Name

Potential Radon Health Effects – Vocabulary

Use web resources to define the following terms:

Cancer:

Tumor suppressor genes:

Oncogene:

Carcinogen:

Malignancy:

Ubiquitous:

DNA (Deoxyribonucleic Acid):

Epidemiologist:

Genetics:

Epigenetics:

Teacher Comments:

Name

LAB 1: DO ENVIRONMENTAL FACTORS CONTRIBUTE TO CANCER?

Student Instructions

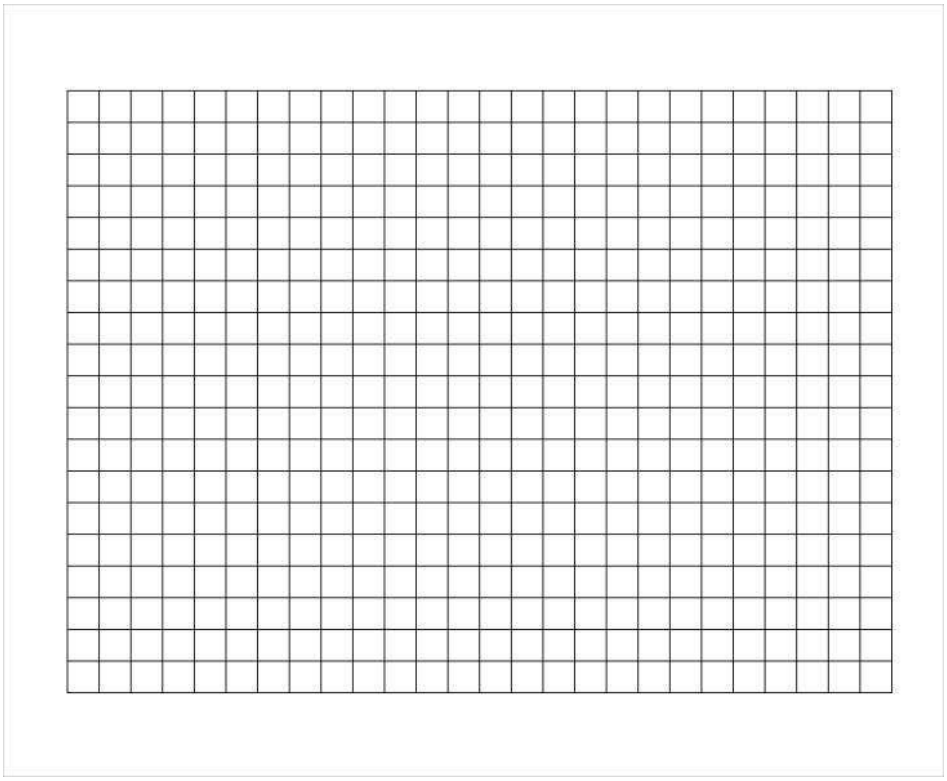
You and your classmates are tasked with the job of determining the primary causes of an increased death rate due to a certain type of cancer within the small town of Cliffside. By analyzing given data, you must determine which type of cancer is increased in Cliffside as well as the possible reason for the increase. Approximately 30% more of the Cliffside population dies from this cancer compared to citizens in the rest of the United States. You will be given epidemiology data collected from the townspeople to analyze.

Cliffside is a rural town with a population of approximately 100,000 people. Despite its relatively small size, there is significant economic diversity. On one side of the town are the Everything Cliffs from which the town is named. In addition, the Everything Cliffs provide a substantial number of jobs through the uranium mines they contain. Cliffside also contains a significant amount of farmland. Some residents complain about the pesticides that are commonly used in the area. Cliffside is also noted for the presence of the Big River, which runs through the town and is a popular site for sport fishing. The following tables contain data about the people of Cliffside. You must analyze the data and look for trends that might provide clues to the mysterious increase in the death rate due to cancer. Create graphs that support your conclusions.

At a minimum, use the data tables to graph these possible scenarios:

1. *Residents with each type of cancer: smokers versus nonsmokers*
2. *Residents with each type of cancer by occupation: smokers versus nonsmokers*
3. *Residents with each type of cancer by type of residency, according to number of years lived in each particular type of housing.*
4. *Residents with each type of cancer versus age.*

Your teacher will help you graph *Resident Smokers with Lung Cancer vs Resident Non-smokers with Lung Cancer*. Graph on the coordinate system below, the data is in the table on the following page.

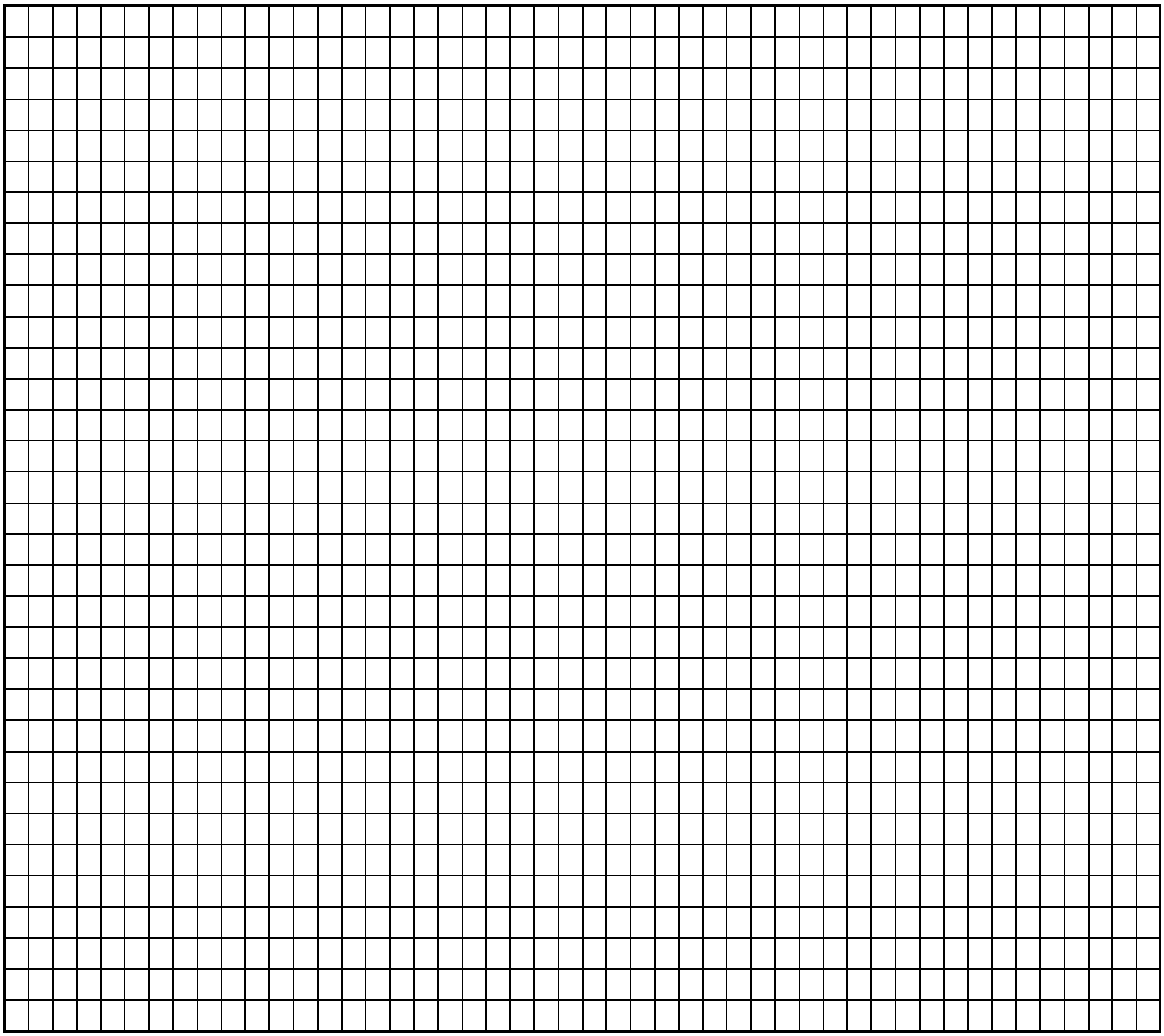


Cliffside Cancer Rate Data Tables

Number of Deaths due to Lung Cancer per 100,000 people

Age		Gender			
35-39		Male		Female	
	Occupation	Smoker	Nonsmoker	Smoker	Nonsmoker
	Ag Worker	1	0	0	0
	Policeman	0	0	0	0
	Miner	1	0	0	0
	Teacher	0	0	0	0
40-44					
	Ag Worker	1	0	0	0
	Policeman	0	0	0	0
	Miner	1	0	0	0
	Teacher	0	0	1	0
45-49					
	Ag Worker	1	0	0	0
	Policeman	0	0	0	1
	Miner	2	0	0	0
	Teacher	0	0	1	0
50-54					
	Ag Worker	1	1	0	0
	Policeman	1	0	1	0
	Miner	4	3	0	0
	Teacher	1	0	1	0
55-59					
	Ag Worker	3	0	1	0
	Policeman	2	0	0	0
	Miner	6	4	1	0
	Teacher	1	1	1	0
60-64					
	Ag Worker	6	1	0	1
	Policeman	5	1	3	1
	Miner	8	5	0	0
	Teacher	1	1	2	1
65-70					
	Ag Worker	10	4	0	1
	Policeman	4	2	5	1
	Miner	22	13	0	0
	Teacher	2	1	4	3

Use the data from the previous page and the data found in tables from pages 9 - 10 to graph *Residents with each type of cancer: smokers vs. non-smokers*. The three types of cancer are lung cancer, colorectal cancer, and breast cancer. Be sure that your graph has all of the properties of a properly constructed graph: a title, labeled axis, and the appropriate units.



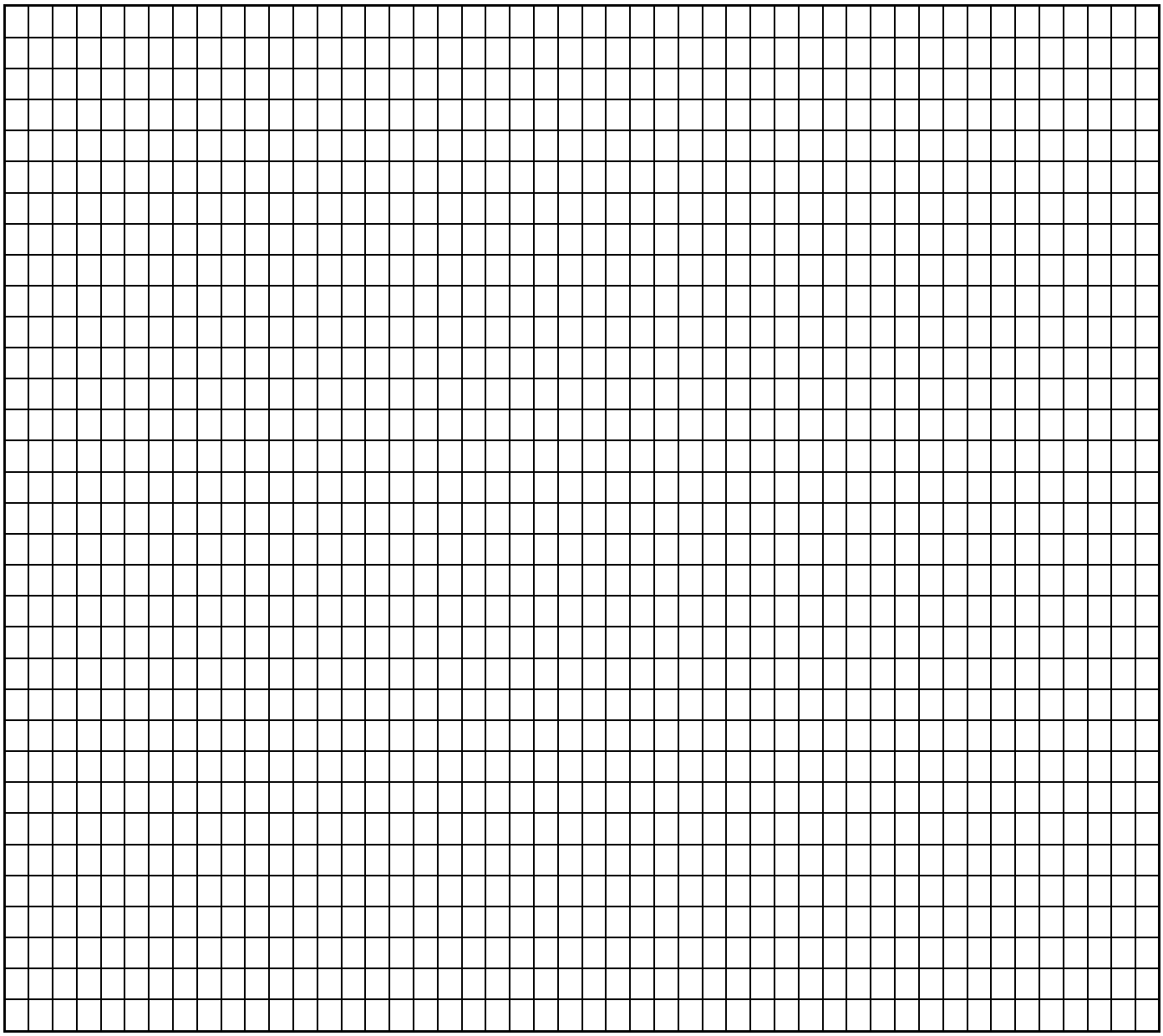
Number of Deaths due to Colorectal Cancer per 100,000 People

Age		Gender			
35-39		Male		Female	
	Occupation	Smoker	Nonsmoker	Smoker	Nonsmoker
	Ag Worker	0	0	0	0
	Policeman	0	0	0	0
	Miner	1	0	0	0
	Teacher	0	0	0	0
40-44					
	Ag Worker	1	0	0	0
	Policeman	0	0	1	0
	Miner	1	0	0	0
	Teacher	0	0	0	0
45-49					
	Ag Worker	1	0	0	0
	Policeman	1	0	0	0
	Miner	0	0	0	0
	Teacher	0	0	0	0
50-54					
	Ag Worker	0	0	0	0
	Policeman	0	1	0	0
	Miner	0	0	0	0
	Teacher	0	0	0	0
55-59					
	Ag Worker	1	0	0	0
	Policeman	1	0	0	1
	Miner	1	0	0	0
	Teacher	0	0	1	0
60-64					
	Ag Worker	4	3	1	0
	Policeman	2	1	1	2
	Miner	4	3	1	0
	Teacher	2	1	1	1
65-70					
	Ag Worker	2	1	0	0
	Policeman	1	0	1	0
	Miner	2	0	0	0
	Teacher	2	1	1	0

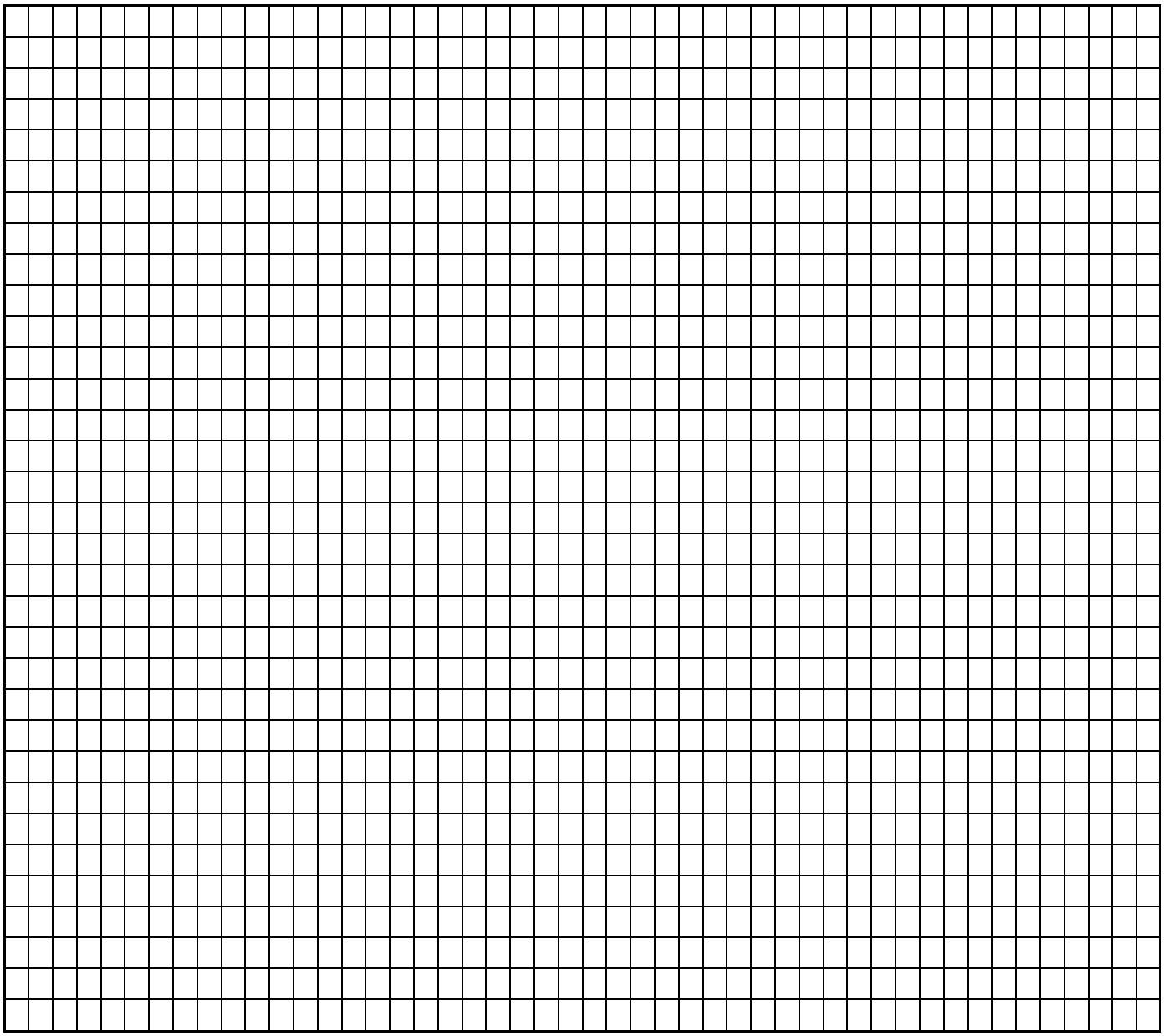
Number of Deaths due to Breast Cancer per 100,000 People

Age		Gender			
35-39		Male		Female	
	Occupation	Smoker	Nonsmoker	Smoker	Nonsmoker
	Ag Worker	0	0	0	0
	Policeman	0	0	0	0
	Miner	0	0	0	0
	Teacher	0	0	0	0
40-44					
	Ag Worker	0	0	0	0
	Policeman	0	0	0	0
	Miner	0	0	0	0
	Teacher	0	0	0	0
45-49					
	Ag Worker	0	0	0	0
	Policeman	0	0	0	0
	Miner	0	0	0	0
	Teacher	0	0	1	0
50-54					
	Ag Worker	0	0	0	0
	Policeman	0	0	1	0
	Miner	0	0	0	0
	Teacher	0	0	2	0
55-59					
	Ag Worker	0	0	1	0
	Policeman	0	0	0	0
	Miner	0	0	0	0
	Teacher	0	0	2	2
60-64					
	Ag Worker	1	0	1	0
	Policeman	0	0	3	1
	Miner	1	0	0	0
	Teacher	0	0	2	1
65-70					
	Ag Worker	0	0	0	0
	Policeman	0	0	2	2
	Miner	0	0	0	0
	Teacher	0	0	2	1

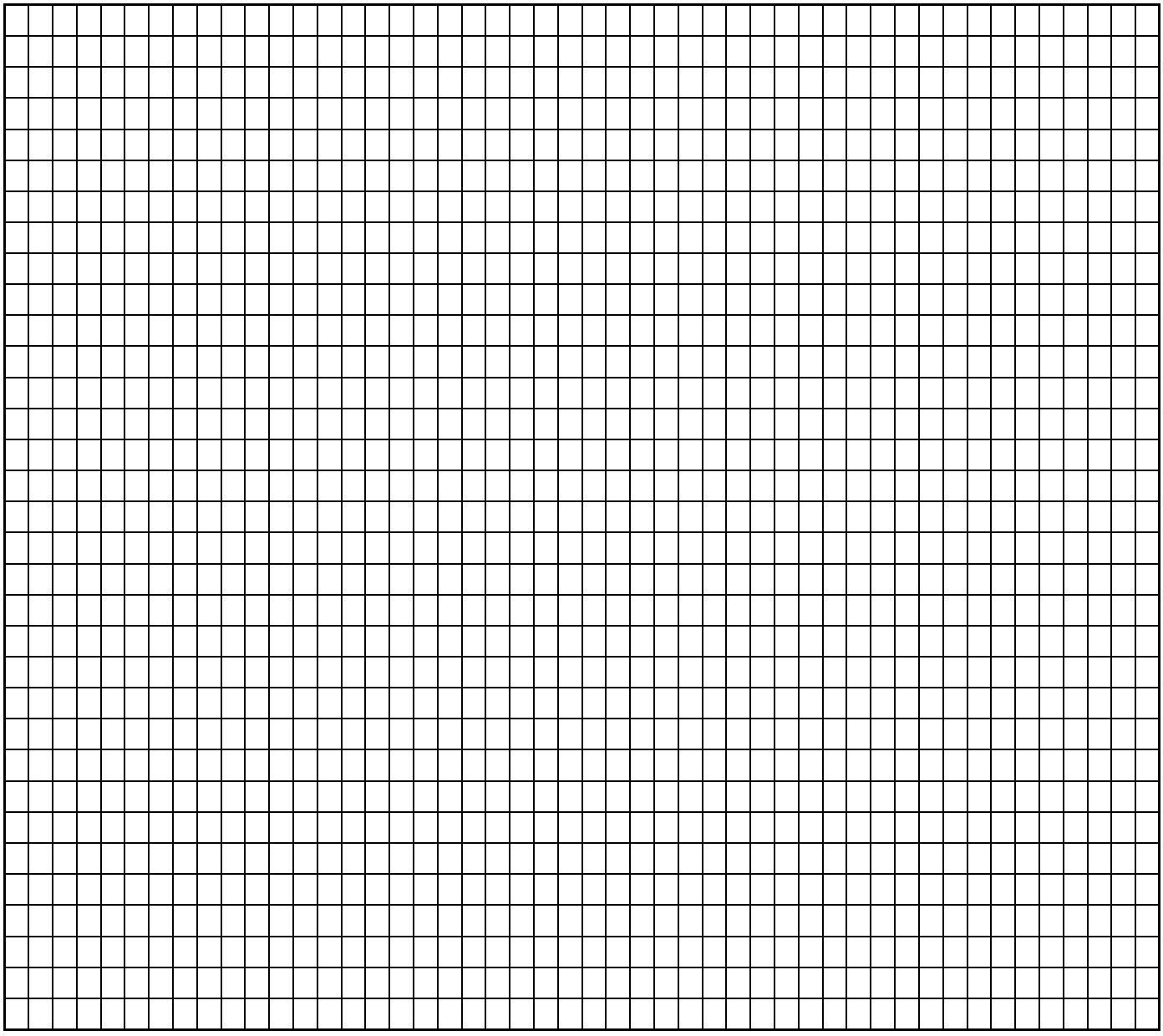
Use the data from the tables on pages 7, 9, and 10 to graph *Residents with each type of cancer by occupation: smokers vs. non-smokers.*



Use the data in the tables on pages 7, 9, and 10 to graph *Residents with each type of cancer vs. age*.



Use the data in the tables on pages 14 – 16 to graph Residents with each type of cancer by type of residency, according to number of years lived in each particular type of housing.



Type of Residency and Lung Cancer Deaths in Cliffside (2012)

Years of Occupancy	Type of Residency	Total # of Cliffside Residents	Total # with Lung Cancer	% with Lung Cancer
0-4	House without BSMT	50,000	675	1.35
	House with BSMT	34,000	493	1.45
	1st level or higher Apt	65,000	865	1.33
	BSMT Apt	25,000	375	1.50
5-9	House without BSMT	65,000	900	1.38
	House with BSMT	50,000	800	1.6
	1st level or higher Apt	45,000	650	1.44
	BSMT Apt	23,000	368	1.6
10-14	House without BSMT	70,000	850	1.21
	House with BSMT	69,000	1050	1.52
	1st level or higher Apt	38,000	480	1.26
	BSMT Apt	20,000	375	1.88
15-19	House without BSMT	75,000	1,100	1.47
	House with BSMT	83,000	1,328	1.60
	1st level or higher Apt	35,000	510	1.26
	BSMT Apt	15,000	308	2.05
20+	House without BSMT	80,000	1,200	1.5
	House with BSMT	84,000	1,496	1.78
	1st level or higher Apt	30,000	380	1.27
	BSMT Apt	10,000	215	2.15

Effect of Type of Residency on Colorectal Cancer Death Rate in Cliffside (2007-2012)

Years of Occupancy	Type of Residency	Total # of Cliffside Residents	Total # with Colorectal Cancer	% with Colorectal Cancer
0-4	House without BSMT	50,000	375	0.75
	House with BSMT	34,000	282	0.83
	1st level or higher Apt	65,000	416	0.64
	BSMT Apt	25,000	193	0.77
5-9	House without BSMT	65,000	585	0.9
	House with BSMT	50,000	325	0.65
	1st level or higher Apt	45,000	329	0.73
	BSMT Apt	23,000	138	0.6
10-14	House without BSMT	70,000	420	0.6
	House with BSMT	69,000	559	0.81
	1st level or higher Apt	38,000	274	0.72
	BSMT Apt	20,000	138	0.69
15-19	House without BSMT	75,000	623	0.83
	House with BSMT	83,000	623	0.75
	1st level or higher Apt	35,000	245	0.7
	BSMT Apt	15,000	95	0.63
20+	House without BSMT	80,000	728	0.91
	House with BSMT	84,000	689	0.82
	1st level or higher Apt	30,000	222	0.74
	BSMT Apt	10,000	70	0.70

Effect of Type of Residency on Breast Cancer Death Rate in Cliffside (2007-2012)

Years of Occupancy	Type of Residency	Total # of Cliffside Residents	Total # with Breast Cancer	% with Breast Cancer
0-4	House without BSMT	50,000	250	0.50
	House with BSMT	34,000	146	0.43
	1st level or higher Apt	65,000	397	0.61
	BSMT Apt	25,000	143	0.57
5-9	House without BSMT	65,000	384	0.59
	House with BSMT	50,000	210	0.42
	1st level or higher Apt	45,000	171	0.38
	BSMT Apt	23,000	69	0.30
10-14	House without BSMT	70,000	315	0.45
	House with BSMT	69,000	428	0.62
	1st level or higher Apt	38,000	220	0.58
	BSMT Apt	20,000	96	0.48
15-19	House without BSMT	75,000	450	0.60
	House with BSMT	83,000	457	0.55
	1st level or higher Apt	35,000	112	0.32
	BSMT Apt	15,000	68	0.45
20+	House without BSMT	80,000	400	0.50
	House with BSMT	84,000	689	0.61
	1st level or higher Apt	30,000	117	0.39
	BSMT Apt	10,000	45	0.45

Teacher Comments:

COMPREHENSION 1

What are the Potential Health Effects of Radon?

WHAT IS RADON?

Radon is a radioactive gas that emanates from uranium-bearing soil and porous rock. The presence of trace amounts of uranium in most ground sources means that all humans are exposed to radon to some degree. Radon migrates out of soil and rock into the surrounding air and accumulates in poorly ventilated or closed areas. Such areas represent the primary environments in which humans are exposed to radioactivity from radon. The gaseous and carcinogenic nature of radon makes it of particular interest to epidemiologists because it is able to migrate out of soil and rock.

WHAT IS THE RELATION BETWEEN RADON AND CANCER?

For more information on the health risks of radon exposure, please visit: http://1.usa.gov/VQqAT

When radon and other radioactive materials decay, they eject particles (gamma rays, beta rays, charged particles or neutrons), which can then interact with other material, including mammalian cells. Biological damage resulting in malignancy (cancer) can occur when these ejected particles pass into a cell and deposit some or all of their energy. This energy interacts with the cell at an atomic level and leaves the atoms ionized, which changes their chemical properties. In addition, since mammalian cells are composed primarily of water, the energy from the ejected particles interacts mainly with water and can cause formation of negatively charged hydroxyl free radicals (OH-) by fragmenting the water molecule. These “free radicals” are highly unstable and have a tendency to bind to other molecules, also changing the chemical properties. Therefore, radon and other radioactive materials are extremely toxic to mammalians cells primarily due to the formation of ionized atoms and free radicals, both of which alter the cellular composition.

Mammalian cells exposed to ionizing radiation can potentially develop many types of illness. Of these illnesses, cancer is the most significant and is caused by damage to DNA (deoxyribonucleic acid) molecules within the cell. DNA carries our genetic code and is highly protected by various mechanisms in our body. It is very important that the DNA retains its structural integrity in order for the genetic code to be properly interpreted. Damage to DNA strands can result in several outcomes: 1) the breaks may be repaired by the normal repair mechanisms of the cell, resulting in a normal DNA strand, 2) there may be loss of a DNA base, resulting in permanent change to the DNA, 3) there may be a break in one or both strands of the DNA, resulting in a permanent change. Permanent changes to DNA result in mutations that may give rise to cancer.

WHY ARE RADON-ASSOCIATED MUTATIONS IN TUMOR SUPPRESSOR AND ONCOGENES IMPORTANT?

Radon is believed to cause the most biological damage when two of the decay products, Polonium-214 and -218, come into close proximity to lung tissue. There is evidence that exposure to the decay products of radon results in mutations to tumor suppressor genes and oncogenes, increasing the likelihood of cancer developing.

WHAT IS CANCER?

Cancer is a group of more than 100 diseases that develop across time and in virtually any of the body's tissues. Cancer develops when mutations occur in genes that normally operate to control cell division, causing the cell to divide inappropriately. Cancer-causing mutations can be caused by exposure to a variety of environmental agents. Such mutations can also be inherited, which predisposes a person for an increased risk of developing certain cancers. This is demonstrated by the increased incidence of cancer observed in certain families.

WHAT IS THE IMPORTANCE OF GENETICS AND EPIGENETICS?

The status of human health is due to a combination of genetics, environmental factors, and epigenetic influences. A discussion lacking any one of those three components will fail to fully predict human health outcomes. The unique sequence of an individual's DNA provides a basic "blue print" for the genes necessary to sustain life. However, modification of the factors that can change expression of specific genes can influence an individual's physiology and behavior. These "epigenetic" modifications are a result of environmental events that often begin in the before birth.

The DNA that makes up our genetic code can be directly linked to many diseases. Genetic abnormalities can result in functional diseases such as Down's syndrome and Cystic fibrosis. Alternatively, mutations in DNA can lead to increased susceptibility to diseases such as lung cancer, breast cancer, and colon cancer to name a few. Also, variations in genetics will partially determine if environmental exposure to toxicants such as asbestos will result in an individual developing cancer in their lifetime.

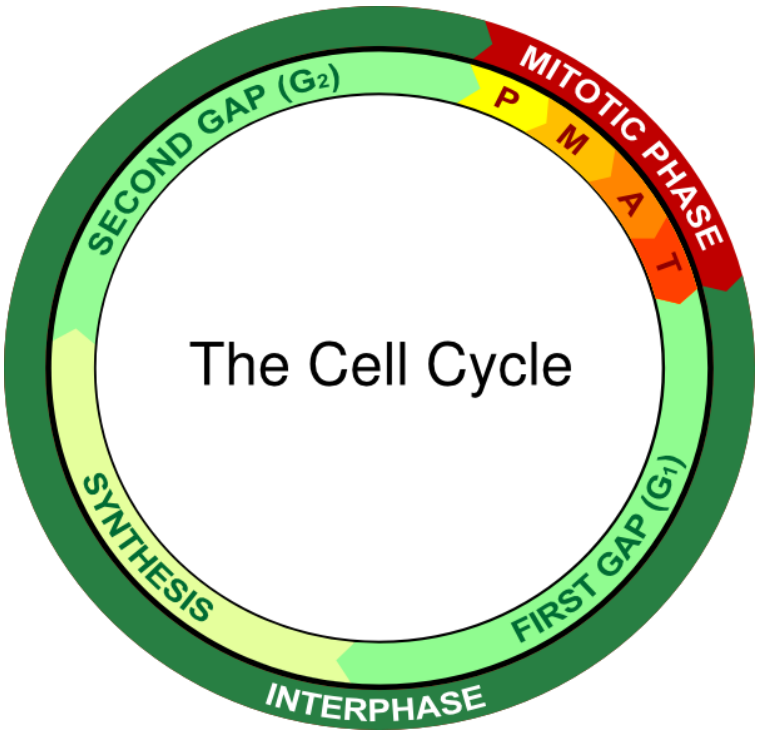
The importance of epigenetic influences on human health has been highlighted in recent years. Epigenetic "imprinting" can significantly affect the pattern of gene expression within an individual and influence behavior, physiology, and disease status. In some cases, changes to the genetic material through epigenetics can be passed on to the next generations.

WHAT IS THE CELL CYCLE?

The cell cycle describes the process by which a cell divides and is duplicated. In eukaryotic cells, this process can be divided into two periods: 1) Interphase, or the time in which the cell grows and accumulates the nutrients needed for division and for DNA replication and 2) Mitosis, or the period in which the cell splits itself into two distinct "daughter" cells.

The Interphase is further divided into three distinct phases known as Gap1 (G1), Synthesis (S) and Gap2 (G2) phase. During the G1 period, a control mechanism known as the "G1 checkpoint" ensures that the cell is ready for DNA synthesis. Following the G1 phase is the S phase, in which DNA replication is known to occur. Finally, during the G2 phase the cell continues to grow and the "G2 checkpoint" ensures that everything is ready for the cell to divide during the period of Mitosis. It is during the G1 period when a cell is able to leave the cell cycle indefinitely and enter a state of quiescence. This is known as the Gap0 (G0) or resting period.

Mitosis is a relatively short period of time in which cell growth is halted in order to allow all cellular energy to be focused on the methodical division into two daughter cells. Another checkpoint, known as the "Metaphase Checkpoint" occurs in the middle of the mitotic process to ensure that the cell is ready to complete cell division.



This graphic was taken from the http://www.clker.com/clipart-the-cell-cycle.html website and used under a creative commons license. (http://creativecommons.org/licenses/by-nc-sa/2.0/uk/)

HOW DOES CANCER DEVELOP?

Cancer develops when cells lose the ability to tightly regulate the cell cycle, resulting in uncontrolled cell division. The loss of cell cycle regulation is a result of mutations in genes involved in regulation of the cell as it progresses through the phases of the cell cycle. These mutations can be inherited and therefore passed on from generation to generation or they may result from exposure to certain environmental factors. Radon is one such factor that may increase an individual's risk of lung cancer. Inhalation of radon may result in cancer due to cell damage caused by contact with the highly charged alpha particles and other decay products that are released as radon decays. Risk of developing cancer increases as the amount and duration of exposure to radon increases. However, it is important to remember that no single event (such as radon exposure) is enough to turn a cell into a cancerous cell; rather research suggests that the accumulation of damage to a number of genes across time leads to cancer.

 Name

Radon Health Effects Comprehension 1 Guiding Questions

1. What properties make radon of particular concern to epidemiologists?

2. What are two physiological consequences of radon exposure that result in toxicity to mammalian cells?

3. Explain why free radicals can result from radon exposure.

4. People exposed to radon are at higher risk of developing which type of disease? Why?

5. After defining tumor suppressor genes and oncogenes, explain why mutations might increase the likelihood of cancer developing.

6. What are two ways a person might end up with cancer-causing mutations in their DNA?

7. Explain why regulation of the cell cycle is so critical for prevention of cancer.

Teacher Comments: