Use the resources provided to complete this worksheet.

Section 1: Factors Reported to Be Associated with Cancer

Read the News Alert items and use the information provided to identify what each item suggests is the cause of cancer and what evidence supports that claim.

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<th>News Alert</th>
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Section 2: Building an Explanation for the Cause of Cancer Read the resources on Resources for Understanding Cancer. Think about the information each resource presents, then write a one-sentence statement for each that summarizes what you learned.

Resource 1:
Cancer involves . . .
Resource 2:
Cell division normally is . . .

Resource 3:
Cell cycle regulation is accomplished by . . .

Resource 4:
Cancer-causing agents often . . .

Resource 5:
When damage occurs to genes that regulate the cell cycle . . .
News Alerts

News Alert! Cancer and Chemical Poisons
Dr. Percivall Pott
London, 1775
I have been studying the various forms of cancer that plague our society. It has come to my attention that people of certain occupations have higher frequencies of certain types of cancer than the general public. In particular, chimney sweeps have a high rate of cancer of the scrotum. Young boys often enter the profession because they are able to squeeze down narrow chimneys. Once inside the chimneys, they spend hours scraping them clean of the accumulated tars that otherwise would cause disastrous chimney fires. Sweeps are continually covered with flue tar and dust, and because they likely do not bathe regularly, this dust remains trapped in the folds of the skin. I believe that some agent in the coal tar, when exposed to the scrotum across many years, actually causes this disease.

News Alert! Cancer and Your Family History
Dr. Hilario de Gouvea
Brazil, 1886
Today I would like to present a most curious case. It may shed light on an aspect of cancer about which we know little. Fourteen years ago, a man brought his 2-year-old son in for treatment of retinoblastoma, a very rare form of cancer that develops within the eye, often of young children. If untreated, the cancer travels up the optic nerve until it reaches the brain and spreads throughout the body. I removed the tumor, and the boy was completely cured. He married and had seven children. Curiously, two of his girls developed retinoblastoma in both eyes. The parents refused treatment, and both girls died within several months. Here, a form of cancer that normally occurs once in every 20,000 children has occurred three times in one family. I believe this represents evidence that susceptibility to cancer can be transmitted from parents to children, just like hair or eye color.

News Alert! Cancer and Radiation Exposure
X-Ray Technician
New York, 1902
X-rays are the marvel of modern science. These powerful yet invisible rays permit us to see the inner workings of the body and provide treatments that we are just beginning to understand. Let technicians be warned, however, these rays, while capable doing great good, can also do great harm. We have noticed a high rate of skin cancer among technicians who use their hands to focus the energized machine. Patients are exposed only briefly to the these rays. Technicians, on the other hand, work on these machines
all day long and have many hours of exposure. Our advice is to keep the machine off while adjusting it and even to go to the next room when it is time to energize it.

News Alert! Cancer and UV Light
News Reporter
Miami, 1945

Now that the war is over, Americans are ready to relax and enjoy their freedom. What better place to recuperate than at the beach? Women have cast aside the Victorian fashions of yesteryear and have adopted the new, sleek, trimmed-down swimsuit. Sunbathers say the more skin, the better. Be warned, however, that all this skin and sun can lead to painful burns. In fact, now doctors are warning of a possible connection between the sun’s rays and skin cancer. Perhaps the unseen ultraviolet rays that fade our clothes can also damage skin and lead to deadly disease. Maybe a healthy tan is not so healthy after all.
Resources for Understanding Cancer

Resource One

The rate and timing of cell division in your body normally are very precisely regulated. Cells are formed, mature, and eventually die.

As this happens, new cells divide, creating replacement cells. Chemical messengers that pass between neighboring cells help keep the rate of cell division equal to the rate of cell death.

Sometimes, a cell breaks free from its normal restraints and begins to follow its own pattern of cell division. This precancerous cell divides more often than normal, eventually producing a mass of cells that also divide more often.

Further changes in these cells can increase the frequency of cell division even more, until eventually a cancerous tumor develops.

At this point, the tumor grows large, but is confined to the tissue where it originated. Late in the development of cancer, some cells may gain the ability to move into blood vessels and travel to other parts of the body.

Resource Two

For many years, it was a mystery to scientists how cells controlled their cell division. Scientists now know that the chemical messages that cells receive from neighboring cells affect a complicated group of molecules in the cell. These molecules are called the “cell cycle clock.”

The cell cycle clock integrates the mixture of signals the cell receives from its neighbors and determines whether the cell should move through each stage of growth and division. If the answer is “yes,” the cell grows and divides.

The cell cycle is composed of four phases. In the $G_1$, or Gap 1, phase, the cell increases in size and prepares to copy its DNA.

Once all the necessary molecules are made, the clock moves the cell to the $S$ phase, called $S$ for “synthesis.” This is when the cell copies its DNA.

After the DNA is copied, a second gap period, called $G_2$, occurs, and then the cell divides. The phase in which the cell divides is called $M$, for mitosis.

The new daughter cells immediately enter $G_1$. Depending on the signals they receive from neighboring cells and the decisions their cell cycle clocks make, they may go through the cell cycle again or stop cycling temporarily or permanently. Thus, in normal tissues, cell growth and division is precisely controlled by internal clocks.

Resource Three
Two types of genes play a major role in regulating the cell cycle. Genes called proto-oncogenes encourage cell division. Proteins produced by these genes act like accelerators, stimulating the cell to grow and divide. In contrast, genes called tumor suppressor genes inhibit cell division. Proteins produced by these genes act like brakes to slow down or stop cell division.

The balance between the activities of proto-oncogenes and tumor suppressor genes keeps normal cells dividing at a rate that is appropriate for their position and role in the body.

**Resource Four**

An important milestone in scientists’ efforts to understand cancer came in the 1970s when it was shown that many cancer-causing agents also are able to cause changes in DNA that we call mutations.

In fact, research showed that in many cases, chemicals that are powerful cancer-causing agents also are powerful mutagens. Mutagens are agents that produce mutations. This is shown here on a graph that compares the ability of several chemicals to cause cancer with their ability to cause mutations.

In contrast, chemicals that had only a weak ability to stimulate the development of cancer were only weak mutagens.

We now know that some cancer-causing agents do not fit this simple pattern. But the fact that many cancer-causing agents also cause mutations gave scientists an important clue about what might cause cells to become cancerous.

**Resource Five**

Normal cell division in the body depends on a precisely regulated set of events that determine when a cell will divide and when it will not divide. Two types of genes, called proto-oncogenes and tumor suppressor genes, are primarily responsible for this regulation.

When mutated, however, proto-oncogenes can become what scientists call “oncogenes,” genes that stimulate excessive division. This situation is similar to getting a car’s accelerator stuck in the downward position: A cell that experiences such mutations tends to divide more frequently than it normally would.

In contrast, mutated tumor suppressor genes can become inactive. A cell that experiences a mutation in a tumor suppressor gene loses some of its crucial braking power. Again, the result is a tendency for the cell to divide more frequently than it normally would.

For a cancerous tumor to develop, mutations must occur in several of a cell’s division-controlling genes. These mutations disturb the balance that normally exists between signals that stimulate cell division and signals that inhibit cell division. The result is uncontrolled division.