

## **APPENDIX L - RADON RISK MAPS AND INFORMATION**

Courtesy of the Bear River Health Department

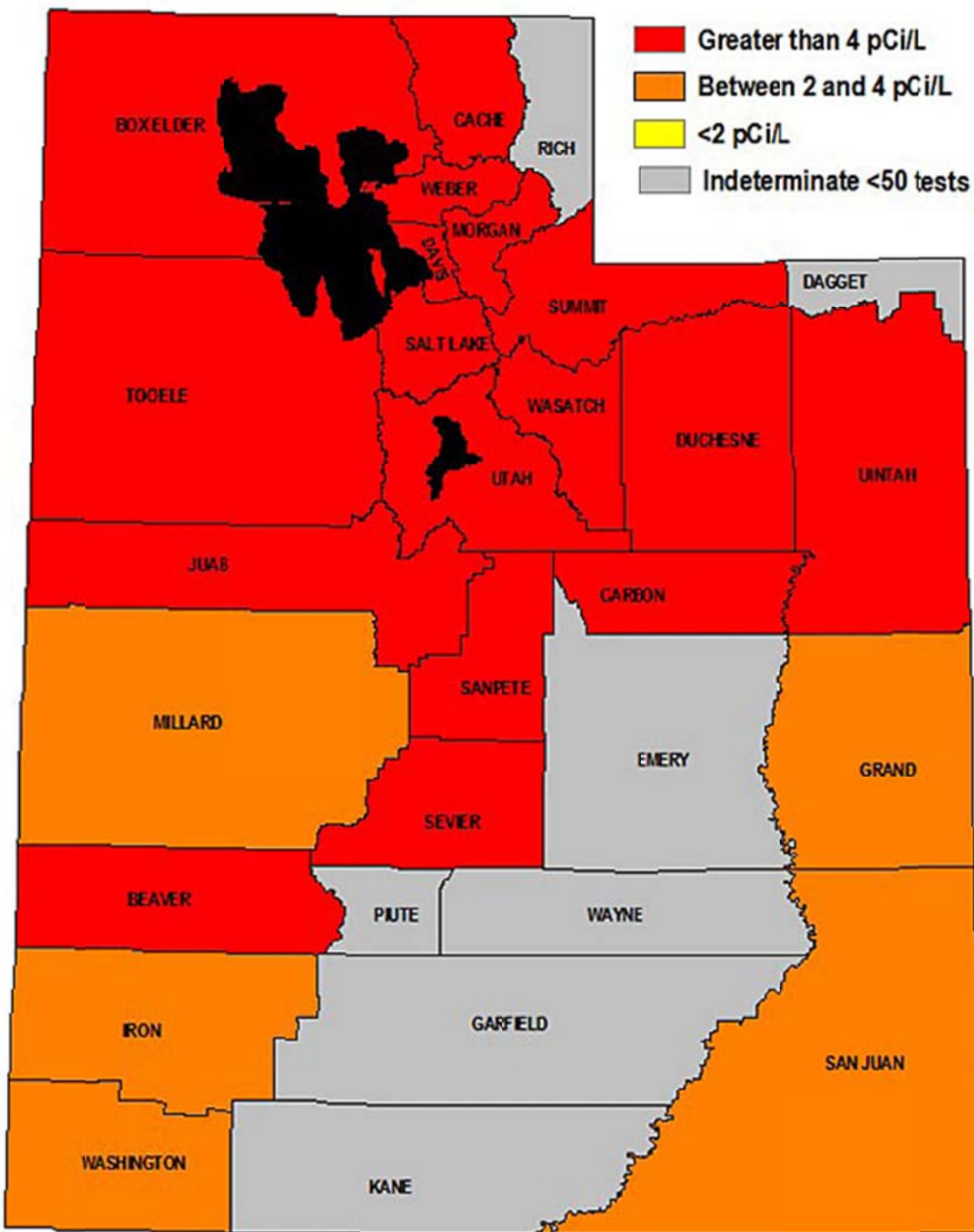


## Basic Radon Information Summary

- Many lung cancer victims never smoked tobacco products - and were never around second-hand smoke. Their lung cancers have been scientifically proven to have originated from radon gas exposure. Radon is odorless and colorless. It is estimated that 21,000 people die each year in the U.S. from lung cancer caused by radon. Radon-induced lung cancer is highly preventable.
- Radon gas is present throughout the U.S. Radon comes from the natural radioactive decay of uranium. It is estimated that the top 6 feet of soil for an average acre of land contains about 50 lbs. of uranium. Radon gas enters homes and radioactively decays - creating radon decay products (RDPs). RDPs are carried by dust, cigarette smoke, etc. - deep into our lungs where they emit alpha particles (a type of radiation) that damage our DNA - causing lung cancer.
- Radon gas enters homes through tiny (hair-like) pores in concrete slabs and basement walls. As air tends to rise in homes (especially in the winter-time). This air movement (chimney-effect) draws radon into homes. When the outside ground is frozen, has a snow-cover or is saturated with water - a "lid" is created over the ground outside - so radon more easily enters our homes. Wintertime radon gas levels measured in homes are often double summertime levels.
- Radon gas is very common within areas of the BRHD's jurisdiction. US-EPA recommends corrective action when radon gas (year-round average) measures at or above 4pCi/L (units pronounced "pea-co-cure-ase" per liter). Many homes in Box Elder, Cache and Rich counties have tested much higher than 4pCi/L. The % of homes over 4pCi/L (as of July 2014 for people who used Utah DEQ radon test kits) are: Box Elder = 59.0%, Cache = 50.3% and Rich = 59.1%). Highest radon levels found: Box Elder = 71.1pCi/L, Cache = 152.5pCi/L and Rich = 30.8pCi/L.
- Homes next door to each other can have very different levels of radon (due to differing geology beneath every home). Testing of bare ground for radon before building a home is impossible (see RRNC info for new homes on next/back page). Everyone needs to test for radon gas in existing homes. Testing is the only way to know if dangerous levels of radon are present.
- Bear River Health Department is now selling Utah DEQ \$7 (BRHD's cost) easy to use short-term radon test kits at 4 BRHD offices: **North Logan** (85 E. 1800 N.); **Brigham City** (992 S. 88 W.); **Tremonton** (440 W. 600 N.) and **Randolph** (275 N. Main Street). These (and other radon kits) may also be ordered on-line through the Utah DEQ radon web-site: [www.radon.utah.gov](http://www.radon.utah.gov).

(Please see next page/back page)

- The most common way to stop radon gas from entering homes is “sub-slab depressurization.” With SSDP - a diamond-bit is used to drill a 3” or 4” hole into and to below the concrete slab. About 5 gal. of soil (sand/gravel) is excavated. Then, 3” or 4” PVC piping is sealed in the hole and connected so that radon vents above the roof. SSDP creates a pathway of least resistance for radon to exit soil beneath homes (so only a tiny amount of radon enters homes). A fan may be connected to increase flow (about 5-10 cents/day). SSDP systems cost about \$1,200-\$1,500.
- BRHD recommends that homeowners considering radon mitigation get several competitive bids from radon mitigators - and to only use currently certified National Radon Proficiency Program (NRPP) radon mitigators (see current list at [www.radon.utah.gov](http://www.radon.utah.gov).) Many NRPP mitigators will warranty that radon in mitigated homes will not exceed 2.7pCi/L for 15 years (or longer) – including the warranty being transferable to new owners for the life of the warranty.
- The modern and smart way to prevent radon gas from entering a new home is to build-in radon resistant new construction (RRNC) features. With trained mitigators in the construction crew, RRNC costs can be 1/2 the cost of doing mitigation. RRNC can be more efficient and attractive (with pipes carrying radon completely hidden under concrete and inside walls). Because of high radon levels in almost every community within BRHD’s jurisdiction, BRHD strongly encourages everyone building a new home to consider installing RRNC features in it. (Please go to [www.radon.utah.gov](http://www.radon.utah.gov) to watch a short video showing how RRNC is installed.)
- Home buyers are increasingly asking for radon mitigated homes (radon <4pCi/L). And with new construction, more people are asking their builders to install RRNC features. When such mitigated/RRNC homes are sold, people are often getting their mitigation/RRNC costs back.
- Older homes are often drafty (poor insulation, cracks, open windows, evaporative coolers); and such conditions allow outdoor air to dilute radon levels. Newer homes are often very energy efficient (“tight” - more insulation, less cracks and AC) - which keeps more radon inside homes.
- Please contact Mark Stevens-BRHD (435-792-6578) for radon information/answers to your questions. And view current radon test results for your community, and find other useful radon info at: [www.brhd.org](http://www.brhd.org) (Scroll down/click on Environmental Health, and then click on Radon.)
- Please go to [www.epa.gov/radon](http://www.epa.gov/radon) for many extensive radon information guides. You will also see radon research references documenting how radon has been scientifically proven to cause approximately 21,000 lung cancer deaths in the U.S. each year. Most of these deaths could have been prevented with radon mitigation (<4pCi/L) - or with RRNC features in new homes.



This map represents radon test results reported (by zip code only) to the Utah Department of Environmental Quality (DEQ) - as of approx. July 2014. This map is helpful in encouraging all Utah home builders (and their clients) to strongly consider the advantages of installing Radon Resistant New Construction (RRNC) features in all new homes. (RRNC features can be ½ the cost of doing mitigation after a home is built.) ***This DEQ map should never be used to predict radon levels in existing homes.*** Because the geology beneath every home is different, similar homes next door to each other can have greatly differing radon levels. ***Every existing home needs to be tested for radon*** - and when high levels are found - mitigated by currently certified National Radon Proficiency Program (NRPP) mitigators only.

(Bear River Health Department Annotated Short-Term Radon Test Results From DEQ July 2014 Data)

**Utah Dept. of Environmental Quality – Division of Radiation Control  
Short-Term Radon Test Results by County, Community & Zip Code (as of July 2014)**

\* 4 picocuries (pronounced “pea-co-cure-ease”) per liter (pCi/L) is the US-EPA’s recommended radon action level.  
Note: all homes should be tested for radon. Homes next door to each other frequently have very different radon readings.

<b>BOX ELDER COUNTY</b>						
Communities in Zip Code >	Zip Code	<4 pCi/L*	>=4 pCi/L*	Maximum	Average	Total Tests
Bear River City	84301	100.0%	0.0%	3.7	2.7	3
Brigham City, Bushnell, Perry	84302	38.3%	61.7%	71.1	8.1	368
Beaverdam, Collinston, Wheelon	84306	62.5%	37.5%	13.3	5.4	8
Corinne, Promontory	84307	100.0%	0.0%	2.8	1.6	3
Beeton, Deweyville,	84309	14.3%	85.7%	38.7	13.4	7
Fielding	84311	75.0%	25.0%	10.9	4.8	4
Garland	84312	76.2%	23.8%	10.4	2.9	21
Crystal Sprs, Honeyville, Madsen	84314	30.0%	70.0%	11.7	6.5	10
Mantua	84324	18.8%	81.3%	38.1	15.0	16
Park Valley, Rosette	84329	100.0%	0.0%	2.7	2.7	1
Plymouth	84330	100.0%	0.0%	0.8	0.8	1
Portage	84331	0.0%	100.0%	8.5	8.5	1
Riverside	84334	50.0%	50.0%	5.0	3.2	2
Penrose, Thatcher, Tremonton	84337	59.0%	41.0%	24.9	4.2	39
Willard	84340	30.0%	70.0%	20.3	6.1	50
<b>All Short-Term Test Results - Box E. County</b>		<b>41.0%</b>	<b>59.0%</b>	<b>71.1</b>	<b>7.5</b>	<b>534</b>

<b>CACHE COUNTY</b>						
Communities in Zip Code >	Zip Code	<4 pCi/L*	>=4 pCi/L*	Maximum	Average	Total Tests
Clarkston	84305	100.0%	0.0%	0.7	0.7	1
Hyde Park	84318	36.3%	63.7%	40.9	7.6	91
Hyrum	84319	54.7%	45.3%	32.0	5.3	64
Cove, Lewiston	84320	51.7%	48.3%	14.8	6.0	29
Logan, Nibley, River Heights	84321	57.0%	43.0%	112.6	6.0	628
Logan, Utah State University	84322	85.7%	14.3%	4.9	1.9	7
Logan	84323	64.7%	35.3%	19.2	5.9	17
Mendon, Petersboro	84325	50.0%	50.0%	19.9	5.3	42
Millville	84326	35.1%	64.9%	19.6	6.2	37
Newton	84327	42.9%	57.1%	10.7	5.6	7
Avon, Paradise	84328	17.9%	82.1%	67.6	14.6	28
Providence	84332	36.1%	63.9%	87.0	8.9	191
Richmond	84333	55.3%	44.7%	18.2	4.7	38
Benson, Smithfield	84335	46.5%	53.5%	42.4	6.9	172
Trenton	84338	100.0%	0.0%	1.7	1.3	4
College Wd., Wellsville, Young Wd.	84339	35.1%	64.9%	152.5	21.1	77
Logan, North Logan	84341	51.6%	48.4%	52.2	6.4	304
<b>All Short-Term Test Results – Cache County</b>		<b>49.5%</b>	<b>50.5%</b>	<b>152.5</b>	<b>7.3</b>	<b>1737</b>

<b>RICH COUNTY</b>						
Communities in Zip Code >	Zip Code	<4 pCi/L*	>=4 pCi/L*	Maximum	Average	Total Tests
Garden C., Pickleville, Swan Cr.	84028	100.0%	0.0%	2.1	1.3	5
Laketown, Meadowv., Round V.	84038	0.0%	100.0%	30.8	11.7	11
Randolph	84064	71.4%	28.6%	21.2	5.7	7
<b>All Short-Term Results - Rich County</b>		<b>43.5%</b>	<b>56.5%</b>	<b>30.8</b>	<b>7.6</b>	<b>23</b>

## Why Do Radon Levels Inside a Home Fluctuate So Much?

### Air Pressure Differentials Caused by Building Induced Soil Suction & Stack Effect from Heating

- Buildings can create vacuums that suck in soil gases/radon. These vacuums (referred to as **Air Pressure Differentials APD's**) may be very small. But even small APD's between the house air pressure and the soil gas pressure - can greatly change radon readings inside a home.
- When indoor air is warmer than outside air, it rises up and exits through the upper portion of the house. This air is replaced by soil gases which contain radon. The warmer the house and the colder it is outside – the greater is the stack (chimney) effect drawing radon into a home.
- APD's and the stack effect are the greatest factors causing radon levels to rise or fall inside a home. Because APD's and the stack effect are usually higher at night and lower during the day – indoor radon levels are usually higher at night and lower in the day (diurnal APD/stack effect).

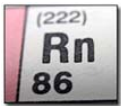
### Use of Home Air Exhaust Devices

- When exhaust devices push air out of a home, the home's partial vacuum is increased - causing more soil gases and radon to be sucked in.
- Estimated air flows (cubic feet per minute – cfm) of home devices that exhaust air to the outside:
  - Open wood fireplace 170cfm
  - Central vacuum cleaner 110cfm
  - Clothes dryer 100cfm
  - Bathroom fan 24-90cfm
  - Open wood stove 65cfm
  - Gas combustion appliances 21-72cfm  
(furnaces, space heaters, ranges, water heaters, etc.)
  - Air-tight wood stove 30cfm

### Rain, Winds and Other Natural Forces

- Light rain and gentle winds have little effect on indoor radon concentrations.
- Severe storms and high winds can have a great effect on indoor radon levels.
- Rain can block soil pathways and either raise or reduce indoor radon concentrations.
- Indoor radon concentrations are usually higher during heavy rain events and winter seasons.
- High winds can raise or lower indoor radon. When wind blows on side of house with most door(s)/window(s), it creates more positive indoor pressure which pushes radon out. When it blows on side with least door(s)/window(s), it creates more negative indoor pressure, which sucks more radon in.
- Barometric pressure changes can change soil gas pressures and amount of radon entering a home.
- Indoor radon levels are usually higher in the wintertime because: 1. - the heating system is pulling air up and out of the home (stack effect); and 2. - frozen ground/soil saturation caps/blocks soil gas/radon from normal exiting into the atmosphere from outside soil - causing soil gas/radon pressures to rise. Thus entering the home becomes the pathway of least resistance for soil gas/radon to follow.
- Daily radon variation (sometimes 2-3 fold) is usually greater in the summer than in the winter. because of more variations in soil surface temperatures during the summer than in the winter.
- An activated sump pump can pump some radon out with the water (and lower indoor radon levels).

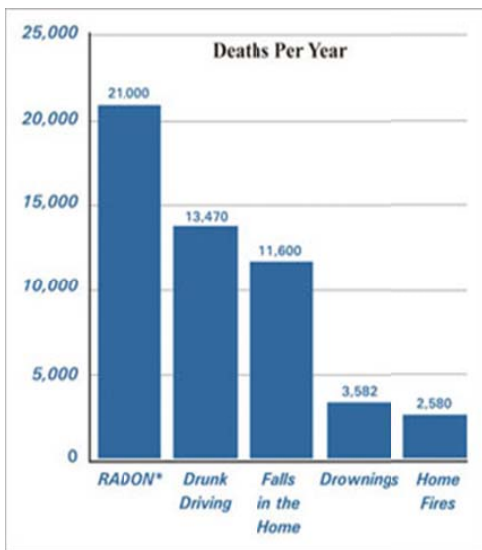
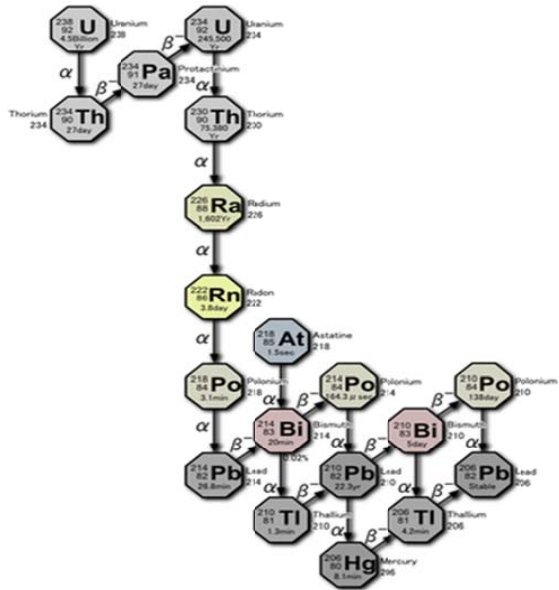
**Brief Scientific (Technical) Explanation of How Radon Causes Lung Cancer**



Radon is a colorless/odorless gas - a radioactive byproduct and part of the natural radioactive decay of uranium 238. Radon has a half-life of 3.8 days, decaying by emission of alpha particles and beta radiation to polonium, bismuth, and lead in successive steps (shown in the chart below).

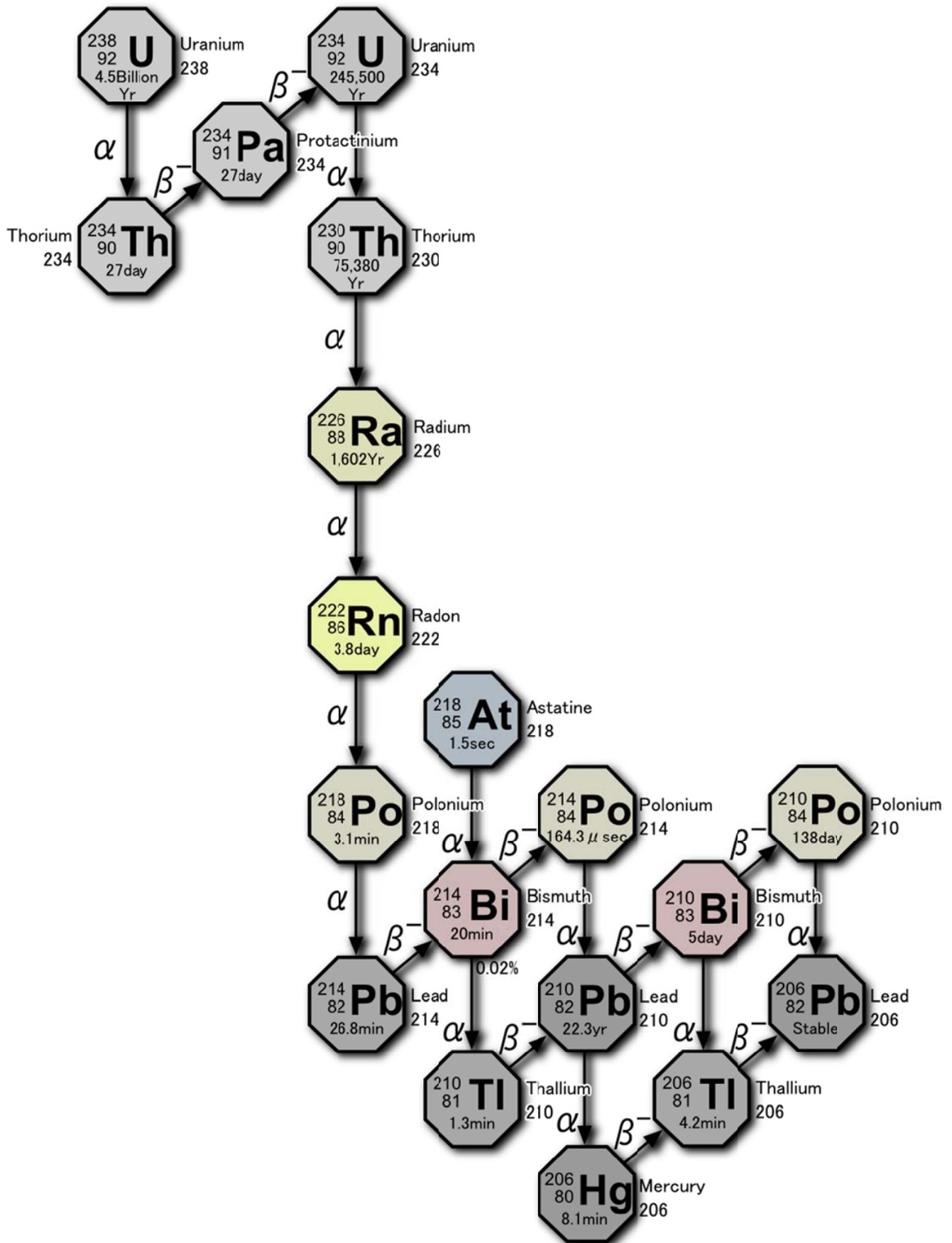
Radon 222 emits an alpha particle (alpha) and decays further into isotopes of polonium, lead, and bismuth [the most important being polonium isotopes 218 and 214 with a combined 13.7 million electron volts (MeV) of energy]. These isotopes are called radon decay products (RDPs). RDPs float around in the air during their minutes/seconds of existence, often become attached to dust particles, enter our lungs, and emit alphas which cause harm. (Details continue below-right.)

The top 6 feet of soil in an average acre of land contains about 50 lbs. of uranium that will decay into radon and RDPs. On average, about six atoms of radon emerge from every square inch of soil per second. Radon in outside air is diluted rapidly, but if it enters through basement floors and is trapped in tight houses, it can reach dangerous concentrations. Being an atom, radon can easily penetrate through concrete. As concrete cures, the water that was originally part of the concrete mix migrates to the surface and evaporates, leaving behind tiny capillaries (tubes). These tubes are thinner than a human hair, but large enough for radon gas atoms to pass through. Cement sealers, plastic sheeting, etc. also don't stop radon from entering homes. Only by creating a partial vacuum beneath concrete (sub-slab depressurization) and venting radon through piping (often with an exhaust fan) to above the roof - can radon be largely prevented from entering homes.

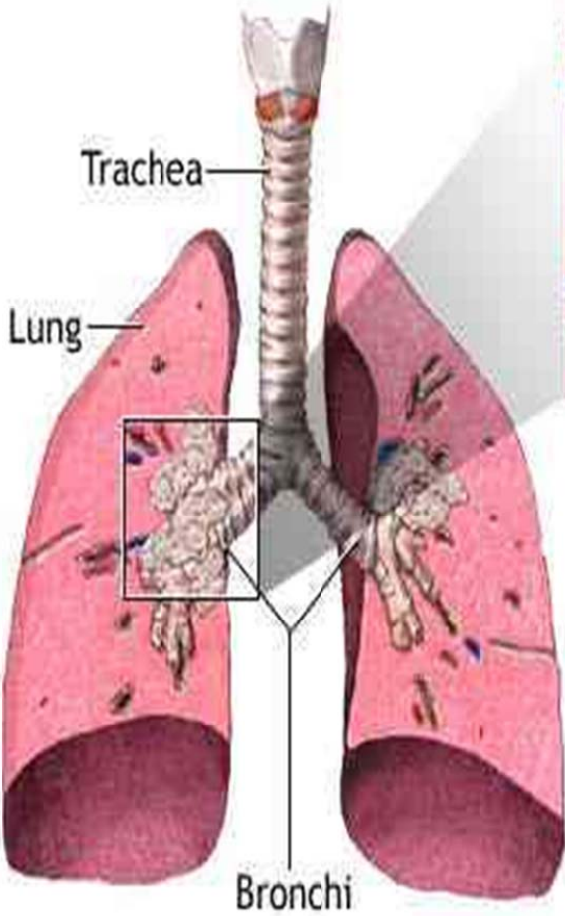


*The US-EPA estimates radon causes many thousands of cancer deaths in the United States each year.*

RDPs, being electrically charged solid particles often stick to the surfaces of our bronchial tubes where they can do the most harm (cells lining bronchial tubes are among the most sensitive cells of the body). When RDP alphas are emitted, they dump a lot of energy (MeV) into and severely damage the DNA of these cells. Passage of a single alpha has the potential to cause irreparable damage in cells that are not killed. If not properly repaired, DNA damage from the linear energy transfer (LET) in this type of interaction - can be preserved and incorporated into the genetic structure of transcribed DNA. Since LET-induced DNA mutations can sometimes exist through 50 cellular generations (or more) - at some point the mutational insult becomes too cytotoxic for the cell to continue correct replications, resulting in cancerous tumors. It is also believed that alphas induce oncogenes (make genes that may cause cancer) and damage tumor-suppressor genes, and that this results in chromosomes being fractured/improperly repaired. Also, the rebounding RDP atoms also release a lot of energy which damages DNA in adjacent cells. Because alphas/rebounding atoms are so harmful, they are a 100 times more likely to cause cancer than other radiation types. US-EPA estimates radon causes about 21,000 U.S. deaths each year. Only cigarette smoking causes more lung cancer deaths per year than radon.







Squamous cell carcinoma