INVESTIGATION 6

HOW DOES RADON AFFECT HUMAN LUNGS?

INTRODUCTION

When a radioactive substance that gives off alpha particles makes its way into the respiratory system, there are several factors that will affect the amount of damage that could be done to sensitive lung tissue. First is the half-life of the radioactive material, which influences the probability that the material will decay and emit its alpha radiation *while inside the lungs.* Second is the amount of energy at which the alpha particle is ejected; the higher the energy, the further the particle can penetrate. [Analogy: Cecil Fielder hits a baseball with considerably more energy than does a little-leaguer. Who do you suppose hits the ball further into the atmosphere?] Third is the thickness of the protective layer of cells (surface epithelial cells) through which the radiation must pass in order to strike the sensitive tissues (basal epithelial cells). Fourth, and finally, is chance; the alpha might miss the nuclei of the sensitive cells through which it passes.

The large, highly charged alpha particles emitted from radon and two of its decay products have the ability to cause serious DNA damage. The alpha particle may strike the DNA molecule and cause actual structural damage. The charged alpha particle may also produce chemical damage to the water molecules surrounding cells and their DNA. This chemical damage, however, is beyond the scope of this lesson.

DNA structure, function, and replication can easily be affected by the radiation emitted from inhaled radon and its decay products. These deleterious effects are usually confined to the respiratory tract. Exposure, then, to elevated levels of radon and its decay products over time will increase a person's risk of developing lung cancer during his or her lifetime.

Surface epithelial cells - cells that line the inside of the airways within the lungs. They have tiny hairs called cilia and produce a mucus secretion, both of which help to remove foreign substances from the system.

Basal epithelial cells - cells located beneath the surface epithelial cells. They frequently divide to form new cells. This makes them sensitive to development of cancer.

In this exercise you will explore the major elements of lung anatomy and how they interact with cancer causing agents (called carcinogens) such as radon and cigarette smoke. Americans have found these topics to be highly relevant, in view of the fact that cigarette smoke and radon are the two leading causes of lung cancer in this country, and together account for somewhere around 100,000 to 150,000 deaths per year.

OBJECTIVE

To examine those elements of lung anatomy that influence the body's response to cigarette smoke and radon.

PROCEDURE

1. Examine the data presented in Table 1 and the anatomy of the human lung (Figures 1 and 2).

2. Answer the questions that follow.

DATA

Table 1. Some examples of radioactive isotopes of elements that occur in the uranium-238 decay series. Included are each isotope's half-life, the energy of its emitted alpha particles, and the approximate range of penetration into lung tissue.

Radioactive Isotope	Half-life	Energy of alpha particle (Mev)[1]	Approx. range of penetration into lung tissue (microns)[2]
radon-222	3.8 days	5.49	41
polonium-218	3 minutes	6.00	48
polonium-214	164 micro-seconds	7.69	71

[1] Mev is a unit of energy (million electron volts)
[2] Micron is a unit of length (one millionth of a meter)

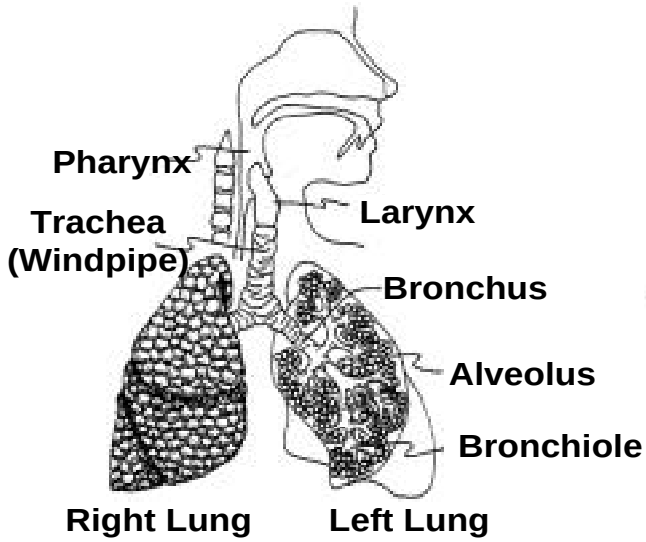

Figure 1. Anatomy of the human lung.

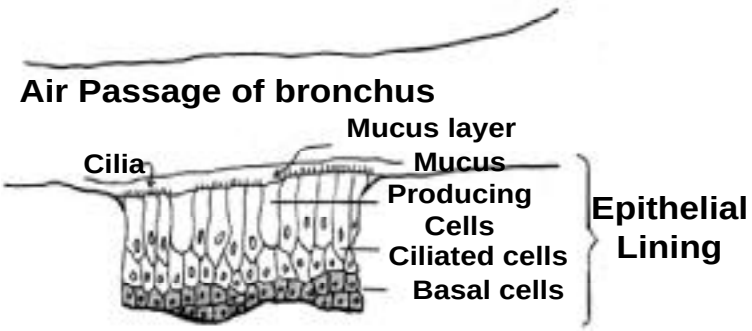

Figure 2. Close-up view of the bronchi, inside the lung.

ANALYSIS

3. Looking at the length of half-life and the depth of penetration of particles, which of the radioactive isotopes listed in Table 1 would probably damage your lungs most? Why?

4. Cell division (mitosis) occurs rapidly in the basal epithelial cells in the lungs (Figure 2). Cancer is basically out-of-control cell division. How is this relevant to radon-induced lung cancer?

5. The layer of surface epithelium in the lungs is about 40 to 80 microns thick. This outer layer produces a mucus that is generally about 10 microns thick. What do you think these thicknesses have to do with radon-induced lung cancer?

6. What if the layers were much thicker or thinner?

7. Describe the journey followed by an oxygen atom from the time it enters your body until it leaves your body.

8. Describe the journey followed by a radon atom from the time it is breathed into your body until it leaves your body. Include in your discussions the various possibilities, such as emitting its radiation inside your bronchi.

CONCLUSIONS

9. List and describe three properties of radon (including its decay products) and three properties of human lungs that cause radon and lungs to be an unwanted combination.

10. Health officials have concluded that smokers may be at higher risk from radon exposure, because there may be a synergistic relationship between these two causes of cancer. What do you think this means?