiting the pulmonary circulation is about ___________?
12. The normal level of water vapor pressure in the lung is about ___________?
13. If at atmospheric pressure with alveolar pressure = -5 cm H20 and intrapleural pressure = -10 cm H20 What are the translung, transwall and total respiratory system pressure?
14. What is meant by lung compliance? What are its units?
15. Is the compliance of all lung alveoli the same?
16. Do alveoli at the lung apex have a higher or lower compliance than at the apex?
17. If they are different what is the reason?
18. If alveoli have lower compliance, is it easier or harder to inflate them?
19. What would happen to alveolar CO2 tension if total ventilation were increased?
20. What is meant by the following terms?
   Hypocapnea, Hypoxemia, Atelectasis, Hypoventilation, Hyperventilation
21. As you inspire does intrapleural pressure increase or decrease?
22. As you inspire does translung pressure increase or decrease?
23. What main muscles are involved in inspiration during "quiet" breathing?
24. What main muscles are activated during "quiet" expiration?
25. Is total respiratory compliance greater on less than lung compliance?
26. What is a primary defect associated with respiratory distress syndrome?
27. What is meant by restrictive lung disease?
28. What is meant by obstructive lung disease?
29. Which pressures are needed to determine airway resistance
30. What is meant by time constant and how does it effect respiration?
31. Is airway resistance higher in upper or lower airways?
32. Is turbulent air flow normally present anywhere in the airways?
33. In order to minimize work of breathing what pattern may people with obstructive lung adopt?
34. According to the Alveolar Ventilation Equation, if alveolar ventilation decreases in relation to CO2 removal, what happens to alveolar CO2 tension?
35. According to the Alveolar Gas Equation, if alveolar CO2 tension increases, what happens to alveolar PO2?
36. If the lung becomes stiffer, what happens to its compliance?
37. If the lung becomes stiffer, what happens to lung recoil pressure? Does this help or hinder inspiration? Does this help or hinder expiration?
38. What are the three main processes associated with respiratory function?
39. What is meant by the term "arterialized" blood?
40. How would you determine the A-a gradient?
41. What airways contribute to anatomical dead space?
42. Which pleura surrounds the lung?
43. Which artery supplies most of the lung tissues?
44. If the tracheal temperature decreases, does the water vapor pressure increase or decrease?
45. If the atmospheric pressure is 600 mmHg what is the partial pressure of oxygen in the trachea?
46. During a normal respiration cycle, when is the air flow zero?
47. What helps prevent collapse of smaller alveoli into larger alveoli?
48. A person with emphysema would have a high or low lung recoil pressure?
49. A person with interstitial fibrosis would have a high or low lung recoil pressure?
50. Which of the above two conditions is usually associated with a reduced lung compliance?
51. What would happen to lung compliance for each of the following?
   - Lung volume increases from FRC to TLC
   - Surfactant concentration decreases
   - Fibrosis develops within interstitial spaces
   - Alveoli walls break as in emphysema
   - Pulmonary capillaries leak fluid (edema)
52. What happens to the energy needed for inspiration if:
   - Lung compliance decreases
   - Lung recoil pressure increases
   - Airway resistance increases
   - Alveolar surface tension decreases
53. If alveolar ventilation falls below normal what happens to the following?
   - Alveolar CO2 tension
   - Alveolar O2 tension
   - PO2 in capillary blood exiting the lung
54. What happens to O2 delivery to tissues if the P50 value is reduced?
55. An increase in which quantities will increase P50?
56. What is the alveolar gas equation?
57. What is the alveolar ventilation equation?
58. What is meant by the term Total Respiratory System Compliance?
59. If lung and chest wall have equal compliances of 0.2 units, what is the total compliance?
60. If a patient breathes 80% oxygen at a pressure of 2 atmospheres, what is the tracheal PO2?
61. What is a shunt?
62. What is the difference between an anatomical and a physiological shunt?
63. What would be the effect of 100% O2 if either of 62 were present?
64. What five major factors can contribute to hypoxemia?
65. What is dynamic compression and in what way does it impact respiration?
66. What is meant by the equal pressure point (EPP)?
67. Explain the determinants of the Flow-Volume (F-V) curve in normals
68. In what ways does the F-V curve change in obstructive and restrictive lung disorders?
69. What does the term FEV represent and how is it used clinically?
70. Contrast the pressure effects of the Muller and Valsalva maneuvers.
71. In what forms may oxygen be carried in the blood?
72. In what forms may carbon dioxide be carried in the blood?
73. In what way does carbon monoxide affect oxygen binding and release?
74. What blood changes would cause peripheral chemoreceptors to increase ventilation?
75. What changes would cause central chemoreceptors to increase ventilation?
76. What are the Hering-Breuer reflexes?
77. What factors can reduce lung diffusion capacity (DL)?
78. Which muscles become activated during eupneic expiration?
79. What is meant by the term "ramping up" with respect to nerve impulses to respiratory muscles?
80. What is the approximate speed of red cells in lung capillaries?

**PART 2: Multiple Choice Study Questions**

1. The basic respiratory rhythm is generated by the
   A) apneustic center
   B) nucleus parabrachialis
   C) dorsal medulla
   D) pneumotaxic center
   E) cerebrum

2. At the end of a quiet inspiration, intraalveolar pressure is normally
   A) -40 cmH2O
   B) -4 cmH2O
   C) 0 cmH2O
   D) +4 cmH2O
   E) +40 cmH2O

3. Immediately after performing a forced vital capacity (VC) test, Mary starts to breathe into a 12 L spirometer containing 10% helium (He). At equilibrium the spirometer He concentration is 8.5%. If her VC is 5 L, her total lung capacity (TLC) is closest to which of the following volumes?
   A) 3 L
   B) 5 L
   C) 7 L
   D) 9 L
   E) 11 L

4. Rose has a respiratory rate (RR) of 18, a tidal volume (TV) of 350 ml and an anatomic dead space of 100 ml. She also has a normal alveolar CO2 tension (PACO2) of 40 mmHg. What is her alveolar ventilation?
   A) 4.0 L
   B) 4.5 L
   C) 5.0 L
   D) 5.5 L
   E) 6.0 L

5. If Rose now increases her tidal volume by 75 ml (with CO2 production unchanged), her PACO2 is now closest to
   A) 15 mmHg
   B) 10 mmHg
   C) 25 mmHg
   D) 30 mmHg
   E) 35 mmHg
6. In emphysema, which of the following would be expected to occur?
A) reduced airway resistance
B) reduced lung compliance
C) more negative intrapleural pressure
D) reduced FEV₁
E) both C and D

7. Which of the following would increase in obstructive but not in restrictive lung disease?
A) Vital capacity
B) Maximum breathing capacity
C) FEV₁
D) Functional residual capacity
E) Breathing frequency

8. Providing O₂ to a patient with long standing chronic obstructive pulmonary disease (COPD) may cause a decrease in ventilation. Which one of the following statements best explains this observation?
A) Mucous secretion increases
B) Airway resistance increases
C) Physiologic dead space increases
D) Peripheral chemoreceptor activity decreases
E) Diffusing capacity for oxygen decreases

9. At which of the following sites is the partial pressure of carbon dioxide highest?
A) exhaled gas
B) alveolar gas
C) systemic arterial blood
D) systemic venous blood
E) about the same in all of the above (40 mmHg)

10. At which of the following is the partial pressure of oxygen (PO₂) highest?
A) exhaled gas
B) anatomical dead space at the end of expiration
C) anatomical dead space at the end of inspiration
D) alveolar gas
E) about the same in all of the above (100 mmHg)

11. At the top of a 3000 meter high mountain, which alveolar partial pressures is expected to be lower than normal?
A) Alveolar oxygen
B) Alveolar carbon dioxide
C) Alveolar water vapor
D) all of the above
E) only A and B above

12. Low arterial O₂ tension and content is most likely to be observed in association with which of the following?
A) hypertension
B) fever
C) anemia
D) carbon monoxide poisoning
E) respiratory acidosis

13. Which one of the following is higher at the apex of the lung than at the base when a person is standing?
A) V/Q ratio
B) Blood flow
C) Ventilation
D) PA baggage
E) Lung compliance
14. The bulk of CO₂ is transported in arterial blood as
A) dissolved CO₂
B) carbonic acid
C) carbaminohemoglobin
D) bicarbonate
E) carboxyhemoglobin

15. At 100 feet below sea level (4 atmospheres) what would be the O₂ partial pressure of inspired air?
A) 160 mmHg
B) 320 mmHg
C) 640 mmHg
D) 1280 mmHg
E) none of the above

16. A patient is on a ventilatory adjusted for a tidal volume of 1 L at a frequency of 10/min. If the patient's anatomic dead space is 200 mL and the machine's dead space 50 mL, the alveolar ventilation is
A) 10 L/min
B) 8.5 L/min
C) 7.5 L/min
D) 5 L/min
E) not determinable from the information given

17. Subjects A and B have identical TV and RR and are subjected to spirometry and blood gas measurements. Subject A doubles her TV and decreases her RR to one-half of baseline. Subject B decreases her TV to one-half of baseline and doubles her RR. Which of the following statements about the resulting alveolar ventilation in the two women is true?
A) Alveolar ventilation is unchanged in both subjects
B) Alveolar ventilation increases in both subjects
C) Alveolar ventilation decreases in both subjects
D) Alveolar ventilation increases in subject A and decreases in subject B
E) Alveolar ventilation decreases in subject A and increases in subject B

18. The concentration of CO₂ is lowest in
A) the anatomic dead space at end inspiration
B) the anatomic dead space at end expiration
C) the alveoli at end inspiration
D) the alveoli at end expiration
E) the blood in the pulmonary veins

19. Complete transection of the brainstem above the pons would
A) result in cessation of all breathing movements
B) prevent any voluntary holding of breath
C) prevent the central chemoreceptors from exerting any control over ventilation
D) prevent the peripheral chemoreceptors from exerting any control over ventilation
E) abolish the Hering-Breuer reflex

20. Peripheral AND central chemoreceptors may both contribute to increased ventilation that occurs as a result of
A) decreased arterial oxygen content
B) decreased arterial blood pressure
C) increased arterial CO₂ tension
D) decreased arterial O₂ tension
E) increased arterial pH

21. The water vapor pressure of alveolar gas at a barometric pressure of 380 mmHg is
A) 23.5 mmHg
B) 47.0 mmHg
C) 76.0 mmHg
D) 94.0 mmHg
E) 105.0 mmHg
22. A deficiency of pulmonary surfactant would
A) decrease surface tension in the alveoli
B) decrease the change in intrapleural pressure required to achieve a given tidal volume
C) decrease lung compliance
D) decrease the work of breathing
E) increase functional residual capacity (FRC)

23. Bill breathes room air at sea level has an alveolar ventilation of 2 L/min. Blood gases show a PaCO2 of 48 mmHg and a PaO2 of 70 mmHg. Bill's alveolar O2 tension is equal to which of the following?
A) 150 mmHg
B) 110 mmHg
C) 100 mmHg
D) 90 mmHg
E) 60 mmHg

24. When the respiratory muscles are relaxed, the lungs are at
A) residual volume (RV)
B) expiratory reserve volume (ERV)
C) functional residual capacity (FRC)
D) inspiratory reserve volume (IRV)
E) total lung capacity (TLC)

25. Which one of the following is the most likely to cause a high arterial PCO2?
A) Increased metabolic activity
B) Increased alveolar dead space
C) Depressed medullary respiratory centers
D) Alveolar capillary block
E) Increased alveolar ventilation

26. Which of the following best represents a "right-to-left shunt"?
A) pulmonary blood flow through a region of lung atelectasis
B) blood flow from the left ventricle to the right ventricle through a hole in the interventricular septum
C) blood flow from skin arteries to skin veins which does not pass through skin capillaries
D) blood flow from the aorta into the pulmonary artery through the ductus arteriosus
E) Both A and B

27. Normal resistance of large and medium-sized airways as a percentage of the total airway resistance is approximately
A) 10 percent
B) 20 percent
C) 40 percent
D) 60 percent
E) 80 percent

28. Tom's alveolar PO2 is 60 mmHg and his systemic arterial PO2 is 56 mmHg. Which is the most likely explanation?
A. hypoventilation
B. diffusion limitation
C. right-to-left shunt
D. V/Q non-uniformity
E. V/Q is abnormally large

29. Pulmonary vascular resistance increases
A) as the lung volume approaches TLC
B) as the lung volume approaches FRC
C) as the cardiac output increases
D) as the pulmonary artery pressure increases
E) as left atrial pressure increases
30. Reduced functional hemoglobin due to anemia or CO poisoning does not produce increased ventilation because the 
A) blood flow to the carotid body is decreased 
B) total arterial O2 content is maintained within the normal range 
C) carotid body chemoreceptors are stimulated 
D) central chemoreceptors are stimulated 
E) P_{O2} of arterial blood does not change

31. Sarah’s systemic arterial O2 content is normal but her systemic venous O2 content is low. This is characteristic of 
A) diffusion limitation 
B) right-to-left shunt 
C) pulmonary V/Q increase 
D) low Hb concentration 
E) low cardiac output

32. Alice has a normal O2 tension and O2 content in pulmonary venous blood but her systemic arterial blood shows a 
significantly lower than normal O2 tension and O2 content. This is most likely due to a 
A) diffusion limitation 
B) right-to-left shunt 
C) pulmonary V/Q increase 
D) low cardiac output 
E) high cardiac output

33. As blood passes through systemic capillaries, what happens to the affinity of hemoglobin for oxygen and what 
happens to the Hb-O2 dissociation curve? 
A) Hb affinity for O2 increases and the dissociation curves shifts to the left 
B) Hb affinity for O2 increases and the dissociation curves shifts to the right 
C) Hb affinity for O2 decreases and the dissociation curves shifts to the left 
D) Hb affinity for O2 decreases and the dissociation curves shifts to the right 
E) neither Hb affinity for O2 nor the Hb-O2 dissociation curve change

34. Pulmonary compliance is characterized by which of the following statements?
A) It is independent of lung volume 
B) It is inversely related to the elastic recoil properties of the lung 
C) It increases in patients with pulmonary edema 
D) It is equivalent to P V 
E) It increases when there is a deficiency of surfactant

35. The percentage of hemoglobin saturated with O2 will increase if 
A) arterial P_{CO2} is increased 
B) hemoglobin concentration is increased 
C) temperature is increased 
D) arterial P_{O2} is increased 
E) arterial pH is decreased

36. Activity of central chemoreceptors is stimulated by 
A) an increase in the P_{CO2} of blood flowing through the brain 
B) a decrease of the P_{CO2} of blood flowing through the brain 
C) a decrease in the oxygen content of blood flowing through the brain 
D) a decrease in the metabolic rate of the surrounding brain tissue 
E) an increase in the pH of the CSF

37. In an acclimatized person at high altitudes, O2 delivery to tissues may be adequate at rest because of 
A) an increase in hematocrit and thereby Hb concentration 
B) the presence of an acidosis 
C) a decrease in the number of tissue capillaries 
D) the presence of a normal arterial P_{O2} 
E) the presence of a lower-than-normal arterial P_{CO2}
38. During quiet resting inspiration, more air normally goes to lung base alveoli than to alveoli at the lung apex because 
A) the alveoli at the base of the lung have more surfactant 
B) the alveoli at the base of the lung are more compliant 
C) the alveoli at the base of the lung have higher V/Q ratios 
D) there is a more negative intrapleural pressure at the base of the lung 
E) there is more blood flow to the base of the lung 

39. Which of the following increases due to stimulating parasympathetic nerves to smooth muscle in bronchioles? 
A) Lung compliance 
B) Airway diameter 
C) Elastic work of breathing 
D) Resistive work of breathing 
E) Anatomic dead space 

40. A spirometer can be used to measure directly 
A) functional residual capacity 
B) inspiratory capacity 
C) residual volume 
D) total lung capacity 
E) none of the above 

41. The oxygen required by the respiratory muscles would be increased by all the following EXCEPT 
A) a decrease in lung compliance 
B) a decrease in airway resistance 
C) an increase in the rate of respiration 
D) a decrease in the production of pulmonary surfactant 
E) an increase in tidal volume 

42) What is the expected systemic arterial O2 content if a normal person inhales 100% oxygen for an hour or so? 
A) 100 ml O2 / dl blood 
B) 40 ml O2 / dl blood 
C) 22 ml O2 / dl blood 
D) 11 ml O2 / dl blood 
E) none of the above, since pure O2 is toxic and would cause death within the hour 

43. Functions of alveolar macrophages include all the following EXCEPT 
A) phagocytosis of bacteria 
B) secretion of surfactant 
C) release of lysosomal enzymes into the alveolar space 
D) transport of inhaled particles out of the alveoli 
E) release of leukocyte chemotactic factors 

44. In a standing person, all the following contribute significantly to the presence of an A-a gradient for O2 EXCEPT 
A) variations in the V/Q ratios throughout the lungs 
B) a small right-to-left absolute shunt 
C) the nonlinearity of the oxyhemoglobin dissociation curve 
D) the disequilibrium of end-pulmonary PO2 and alveolar PO2 
E) blood flow from the bronchial circulation 

45. When is the resistance to blood flow of the pulmonary vascular bed lowest? 
A) When a person is at rest sitting up 
B) When a person is at rest lying down 
C) When a person is breathing air at high altitude 
D) When a person is exercising maximally 
E) None of the above because pulmonary vascular resistance is approximately constant
46. Surfactant is accurately described by all the following statements EXCEPT
A) it is a lipoprotein containing lecithin
B) it is in part responsible for hysteresis in the pressure-volume curve of the human lung
C) it reduces surface tension in the alveoli
D) it is made in type II cells
E) it is present in increased amounts in hyaline membrane disease

47. While standing which lung region has the highest ventilation and which region has the highest blood perfusion?
A) highest ventilation: Apex; highest perfusion: Apex
B) highest ventilation: Apex; highest perfusion: Base
C) highest ventilation: Base; highest perfusion: Apex
D) highest ventilation: Base; highest perfusion: Base
E) there is no “highest” region as the apex and base have equal ventilation and perfusion rates

48. Metabolic functions of the lung include all the following EXCEPT
A) inactivation of angiotensin II
B) inactivation of bradykinin
C) inactivation of prostaglandins
D) synthesis of prostaglandins
E) synthesis of surfactant

49. Normally, end-pulmonary capillary blood reaches diffusion equilibrium with alveolar partial pressure of all EXCEPT
A) oxygen
B) nitrogen
C) carbon dioxide
D) carbon monoxide
E) nitrous oxide (N₂O)

50. A stroke that destroyed the respiratory center of the medulla would be expected to lead to
A) quick cessation of breathing
B) apneustic breathing
C) ataxic breathing
D) very rapid breathing
E) very slow and deep breathing

51. Hypoxemia at a PO₂ of 55 mmHg has all the following effects EXCEPT
A) it stimulates carotid body chemoreceptors
B) it stimulates central chemoreceptors
C) it stimulates aortic body chemoreceptors
D) it causes a reflex increase in ventilation
E) it causes a reflex increase in arterial blood pressure

52. Increased ventilation may be produced by stimulation of all the following receptors EXCEPT
A) peripheral chemoreceptors
B) irritant receptors
C) peripheral pain receptors
D) pulmonary stretch receptors
E) J receptors

53. The functional residual capacity (FRC) in the lungs of a young healthy adult of average size:
A) is about 500 ml
B) becomes smaller if airflow resistance increases
C) can be estimated using a helium dilution method
D) has the effect of damping fluctuations of alveolar gas concentrations during the breathing cycle
E) is the volume at which some airways normally begin to close during expiration
54. Sam is healthy and sitting upright at rest. For Sam, which one of the following is true?
A) His tidal volume is 10% or less of total lung volume
B) His lungs inflate and deflate around a mean volume that is about 25% of their full capacity
C) During a forced exhalation his small airways start to close in lower parts of the lungs sooner than in upper parts
D) During a forced exhalation to RV the first air subsequently inhaled enters the apical regions of the lungs
E) If a resistance is added to the airways, the tidal exchange will shift to a higher lung volume

55. While breathing room air petite Sally is found to have the following lung volumes:

- Vital capacity: 3.5 liters
- Forced expiratory volume in 1 sec (FEV₁): 2.8 liters
- Functional residual capacity (FRC): 1.8 liters
- Residual volume (RV): 0.8 liters

For Sally:
A) airflow resistance is normal
B) the subject must be abnormal
C) the expiratory reserve volume is 1 liter
D) all of these measurements could have been made using only a spirometer

56. Compliance of the lungs:
A) is defined as the change in volume per unit change in expanding (inflating) pressure
B) is greatest, for the whole lung, between residual volume and functional residual capacity
C) is decreased if surfactant is depleted
D) within the tidal range, is greater at the apex than at the base of the lungs in the upright position

57. Concerning mechanical factors in breathing:
A) in the tidal range, there is more muscular work involved in breathing in than in breathing out
B) forced expiration is more difficult than forced inspiration
C) recoil of the chest wall assists inspiration
D) the pressure holding the lungs inflated is less effective at the base than at the apex
E) respiratory muscles use about 10% of the whole body oxygen consumption in normal people at rest

58. The muscular work done during inspiration:
A) is made less by the effect of surfactant
B) is greater if the elastic recoil of the lungs is greater
C) is greater if inspiration starts at a high lung volume than if it is in the normal tidal range
D) could be lessened by bronchiole dilatation
E) is partly spent in overcoming surface tension forces

59. Respiration of a paralyzed man, who has a dead space of 200 ml, is maintained with a respirator. When the Tidal volume (TV) is set to 600 ml at a RR of 10, his alveolar PCO₂ is 60 mmHg. To obtain a normal PACO₂ (40 mmHg), what changes should be made to the respirator?
A) Don't change TV but increase RR to 15
B) Don't change TV but increase RR to 20
C) Increase RR to 15 and increase TV to 800 ml
D) Don't change RR but increase TV to 700 ml
E) Don't change RR but increase TV to 900 ml

60. In a measurement of FRC via the helium dilution method, the initial and final concentration of He are 6% and 5% respectively. The initial volume of the helium gas mixture in the spirometer is 10 liters. What is his FRC in liters?
A) 10
B) 7
C) 4
D) 3
E) 2
#61. Decreased arterial O2 tension is a consequence of:
A) hypoventilation
B) low hemoglobin concentration
C) carbon monoxide poisoning
D) living at high altitude
E) ventilation-perfusion mismatch in the lungs

#62. In a healthy person, the following values were found for end-tidal (end expired) gas, and can be taken to represent alveolar partial pressures: PO2: 115 mmHg PCO2: 25 mmHg
A) the subject was overbreathing (hyperventilating)
B) the O2 percentage in the inspired gas must have been higher than in room air
C) the arterial PCO2 would be close to 25 mmHg
D) the arterial PO2 would be 90-100 mmHg
E) there must be a respiratory alkalosis

#63. With reference to the control of breathing:
A) the increase in ventilation in exercise is proportional to a rise in arterial PCO2
B) peripheral (arterial) chemoreceptors are stimulated by any form of diminished O2 content in arterial blood
C) afferent fibers in the vagus nerves carry information on the state of inflation of the lungs
D) breathing can continue when the brain stem is the only functioning part of the brain

#64. A healthy person (Bill) is at rest and is given pure O2 to breathe for five minutes. Which of the following is true?
A) During the 1st minute, ventilation will be considerably depressed
B) During the 5th minute, ventilation will be virtually the same as it was breathing air
C) Over the O2 breathing interval the arterial PCO2 will decrease considerably
D) Over the O2 breathing interval the arterial PO2 will rise to over 600 mmHg
E) Bill can hold his breath at the end of the five minutes for significantly longer than if he was breathing room air

#65. Concerning breathing, in a healthy person:
A) speech involves modified expiration
B) inhalation of 100% oxygen results in apnea (cessation of breathing)
C) inhalation of a gas mixture containing 5% CO2 stimulates breathing
D) the respiratory centers lie in the diencephalon
E) after hyperventilating, the breath can be held for longer than after normal breathing

#66. The neurons whose activity causes inspiratory muscle activity:
A) are situated in the medulla
B) are stimulated by their own extracellular acidity
C) show increase AP frequency during inspiration when chemoreceptor stimulation is increased
D) cease firing at the end of inspiration
E) project directly on to spinal motorneurons

#67. The central (medullary) chemoreceptors:
A) are stimulated by a rise in the acidity of the cerebral interstitial fluid
B) are stimulated when arterial CO2 tension increases
C) are stimulated when arterial O2 tension decreases
D) are stimulated when arteria pH decreases because of metabolic acidemia (e.g. lactic acid)
E) are entirely responsible for the increase in ventilation in response to rebreathing expired air

#68. Stimulation of the carotid bodies
A) occurs when there is a low arterial O2 tension
B) occurs when there is a raised arterial CO2 tension
C) causes an increase in ventilation
D) causes an increase in arterial blood pressure
E) is attenuated by breathing a high percentage of O2
#69. Concerning the carriage of gases by the blood:
A) a rise in PCO₂ increases the oxygen carrying capacity of the blood
B) at a fixed PO₂ of 40 mmHg, a rise in PCO₂ would increase the O₂ content of the blood
C) a rise in PCO₂ assists in off-loading of oxygen in the tissues
D) for blood with a given content of CO₂ a rise in PO₂ increases the PCO₂ of the blood
E) a rise in PO₂ assists in off-loading of CO₂ in the pulmonary capillaries

#70. 2,3-DPG (diphosphoglycerate):
A) decreases the affinity of hemoglobin for oxygen
B) increases in concentration in the erythrocytes in chronic hypoxia
C) increases in concentration in stored blood
D) binds to deoxygenated hemoglobin

#71. As blood passes through the lungs, the CO₂ that is released into the alveolar gas:
A) has been carried in the blood mainly as bicarbonate
B) has been carried in the blood partly in physical solution
C) has been carried in the blood partly by attachment to hemoglobin
D) is released with the assistance of carbonic anhydrase
E) is actively transported across the capillary-alveolar barrier

#72. As blood passes through the lungs, the CO₂ that is released into the alveolar gas:
A) matches, in a steady state, the rate of metabolic production of CO₂ by the tissues
B) is greater than the amount of O₂ taken into the blood, at a respiratory quotient (RQ) if 0.8
C) diffuses down a partial pressure gradient of about 45 mmHg at rest
D) causes the alveolar CO₂ partial pressure to rise even during expiration

#73. With reference to carbon dioxide:
A) more is taken up at any given PCO₂ by desaturated than by fully oxygenated blood
B) most of the blood 'CO₂ content' is in the form of bicarbonate in the plasma
C) it readily diffuses in and out of red blood cells
D) it forms carbonic acid more readily in plasma than in red blood cells
E) its uptake by blood passing through the tissues is enhanced by carbonic anhydrase inhibitors

#74. In the pulmonary circulation:
A) the vascular resistance decreases at birth
B) hypoxia is a vasodilator
C) the arterioles are thinner walled than systemic arterioles of similar diameter
D) the vascular resistance is about 18 times lower than the total peripheral (systemic) resistance
E) if cardiac output doubles, e.g. in exercise, pulmonary artery pressure also doubles

#75. Concerning the pulmonary circulation, in the upright position:
A) the pulmonary artery pressure at the apex is close to zero
B) vessels are more distended at the base of the lungs than at the apex
C) pulmonary artery and pulmonary vein pressures increase by about the same amount from heart level to lung base
D) the blood flow per unit lung volume is greater at the base than at the apex
E) there is a greater tendency for fluid to escape from pulmonary capillaries at the apex than at the base

#76. Movement of fluid out of pulmonary capillaries:
A) is increased if surfactant is deficient
B) normally occurs to some extent all the time
C) implies movement of fluid into the alveoli
D) is increased in rate by any increase in pulmonary capillary pressure
E) is increased in rate by any increase in pulmonary blood flow
#77. Consider blood leaving a lobe of the lung for which the ventilation-perfusion (V'/Q) ratio is initially 1.0. If the V'/Q ratio then increases to 2.0, in the blood leaving this lobe:
A) the O2 content will rise  
B) the PO2 will rise  
C) the PCO2 will be reduced  
D) the CO2 content will be reduced  
E) both CO2 and O2 content will increase

#78. Concerning ventilation-perfusion (V'/Q) matching/mismatching:
A) in the upright posture, alveolar ventilation per unit lung volume is greater at the apex than at the base  
B) in the upright posture, the V'/Q ratio is greater at the apex than at the base  
C) in the supine posture, the VQ ratio is lowest in the back of the lungs  
D) blockage of pulmonary capillaries by scattered emboli causes an increase in alveolar dead space  
E) collapse of alveoli causes an increase in venous admixture

#79. Concerning alveolar V'/Q ratios in different regions of the lungs:
A) an ‘infinite’ ratio implies alveolar dead space  
B) a ratio of zero implies venous admixture  
C) a high ratio causes a higher than average PO2 in the blood leaving that region  
D) a low ratio causes pulmonary capillary blood to leave without reaching the PO2 in the alveoli of that region  
E) an excess of areas with low ratios would necessarily cause a rise in arterial PCO2

#80. Mary has 13.5 g Hb/100 ml blood with 100% saturated Hb at a PO2 of 100 mmHg. When she breathes room air, her cardiac output (CO) is 6 L/min, and her O2 use is 300 ml/min. Assuming that Hb carries 1.34 mlO2/g, and that 0.3 ml of O2 dissolve per 100 ml of blood at a PO2 of 100 mmHg, which of the following is true for Mary?
A) her whole body arteriovenous difference for oxygen is 5 ml per 100 ml  
B) her mixed venous oxygen content is 1.5 ml per 100 ml  
C) if O2 use increases to 1.2 L/min & CO doubles, tissues must be extracting twice as much O2 from each liter of blood  
D) if she breathes 100% O2 so that her alveolar PO2 becomes 600 mmHg the arterial O2 content increases by 15 ml/L  
E) when the alveolar PO2 becomes 600 mmHg, the arterial PO2 will rise above 120 mmHg (do in class?)

#81. A 150 lb healthy normal weight man is under anesthesia and is mechanically ventilated at 8 L/min. The respirator TV is set at 0.8 liters. Inspired gas has 50% O2, CO2 production is 195 ml/min, O2 use is 240 ml/min:
A) the alveolar ventilation is 6.5 liters per min  
B) the patient is being hyperventilated  
C) the respiratory quotient (RQ) is greater than 1.2  
D) his alveolar CO2 tension is near 327 mmHg

82 All of the following statements concerning lung dead space and airways are correct EXCEPT which one?
A) Physiological dead space = (anatomic dead space) + (alveolar dead space)  
B) Anatomic dead space is the volume of the conducting airways  
C) Physiological dead space (PDS) increases as a result of pulmonary embolism  
D) If ventilation is fixed, increased PDS leads to an increase in arterial CO2 tension  
E) The ventilation/perfusion ratio is zero in the alveolar dead space

83) All of the following statements concerning intrapleural pressure (IPP) are correct EXCEPT which one?
A) During quiet breathing IPP is always less than atmospheric  
B) When standing, IPP at lung apex is more negative than at the lung base  
C) During inspiration, IPP becomes more negative  
D) At FRC the IPP equals the alveolar pressure

84. Which one 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 (VL)
An infant born prematurely in gestational week 25 has neonatal respiratory distress syndrome. Which one of the following would be expected in this infant?
A) arterial \( [\text{PO}_2] \) of 100 mmHg
B) collapse of the small alveoli
C) increased lung compliance
D) normal breathing rate

Which one 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

Which one of the following remains in the lungs after tidal volume (TV) is expired?
A) Vital capacity (VC)
B) Expiratory reserve volume (ERV)
C) Residual volume (RV)
D) Functional residual capacity (FRC)
E) Inspiratory capacity

Bob has a severe asthmatic attack with wheezing. He experiences rapid breathing and becomes cyanotic. His arterial \( [\text{PO}_2] \) is 60 mmHg and his \( [\text{PCO}_2] \) is 30 mmHg. For Bob, which one of the following statements is most likely true?
A) forced expiratory volume/forced vital capacity (FEV\(_1\)/FVC) is increased
B) ventilation/perfusion (V/Q) ratio is increased in the affected areas of his lungs
C) his arterial \( [\text{PCO}_2] \) is higher than normal because of inadequate gas exchange
D) his arterial \( [\text{PCO}_2] \) is lower than normal because hypoxemia is causing him to hyperventilate
E) his residual volume (RV) is decreased

A person 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) 1.5 L

During quiet breathing at rest, elastic recoil of the lung and chest wall balance each other at which lung volume?
A) TLC
B) RV
C) End of a normal expiration
D) End of a normal inspiration
E) VC

Mary is anemic but has normal pulmonary function. All values of the following will be lower than normal EXCEPT:
A) arterial \( [\text{O}_2] \) tension
B) arterial \( [\text{O}_2] \) content
C) venous \( [\text{O}_2] \) tension
D) venous \( [\text{O}_2] \) content
E) \( [\text{O}_2] \) carrying capacity

If blood flow to the left lung is completely blocked by a pulmonary artery embolism, which of the following occurs?
A) Ventilation/perfusion (V/Q) ratio in the left lung will be zero
B) Systemic arterial \( [\text{PO}_2] \) will be elevated
C) V/Q ratio in the left lung will be lower than in the right lung
D) Alveolar \( [\text{PO}_2] \) in the left lung will be approximately equal to the \( [\text{PO}_2] \) in inspired air
E) Alveolar \( [\text{PO}_2] \) in the right lung will be approximately equal to the \( [\text{PO}_2] \) in venous blood
93. Which one of the following 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)

94. The lung diffusion capacity decreases in all of the following EXCEPT:
A) Interstitial edema
B) Interstitial fibrosis
C) Alveolar edema
D) Emphysema
E) Exercise

95. Compared with the apex of the lung, the base of the lung has
A) a higher pulmonary capillary PO₂
B) a higher pulmonary capillary PCO₂
C) a higher ventilation/perfusion (V/Q) ratio
D) the same V/Q ratio

96. 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

97. All of the following cause tissue hypoxia and all reduce O₂ content of systemic venous blood EXCEPT
A) Hypoxic hypoxia (e.g. diffusion impairment)
B) Histotoxic hypoxia (e.g. cyanide poisoning)
C) Anemic hypoxia (e.g. low Hb concentration ~ 10g/100 ml of blood)
D) Carbon Monoxide poisoning (e.g. 50% Hb bound with CO)
E) Hypoperfusion hypoxia (e.g. low CO)

98. A lung area is not ventilated due to bronchial obstruction. Pulmonary capillary blood serving that area will have a PO₂ that is
A) equal to atmospheric PO₂
B) equal to mixed venous PO₂
C) equal to normal systemic arterial PO₂
D) higher than inspired PO₂
E) lower than mixed venous PO₂

99. Which causes of hypoxia is characterized by a decreased arterial PO₂ and an increased A-a gradient?
A) Hypeventilation
B) Right-to-left cardiac shunt
C) Anemia
D) Carbon monoxide poisoning
E) Ascent to high altitude

100. A patient with severe pulmonary fibrosis is evaluated by her physician and has the following arterial blood gases: pH = 7.48, Pao₂ = 55 mmHg, and Paco₂ = 32 mmHg. Which statement best explains the observed value of Paco₂?
A) The increased pH stimulates breathing via peripheral chemoreceptors
B) The increased pH stimulates breathing via central chemoreceptors
C) The decreased Pao₂ inhibits breathing via peripheral chemoreceptors
D) The decreased Pao₂ stimulates breathing via peripheral chemoreceptors
E) The decreased Pao₂ stimulates breathing via central chemoreceptors
101. At rest the O2 tension is lowest in the venous blood coming from which one of the following?
A) Brain
B) Kidney
C) Skeletal Muscle
D) Heart
E) Skin

102. Which of the following will occur as a result of residing at high altitude?
A) Hypoventilation
B) Arterial PO2 greater than 100 mmHg
C) Decreased 2,3-diphosphoglycerate (DPG) concentration
D) Shift to the right of the hemoglobin-O2 dissociation curve
E) Respiratory acidosis

103. The pH of venous blood is only slightly more acid 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

104. 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)

105. Which person would be expected to have the largest A-a O2 gradient?
A) Person with pulmonary fibrosis
B) Person who is hypoventilating
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

106. If ventilation demand becomes greater than normal, normally quiet neurons of which structure become active?
A) Apneustic center
B) Dorsal respiratory group
C) Nucleus of the tractus solitarius
D) Pneumotaxic center
E) Ventral respiratory group

107. A 43-year-old woman is biking in the mountains, where the atmospheric pressure is 700 mmHg and the relative humidity is close to zero. What is the partial pressure (mmHg) of oxygen in the mountain air?
A) 100
B) 110
C) 133
D) 147
E) 92

108. The basic rhythm of respiration is generated by neurons located in the medulla. Which of the following limits the duration of inspiration and increases respiratory rate?
A) Apneustic center
B) Dorsal respiratory group
C) Nucleus of the tractus solitarius
D) Pneumotaxic center
E) Ventral respiratory group
109. The forces governing the diffusion of a gas through a biological membrane include the pressure difference across the membrane $\Delta P$, the cross-sectional area of the membrane ($A$), the solubility of the gas ($S$), the distance of diffusion ($d$), and the molecular weight of the gas ($MW$). Which of the following changes decreases gas diffusion?

<table>
<thead>
<tr>
<th>$\Delta P$</th>
<th>$A$</th>
<th>$S$</th>
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<td>E) Increase</td>
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110. At FRC, Doris’s intrapleural pressure is -5 cm H$_2$O. What is her intrapleural pressure during inspiration?

A) +1 cm H$_2$O  
B) +4 cm H$_2$O  
C) 0 cm H$_2$O  
D) -3 cm H$_2$O  
E) -7 cm H$_2$O

111. Tom is at the top of Pike’s Peak, where the barometric pressure is 462 mmHg. Partial pressures of the various gases in his alveolar air are as follows:

- Nitrogen: 328 mmHg  
- Carbon dioxide: 20 mmHg  
- Water vapor pressure: 47 mmHg  

What is the oxygen partial pressure ($PO_2$) in his alveoli?

A) 52 mmHg  
B) 67 mmHg  
C) 75 mmHg  
D) 96 mmHg  
E) 104 mmHg

112. Dan has a static pulmonary compliance of 0.25 L/cm H$_2$O. His intrapleural pressure changes from -4 cm H$_2$O to -8 cm H$_2$O when he inhales. How much air did he inhale?

A) 0.5 liter  
B) 0.75 liter  
C) 1.0 liter  
D) 1.5 liter  
E) 2.0 liter

113. Jon breathes in as much air as he can and then exhales as much air as possible. His lung volume at maximum inspiration is 6.0 L, and the lung volume after maximum expiration is 1 L. His TV at rest is 0.5 liter, and his FRC is 3.5 liters. What is his VC?

A) 3.0 liters  
B) 3.5 liters  
C) 4.0 liters  
D) 5.0 liters  
E) 5.5 liters

114. Normal inspiration results from

A) decreased intrapleural pressure  
B) increased alveolar pressure  
C) decreased intrapleural pressure and an increased alveolar pressure  
D) depression of the thorax  
E) relaxation of the diaphragm
115. During the initial phase of inspiration in a healthy subject at rest,
A) intrapulmonary pressure rises
B) intra-abdominal pressure rises
C) intrapulmonary and intra-abdominal pressures rise
D) there is less muscular effort than during the initial phase of expiration
E) the larynx is elevated

116. In young, healthy men the compliance for both the pulmonary system and the thoracic cage are each 0.2 L/cm of H₂O. What is the compliance of the respiratory system?
A) 0.01
B) 0.1
C) 1.0
D) 10
E) 100

117. Which of the following statements is correct about surfactant?
A) It is distributed homogeneously throughout the liquid that covers the alveolar epithelium
B) It is usually at a high concentration in the lung of the premature infant
C) It causes surface tension of small alveoli to be less than that of large alveoli
D) It increases surface tension
E) It is not formed by alveolar cells

118. In a standing person, which statement best describes the pattern of ventilation in the lungs during quiet breathing?
A) surfactant keeps each region of the lung equally distended and ventilated
B) gravity keeps the lung base more poorly expanded and ventilated than the apex
C) gravity keeps the lung base more poorly expanded and better ventilated than the apex
D) gravity keeps the lung base more expanded and ventilated than the apex
E) gravity keeps the lung base more expanded and less ventilated than the apex

119. Which one of the following best describes factors that increase the work of breathing?
A) airway constriction
B) increased tidal volume
C) airway constriction and increased tidal volume
D) increased compliance of the lungs
E) decreased density of the inspired gas

120. What is the most efficient method for an asthmatic to use during respiration?
A) hyperventilation
B) higher RR and lower TV than a healthy subject
C) lower RR and higher TV than the healthy subject
D) a RR and TV comparable to that of a healthy person
E) a RR and TV comparable to that for a person with a reduced lung compliance

121. The only factor below that is not a determinant of the quantity of gas that will diffuse through a barrier is:
A) surface area available for diffusion
B) thickness of barrier
C) molecular weight of diffusing particle
D) viscosity of the medium
E) driving pressure
122. When inhaled, which of the following gases would diffuse most slowly from the lungs into the blood:
A) CO$_2$ at a PCO$_2$ of 60 mmHg
B) CO at a PCO of 0.5 mmHg
C) O$_2$ at a PO$_2$ of 130 mmHg
D) O$_2$ at a PO$_2$ of 150 mmHg
E) nitrous oxide at a PN$_2$O of 0.3 mmHg

123. Which of the following procedures will cause an immediate cessation of respiration?
A) transection of the cord at C6
B) transection of the cord at C2
C) transection between the medulla and pons
D) transection of the cord at T3
E) transection of the cord at L1

124. Which of the following statements can be said about the pneumotaxic center?
A) it is in the midbrain
B) it inhibits inspiratory activity
C) it contains the major central chemoreceptor area
D) it causes long inspiratory gasps when separated from the more superior parts of the brain
E) it causes long expiratory gasps when separated from the more superior parts of the brain

125. Which structure is most important in increasing ventilation in response to small increases in body fluid PCO$_2$?
A) pulmonary chemoreceptors
B) venous chemoreceptors
C) lung receptors
D) peripheral chemoreceptors
E) medullary chemoreceptors

126. A major importance the peripheral chemoreceptors is that they respond to
A) decreases in PO$_2$ in the venous blood
B) decreases in PO$_2$ in the arterial blood
C) decreases in PO$_2$ in the cerebrospinal fluid
D) increases in PO$_2$ in the venous blood
E) increases in PO$_2$ in the arterial blood

127. Chemoreceptors in the carotid and aortic bodies send impulses via the 9th and 10th cranial nerves to the respiratory centers. Which of the following best characterizes their function?
A) send increasing frequencies of impulses up their nerves as the PO$_2$ of arterial blood increases
B) breath holding causes a more rapid increase in ventilation in response to PCO$_2$ than do central chemoreceptors
C) are less sensitive to hypoxia than the central chemoreceptors
D) are least important to the control of respiration during sleep and barbiturate depression
E) affect only respiratory rate

128. The peripheral chemoreceptors produce a more pronounced increase in ventilation in response to
A) a decrease in arterial PO$_2$ from 150 to 90 mmHg than from 70 to 40 mmHg under usual resting conditions
B) a change in arterial PO$_2$ from 100 to 80 mmHg at a PCO$_2$ of 48 mmHg than at a PCO$_2$ of 40 mmHg
C) both of the above statements
D) a 30% reduction in the O$_2$ content of arterial blood, as in anemia, than to a 30% reduction in arterial PO$_2$
E) a change in pH from 7.4 to 7.3 than cyanide poisoning

129. If the 9th and 10th cranial nerves are blocked in the neck, the subject will no longer respond to
A) hypercapnea by causing an increased respiratory minute volume
B) alkalosis by causing an increased respiratory minute volume
C) hypoxia by causing an increased respiratory minute volume
D) hypercapnea or acidity by causing an increased respiratory minute volume
E) acidity or hypoxia by causing an increased respiratory minute volume
130. Which of the following usually causes an increased impulse frequency in afferent neurons from carotid bodies?
A) CO poisoning
B) anemia
C) hyperoxemia
D) hypoxic hypoxia
E) a 20% reduction in carotid body blood flow

131. A patient is brought to the ER suffering from an overdose of a barbiturate. He exhibits hypoventilation caused by respiratory center depression. He is given 100% O₂ and his ventilation decreases markedly, but his mixed venous plasma PO₂ rises to 130 mmHg. The patient probably
A) is well oxygenated and needs no additional treatment
B) should be switched to 95% O₂ + 5% CO₂
C) should receive a vasoconstrictor agent
D) should be treated for systemic acidosis
E) should be treated for systemic alkalosis

132. Which of the following would not be a useful change with acclimatization to high altitude?
A) hyperventilation
B) polycythemia
C) increased number of systemic capillaries
D) shift to the right of the O₂ dissociation curve
E) a decrease in plasma 2,3-diphosphoglycerate concentration

133. A decrease in plasma pH
A) causes a decrease in ventilation through the stimulation of the carotid bodies
B) is frequently associated with a decrease in arterial PCO₂
C) is frequently associated with an increase in ventilation in metabolic acidosis
D) may not cause as great a decrease in the pH of the cerebrospinal fluid because the blood-brain barrier and blood-cerebrospinal fluid barrier are not freely permeable to H⁺
E) is caused by a decrease in hydrogen ion concentration

134. The trachea, bronchi, and bronchioles do all of the following EXCEPT
A) warm the air
B) filter the air to remove impurities
C) distribute air to exchange surfaces
D) remove O₂ from the air
E) humidify the air

135. Which one of the following conditions does NOT occur on a large inspiration?
A) inspiratory muscles contract
B) size of the thoracic cavity increases
C) pleural pressure becomes more positive
D) transpulmonary pressure becomes more positive
E) lung becomes more inflated

136. During expiration, which of the following does NOT occur?
A) respiratory muscles relax
B) pleural pressure becomes less negative
C) transpulmonary pressure decreases
D) lung deflates
E) alveolar pressure decreases below atmospheric pressure

137. Transpulmonary pressure is greatest at the
A) end of expiration
B) middle of inspiration
C) end of inspiration
D) middle of expiration
E) beginning of inspiration
138. All of the following can be determined from a spirogram EXCEPT
A) expiratory reserve volume
B) inspiratory reserve volume
C) FEV1
D) functional residual capacity
E) inspiratory capacity

139. Blood circulation to the lung is greatest in the parts
A) furthest from the heart
B) closest to the ground
C) closest to the midline
D) furthest from the ground
E) closest to the heart

140. The greatest partial pressure gradient across the alveolar membrane is found for
A) H₂O
B) CO₂
C) N₂
D) O₂

141. The carbon dioxide transport route that is most used is:
A) carboxyhemoglobin
B) bicarbonate
C) dissolved in plasma
D) carbonic acid
E) dissolved in RBC intracellular fluid

142. Carbonic anhydrase is:
A) a carrier of CO₂ in the blood
B) a storage site for CO₂
C) an enzyme that accelerates the combination of CO₂ and water
D) an enzyme that splits the bicarbonate ion
E) an enzyme that splits carbonic acid into hydrogen and bicarbonate ions

143. For small changes in the following, which is the most powerful stimulant to alveolar ventilation?
A) increased PO₂
B) decreased PO₂
C) increased H⁺
D) decreased arterial pH
E) increased PCO₂

144. Which of the below causes a substantial increase in total O₂ carrying capacity of arterial blood (ml of O₂/100 ml)?
A) Breathing pure oxygen
B) Increasing blood temperature
C) Increasing hydrogen-ion concentration
D) Increasing alveolar ventilation
E) Increasing the hematocrit

145. Which one of the following statements regarding intrapleural pressure is true?
A) It is defined as the pressure inside the lungs
B) It is defined as the difference between alveolar and atmospheric pressures
C) It becomes more negative when the residual volume increases
D) It prevents the lungs from collapsing at the end of expiration
E) It is generally more positive than alveolar pressure
146. A healthy person is flying in an airplane that has been pressurized to 10,000 feet above sea level (atmospheric pressure = 500 mmHg). Which one of the following statements is true in this person while flying?
A) Alveolar PO₂ remains normal because the fractional composition of the air O₂ remains unchanged (O₂ = 21%)
B) Alveolar PO₂ will be increased because water vapor pressure will be decreased
C) Alveolar PO₂ decreases but not enough to significantly effect on Hb saturation in the passenger's arterial blood
D) Hemoglobin saturation in the passenger's arterial blood will be less than 80%

147. A 27-year-old man is breathing quietly. He then inhales as much air as possible and exhales as much air as he can, producing the spirogram shown (left). What is his expiratory reserve volume?
A) 2.0 liters
B) 2.5 liters
C) 3.0 liters
D) 3.5 liters
E) 4.0 liters

148. For the spirogram shown, what is his vital capacity?
A) 2.0 liters
B) 2.5 liters
C) 3.0 liters
D) 3.5 liters
E) 5.0 liters

149. The volume-pressure curves shown were obtained from a normal subject and a patient suffering from a pulmonary disease. Which of the following abnormalities is more likely present in the patient?
A) Asbestosis
B) Emphysema
C) Mitral obstruction
D) Rheumatic heart disease
E) Silicosis

150. The diagram shows two lung units (S and T) with their blood supplies. Lung unit S has an ideal relationship between blood flow and ventilation. Lung unit T has a compromised blood flow. What is the relationship between alveolar dead space (DALV), physiologic dead space (DPHY), and anatomic dead space DANAT for these lung units?

<table>
<thead>
<tr>
<th>Lung Unit S</th>
<th>Lung Unit T</th>
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<tbody>
<tr>
<td>A) DPHY &lt; DANAT</td>
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<tr>
<td>B) DPHY = DALV</td>
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<td>C) DPHY = DANAT</td>
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<td>E) DPHY &gt; DANAT</td>
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