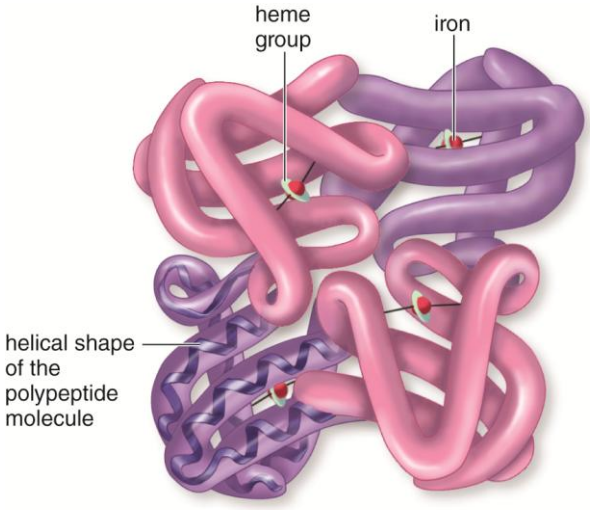
DATE: NAME: CLASS:

CHAPTER 11 WORKSHEET	Internal and External Respiration	BLM 11-5 ANSWERS

1. Describe the hemoglobin molecule (what it is made of, where it is located, etc.).

-protein molecule
-has a quaternary structure (2 alpha and 2 beta chains connected)
-located in red blood cells
-there are millions per red blood cell
-contain iron
-molecule turns bright red when combined with oxygen
-molecule is blueish in colour when combined with carbon dioxide



Hemoglobin molecule

2. Complete the chart below about the three materials carried by hemoglobin.

	When carrying…	We call it…	And abbreviate it as…
A	Oxygen	**Oxyhemoglobin**	**HbO_2**
B	Carbon dioxide	Carbaminohemoglobin	**$HbCO_2$**
C	**Hydrogen ion**	**Reduced hemoglobin**	HHb

3. Under what conditions does hemoglobin have a greater affinity for oxygen? Where in the body do these conditions exist?

When the temperature is lower, and the pH is higher.

4. Under what conditions does hemoglobin release oxygen in favour of other molecules? Where in the body do these conditions exist?

When the temperature is higher and the pH is lower. Low pH is due to the presence of H^+ ions formed from the reaction between carbon dioxide and water.

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5. A small amount (about 7%) of carbon dioxide is carried in the plasma as a dissolved gas. Describe how the rest of the carbon dioxide is transported by the blood.

20–30% is carried as carbaminohemoglobin, and 70–80% is carried as a bicarbonate ion.

6. Why is hemoglobin considered to be a buffer?

Hemoglobin can react with hydrogen ions, thereby minimizing huge pH fluctuations. Anything that can react with either H^+ or OH^- is considered a buffer.

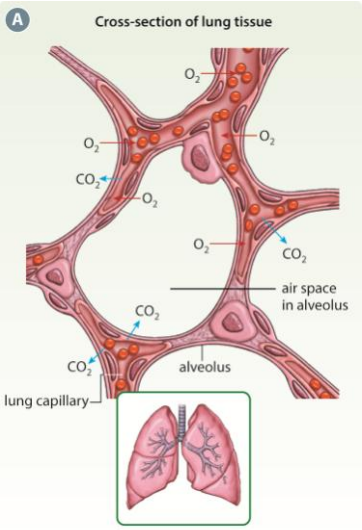
7. Describe the four chemical reactions that occur during external respiration.

$HbCO_2 \longrightarrow Hb + CO_2$ (Hb has a higher affinity for oxygen, and so it dissociates from carbon dioxide)

$HHb \longrightarrow Hb + H^+$ (Hb has a higher affinity for oxygen, and so it dissociates from hydrogen)

$HCO_3^- + H^+ \longrightarrow H_2O + CO_2$ (As H^+ is no longer with Hb and is in large supply, this reaction occurs in this direction. The removal of carbon dioxide also drives the reaction in this direction.)

$Hb + O_2 \longrightarrow HbO_2$ (Hb has a higher affinity for oxygen due to lower temperature and higher pH. Higher pH results from the removal of H^+ as it reacts with HCO_3^-)



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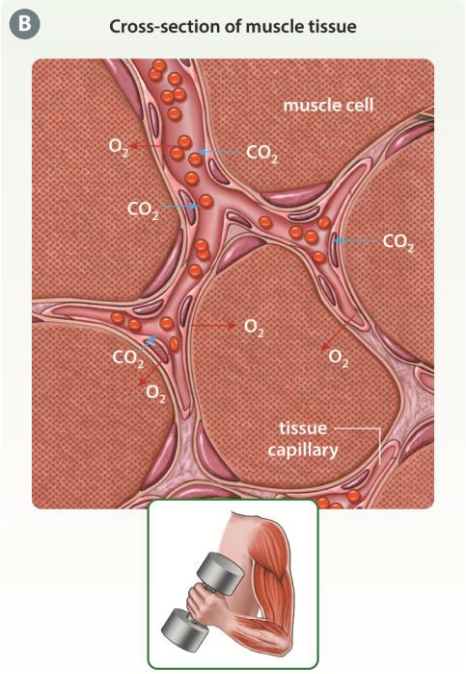
8. Describe the four chemical reactions that occur during internal respiration.

$HbO_2 \longrightarrow Hb + O_2$ (Hb has a lower affinity for oxygen at the tissues where pH is lower and temperature is higher)

$Hb + CO_2 \longrightarrow HbCO_2$ (not all Hb combines with CO_2)

$Hb + H^+ \longrightarrow HHb$ (Hb has a higher affinity for hydrogen ions and CO_2 rather than O_2)

$H_2O + CO_2 \longrightarrow HCO_3^- + H^+$ (CO_2 and H_2O are plentiful as products of cellular respiration, driving the reaction in this direction)



9. What is the role of carbonic anhydrase during external and internal respiration?
This enzyme catalyzes the reaction between water and carbon dioxide (in either direction, depending on relative amounts of reactants and products).

10. Provide an argument to support the statement "Hemoglobin is an amazing molecule."
Hemoglobin is able to bind to oxygen at the lungs, but release it at the tissues. When it is not carrying oxygen, it is still useful in carrying carbon dioxide and hydrogen ions. Hemoglobin protects our cells and tissues from the denaturing effects of hydrogen ions by binding to it and preventing large pH fluctuations.

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