INVESTIGATION 5

HOW DOES HUMAN RESPIRATION RELATE TO RADON?

INTRODUCTION

Respiration is important. If you don't breathe, you die! All cells in the human body require oxygen to survive. Oxygen is used during the respiration process, and carbon dioxide is given off as a waste product. Oxygen is carried to the individual cells throughout the body via the blood system; the blood also removes the carbon dioxide waste which is toxic to the cells. If you were a fish, you would obtain your needed oxygen from the water in which you lived, using gills. Since you presumably spend little time in water, you obtain oxygen from the air through your lungs. The boundary between the inside of the body (blood) and the outside of the body (atmosphere) is found inside the lungs within the alveoli. There oxygen and carbon dioxide pass across very thin membranes. Oxygen moves from the lung passages into the blood to replenish the oxygen-poor blood. Carbon dioxide passes from the blood into tiny air sacs called alveoli, to be removed from the body when you exhale. From the lungs, oxygen-rich blood is pumped to the heart for distribution to the rest of the body.

Alveoli - tiny air sacs located at the end of the branches of the respiratory passageways inside the lungs. Here oxygen and carbon dioxide are exchanged across the boundary between airways and blood.

In this exercise, you will investigate the effect of exercise on the rate of respiration and the release of carbon dioxide from the lungs. Exhaled carbon dioxide can be easily detected because it combines with water to form a weak acid, called carbonic acid. The resulting increase in acidity can be determined using a pH meter or a pH indicator solution that changes color in response to changes in pH.

OBJECTIVE

To measure the change in the rate of carbon dioxide released from the lungs in response to exercise.

MATERIALS

100 ml graduated cylinder
drinking straws
beaker
bromthymol blue stock solution

PROCEDURE

1. Measure 100 ml of the stock solution (containing dilute ammonia water and bromthymol blue indicator), and pour it into a beaker. Be sure to use a beaker that is tall enough so that it will not bubble over when you blow into it.

2. Blow gently into the beaker of water using the drinking straw. Your breath will inject carbon dioxide into the solution, thus making the solution more acidic.

Caution: Be sure to only breathe out through the straw!

3. Count and record (using Table 1) the number of breaths and the number of seconds required to turn the solution yellow before exercise.

4. Empty and rinse the beaker and repeat the procedure. Record your results for a total of three trials. Average the results of the trials.

5. Run in place for 3 minutes, and then *immediately* repeat the procedure of blowing into the beaker. Record your results for 3 trials, running for 3 minutes each time. Take short rests between trials, as needed.

Table 1. Number of breaths required to turn solution yellow.

Trial	Before Exercise	After Exercise
Trial 1		
Trial 2		
Trial 3		
Average		

ANALYSIS

6. Carbon dioxide combines with water to produce a weak solution of carbonic acid, according to the following equation:

$CO_2 + H_2O$ ---> $H_2CO_3(1)$
carbon dioxide + water ---> carbonic acid solution

Why does the solution turn yellow when you breathe into it?

7. Where did the carbon dioxide in your breath originate?

8. What reaction in the cells of the body is associated with the production of carbon dioxide?

9. Did it take more or fewer breaths to turn the solution yellow after exercise, as compared to before exercise? Did it take longer to turn the solution yellow before or after exercise? Why?

10. What differences did you observe among the three trials before exercise? among the three trials after exercise? Which set of trials had more variation (before or after exercise)? Why?

CONCLUSIONS

11. Given what you have learned previously about radon and the material presented in this exercise, what is the relationship between human respiration and radon gas?

12. Is a person more susceptible to the negative effects of radon gas while asleep in bed or while exercising vigorously to a Richard Simmons or Cathy Smith video? Why?

13. Which investigation gave you more useful results: recording the number of breaths or the time required to turn the solution yellow? Why?