NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Why Homeostasis Is Important to Everyday Activities

by
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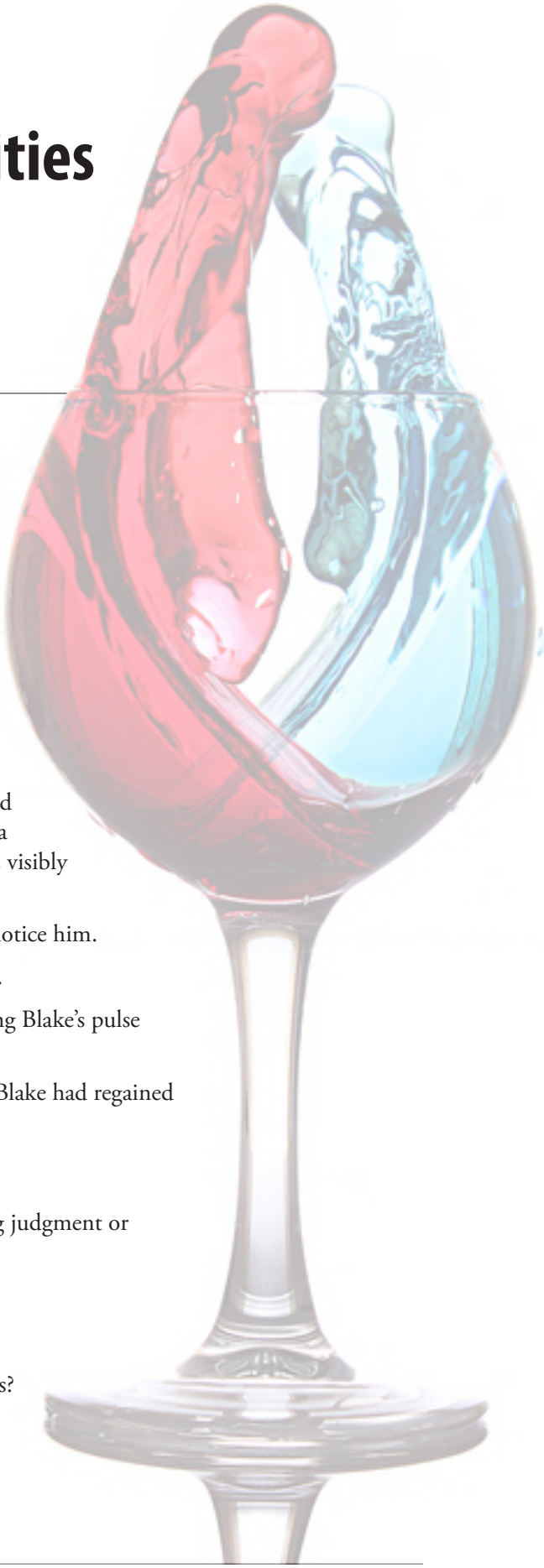


Part I – Where Is Blake?

"Where is Blake?" Ashton asked, apparently expecting Blake, his roommate, to be following Sam into their apartment.

"I thought he was with you," replied Sam, confused by Ashton's question. "Blake told me you and he had a heart-to-heart talk at the party about his drinking. He told me he decided to leave with you to come back to the apartment."

"We did talk and agreed to call it a night, but he didn't leave with me," said Ashton. "He just doesn't get it. It's so stupid to be chugging beers and drinking RockStar; he just ends up being 'wide awake drunk'!"

Several hours passed before Blake tumbled through the apartment door and collapsed on the kitchen floor. At first, the roommates thought it was just a typical Blake prank. But Blake seemed to be having a panic attack. He was visibly anxious and his breathing was out of control.

"Blake, dude, calm down!" howled Ashton, but Blake didn't even seem to notice him.

"What are we going to do?" yelled Sam, upset and concerned for his friend.

"Call 911 and help me get him up on the couch!" yelled Ashton, after taking Blake's pulse and finding it really weak.

By the time the first responders had made their way up to the apartment, Blake had regained consciousness but was still clearly in distress.

Questions

1. What observations can you make about this scenario without providing judgment or conclusions?

2. What information would you ask if you were one of the first responders?

Part II – Is Blake Going to Be Okay?

Blake was confused and short of breath, and he was complaining that his ankles were killing him. As the first responders took Blake's vitals, Blake told them he felt dizzy and had a tingling sensation in his hands and arms. He also said that his chest was "heavy."

Susan, the EMT on duty that night, had unfortunately seen this situation increasingly often over the last several years. She finished taking Blake's vitals and interviewing him.

"So is Blake going to be okay?" asked Ashton, still trying to get a hold of his emotions.

Susan and her partner had succeeded in calming Blake down and had his breathing under control. "He's clearly drunk," she said. "But has he also been taking some type of stimulant?"

After a short pause, Ashton explained how Blake liked to go hard at parties by drinking energy drinks and alcohol.

"I'm so confused. Blake is just drunk, right?" Sam interjected.

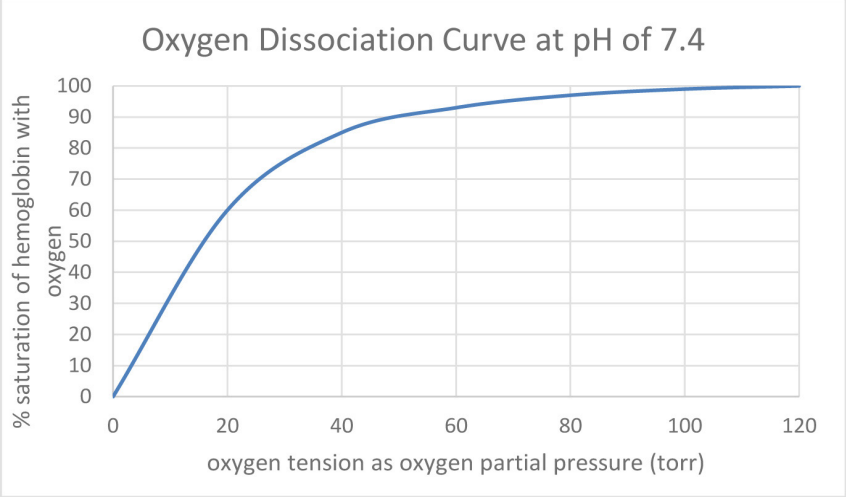
Susan explained, "Blake is suffering from the effects of respiratory alkalosis brought on by his panic attack and subsequent hyperventilation."

She grabbed a piece of paper and began to explain what happens when someone hyperventilates. She drew the equation below to demonstrate what happens chemically in your body when you hyperventilate. She also explained that a normal respiratory rate is around 12 to 16 breaths per minute and added that Blake's respiration rate was probably over 25 breaths per minute.

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow HCO_{3^-} + H^+$$

Questions

1. Draw your prediction for what will happen to the binding affinity of hemoglobin for oxygen if you increased the pH or created a more alkaline situation. (*Hint:* you need two lines on the graph to show "normal" and an increase in pH.)



2. How does pH influence oxygen saturation of hemoglobin at the same partial pressure?

3. How does pH affect hemoglobin affinity for oxygen in the body tissue that is metabolically active? What is the significance of this hemoglobin affinity difference?

4. How would the respiration rate impact this curve given the changes in blood pH?

Part III – Mixing Alcohol with Energy Drinks

Susan told both Sam and Ashton that Blake was fortunate to be stable and not in worse shape. She showed Sam and Ashton the following abstract from one of her research papers that she was using for an assignment she was working on for her degree. Despite the fact that it was published before they were born, the take-home message did sink in. There were a lot of big words in the abstract, but they knew what a coma was and perhaps Blake had been lucky tonight.

Vet Hum Toxicol. 1991 Oct;33(5):482–5.

Acid-base balance in alcohol users seen in an emergency room

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Abstract

Over 10% of emergency room patients are diagnosed as having alcohol (6.0%) or drug intoxication. In the present study 196 alcohol intoxications treated in a hospital were studied retrospectively; 49.2% of the patients had abnormal acid-base values, alcoholics more often than non-alcoholics (p = 0.04). Mean blood ethanol concentration (BAC) was 310 mg/dl (SD 120); alcoholics had higher concentrations of alcohol. BAC was the higher the lower the serum pH was (p less than 0.002, r = -0.45). The deeper the coma the lower the serum pH (p less than 0.05) and the higher the BAC (p less than 0.0001). Respiratory acidosis (31.7%) was an important finding in those intoxicated. Metabolic acidosis (7.9%) could be explained by the presence metabolites of ethanol in the serum and by decreased extra-cellular fluid volume. Metabolic alkalosis related to vomiting and an extra-cellular fluid volume decrease was found in 7.9% of the patients. Respiratory alkalosis was a rare finding (1.6%). Hypokalemia (22.5%) and hypernatremia (15.3%) were the most important electrolyte changes. Chronic alcoholics had lower serum potassium than had non-alcoholics; 3.6% (n = 7) of the patients had to be intubated. Acid-base disturbances were frequent in adults with alcohol intoxication. Serum pH correlated well with the state of consciousness and the BAC.

Questions

1. Define the following terms:
   a. respiratory acidosis

   b. metabolic acidosis

   c. coma

2. Compare/contrast respiratory acidosis to the case study scenario.

3. Suppose you were to drink an energy drink (with caffeine or another stimulant like guarana or gensing) while consuming alcohol. Would there be an impact on the amount of alcohol consumed? Please explain in terms of the acid-base balance in your body.