Name: _____

Physiology: Respiratory System

Directions: Write in and circle best answer on this sheet.

Part 1. Fill-in questions for the respiratory system.

1. There are _____ lobes in the right lung and _____ lobes in the left lung. Each of the lungs (the right and left) is contained within the thoracic cage in a cavity called the _____.

2. Air flows from regions of _____, to regions of _____. In other words, air moves _____ its _____ gradient.

3. Boyle's Law describes the **inverse pressure-volume** relationship of gases in a closed container. Simply put, as volume _____, pressure _____.

4. What is the primary muscle of respiration? _____. This muscle, and all the muscles of ventilation, are _____muscle. Therefore, what division of the nervous system controls muscles of ventilation? _____. The neurotransmitter released is _____ onto _____ receptors.

5. Tick which of these muscles are contracting in eupnea during inspiration:
   External intercostal muscles __, Internal intercostal muscles__, Diaphragm __, Abdominal muscles __.

6. Tick which of these muscles are contracting in forced expiration:
   External intercostal muscles __, Internal intercostal muscles__, Diaphragm __, Abdominal muscles __.

7. During **inspiration**, the volume of the thoracic cavity _____, and this causes the pressure of the thoracic cavity to _____. This results in Air moving _____ the lungs.

8. What is lost from the body through breathing besides carbon dioxide (CO_2)? _____.

9. There are ~_____ alveoli in each lung. About ____% of an alveolus is covered by capillaries.

10. Name the three types of cells in the **alveoli** and what their primary role is.
    1)
    2)
    3)

11. Surfactant is a _____, its function _____.

12. Are all alveoli the same size? _____. According to the **Law of La Place**, if two alveoli have equal ***surface tension***, then the _____ one will have a *higher* internal pressure.

13. The alveolus with a higher concentration of surfactant would be a _____ one.

14. It is _____ on the inner surface of the alveolus that creates _____, which is a force that contributes to the elasticity of the lungs, enhancing their tendency to recoil.

15. Use a *familiar* formula for **Air Flow** through a tube. The formula displays the relationship between the driving force and the resistance (R) to air flow. Also write the formula for **R** which includes length of airways (L), viscosity of air (n) and radius of airways (r). Simplify it to show the most significant factor.

Air Flow = R = *Simplified to:*

16. When a gas is in contact with water or plasma, what 3 factors determine how much gas will dissolve in it? Include for each what condition of the factor would make ***more*** gas dissolve in water or plasma.

1)

2)

3)

17. If a liquid is exposed to a P_{CO2} of 100 mmHg and a P_{O2} of 100 mmHg, equal amounts of oxygen (O_2) and carbon dioxide (CO_2) will dissolve in the liquid. True or false? _____.

18. The more soluble a gas is, the _____ partial pressure is needed to force the gas into solution. Gases move between liquid and gaseous phases until _____is reached. Which gas is more soluble in body fluids: O_2 or CO_2? _____.

19. By what mechanism do gases move between the alveoli and the plasma? _____.

20. If **bronchioles** constrict, then resistance _____ and air flow into the alveoli _____.

21. How do each of the following affect ***bronchiole diameter*** (bronchodilation or bronchoconstriction?)

1) CO_2: _____ **2)** Histamine: _____

3) Epinephrine: _____ **4)** Parasympathetic neurons: _____

22. Atmospheric pressure at sea level is _____. Alveolar pressure normally oscillates between_____. (Intra) Pleural pressure normally ranges from _____.

23. What are the **Partial Pressures** of $\mathbf{P_{O2}}$ and $\mathbf{P_{CO2}}$ for the atmosphere and alveoli during normal breathing?

a) P_{O2} atmosphere _____. P_{O2} alveoli _____.

b) P_{CO2} atmosphere_____. P_{CO2} alveoli _____.

24. What specific 2 cell layers must gases cross to go from the alveoli into the plasma?

1) _____ and **2)** _____.

25. How many globin protein subunits make a **Hb** molecule? ___. At the center of the globin is the element _____. This is where _____ binds to Hb. Hb bound to O_2 is called _____.

26. As dissolved O_2 diffuses into RBCs, what happens to PO_2 of surrounding plasma? _____.

27. Therefore, when O_2 binds with Hb, _____ O_2 can diffuse from the alveoli into plasma. At 100% saturation, all possible binding sites on the _____ portion are _____.

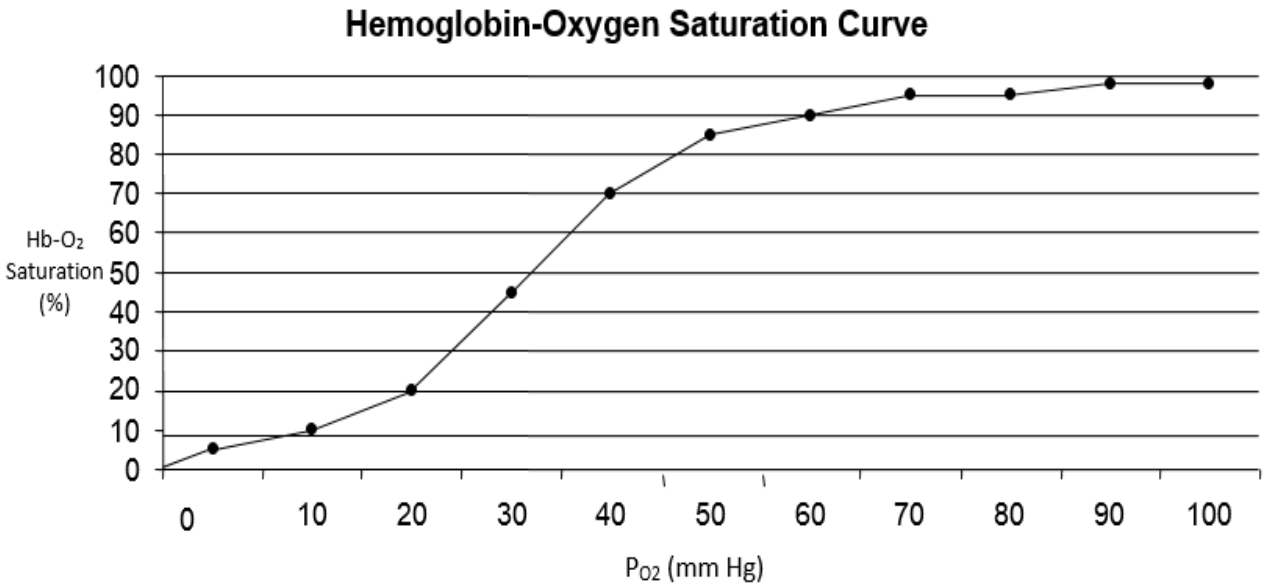
28. At the cells in the tissue, dissolved O_2 in plasma moves _____ the cells. This disturbs the _____ so O_2 dissociates from hemoglobin, obeying the Law of _____.

29. When equilibrium is restored, the P_{O2} of the plasma reflects the P_{O2} of the _____.

30. What is the name for hemoglobin when bound to CO_2 _____.

31. Write a labeled equation for the bicarbonate buffer. Include the enzyme catalyzes this reaction.

32. In the O_2-Hb saturation (dissociation) curve (below), the _____ determines the _____.



33. Reading the graph above, when the P_{O2} is 80 mm Hg, the Hb-O_2 saturation is _____. When the P_{O2} is 30 mm Hg, the Hb-O_2 saturation is _____.

34. The steep phase of the curve above represents the _____ capillaries, and the plateau phase represents the _____ capillaries.

35. Temperature, pH, and Metabolites Affect Oxygen-Hemoglobin Binding. Complete the following:

a. An increase in pH _____ hemoglobin's affinity for O_2.

b. An increase in temperature _____ hemoglobin's affinity for O_2.

c. An increase in P_{CO2} _____ hemoglobin's affinity for O_2.

d. The metabolite 2, 3-Diphosphoglycerate (DPG) _____ hemoglobin's affinity for O_2.

e. A left shift of the Hb-O_2 saturation curve indicates _____ binding affinity of Hb to O_2.

f. A right shift of the Hb-O_2 saturation curve indicates _____ binding affinity of Hb to O_2.

36. A **Left shift** of the curve occurs as we _____ and a **Right shift** occurs as we _____.

37. The molecule **2, 3-DPG** is made by _____. As 2, 3-DPG increases, it _____ Hemoglobin's affinity for O_2. Give an example of when production of 2, 3-DPG increases: _____.

38. Explain the three ways that **CO_2 is transported** in the blood, and the %'s of each.

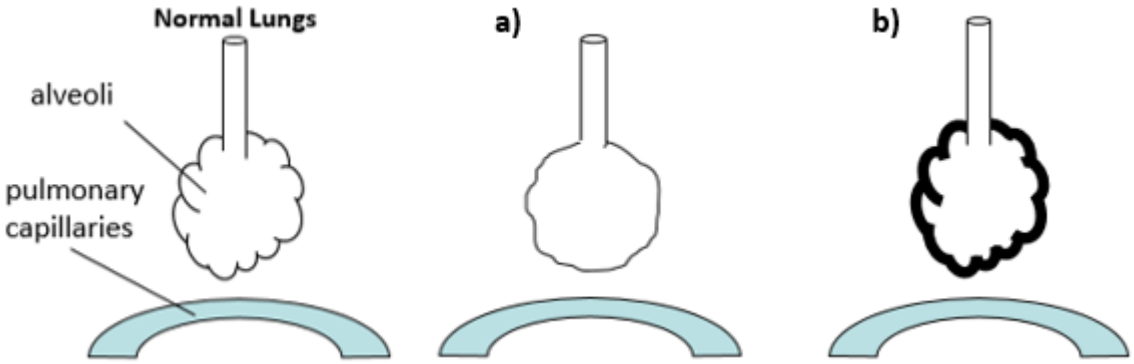
1)

2)

3)

39. Why does **pulmonary edema** decrease gas exchange? _____.

40. For the diagrams below, <u>make an assessment</u> of the states of the lungs for **a)** and **b)** below.



For a):

Name the likely disease for **a)**: _____. Restrictive or Obstructive? _____.

Major difference from normal: _____.

Changes in alveolar P_{O2} (O_2 levels)? _____.

Other functional changes? _____.

For b):

Name the likely disease for **b)**: _____. Restrictive or Obstructive? _____.

Major difference from normal: _____.

Changes in alveolar P_{O2} (O_2 levels)? _____.

Other functional changes? _____.

Part 2. From what you have learned in Part 1, please answer these multiple choice questions.

1. Starting at any point, which is the correct pathway air that travels into the human respiratory system?

a) mouth ➞ trachea ➞ bronchus ➞ bronchiole ➞ alveoli
b) nose ➞ larynx ➞ trachea ➞ bronchus ➞ bronchiole ➞ alveoli
c) nose ➞ trachea ➞ alveoli ➞ respiratory bronchiole ➞ bronchiole
d) trachea ➞ bronchiole ➞ 3^{o} bronchus ➞ alveolar duct ➞ alveoli
e) trachea ➞ respiratory bronchiole ➞ terminal bronchiole ➞ alveoli

2. For the respiratory system, a **decrease in volume** of the thoracic cavity leads to a(n) _____ pressure.
a) increase in **b)** equalization of **c)** decrease in **d)** zero pressure gradient **e)** both a and b

3. Air flow decreases as _____ increases.
a) the pressure gradient **b)** atmosphere pressure **c)** airway diameter **d)** force **e)** Resistance (R)

4. The primary role of the nasal conchae (turbinate) bones within the nasal cavity are to:
a) protect the lungs **b)** create turbulent air flow **c)** remove pathogens and debris
d) facilitate gas exchange in the nasal cavity **e)** speed up the air flow through the nasal cavity

5. The thin walls separating the alveoli from the pulmonary capillaries allow gas exchange to occur by:
a) facilitated diffusion **b)** filtration **c)** diffusion **d)** circulation **e)** osmosis

6. Alveolar macrophages
1. release α anti-trypsin **2.** phagocytose particles **3.** oppose the actions of surfactant
4. release trypsin in the lungs **5.** secrete mucus on alveolar surface for protection
a) 1 and 4 **b)** 2, 1 and 4 **c)** 2, 4 and 5 **d)** 4 and 2 **e)** 2, 5 and 1

7. The term _____ is a measure of the work required to _____ the lung. When this quality is low it's often due to a condition termed 'stiff' lung.
a) compliance; compress **b)** elasticity; stretch **c)** elasticity; recoil
d) surface tension; compress **e)** compliance; stretch

8. The values (mm Hg) for $\mathbf{P_{O2}}$ and $\mathbf{P_{CO2}}$ in the interstitial spaces of peripheral tissues are approximately:
a) 60: 40 **b)** 60: 46 **c)** 40: 100 **d)** 40: 46 **e)** 100: 40

9. Surfactant
a) protects the surface of the lungs **b)** reduces surface tension in alveoli **c)** replaces mucus in alveoli
d) helps to ensure that alveoli collapse to assist elastic recoil **e)** is only found in infant lung tissue

10. Which of the following occur during inhalation?
a) diaphragm contracts, pleural pressure increases, alveolar pressure decreases
b) diaphragm relaxes, external intercostals contract, pleural pressure increases
c) diaphragm relaxes, pleural pressure decreases, internal intercostals relax
d) external and internal intercostals contract, pleural and alveolar pressure increase
e) diaphragm and external intercostals contract, pleural and alveolar pressures decrease

11. According to this: $CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow H^+ + HCO_3^-$, what happens if CO_2 is increased?

a) the equation shifts to the left **b)** the equation shifts to the left first, then rapidly to the right
c) less carbon monoxide is made **d)** more bicarbonate ions are made **e)** fewer protons are made

12. Asthma is characterized by which these statements?
1. involves severe bronchoconstriction **2.** It is a restrictive lung disorder **3.** bronchodilation
4. shows an increased FEV_1 value **5.** is an obstructive lung disorder
a) 1 only **b)** 1, 2 and 3 **c)** 1 and 5 **d)** 1, 4 and 5 **e)** 5, 4 and 1

13. The values (mm Hg) for P_{CO2} and P_{O2} leaving the pulmonary capillaries are approximately:
a) 40: 100 **b)** 46: 100 **c)** 46: 40 **d)** 66: 46 **e)** 60: 40

14. Pulmonary ventilation is:
a) V_T x FEV_1 **b)** always less than alveolar ventilation **c)** the same as alveolar ventilation
d) always greater than alveolar ventilation **e)** the amount of air reaching alveoli

15. Which of the following reactions takes place in the **pulmonary capillaries** (i.e., at the alveoli)?
a) $Hb + CO \rightarrow HbCO$ **b)** $Hb + O_2 \rightarrow HbO_2$ **c)** $HbO_2 \rightarrow Hb + O_2$ **d)** $Hb + CO_2 \rightarrow HbCO_2$

16. For air to <u>exit</u> the lungs during expiration
a) alveolar pressure must be higher than the atmospheric pressure
b) atmospheric pressure inside the lungs must be less than alveolar pressure
c) alveolar pressure must become lower than the atmospheric pressure

17. Bronchitis will involve which of these conditions?
1. a loss of lung elasticity **2.** Inflammation of bronchioles **3.** bronchodilation
4. increased mucous production in the bronchioles **5.** a reduction of air flow in airways
a) 4 and 2 **b)** 2 only **c)** 1, 4 and 5 **d)** 3, 5 and 1 **e)** 2, 4 and 5

18. An increase in the pH of blood will:
a) shift the oxyhemoglobin ($Hb\text{-}O_2$) saturation (dissociation) curve to the right
b) increase the affinity of hemoglobin for O_2
c) decrease the O_2 carrying capacity of the lungs
d) decrease the affinity of hemoglobin for O_2
e) do all of these

19. Approximately how much of the CO_2 in the body is bound to Hb?
a) 10% **b)** 20% **c)** 30% **d)** 60% **e)** 80

20. Which statement is most accurate regarding Hb and the two gases CO_2 and O_2?
a) CO_2 and O_2 compete for the same site on the Hb molecule
b) the less O_2 there is, the lower the affinity Hb has for CO_2
c) the more O_2 there is, the lower the affinity Hb has for CO_2
d) the less CO_2 there is, the lower the affinity Hb has for O_2
e) the affinity that Hb has for both CO_2 and O_2 is constant and never changes

Part 3. Control and Regulation of Ventilation

Respiratory Neurons in the Medulla Control Inspiration and Expiration

1. Compare the functions of the dorsal and ventral respiratory groups of neurons in the medulla.

Carbon Dioxide, Oxygen, and pH Influence Ventilation

2. List three chemical factors that affect ventilation. Where are the sensory receptors located for each?

1)
2)
3)

Peripheral Chemoreceptors

3. Explain the strategic significance of the location of the *peripheral chemoreceptors*. To what chemical signals (and limited ranges) do the carotid and aortic bodies respond?

Central Chemoreceptors

4. How do *central chemoreceptors* respond to elevated blood Pco_2?

5. Central receptors in the medulla mediate ventilation changes in response to _____. A decrease in Pco_2 will trigger a/an (decrease/increase?) in ventilation.

6. A decrease in pH will trigger a/an (decrease/increase?) in ventilation. A decrease in arterial Po_2 below mm Hg will trigger a/an (decrease/increase?) An increase in Pco_2 will cause a/an (decrease/increase?) in pH, which in turn will trigger a/an (decrease/increase?) in ventilation.
What is the primary chemical stimulus for changes in ventilation? _____.

7. The **Hering-Breuer** inflation reflex is designed to _____.

8. If tidal volume exceeds _____, then _____ receptors in the lung will signal the brain stem to _____ inspiration.

Some Multiple Choice Questions for Part 3:

1) Which of the following areas of the brain can have an influence a person's breathing?
a) pons and cerebellum **b)** limbic system **c)** cerebrum **d)** medulla oblongata **e)** b, c and d

2) In the plasma of the blood, the most important regulator of respiration are the levels of _____.
a) O_2 **b)** CO_2 **c)** CO **d)** H^+ **e)** HCO_3^-

3) What does the ventral respiratory group within the medulla oblongata do?
a) triggers inspiration **b)** decreased ventilation rate **c)** nothing
d) for forced breathing **e)** inhibits apneustic center, sets limits to over inflation of lungs