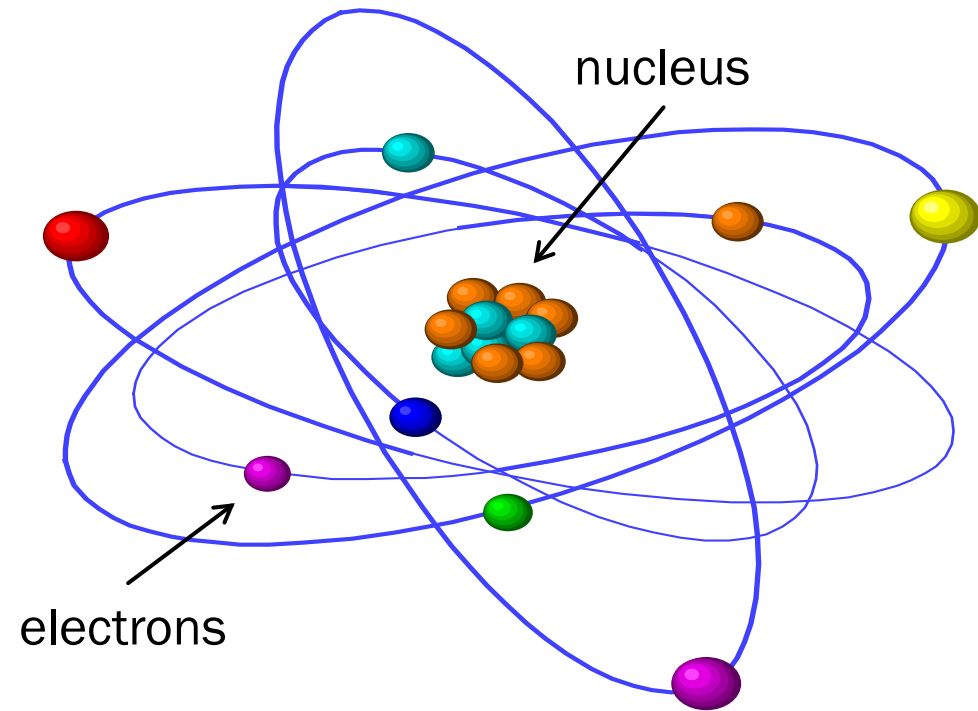


Health Effects of Radium and Radon

- ▶ David O. Carpenter, MD
- ▶ Director, Institute for Health and the Environment
- ▶ University at Albany
- ▶ dcarpenter@Albany.edu
- ▶ 518-525-2660

Atomic and Nuclear Structure

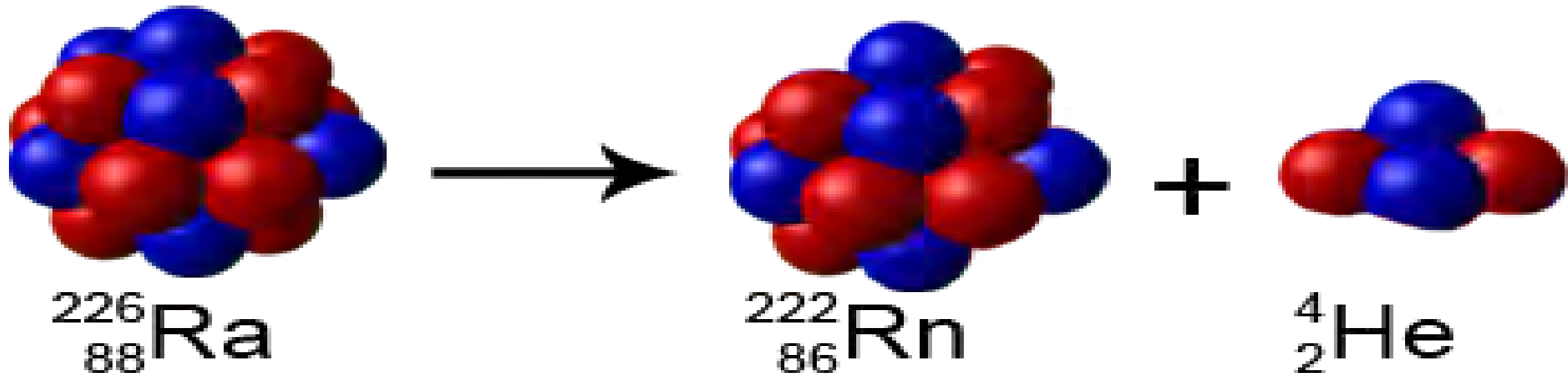


Each atom is composed of a nucleus with a certain number of positively charged PROTONS and neutral NEUTRONS and has orbiting ELECTRONS, negatively charged and usually equal in number to the protons. Protons and neutrons are 1800 times heavier than electrons.

Radioactivity Associated with Radon

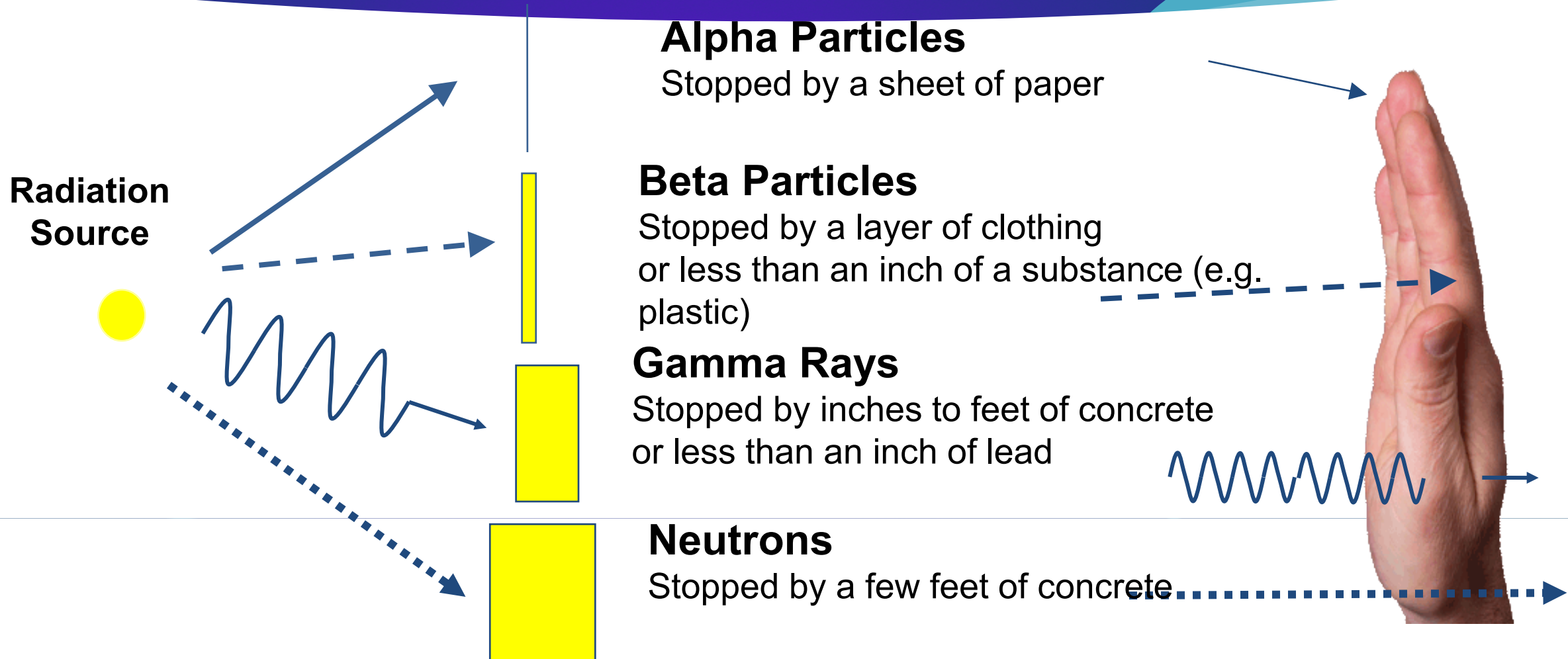
- ▶ Alpha particles are composed of two protons and two neutrons. These are emitted when radium decays to radon. Since both protons and neutrons are relatively heavy alpha particles are relatively large and can cause a lot of damage but don't penetrate the body very far. Alpha particles have two positive charges.
- ▶ Beta particles are electrons, so are much smaller than alpha particles, but are negatively charged. These can penetrate the body for short distances.
- ▶ Gamma waves are electromagnetic, having energy but no weight. These penetrate the body very easily, but are not important products of radon.





The nucleus of an atom of radium-226 contains 88 protons and 138 neutrons. A radium-226 nucleus undergoes alpha decay to form a different element, radon-222, and an alpha particle.

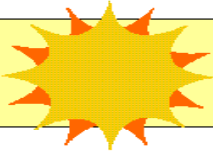


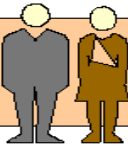
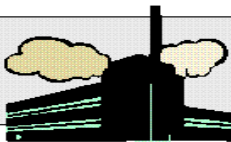
Penetration Abilities of Different Types of Radiation





Radon

- ▶ Radon comes from radium, which is relatively water soluble, so closely associated with fracking wells, both in flow-back water and in solid scrapings.
- ▶ Radon is a gas, unlike most natural radioactive elements.
- ▶ It has no odor, color or taste. Therefore one has no indication if it is present.
- ▶ The half-life of radon is 3.8 days.
- ▶ The most common route of exposure is inhalation.
- ▶ Radon can also be present in water, especially ground water from deep wells.
- ▶ Radon is about eight-times heavier than most other component of air, and therefore will stay close to the ground.

Radiation from Natural Sources

	Source	mrem/year
	Cosmic rays	28
	The earth	26
	Radon	200
	The human body	25
	Building materials	4

A. Uranium-238

Uranium	U-238 4.5×10^9 y	U-234 2.5×10^5 y	EXPLANATION  Alpha decay  Beta decay
Protactinium		Pa-234 6.7 h	
Thorium	Th-234 24.1 d	Th-230 7.5×10^4 y	
Radium		Ra-226 1600 y	
Radon		Rn-222 3.8 d	
Polonium		Po-218 3.1 m	
Bismuth		Bi-214 19.9 m	
Lead		Pb-214 26.8 m	
		Pb-210 22.2 y	
		Pb-206 (stable)	

Health Effects of Radon Exposure

- ▶ Radioactivity is a proven human carcinogen. Radon exposure is the second most common cause of lung cancer after smoking. Gaskin et al. (2018) attribute about 15% of all cases of lung cancer to radon exposure.
- ▶ Alpha particles from radon don't penetrate far, but when deep in the lung they directly damage the lung epithelial cells.
- ▶ Radioactivity causes damage to DNA resulting in birth defects.
- ▶ In both animals and people, exposure to radioactivity shortens life span.
- ▶ Radioactivity is more damaging to the young, and also to females for reasons that are not clear.

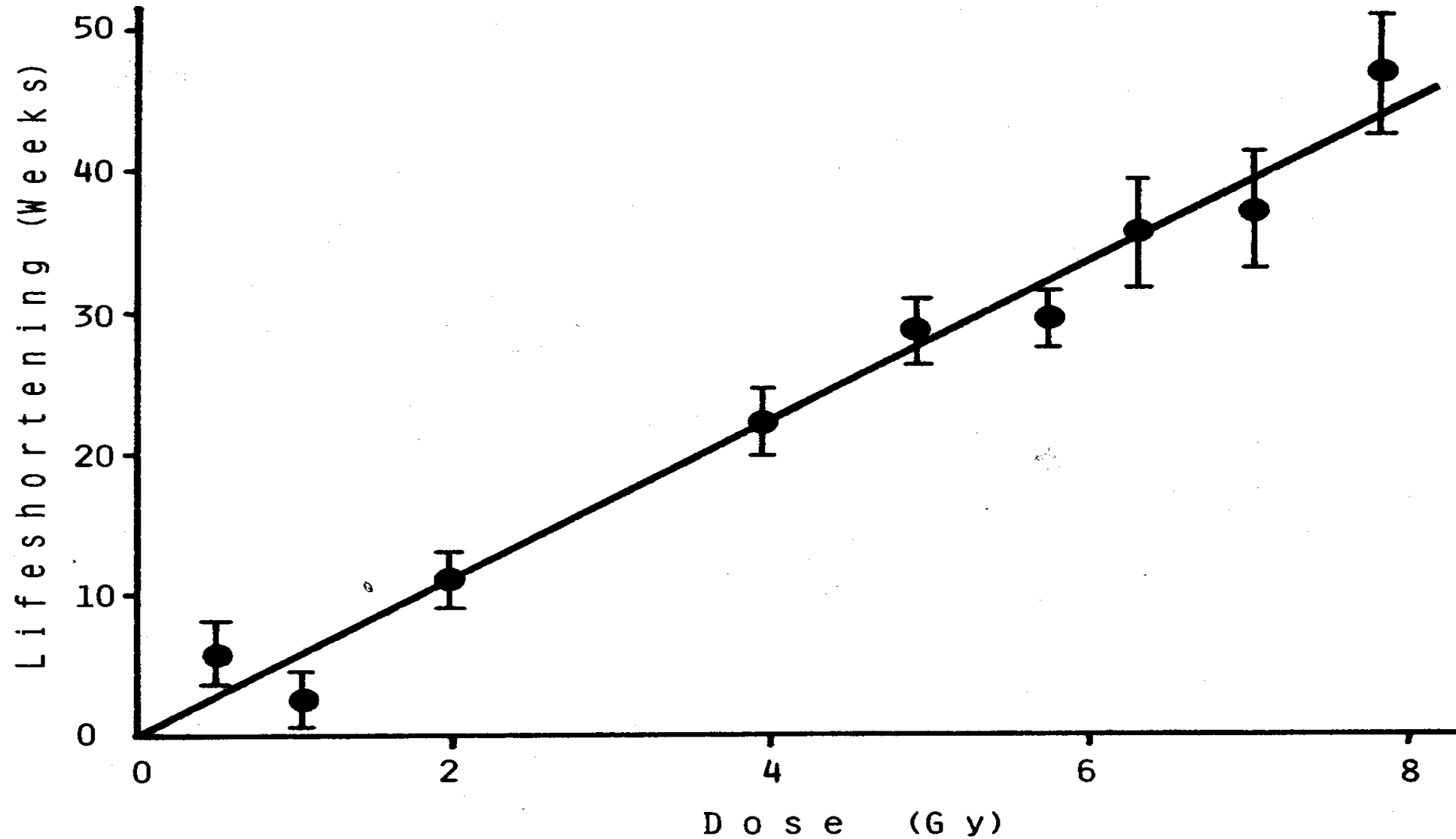
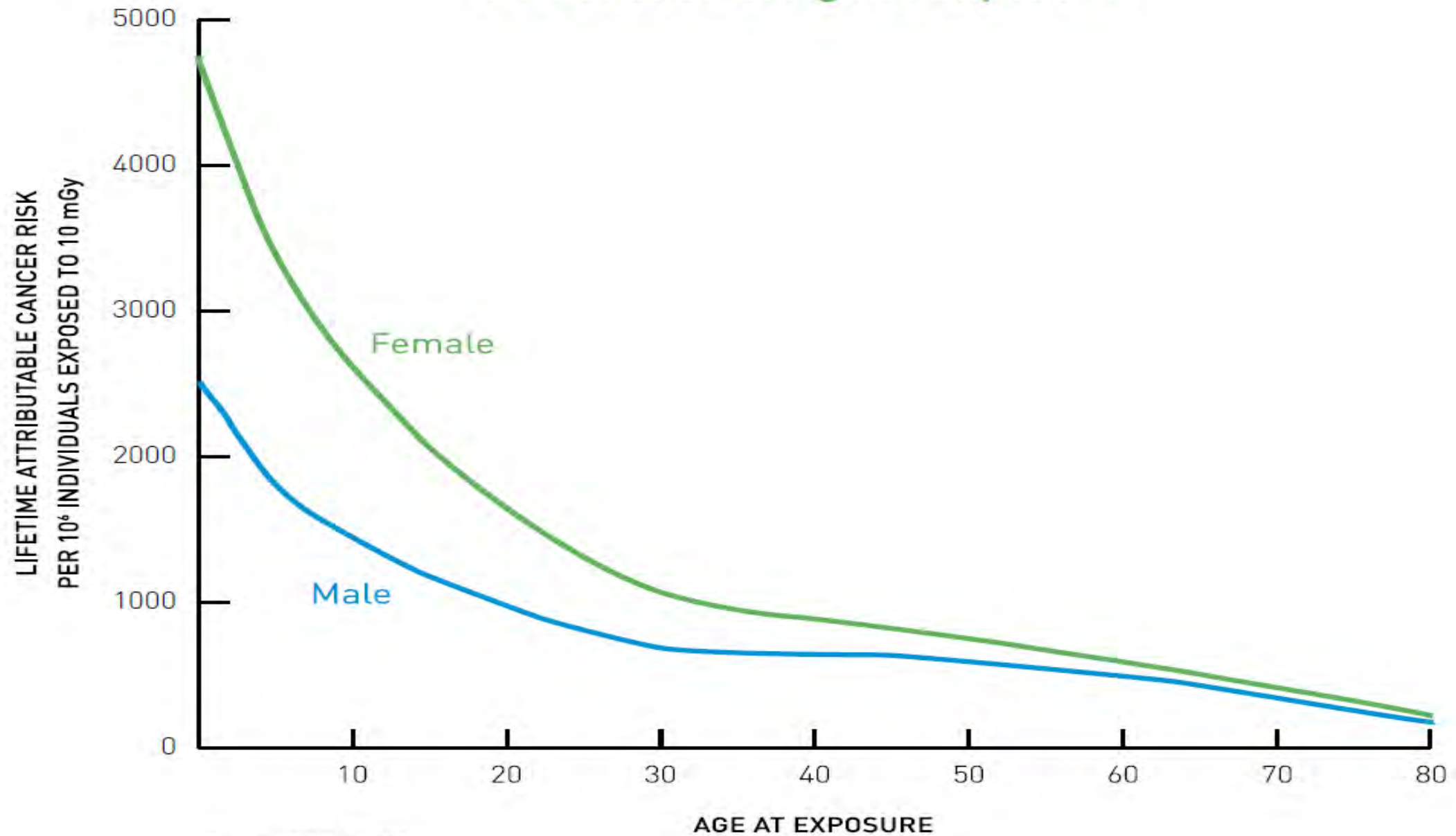


Figure 10.3. Lifeshortening as a function of dose for mice of both sexes

Source: P. J. Lindop, 1965, *Scientific Basis of Medicine: Annual Reviews*, p. 91; courtesy the author and Athlone Press.

Estimated Radiation-Induced Lifetime Cancer Risk as a Function of Age at Exposure



Source: BEIR-VII, 2006.

Conclusions

- ▶ Exposure to any source of ionizing radiation poses threats to human health
- ▶ The major concern is radiation-induced cancer. For radon the major cancer of concern is lung cancer, since as a gas, radon is inhaled.
- ▶ For cancer that directly damages DNA, as is the case for ionizing radiation, there is no level of exposure that does not increase risk.
- ▶ This means that any increased exposure to radon will increase the risk of lung cancer and will cause a reduction in life expectancy.