Review Questions for Respiration and pH topic

Review questions will not be collected and are not worth any points. Doing them will, however, help you prepare for the midterms and quizzes in this course. Furthermore, some of these review questions will appear on the final exam (although the numbers within the questions may be changed).

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Nitrogen gas (N_2) and oxygen gas (O_2) can undergo a chemical reaction that makes nitric oxide gas (NO). The chemical equation for this reaction is shown below. Use this chemical equation to answer question 1 – 6 below.

N_2 + O_2 -> 2NO

1) N_2 is a
   A) Reactant
   B) Product
   C) Byproduct
   D) Catalyst
   E) Enzyme
   F) Reaction

2) O_2 is a
   A) Reactant
   B) Product
   C) Byproduct
   D) Catalyst
   E) Enzyme
   F) Reaction

3) NO is a
   A) Reactant
   B) Product
   C) Byproduct
   D) Catalyst
   E) Enzyme
   F) Reaction

4) If this reaction occurred in a closed vessel (such as a sealed test tube), as the reaction took place the amount of N_2 gas inside the vessel would
   A) Increase
   B) Decrease
   C) Stay the same (chemical equilibrium)

5) If this reaction occurred in a closed vessel (such as a sealed test tube), as the reaction took place the amount of O_2 gas inside the vessel would

A) Increase
B) Decrease
C) Stay the same (chemical equilibrium)

6) If this reaction occurred in a closed vessel (such as a sealed test tube), as the reaction took place the amount of NO gas inside the vessel would

A) Increase
B) Decrease
C) Stay the same (chemical equilibrium)

7) Carbon dioxide travels in the blood as which molecule(s)? (More than one answer is possible).

A) Carbonic acid.
B) Bicarbonate ion.
C) Carbon monoxide
D) Glucose

8) Bicarbonate ion (HCO_3^-) and hydrogen ion (H+) are made when _____ reacts with water.

A) oxygen
B) hydrogen
C) carbon dioxide
D) carbon monoxide

9) In the systemic loop, which reaction occurs?

A) $CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$
B) $CO_2 + H^+ \rightarrow HCO_3^- + H_2O \rightarrow H_2CO_3$
C) $HCO_3^- + H^+ \rightarrow H_2CO_3 \rightarrow CO_2 + H^+$
D) $HCO_3^- + H_2O \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$

10) An acid (for example, HCl) always…

A) adds H^+ ions to a solution.
B) increases the pH when added to a solution.
C) creates a buffer when added to a solution.
D) is a strong buffer at low pH only.
E) removes H^+ ions to a solution.

11) A base (for example, OH^-) always…

A) adds H^+ ions to a solution.
B) increases the pH when added to a solution.
C) creates a buffer when added to a solution.
D) is a strong buffer at low pH only.
E) removes H^+ ions to a solution.

12) Any molecule that adds H^+ ions to a solution is a…

A) Cell
B) Cell membrane
C) Acid
D) Buffer

13) Any molecule that removes H^+ ions from a solution is a…

A) Amino acid
B) Base
C) Organic molecule
D) Buffer

14) If the hydrogen ion concentration of a solution is the same as water, the solution has a pH of ____.

A) 0
B) 1
C) 7
D) 14

15) Which is **not** true of a solution that is pH 1?

A) It is acidic
B) It has more hydrogen ions than a solution that is pH 2
C) It has more hydrogen ions than pure water
D) It is a basic solution

16) If solution A has less hydrogen ions than solution B, and solution B has a pH of 7.0, then solution A must always have a pH

A) outside the 0 – 14 range
B) equal to 7.0
C) less than 7.0
D) greater than 7.0

17) A solution of a substance has a pH of 2. What can you conclude about this substance?

A) It is an acid
B) It is a base
C) It is a buffer

18) A given solution is pH 12. This solution is…

A) acidic.
B) basic.
C) buffered.
D) neutral.

19) A given solution is pH 0. This solution is…

A) acidic.
B) basic.
C) buffered.
D) neutral.

20) A given solution is pH 7.0. This solution is…

A) acidic.
B) basic.
C) buffered.
D) neutral.

21) Which of the following solutions would require the greatest amount of base to be added to bring the solution to neutral pH?

A) gastric juice at pH 2
B) vinegar at pH 3
C) tomato juice at pH 4
D) black coffee at pH 5
E) household bleach at pH 12

22) If the pH of a solution is decreased from 9 to 8, it means that the

A) concentration of H^+ has decreased.
B) concentration of H^+ has increased.
C) The H^+ concentration has not changed, but the concentration of pH has increased.
D) The H^+ concentration has not changed, but the concentration of pH has decreased.

23) If the pH of a solution is increased from pH 5 to pH 7, it means that the

A) concentration of H^+ has decreased.
B) concentration of H^+ has increased.
C) The H^+ concentration has not changed, but the concentration of pH has increased.
D) The H^+ concentration has not changed, but the concentration of pH has decreased.

24) Blood pH above the normal range is called

A) Acidosis
B) Buffering
C) Alkalosis
D) H^+
E) Bicarbonate ion
F) Respiratory compensation

25) Blood pH below the normal range is called

A) Acidosis
B) Buffering
C) Alkalosis
D) H^+
E) Bicarbonate ion
F) Respiratory compensation

26) In the pulmonary loop, which reaction occurs?

A) $CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$
B) $CO_2 + H^+ \rightarrow HCO_3^- + H_2O \rightarrow H_2CO_3$
C) $HCO_3^- + H_2O \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$
D) $HCO_3^- + H^+ \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$

27) Normal breathing rate for adults is _____ breaths per minute

A) 6 - 10
B) 12 - 18
C) 30 - 36
D) 80 - 120

28) The rate and depth of respiration are set by control centers located in the

A) pleurae.
B) lungs.
C) brain stem.
D) diaphragm.

29) The molecule in the blood that is measured by our breathing control centers and that is the major determinant of our breathing rate is:

A) Bicarbonate ion
B) O_2
C) H^+
D) CO_2

30) Hypoventilation tends to cause

A) a rise in blood pH.
B) increased CO_2 in the blood
C) increased O_2 in the blood
D) acidosis.
E) both b and d

31) If a person started to hyperventilate, the _____ in their blood would _____.

A) CO_2, Increase
B) O_2, Decrease
C) H^+, Decrease
D) Fe^{3+}, Decrease

32) Alkalosis can result from

A) Hyperventilation.
B) Increased iron in the diet
C) Excessive exercise
D) Hypoventilation.

33) If a non-respiratory problem causes an increase in the amount of _____ in the blood, the body will respond with _____ ventilation rate.

A) H^+; increased
B) acid; decreased
C) O2; increased
D) CO2; decreased

34) In response to metabolic alkalosis, ventilation rate will _____.

A) Increase
B) Decrease
C) Remain the same (breathing rate is controlled by O_2 concentration)

35) The ability of the body to maintain normal blood pH by altering the breathing rate is called

A) Alkalosis
B) Hyperventilation
C) Respiratory compensation
D) Cellular aerobic respiration
E) Metabolic acidosis

36) A person had chronic diarrhea for several days. The person's blood became pH 7.28. This is an example of

A) Respiratory alkalosis
B) Respiratory acidosis
C) Metabolic alkalosis
D) Metabolic acidosis

37) The respiratory compensation for the pH imbalance described in the problem above would be _____ in breathing rate.

A) an increase
B) a decrease

38) Any substance that resists changes in H^+ concentration and therefore tends to maintain a stable pH is called a ____.

A) stabilizing
B) buffer
C) carbonic acid
D) pH

39) Which of the following statements is true about buffered solutions?

A) They maintain a constant pH when bases are added to them but not when acids are added to them.
B) They maintain a constant pH when acids are added to them but not when bases are added to them.
C) They maintain a relatively constant pH of approximately 7 when either acids or bases are added to them.
D) They maintain a relatively constant pH when either acids or bases are added to them.
E) They are found only in living systems and biological fluids.

40) Buffers are substances that help resist shifts in pH by

A) adding H^+ to a solution when acids are added.

B) adding H^+ to a solution when bases are added.

C) adding OH^- to a solution when bases are added.

D) removing H^+ from a solution when acids are added.

E) A and D

F) B and D

41) If some abnormality caused the blood pH to begin to decrease, the carbonic acid/bicarbonate ion buffer would act to correct the pH imbalance. As the buffer was correcting the pH imbalance, which of the following would occur? (More than one possible answer).

A) There would be a decrease in the concentration of H_2CO_3 and an increase in the concentration of HCO_3^-.

B) There would be a decrease in the concentration of HCO_3^-.and an increase in the concentration of H_2CO_3.

C) The concentration of bicarbonate ion would increase but there would be no change in the concentration of carbonic acid.

D) The concentration of carbonic acid would increase but there would be no change in the concentration of bicarbonate ion.

E) The HCO_3^- would absorb excess H^+ .

F) The H_2CO_3.would release H^+.

42) If some abnormality caused the blood pH to begin to increase, the carbonic acid/bicarbonate ion buffer would act to correct the pH imbalance. As the buffer was correcting the pH imbalance, which of the following would occur? (More than one possible answer).

A) There would be a decrease in the concentration of H_2CO_3 and an increase in the concentration of HCO_3^-.

B) There would be a decrease in the concentration of HCO_3^-.and an increase in the concentration of H_2CO_3.

C) The concentration of bicarbonate ion would increase but there would be no change in the concentration of carbonic acid.

D) The concentration of carbonic acid would increase but there would be no change in the concentration of bicarbonate ion.

E) The HCO_3^- would absorb excess H^+ .

F) The H_2CO_3.would release H^+.

45) If a person drank large amounts of lemonade (pH 4), in their blood one would expect

A) a decrease in the concentration of H_2CO_3 and an increase in the concentration of HCO_3^-.

B) an increase in the concentration of H_2CO_3 and a decrease in the concentration of HCO_3^-.

C) a decrease in the concentration of HCO_3^- and an increase in the concentration of H^+.

D) an increase in the concentration of HCO_3^- and a decrease in the concentration of OH^-.

E) a decrease in the concentration of HCO_3^- and an increase in the concentration of both H_2CO_3 and H^+.

F) A lemon tree to grow in their stomach.

46) Respiring cells release CO_2 into the bloodstream.. Carbon dioxide (CO_2) when mixed with water in the blood undergoes the following chemical reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3 + H^+$$

What will be the effect on the blood's pH as the blood first receives CO_2 from respiring cells?

A) Blood pH will decrease slightly.

B) Blood pH will increase slightly.

C) Blood pH will remain unchanged.

D) Blood pH will first increase, then decrease as CO_2 combines with hemoglobin.

E) Blood pH will first decrease, then increase sharply as CO_2 combines with hemoglobin.

47) Define the following terms as they were defined in class.

a) Acid

b) Base

c) Buffer

d) Acidosis

e) Alkalosis

f) Respiratory acidosis

g) respiratory alkalosis

h) Metabolic acidosis

i) Metabolic alkalosis

j) Respiratory compensation

k) Hypoventilation

l) Hyperventilation

48) Blood is systemic loop arteries is high/low (circle one word) in O_2 and is high/low (circle one word) in CO_2. Blood is pulmonary loop arteries is high/low (circle one word) in O_2 and is high/low (circle one word) in CO_2. Blood is systemic loop veins is high/low (circle one word) in O_2 and is high/low (circle one word) in CO_2. Blood is pulmonary loop veins is high/low (circle one word) in O_2 and is high/low (circle one word) in CO_2.

49) For what purpose does the blood carry oxygen? Name the exact metabolic process that requires oxygen from the blood: _____.

50) Cells perform cellular aerobic respiration to replenish their _____ levels.

51) Most of the carbon dioxide in the blood is transported as _____ (write the name of the molecule); The molecular formula for this molecule is _____.

52) A smaller amount of the carbon dioxide in the blood is transported as _____ (write the name of the molecule); The molecular formula for this molecule is _____.

53) The benefit of converting the carbon dioxide in the blood into bicarbonate ion is _____.

54) For every molecule of CO_2 that becomes a bicarbonate ion in the blood, another ion (other than bicarbonate ion) is also produced in the blood. What is that other ion? _____.

55) Before CO_2 becomes bicarbonate ion, it first becomes a carbon-containing acid called _____. Write the molecular formula for this acid: _____.

56) Almost all of the carbonic acid that forms from CO_2 dissociates to form _____ and _____. The chemical equation for this reaction is written as _____.

57) Write out the full and balanced chemical equation for the conversion of CO_2 into HCO_3^-. (Hints: The CO_2 reacts with water in the blood to form carbonic acid, then the carbonic acid dissociates into bicarbonate ion and another ion. Include all of this in the chemical equation that you write).

58) The carbonic acid, bicarbonate ion, and H^+ in the blood come from CO_2 that is made by the cells. The cells make CO_2 as a waste product of the metabolic process called _____, which is the main process cells use to produce energy for themselves from glucose. Write the full and balanced chemical equation for this metabolic process.

59) A person is resting, then the person gets up and begins to exercise. As they start to exercise, the amount of CO_2 produced by their muscle cells will increase/decrease/not change (circle one of the three answers). Justify the answer you circled.

60) A person is resting, then the person gets up and begins to exercise. As they start to exercise, the amount of bicarbonate ion in their blood will increase/decrease/not change (circle one of the three answers). Justify the answer you circled.

61) A person is resting, then the person gets up and begins to exercise. As they start to exercise, the amount of H^+ in their blood will increase/decrease/not change (circle one of the three answers). Justify the answer you circled.

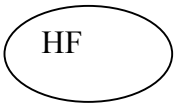
62) Any molecule that adds H+ to a solution is a(n) ____.

63) Any molecule that removes H+ to a solution is a(n) ____.

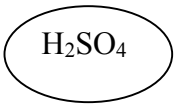
64) List a common acid found in the blood: _____

65) List a common base found in the blood: _____

66) Is the circled molecule below an acid or a base? Justify your answer.



67) Inspect the chemical reaction below. Is the circled molecule an acid or a base? Justify your answer.



68) The pH scale indicates how acidic (or basic) a solution is. The pH scale goes from ___ (a number) to ___ (a number). Pure water has a pH of ____ (a number), which is called the "neutral" pH because it is not acidic or basic.

69) Pure water does/does not (circle one) have H^+ ions.

70) Any solution that has more H^+ than water is called a(n) _____ solution. A solution of this type will always have a pH that is greater/equal to/less (circle one of the three) than pH 7.

71) Any solution that has fewer H^+ than water is called a(n) _____ solution. A solution of this type will always have a pH that is greater/equal to/less (circle one of the three) than pH 7.

72) A solution with a pH of 2.7 is an example of a strongly _____ solution

73) A solution of pH 3 has _____ more/less (choose one) H+ than pure water.

74) A solution of pH 2 has _____ more/less (choose one) H+ as one of pH 3

75) The more hydrogen ions there are in solution, the more acidic/basic (choose one) the solution is.

76) A solution of pH 8 is more/less (circle one) basic than one of pH 7.

77) A solution of pH 1 is more/less (circle one) acidic than one of pH 3.

78) Any process in the body that creates H^+ ions can change the _____ of the blood (hint: A term that describes the H^+ content of a solution).

79) When the blood levels of CO_2 rise above normal, the pH of the blood begins to increase/decrease (circle one).

80) The normal pH range of the blood is _____ to _____ pH.

81) When CO_2 enters the blood in the systemic loop and becomes HCO_3^-, this will increase/decrease (circle one) the H^+ content of the blood. This will increase/decrease (circle one) the pH of the blood.

82) If there is an increase in CO_2 in the blood, the blood's H^+ concentration will increase/decrease (circle one). This will increase/decrease (circle one) the pH of the blood.

83) If there is a decrease in CO_2 in the blood, the blood's H^+ concentration will increase/decrease (circle one). This will increase/decrease (circle one) the pH of the blood.

84) In class, we discussed two methods that the body uses to maintain the blood pH within the normal range. Name these two methods:

_____ & _____

85) In the pulmonary loop (the blood vessels of the lungs), _____ ion and _____ ion in the blood combine to form carbon dioxide. The CO_2 then exits the blood and enters the lungs.

86) Write the full and balanced chemical reaction for bicarbonate ion and hydrogen ion becoming carbon dioxide in the lungs.

87) HCO_3^- becoming CO_2 in the lungs increases/decreases (circle one) the H^+ content of the blood. This will increase/decrease (circle one) the pH of the blood.

88) What body process controls how the rate that HCO_3^- reacts with H^+ to become CO_2 in the lungs? _____.

89) If the breathing control center detects a decrease in blood pH (which means an increase in blood H^+), the breathing control center will attempt to bring the blood back into the correct pH range by increasing/decreasing (circle one word) the breathing rate.

90) If the breathing control center detects a increase in blood pH (which means an decrease in blood H^+), the breathing control center will attempt to bring the blood back into the correct pH range by increasing/decreasing (circle one word) the breathing rate.

91) The breathing control centers are located in the _____ and _____ regions of the _____ (a major brain region).

92) Normal breathing rate for an adult is ____ to ____ breaths per minute.

93) The two gases whose levels in the blood can have an effect on breathing rate are _____ and _____.

94) The blood molecule that is measured by the breathing control center and that has the greatest effect on breathing rate is $O_2/CO_2/H^+$ (circle one of the three).

95) When the sensory neurons in the breathing control center sense a decrease in the pH of the blood, they signal the inspiratory muscles (the diaphragm and external intercostal muscles) to increase/decrease (circle one) the breathing rate.

96) The sensory neurons that monitor the O_2 content of the blood are located in two blood vessels: The _____ and the _____ .

97) A person is at rest, then they get up and begin to run. Soon their breathing rate increases. Circle the best explanation below of why their breathing rate increased when they began the exercise. After circling the best explanation, explain briefly why each of the other explanations is not the best one.

a) The muscles use oxygen to produce energy for themselves. More energy is needed for exercise than for rest, so the muscles consumed large amounts of oxygen from the blood. The breathing control center detected the decrease in blood oxygen and increased the breathing rate to supply the muscles with more oxygen.

b) The muscles produce carbon dioxide when they produce energy for themselves. More energy is needed for exercise than for rest, so the muscles produced large amounts of carbon dioxide in the blood. The breathing control center detected the increase in blood carbon dioxide and increased the breathing rate to remove the carbon dioxide from the blood.

c) The muscles require glucose sugar to make energy from themselves. More energy is required for exercise than for rest, so the muscles consumed large amounts of glucose from the blood. The breathing rate increased because oxygen is required for cells to produce glucose.

d) The muscles produce carbon dioxide when they produce energy for themselves. More energy is needed for exercise than for rest, so the muscles produced large amounts of carbon dioxide in the blood. The carbon dioxide produced by muscles is converted into bicarbonate ion and H^+. The breathing control center detected the increase in blood H^+ and increased the breathing rate to reduce the H^+ to its normal concentration range.

98) When blood pH decreases, the breathing control center will attempt to increase/decrease (circle one word) the breathing rate to help return the pH to its normal value.

99) When blood pH increases, the breathing control center will attempt to increase/decrease (circle one word) the breathing rate to help return the pH to its normal value.

100) If there is an increase in breathing rate, the blood's H^+ concentration will increase/decrease (circle one). This will increase/decrease (circle one) the pH of the blood.

101) If there is an decrease in breathing rate, the blood's H^+ concentration will increase/decrease (circle one). This will increase/decrease (circle one) the pH of the blood.

102) Why does holding your breath cause the blood to get acidic? Your explanation should include a discussion of the chemical reactions in the systemic loop and in the pulmonary loop that can alter blood pH.

103) Abnormally fast breathing can cause the blood pH to go above pH _____, which is the upper limit of the normal blood pH range. This type of too-fast breathing is called _____.

104) Abnormally slow breathing can cause the blood pH to fall below pH _____, which is the lower limit of the normal blood pH range. This type of too-slow breathing is called _____.

105) Hypoventilation will cause the CO_2 levels in the plasma to rise/fall (circle one). This produces a(n) increase/decrease (circle one) in H^+ concentration and a(n) increase/decrease (circle one) in blood pH.

106) Hyperventilation will cause the CO_2 levels to rise/fall (circle one) in the plasma producing a(n) increase/decrease (circle one) in H^+ concentration and a(n) increase/decrease (circle one) in blood pH.

107) Describe the effects of hyperventilation on blood CO_2, blood O_2, and blood pH.

108) Describe the effects of hypoventilation on blood CO_2, blood O_2, and blood pH.

109) Briefly explain (3 or 4 sentences) how hyperventilation causes an increase in blood pH. (Your explanation must include a certain chemical equation we discussed in lecture.)

110) What are some common causes of respiratory acidosis that were listed in class?

111) What are some common causes of respiratory alkalosis that were listed in class?

112) People who hyperventilate (such as may occur during a panic attack) may get dizzy (due to cerebral vasoconstriction), causing anxiety and further hyperventilation. Such people are sometimes urged to breathe into a paper bag. What good would this do? Explain the physiological mechanisms involved.

113) In metabolic alkalosis, the pH of the blood is too high/low (circle one). To correct this pH imbalance, the breathing control centers will increase/decrease (circle one) the breathing rate.

114) In metabolic acidosis, the pH of the blood is too high/low (circle one). To correct this pH imbalance, the breathing control centers will increase/decrease (circle one) the breathing rate.

115) If a person vomited for a long period of time, the person's blood could become pH 7.6 or higher. The respiratory compensation for this pH imbalance would be a(n) increase/decrease (circle one word) in breathing rate.

116) What are some common causes of metabolic acidosis that were listed in class?

117) What are some common causes of metabolic alkalosis that were listed in class?

118) If some evil person injected you with a strong acid, one of the ways your body would react would be to hyperventilate. Explain why this would occur. Your answer must include which part of the body and which chemicals in the body regulate breathing rate.

119) Intravenous infusions of sodium bicarbonate are often given to patients with acidosis to correct the acidosis and relieve the strain of rapid breathing. Explain why bicarbonate is helpful in this situation. What would happen if too much bicarbonate were given? Explain.

120) A person decides to get some exercise by going for a run. The person's breathing rate increases from their resting rate of 15 breaths per minute to 40 breaths per minute as they run. During exercise, the person's blood pH decreases from 7.41 to 7.26. Is the person hyperventilating, hypoventilating, or neither? Justify you r answer.

121) Any substance that acts to prevent changes in H^+ concentration and to stabilize a solution's pH is called a _____.

122) The cells in our body constantly make carbon dioxide. The carbon dioxide reacts with water in our blood to form carbonic acid and bicarbonate ion. The carbonic acid and bicarbonate ions in the blood are important because together, they are the main _____ of the blood.

123) The pH scale is used to describe how acidic or basic a solution is. The blood is normally pH _____ (write a pH range), which is above/below (circle one) the pH of pure water. The pH of our blood does not change when we eat foods that contain acids and bases because our blood contains a buffer, which is any substance that _____. This is how the buffer in our blood works: If we take in too many hydrogen ions, the excess hydrogen ions in our blood are absorbed by the _____ ions of the buffer. If we lose hydrogen ions from our blood, they are replaced by hydrogen ions from _____ acid of the buffer.

124) If you drink lemonade, you are ingesting large amounts of citric acid. The citric acid molecules could potentially make the blood too acidic by creating excess H^+ in the blood. The blood pH, however, usually does not significantly change when we drink acidic drinks because it contains buffers. The main buffer in the blood is the carbonic acid/bicarbonate ion buffer. Write the full and balanced chemical reaction showing this buffer eliminating excess H^+.

125) After each description below, write B if it describes a Buffer in the blood. Write R if it describes Rate of breathing. Some blanks will require both answers.

a) Albumin is an example: _____

b) It is used to help maintain proper blood pH: _____

c) It is the first system to respond if extra H^+ enters the blood: _____

d) It is the first system to respond if too much H^+ is eliminated from the blood: __

e) It has a limited capacity to keep proper blood pH: _____

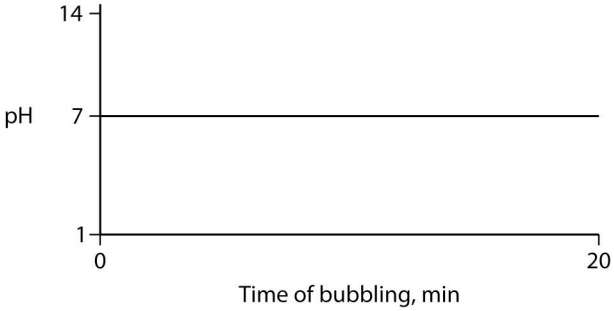
f) Carbonic acid and bicarbonate ion are an example: _____

g) It is controlled by neuron centers in the brain stem: _____

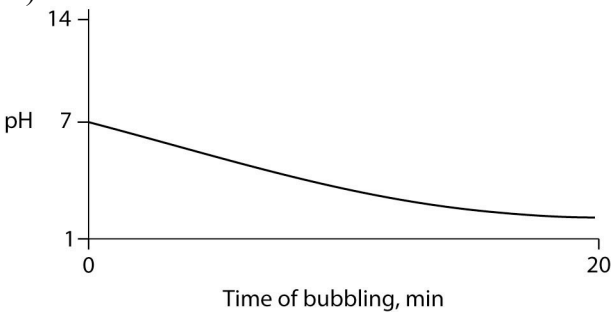
h) It stops working if the concentration of HCO_3^- becomes much lower than its normal level: _____

126) Eating very large amounts of licorice root can potentially make the blood too basic by removing H^+. The blood pH usually does not significantly change when we eat licorice because the blood contains buffers. The main buffer in the blood is the carbonic acid/bicarbonate ion buffer. Write the full and balanced chemical reaction showing this buffer producing H^+ to replace the lost H^+.

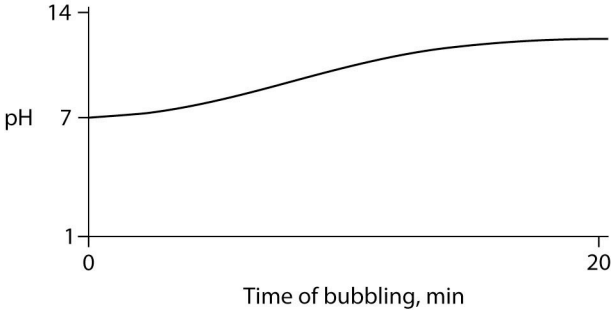
127) If a person bubbles their breath through a straw into a glass of pure water, which of the following graphs accurately shows the effect of their breath on the water's pH?



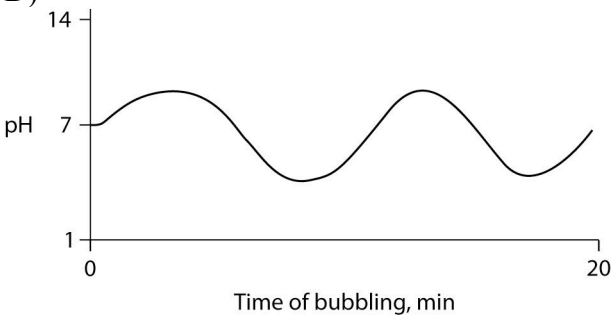
B)



C)

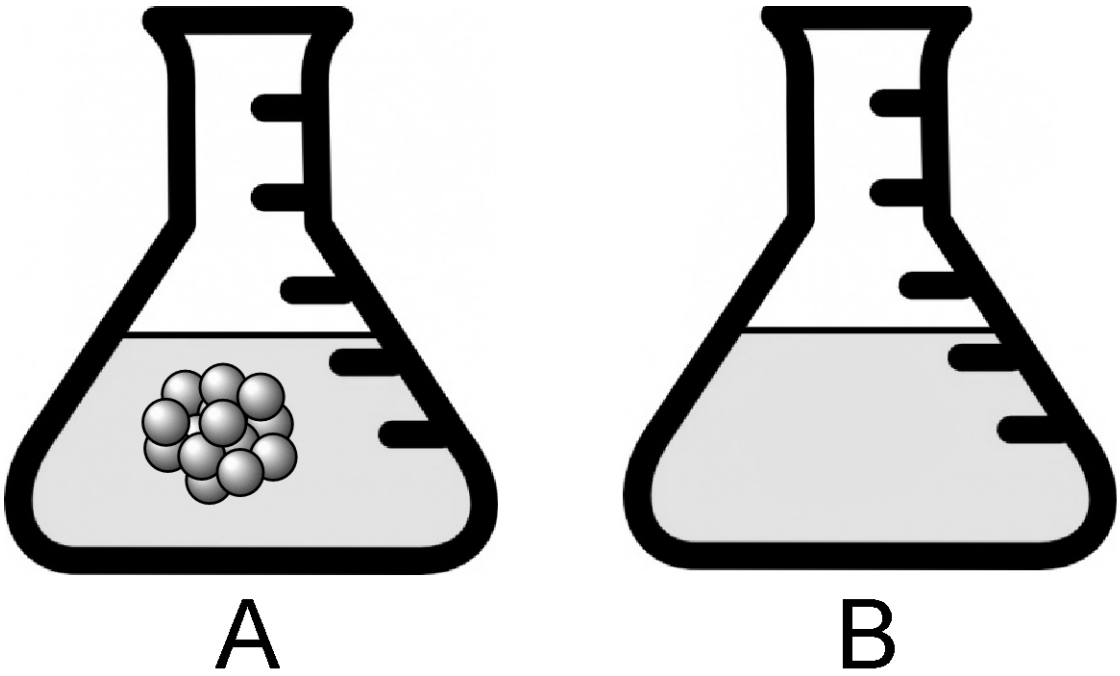


D)



128) Name the molecule in the breath that is responsible for the pH effect in the previous problem: _____. Explain how this molecule in the breath leads to a pH change in the water.

Flasks A and B contain an unbuffered isotonic solution that is pH 7.0. A sample of living tissue is placed in flask A. Flask B contains no cells (See figure below).



The cells in flask A perform cellular aerobic respiration for several minutes. Based on the concepts you learned performing the pH and respiration laboratory activity, answer the following questions.

129) The solution in flask A will become acidic/basic/remain neutral (circle one of the three answers).

130) Justify the answer you circled in question (129)

131) The solution in flask B will become acidic/basic/remain neutral (circle one of the three answers).

132) Justify the answer you circled in question (131)

133) If several drops of ammonia (a strong base) are added to both flasks, which one of the following will occur?

1) The pH of flask A and flask B will decrease by the same number of pH units.
2) The pH of flask A and flask B will increase by the same number of pH units.
3) The pH of flask A will remain unchanged but the pH of flask B will change.
4) Both flasks will change pH, but the pH of flask A will change by a smaller amount than the pH of flask B.
5) Both flasks will change pH, but the pH of flask B will change by a smaller amount than the pH of flask A.
6) The pH of flask B will remain unchanged but the pH of flask A will change.

134) Justify the answer you circled in question (133).

135) If several drops of H_2SO_4 (a strong acid) are added to both flasks, which one of the following will occur?

1) The pH of flask A and flask B will decrease by the same number of pH units.
2) The pH of flask A and flask B will increase by the same number of pH units.
3) The pH of flask A will remain unchanged but the pH of flask B will change.
4) Both flasks will change pH, but the pH of flask A will change by a smaller amount than the pH of flask B.
5) Both flasks will change pH, but the pH of flask B will change by a smaller amount than the pH of flask A.
6) The pH of flask B will remain unchanged but the pH of flask A will change.

136) Justify the answer you circled in question (135).

137) Some albumin protein is added to both flasks, and then several drops of H_2SO_4 (a strong acid) are added to both flasks. Which one of the following will occur?

1) The pH of flask A and flask B will decrease by the same number of pH units.
2) The pH of flask A and flask B will increase by the same number of pH units.
3) The pH of flask A will remain unchanged but the pH of flask B will change.
4) Both flasks will change pH, but the pH of flask A will change by a smaller amount than the pH of flask B.
5) Both flasks will change pH, but the pH of flask B will change by a smaller amount than the pH of flask A.
6) The pH of flask B will remain unchanged but the pH of flask A will change.

138) Justify the answer you circled in question (137).

Answers for Review Questions for Respiration and pH topic:

1) A

2) A

3) B

4) B

5) B

6) A

7) A and B

8) C

9) A

10) A

11) E

12) C

13) B

14) C

15) D

16) D

17) A

18) B

19) A

20) D

21) A

22) B

23) A

24) C

25) A

26) D

27) B

28) C

29) C

30) E

31) C

32) A

33) A

34) B

35) C

36) D

37) A

38) B

39) D

40) F

41) B and E

42) A and F

45) E

46) A

47) a) Acid = Any molecule that can donate a hydrogen ion (H^+).

b) Base = Any molecule that can absorb a hydrogen ion.

c) Buffer = Any substance that makes a solution resistant to pH change by acids or bases.

d) Acidosis = Blood pH below 7.35

e) Alkalosis = Blood pH above 7.45

f) Respiratory acidosis = Blood pH below 7.35 due to hypoventilation

g) Respiratory alkalosis = Blood pH above 7.45 due to hyperventilation

h) Metabolic acidosis = Blood pH below 7.35 not due to a respiratory problem.

i) Metabolic alkalosis = Blood pH above 7.45 not due to a respiratory problem.

j) Respiratory compensation = The change in breathing rate to attempt to bring the blood back into the normal pH range.

k) Hypoventilation = Breathing rate that is too slow to keep blood pH above 7.35.

l) Hyperventilation = Breathing rate that is too rapid to keep blood pH below 7.45.

48) High
Low
Low
High
Low
High
High
Low

49) Blood carries oxygen because cells require oxygen for the metabolic process of cellular aerobic respiration.

50) ATP energy

51) Bicarbonate ion
HCO_3^-

52) Carbonic acid
H_2CO_3

53) Bicarbonate ion dissolves better in the plasma than CO_2

54) H^+ (hydrogen ion)

55) Carbonic acid
H_2CO_3

56) Bicarbonate ion
Hydrogen ion
$H_2CO_3 \rightarrow HCO_3^- + H^+$

57) $CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$

58) Cellular aerobic respiration

59) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

60) Increase.

Exercising requires increased energy by muscle cells. To increase their energy levels, the muscle cells must perform higher levels of cellular aerobic respiration. Since CO_2 is a product of cellular aerobic respiration, the amount of CO_2 entering the blood will increase. Since most of the CO_2 that enters the blood is transformed into bicarbonate ion, the amount of bicarbonate ion in the blood will increase.

61) Increase.

Exercising requires increased energy by muscle cells. To increase their energy levels, the muscle cells must perform higher levels of cellular aerobic respiration. Since CO_2 is a product of cellular aerobic respiration, the amount of CO_2 entering the blood will increase. Most of the CO_2 that enters the blood is transformed into bicarbonate ion, and the chemical reaction that transforms CO_2 into bicarbonate ion also produces H^+ as a product. Therefore, increased CO_2 production leads to increased H^+ levels in the blood.

62) Acid

63) Base

64) H_2CO_3

(Other possible answers include amino acids, fatty acids, and ketoacids)

65) HCO_3^-

66) HF is an acid. This is true because the HF molecule can release a hydrogen ion, as is shown in the chemical reaction of this problem.

67) H_2SO_4 is an acid. This is true because the H_2SO_4 molecule can release a hydrogen ion, as is shown in the chemical reaction of this problem.

68) 0
14
7

69) Does

70) Acidic
Less

71) Basic (or Alkaline)
Greater

72) Acidic

73) More

74) More

75) Acidic

76) More

77) More

78) pH

79) Decrease

80) 7.35
7.45

81) Increase
Decrease
82) Increase
Decrease

83) Decrease
Increase

84) Respiratory compensation (change in breathing rate)
Buffers in the blood

85) HCO_3^-
H^+

86) $HCO_3^- + H^+ \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$

87) Decreases
Increase

88) Breathing rate

89) Increasing

90) Decreasing

91) Pons
Medulla oblongata
Brain stem

92) 12
18

93) CO_2
O_2

94) H^+
95) Increase

96) Aorta

Carotid arteries

97) The best explanation is (d) because it is the H^+ level of the blood that has the greatest control on breathing rate.

Answer (a) is not the best answer because low levels of oxygen in the blood do not result in a change in breathing rate unless the oxygen levels are severely below normal range.

Answer (b) is not the best answer because the breathing control center does not directly monitor blood CO_2 levels. Instead, it monitors the H^+ levels, which are strong correlated to the CO_2 levels.

Answer (c) is not the best answer because oxygen is not a major factor in determining breathing rate, and furthermore, oxygen is not produced when cells produce glucose. Instead, oxygen is consumed when glucose is used by cells for energy.

98) Increase

99) Decrease

100) Decrease
Increase

101) Increase
Decrease

102) Maintaining blood pH within the proper range means that the number of H^+ ions produced in the blood vessels of the systemic loop are exactly balanced by the number of H^+ ions that are removed from the blood in the pulmonary loop. The breathing control center sets the breathing rate so that the number of H^+ ions removed by breathing exactly

balances the number of H^+ ions that are created in the systemic loop.

If a person holds their breath, the number of H^+ ions produced in the systemic loop does not change, but the number of H^+ ions being removed from the blood in the pulmonary loop decreases. This is because breathing rate controls the rate of the H^+ -removing chemical reaction in the pulmonary loop:

$$HCO_3^- + H^+ \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$$

Since, when holding the breath, the number of H^+ ions removed becomes less than the number of H^+ ions produced, the blood becomes acidic when the breath is held.

103) 7.45
Hyperventilation

104) 7.35
Hypoventilation

105) Rise
Increase
Decrease

106) Fall
Decrease
Increase

107) Hyperventilation will decrease CO_2, increase O_2, and increase blood pH.

108) Hypoventilation will increase CO_2, decrease O_2, and decrease blood pH.

109) The breathing rate controls the rate for the following chemical reaction, which occurs in the pulmonary loop blood:

$$HCO_3^- + H^+ \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$$

Since this chemical reaction removes H^+ from the blood, the faster the breathing rate, the more H^+ ions are removed from the blood. This is why hyperventilation decreases the amount of H^+ in the blood, which is equivalent to an increase in blood pH.

110) Severe breathing disorders (such as emphysema, asthma, chronic bronchitis), drug overdose that causes decreased breathing rate, chocking.

111) Hyperventilation due to a panic attack, hyperventilation of a patient on a mechanical ventilator.

112) When a person hyperventilates, the pH of their blood increases (meaning there are too few H^+ ions in the blood). The dizziness that accompanies hyperventilation is due to the pH imbalance affecting blood vessel diameter in the brain. To relieve the dizziness, the person needs to restore the pH balance of th4 blood. They can do this by breathing into a paper bag. By breathing into a paper bag, the person increases the amount of CO_2 in their blood. This occurs because the air in the bag is expired air from the lungs, and expired air is rich in CO_2. The increased CO_2 in the blood leads to a decrease in pH (which means an increase in H^+) in the blood by the following chemical reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$$

113) High
Decrease

114) Low
Increase

115) Decrease

116) Overproduction of natural body acids (such as ketoacidosis due to diabetes mellitus), certain poisons which are metabolized to acids, excessive diarrhea.

117) Excessive vomiting,

118) The injected acid would increase the H^+ concentration of the blood. The amount of H^+ in the blood is the major factor that the breathing control centers (in the pons and the medulla oblongata of the brain stem) use to set breathing rate. When H^+ is above the normal range, the breathing control centers increase the breathing rate.

119) Acidosis is an excess of H^+ ions in the blood. An intravenous infusion of sodium bicarbonate corrects the acidosis because sodium bicarbonate is a base that will absorb the excess H^+ ions that are causing the acidosis.

In aqueous solutions (like water or blood) sodium bicarbonate dissociates to become a separate sodium ion and a bicarbonate ion. The bicarbonate ion removes hydrogen ions by the following chemical reaction:

HCO_3^- + H^+ -> H_2CO_3

If too much sodium bicarbonate was given to the patient, too many H^+ ions would be removed from the blood. This would result in alkalosis (blood pH above 7.45)

120) The person is hypoventilating. Even though the person is breathing much faster than average, a fast breathing rate is **not** the definition of hyperventilating. Hypoventilation is defined as a breathing rate that is too slow to maintain the blood pH above 7.35. Since this person's blood pH is below 7.35 it is clear that 40 breaths per minute is not fast enough for the person to keep their blood pH abobe 7.35. Therefore the person is hypoventilating.

121) Buffer

122) Buffer

123) 7.35 – 7.45
Above
Stabilizes the pH of a solution
Bicarbonate ion
Carbonic acid

124) HCO_3^- + H^+ -> H_2CO_3

125) a) B

b) B R

c) B

d) B

e) B

f) B

g) R

h) B

126) H_2CO_3 -> HCO_3^- + H^+

127) B

128) CO_2. The CO_2 in the breath reacts with the water by the following chemical reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$$

The accumulation of the H^+ product from this chemical reaction decreases the pH of the water.

129) Acidic

130) The cells perform cellular aerobic respiration. The overall chemical reaction for this metabolic process is:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

Since CO_2 is a product of cellular aerobic respiration, the CO_2 concentration in flask A will increase. CO_2 reacts with water molecules to produce H^+ by the following chemical reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$$

The accumulation of the H^+ product from this chemical reaction makes the water acidic.

131) Remain neutral

132) The solution is flask B is pH 7.0. Because no cells (or anything else) was added to flask B, there is nothing to change the pH and thus it will remain pH 7.0.

133) 4 (Both flasks will change pH, but the pH of flask A will change by a smaller amount than the pH of flask B.)

134) Bases remove hydrogen ions from solutions, and therefore the solutions in both flasks will increase in pH (fewer H^+ = increase in pH). Flask A, however, will have a smaller pH increase than flask B because flask A contains the carbonic acid/bicarbonate ion buffer. This buffer is created from the CO_2 released by the cells by the following chemical reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$$

Most of the H^+ ions that were removed by the ammonia base will be replaced by the carbonic acid (H_2CO_3) portion of the buffer, by the following chemical reaction:

$$H_2CO_3 \rightarrow HCO_3^- + H^+$$

135) 4 (Both flasks will change pH, but the pH of flask A will change by a smaller amount than the pH of flask B.)

136) Acids donate hydrogen ions to solutions, and therefore the solutions in both flasks will decrease in pH (more H^+ = decrease in pH). Flask A, however, will have a smaller pH decrease than flask B because flask A contains the carbonic acid/bicarbonate ion buffer. This buffer is created from the CO_2 released by the cells by the following

chemical reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$$

Most of the H^+ ions that were added by the sulfuric acid will be absorbed by the bicarbonate ion (HCO_3^{--}) portion of the buffer, by the following chemical reaction:

$$HCO_3^- + H^+ \rightarrow H_2CO_3$$

137) 4 (Both flasks will change pH, but the pH of flask A will change by a smaller amount than the pH of flask B.)

138) Albumin (and other proteins) are buffers and thus act to make solutions resistant to pH change by acids or bases. Therefore, the solutions in flasks A and B will both have a smaller pH decrease from the sulfuric acid than an unbuffered solution would have. The solution in flask A, however, will have a smaller pH change than the solution in flask B because the solution in flask A contains two buffers and the solution in flask B contains only one buffer. The solution in flask A contains the albumin buffer and the carbonic acid/bicarbonate ion buffer, whereas the solution in flask B contains only the albumin buffer.