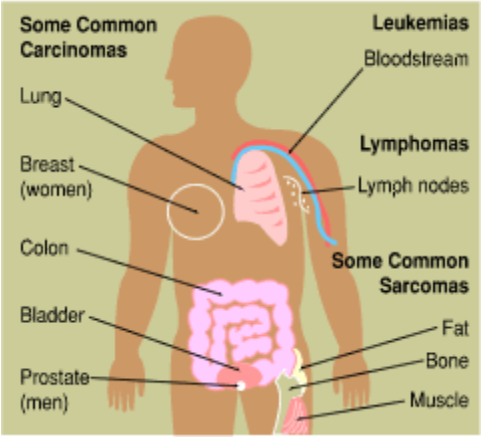
What is Cancer?

The term "cancer" refers to a group of diseases in which cells grow and spread unrestrained throughout the body. It is difficult to imagine anyone who has not heard about this disease. Most people have been affected because either a loved one, a friend, or even they themselves are cancer survivors.

It is therefore important for everyone to have a basic understanding about the nature, diagnosis, causes, prevention, and treatment of cancer.

This tutorial will help you find answers to many of your questions about the nature, causes, and prevention of cancer. You may use the program from start to finish or visit sections of particular interest one at a time. Learn about the following topics:

· What is cancer?
· How is cancer detected and diagnosed?
· What causes cancer?
· What is the link between genes and cancer?
· What is cancer prevention?



Different Kinds of Cancer

Cancer can originate almost anywhere in the body.

Carcinomas, the most common types of cancer, arise from the cells that cover external and internal body surfaces. Lung, breast, and colon are the most frequent cancers of this type in the United States.

Sarcomas are cancers arising from cells found in the supporting tissues of the body such as bone, cartilage, fat, connective tissue, and muscle.

Lymphomas are cancers that arise in the lymph nodes and tissues of the body's immune system.

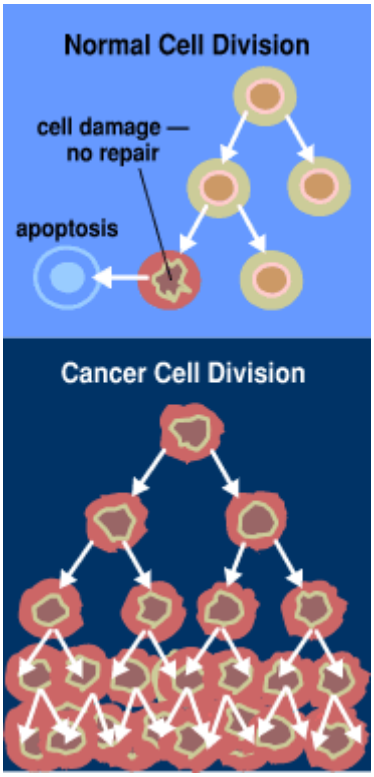
Leukemias are cancers of the immature blood cells that grow in the bone marrow and tend to accumulate in large numbers

in the bloodstream.

Some Prefixes Used in Naming Cancers	
PREFIX	MEANING
adeno-	gland
chrondro-	cartilage
erythro-	red blood cell
hemangio-	blood vessels
hepato-	liver
lipo-	fat
lympho-	lymphocyte
melano-	pigment cell
myelo-	bone marrow
myo-	muscle
osteo-	bone

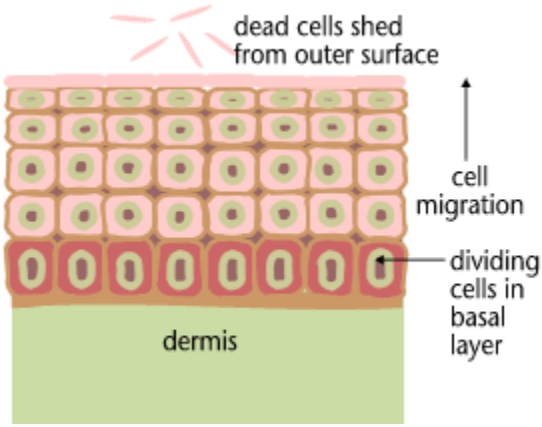
Naming Cancers

Scientists use a variety of technical names to distinguish among the many different types of carcinomas, sarcomas, lymphomas, and leukemias. In general, these names are created by using different prefixes that stand for the name of the cell type involved. For example, the prefix "osteo" means bone, so a cancer arising in bone is called an osteosarcoma. Similarly, the prefix "adeno" means gland, so a cancer of gland cells is called adenocarcinoma—for example, a breast adenocarcinoma.



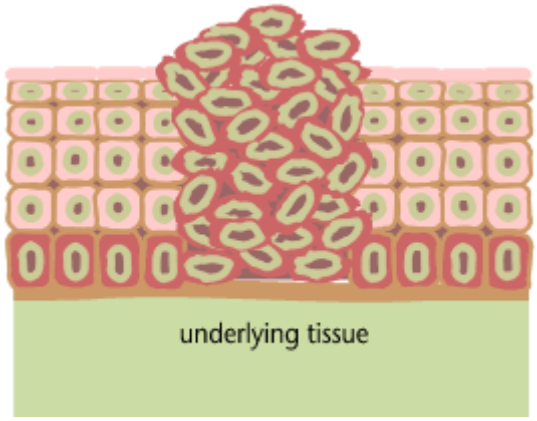
Loss of Normal Growth Control

Cancer arises from a loss of normal growth control. In normal tissues, the rates of new cell growth and old cell death are kept in balance. In cancer, this balance is disrupted. This disruption can result from uncontrolled cell growth or loss of a cell's ability to undergo "apoptosis." Apoptosis, or "cell suicide," is the mechanism by which old or damaged cells normally self-destruct.



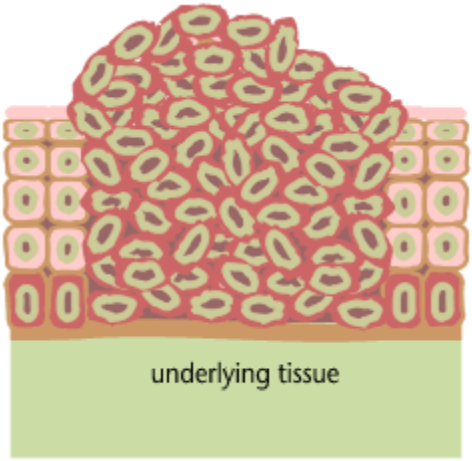
Example of Normal Growth

To illustrate what is meant by normal growth control, consider the outermost layer of the skin. The thin outer layer of normal skin, called the epidermis, is roughly a dozen cells thick. Cells in the bottom row of this layer, called the basal layer, divide just fast enough to replenish cells that are continually being shed from the surface of the skin. Each time one of these basal cells divides, it produces two cells. One remains in the basal layer and retains the capacity to divide. The other migrates out of the basal layer and loses the capacity to divide. The number of dividing cells in the basal layer, therefore, stays the same.



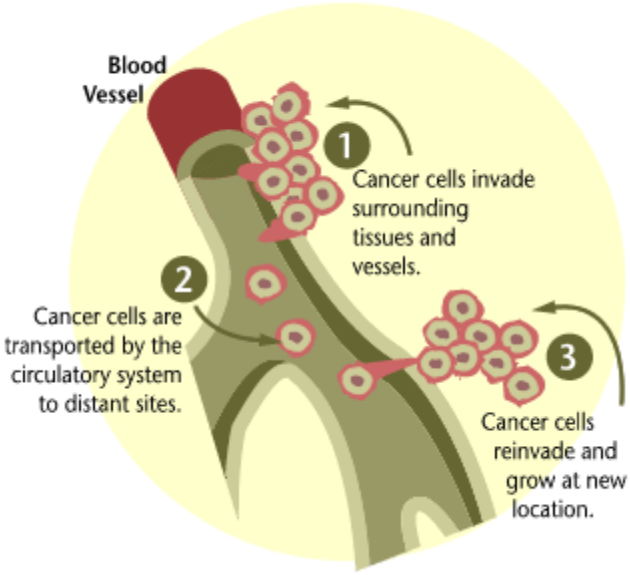
The Beginning of Cancerous Growth

During the development of skin cancer, the normal balance between cell division and cell loss is disrupted. The basal cells now divide faster than is needed to replenish the cells being shed from the surface of the skin. Each time one of these basal cells divides, the two newly formed cells will often retain the capacity to divide, thereby leading to an increase in the total number of dividing cells.



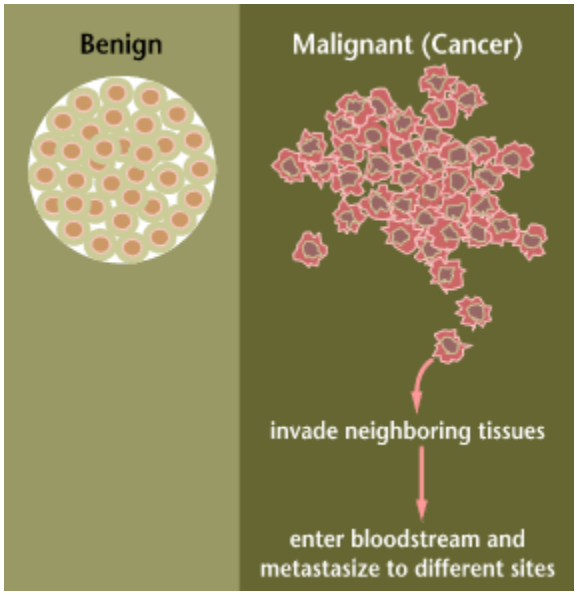
Tumors (Neoplasms)

This gradual increase in the number of dividing cells creates a growing mass of tissue called a "tumor" or "neoplasm." If the rate of cell division is relatively rapid, and no "suicide" signals are in place to trigger cell death, the tumor will grow quickly in size; if the cells divide more slowly, tumor growth will be slower. But regardless of the growth rate, tumors ultimately increase in size because new cells are being produced in greater numbers than needed. As more and more of these dividing cells accumulate, the normal organization of the tissue gradually becomes disrupted.



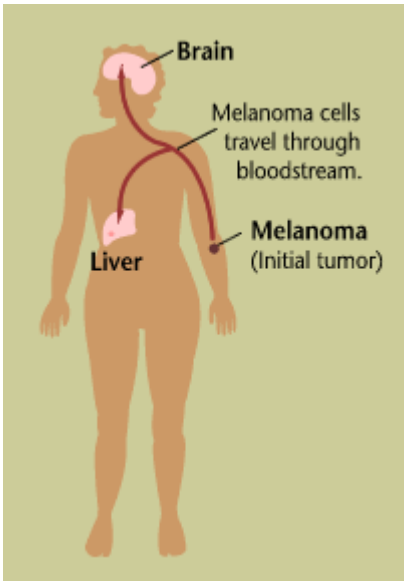
Invasion and Metastasis

Cancers are capable of spreading through the body by two mechanisms: invasion and metastasis. Invasion refers to the direct migration and penetration by cancer cells into neighboring tissues. Metastasis refers to the ability of cancer cells to penetrate into lymphatic and blood vessels, circulate through the bloodstream, and then invade normal tissues elsewhere in the body.



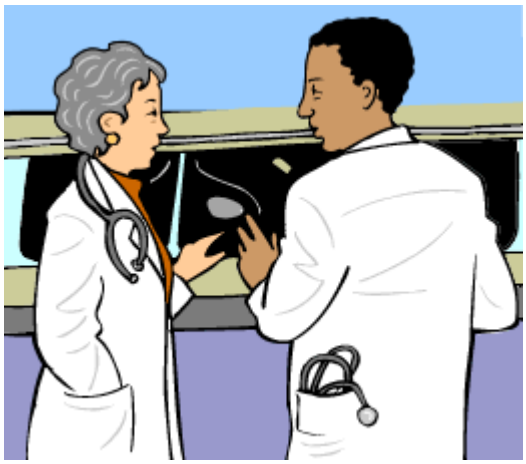
Malignant versus Benign Tumors

Depending on whether or not they can spread by invasion and metastasis, tumors are classified as being either benign or malignant. Benign tumors are tumors that cannot spread by invasion or metastasis; hence, they only grow locally. Malignant tumors are tumors that are capable of spreading by invasion and metastasis. By definition, the term "cancer" applies only to malignant tumors.



Why Cancer Is Potentially Dangerous

A malignant tumor, a "cancer," is a more serious health problem than a benign tumor because cancer cells can spread to distant parts of the body. For example, a melanoma (a cancer of pigmented cells) arising in the skin can have cells that enter the bloodstream and spread to distant organs such as the liver or brain. Cancer cells in the liver would be called metastatic melanoma, not liver cancer. Metastases share the name of the original ("primary") tumor. Melanoma cells growing in the brain or liver can disrupt the functions of these vital organs and so are potentially life threatening.

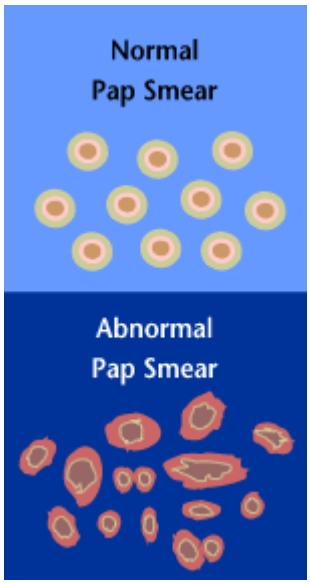


Cancer Detection and Diagnosis

Detecting cancer early can affect the outcome of the disease for some cancers. When cancer is found, a doctor will determine what type it is and how fast it is growing. He or she will also determine whether cancer cells have invaded nearby healthy tissue or spread (metastasized) to other parts of the body. In some cases, finding cancer early may decrease a person's risk of dying from the cancer. For this reason, improving our methods for early detection is currently a high priority for cancer researchers.

Early Cancer May Not Have Any Symptoms

Don't wait to feel pain before getting checked for cancer because cancer does not always have symptoms. Some people visit the doctor only when they notice changes like a lump in the breast or unusual bleeding or discharge. However, early cancer may not have any symptoms. That is why screening for some cancers can help, particularly as you get older. Screening methods are designed to check for cancer in people with no symptoms.



Pap Test

A screening technique called the Pap test (or Pap smear) allows early detection of cancer of the uterine cervix. In this procedure, a doctor uses a small brush or wooden scraper to remove a sample of cells from the cervix and upper vagina. The cells are placed on a slide and sent to a laboratory, where a microscope is used to check for abnormalities. Since the 1930s, early detection using the Pap test has helped lower the death rate from cervical cancer more than 75 percent.

Mammograms

Breast cancer can sometimes be detected in its early stages using a mammogram, an X-ray of the breast. Mammography is most beneficial for women as they age and undergo menopause. Mammography is a screening tool that can detect the possible presence of an abnormal tissue mass. By itself, it is not accurate enough to provide definitive proof for either the presence or absence of breast cancer. If a mammogram indicates the presence of an abnormality, further tests must be done to determine whether breast cancer actually is present.

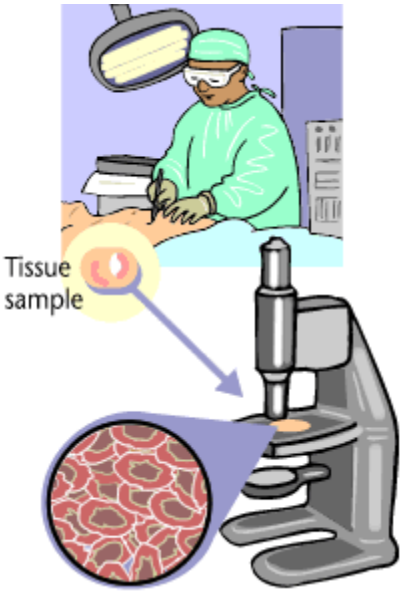
Blood Tests

Many cancers cannot yet be readily detected in their early stages, but scientists are working hard to find new clues. Scientists are trying to develop blood tests that might alert people to such cancers while they are still in their early stages. For example, several blood tests for ovarian or prostate cancer are under active study.

One example is a substance called prostate-specific antigen (PSA), produced by cells of the prostate gland. PSA circulates in the blood and can be detected and measured with a simple blood test.

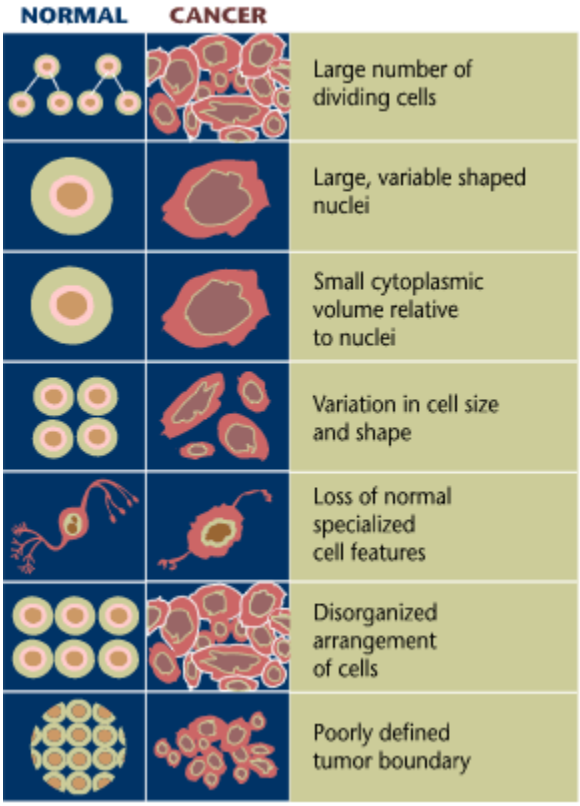
Fecal Occult Blood Test (FOBT)

A procedure called a fecal occult blood test (FOBT) detects invisible amounts of blood in the feces, a possible sign of several disorders, including colon cancer. The test is painless and can be done at home or in the doctor's office. With an application stick, a dab of a stool specimen is smeared on a chemically treated card, which is tested in a laboratory for evidence of blood. If blood is confirmed in the stool, more elaborate tests may be performed to find the source of the bleeding. Early detection using FOBT may help to decrease mortality from colon cancer.



Biopsy

To diagnose the presence of cancer, a doctor must look at a sample of the affected tissue under the microscope. Hence, when preliminary symptoms, Pap test, mammogram, PSA test, or fecal occult blood test indicate the possible existence of cancer, a doctor must then perform a biopsy, which is the surgical removal of a small piece of tissue for microscopic examination. (For leukemias, a small blood sample serves the same purpose.) Microscopic examination will tell the doctor whether a tumor is actually present and, if so, whether it is malignant (i.e., cancer) or benign.

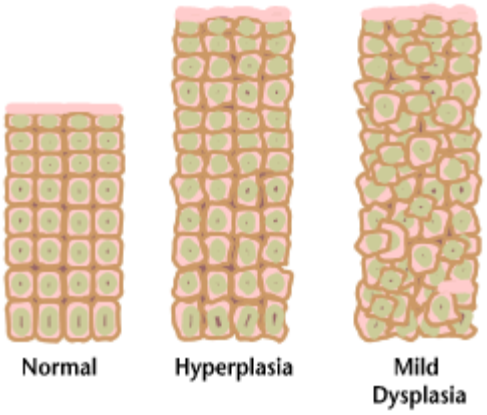


Microscopic Appearance of Cancer Cells

Cancer tissue has a distinctive appearance under the microscope. Among the traits the doctor looks for are a large number of dividing cells, variation in nuclear size and shape, variation in cell size and shape, loss of specialized cell features, loss of normal tissue organization, and a poorly defined tumor boundary.

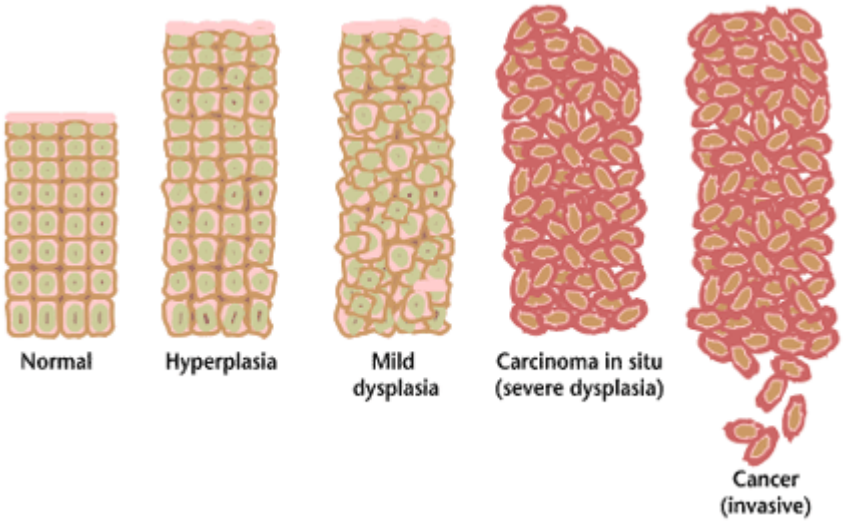
Hyperplasia

Instead of finding a benign or malignant tumor, microscopic examination of a biopsy specimen will sometimes detect a condition called "hyperplasia." Hyperplasia refers to tissue growth based on an excessive rate of cell division, leading to a larger than usual number of cells. Nonetheless, cell structure and the orderly arrangement of cells within the tissue remain normal, and the process of hyperplasia is potentially reversible. Hyperplasia can be a normal tissue response to an irritating stimulus. For example, a callus that may form on your hand when you first learn to swing a tennis racket or a golf club is produced by hyperplasia.



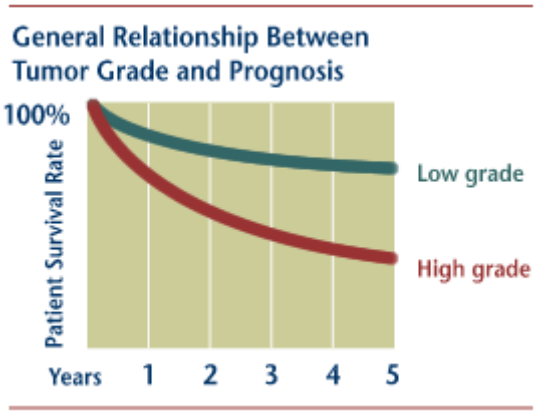
Dysplasia

In addition to hyperplasia, microscopic examination of a biopsy specimen can detect another type of noncancerous condition called "dysplasia." Dysplasia is an abnormal type of excessive cell proliferation characterized by loss of normal tissue arrangement and cell structure. Often such cells revert back to normal behavior, but occasionally, they gradually become malignant. Because of their potential for becoming malignant, areas of dysplasia should be closely monitored by a health professional. Sometimes they need treatment.



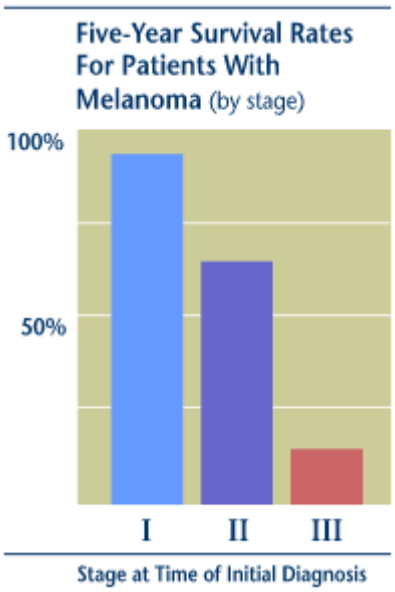
Carcinoma in Situ

The most severe cases of dysplasia are sometimes referred to as "carcinoma in situ." In Latin, the term "in situ" means "in place," so carcinoma in situ refers to an uncontrolled growth of cells that remains in the original location. However, carcinoma in situ may develop into an invasive, metastatic malignancy and, therefore, is usually removed surgically, if possible.



Tumor Grading

Microscopic examination also provides information regarding the likely behavior of a tumor and its responsiveness to treatment. Cancers with highly abnormal cell appearance and large numbers of dividing cells tend to grow more quickly, spread to other organs more frequently, and be less responsive to therapy than cancers whose cells have a more normal appearance. Based on these differences in microscopic appearance, doctors assign a numerical "grade" to most cancers. In this grading system, a low number grade (grade I or II) refers to cancers with fewer cell abnormalities than those with higher numbers (grade III, IV).



Tumor Staging

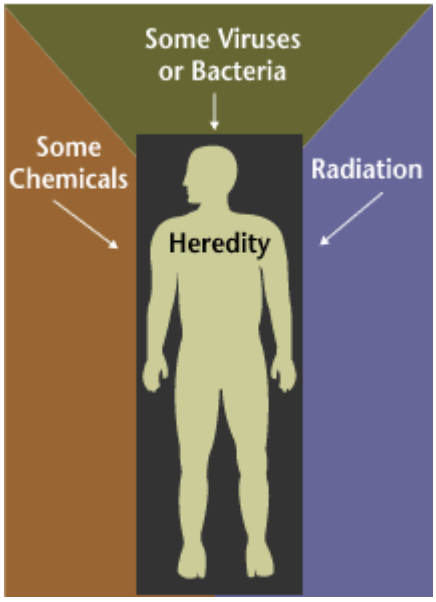
After cancer has been diagnosed, doctors ask the following three questions to determine how far the disease has progressed:

1. How large is the tumor, and how far has it invaded into surrounding tissues?

2. Have cancer cells spread to regional lymph nodes?

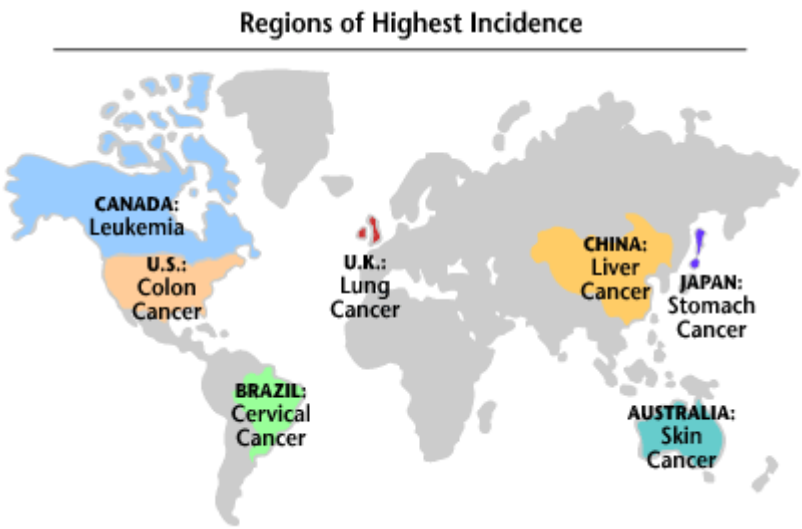
3. Has the cancer spread (metastasized) to other regions of the body?

Based on the answers to these questions, the cancer is assigned a "stage." A patient's chances for survival are better when cancer is detected at a lower stage number.



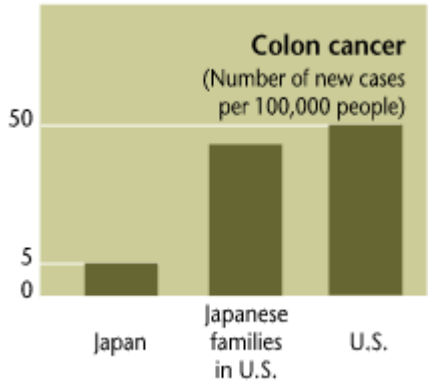
What Causes Cancer?

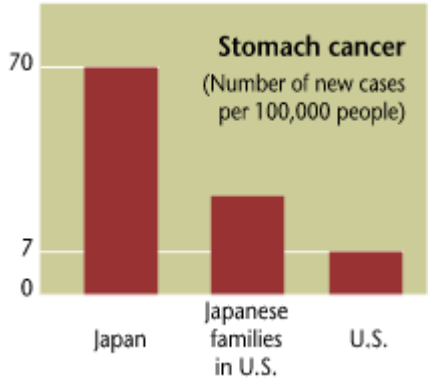
Cancer is often perceived as a disease that strikes for no apparent reason. This is because scientists don't know all the reasons. But many of the causes of cancer have already been identified. Besides heredity, scientific studies point to the existence of three main categories of factors that contribute to the development of cancer: chemicals (e.g., from smoking or diet), radiation, and viruses or bacteria.



Population-Based Studies

One way of identifying the various causes of cancer is by studying populations and behaviors. This approach compares cancer rates among various groups of people exposed to different factors or exhibiting different behaviors. A striking finding to emerge from population studies is that cancers arise with different frequencies in different areas of the world. For example, stomach cancer is especially frequent in Japan, colon cancer is prominent in the United States, and skin cancer is common in Australia. What is the reason for the high rates of specific kinds of cancer in certain countries?





Heredity? Behaviors? Other Factors?

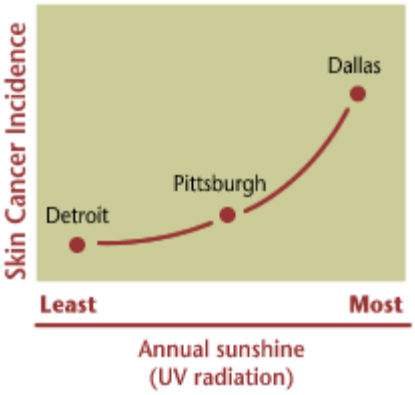
In theory, differences in heredity or environmental risk factors might be responsible for the different cancer rates observed in different countries. Studies on people who have moved from one country to another suggest that exposure to risk factors for cancer vary by geographic location. For example, in Japan, the rate of colon cancer is lower, and the rate of stomach cancer is higher, than in the United States. But this difference has been found to gradually disappear in Japanese families that have moved to the United States. This suggests that the risk of developing the two kinds of cancer is not determined primarily by heredity. The change in risk for cancer for Japanese families could involve cultural or environmental factors predominant in one location and not in the other.

Some Cancer-Causing Chemicals in Tobacco Smoke

aminostilbene
arsenic
benz[*a*]anthracene
benz[*a*]pyrene
benzene
benzo[*b*]fluoranthene
benzo[*c*]phenanthrene
benzo[*f*]fluoranthene
cadmium
chrysene
dibenz[*a c*]anthracene
dibenzo[*a e*]fluoranthene
dibenz[*a h*]acridine
dibenz[*a j*]acridine
dibenzo[*c g*]carbazone
N-dibutylnitrosamine
2,3-dimethylchrysene
indeno[1,2,3-*c d*]pyrene
S-methylchrysene
S-methylfluoranthene
alpha-naphthylamine
nickel compounds
N-nitrosodimethylamine
N-nitrosomethylethylamine
polonium-210
N-nitrosodiethylamine
N-nitrosonornicotine
N-nitrosoanabasine
N-nitrosopiperidine

Tobacco Use and Cancer

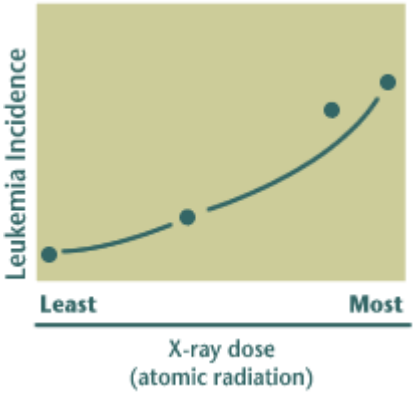
Among the various factors that can cause cancer, the prevalence of tobacco smoking represents the greatest public health hazard. Cigarette smoke contains more than two dozen different chemicals capable of causing cancer. Cigarette smoking is the main cause of lung cancer and contributes to many other kinds of cancer as well, including cancer of the mouth, larynx, esophagus, stomach, pancreas, kidney, and bladder. Current estimates suggest that smoking cigarettes is responsible for at least one out of every three cancer deaths, making it the largest single cause of death from cancer. Other forms of tobacco use also can cause cancer. For example, cigars, pipe smoke, and smokeless tobacco can cause cancers of the mouth.



Low-Strength Radiation

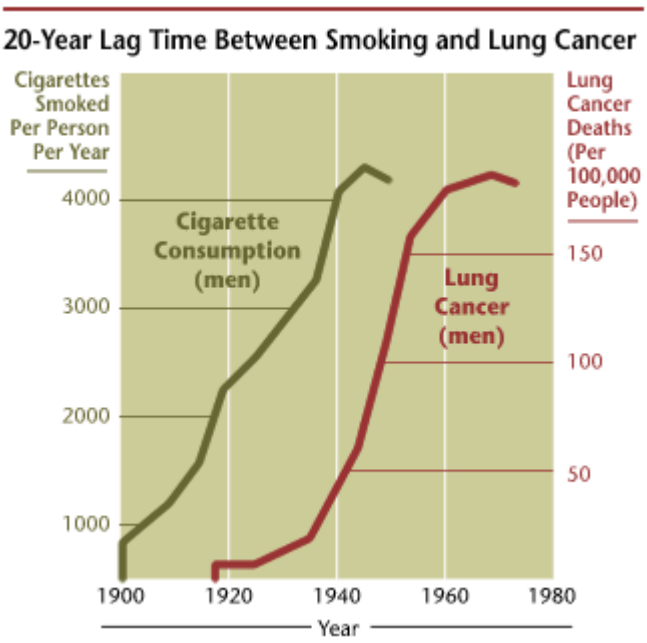
Some atoms give off radiation, which is energy that travels through space. Prolonged or repeated exposure to certain types of radiation can cause cancer. The ability of ultraviolet radiation from the sun to cause cancer is most common in people who spend long hours in strong sunlight. Ultraviolet radiation from sunlight is a low-strength type of radiation. Effective ways to protect against ultraviolet radiation and to prevent skin cancer are to avoid going into strong direct sunlight and to wear protective clothing. Sunscreen lotions reduce the risk of some forms of skin

cancers.



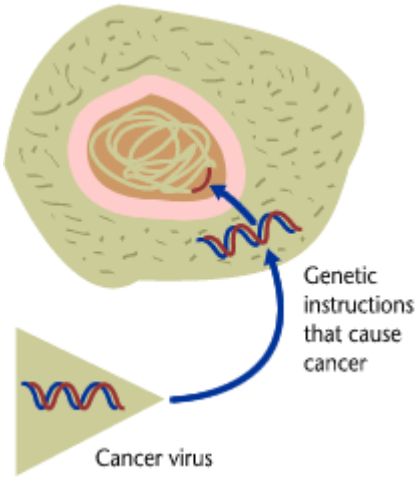
High-Strength Radiation

Increased rates of cancer also have been detected in people exposed to high-strength forms of radiation such as X-rays or radiation emitted from radioisotopes. Because these two types of radiation are stronger than ultraviolet radiation, they can penetrate through clothing and skin and into the body. Therefore, high-strength radiation can cause cancers of internal body tissues. The cancer-causing ability of high-strength radiation has been shown in several instances. Examples include cancer caused by nuclear fallout from atomic explosions and cancers caused by excessive exposure to radioactive chemicals.



Lag Time

Chemicals and radiation that are capable of triggering the development of cancer are called "carcinogens." Carcinogens act through a multistep process that initiates a series of genetic alterations ("mutations") and stimulates cells to proliferate. A prolonged period of time is usually required for these multiple steps. There can be a delay of several decades between exposure to a carcinogen and the onset of cancer. For example, a group of young people exposed to carcinogens from smoking cigarettes generally do not develop cancer for 20 to 30 years. This period between exposure and onset of disease is the lag time.



Viruses

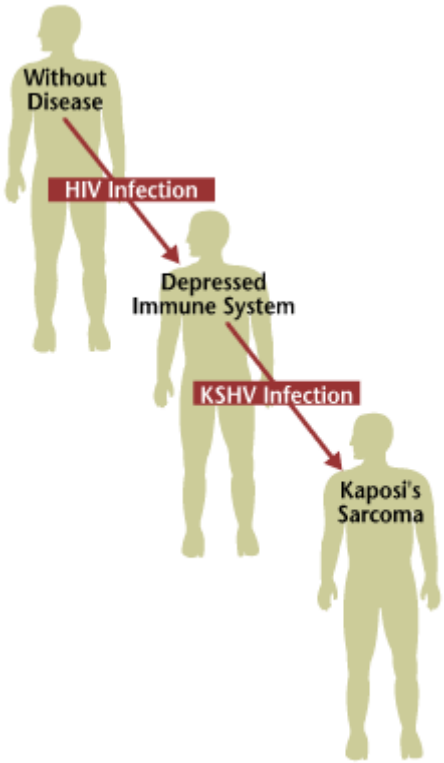
In addition to chemicals and radiation, a few viruses also can trigger the development of cancer. In general, viruses are small infectious agents that cannot reproduce on their own, but instead enter into living cells and cause the infected cell to produce more copies of the virus. Like cells, viruses store their genetic instructions in large molecules called nucleic acids. In the case of cancer viruses, some of the viral genetic information carried in these nucleic acids is inserted into the chromosomes of the infected cell, and this causes the cell to become malignant.

Some Viruses Associated With Human Cancers

VIRUS	TYPE of CANCER
Epstein-Barr virus	Burkitt's lymphoma
Human papillomavirus	Cervical cancer
Hepatitis B virus	Liver cancer
Human T-cell lymphotrophic virus	Adult T-cell leukemia
Kaposi's sarcoma-associated herpesvirus	Kaposi's sarcoma

Examples of Human Cancer Viruses

Only a few viruses that infect human cells actually cause cancer. Included in this category are viruses implicated in cervical cancer, liver cancer, and certain lymphomas, leukemias, and sarcomas. These cancers can sometimes be spread from person to person by infectious viruses, although such events account for only a very small fraction of human cancers. For example, the risk of cervical cancer is increased in women with multiple sexual partners and is especially high in women who marry men whose previous wives had this disease. Transmission of human papillomavirus (HPV) during sexual relations appears to be involved.

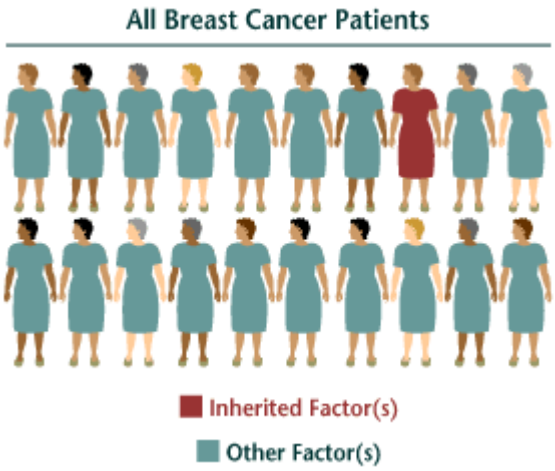


AIDS and Kaposi's Sarcoma

People who develop AIDS after being infected with the human immunodeficiency virus (HIV) are at high risk for developing a specific type of cancer called Kaposi's sarcoma. Kaposi's sarcoma is a malignant tumor of blood vessels located in the skin. This type of cancer is not directly caused by HIV infection. Instead, HIV causes an immune deficiency that makes people more susceptible to viral infection. Infection by a virus called KSHV (Kaposi's sarcoma-associated herpesvirus) then appears to stimulate the development of Kaposi's sarcoma.

Bacteria and Stomach Cancer

Viruses are not the only infectious agents that have been implicated in human cancer. The bacterium H. pylori, which can cause stomach ulcers, has been associated with the development of stomach cancer. People infected with H. pylori are at increased risk of developing stomach cancer. Research is under way to define the genetic interactions between infectious agents and their hosts that may explain why cancer develops.



Heredity and Cancer

Cancer is not considered an inherited illness because most cases of cancer, perhaps 80 to 90 percent, occur in people with no family history of the disease. However, a person's chances of developing cancer can be influenced by the inheritance of certain kinds of genetic alterations. These alterations tend to increase an individual's susceptibility to developing cancer in the future. For example, about 5 percent of breast cancers are thought to be due to inheritance of particular form(s) of a "breast cancer susceptibility gene."

Inherited Conditions That Increase Risk for Cancer

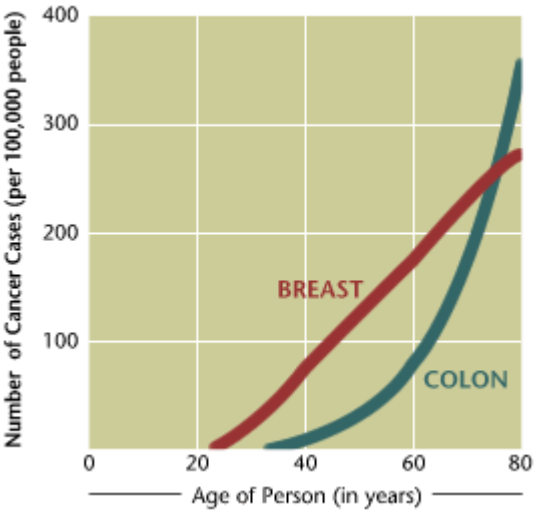
Name of Condition	Type of Cancer
Hereditary retinoblastoma	Retinoblastoma
Xeroderma pigmentosum	Skin
Wilms' tumor	Kidney
Li-Fraumeni syndrome	Sarcomas, brain, breast, leukemia
Familial adenomatous polyposis	Colon, rectum
Paget's disease of bone	Bone
Fanconi's aplastic anemia	Leukemia, liver, skin

Heredity Can Affect Many Types of Cancer

Inherited mutations can influence a person's risk of developing many types of cancer in addition to breast cancer. For example, specific inherited mutations have been described that increase a person's risk of developing colon cancer, kidney cancer, bone cancer, skin cancer, or other specific forms of cancer. But these hereditary conditions that increase a person's risk of developing specific types of cancer are thought to be involved in 10 percent or fewer of all cancer cases.

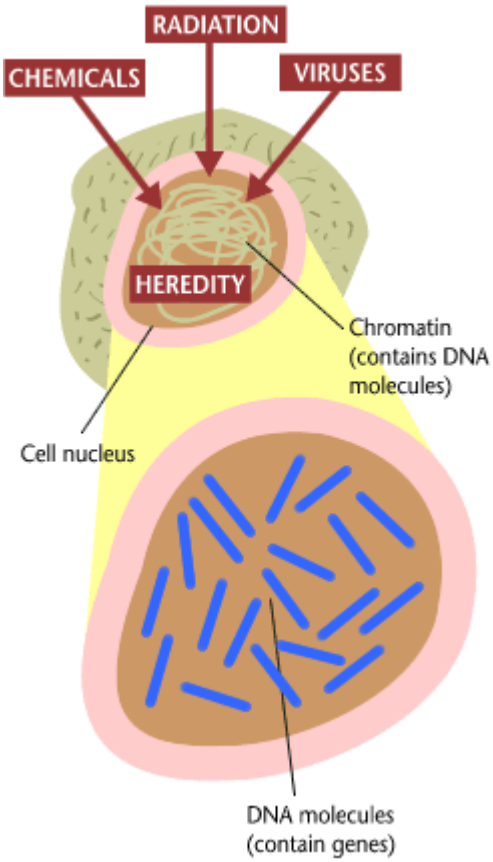
Genetic Testing

Laboratory tests can determine whether a person carries some of the genetic alterations that can increase a person's risk of developing certain cancers. For example, women who inherit certain forms of a gene called BRCA1 have an elevated risk of developing breast cancer. For women with a family history of breast cancer, taking such a test may relieve uncertainty about their future risk. However, the information obtained from genetic tests is often complex and difficult to interpret. The decision to undergo genetic testing should therefore be a personal, voluntary one and should only be made in conjunction with appropriate genetic counseling.



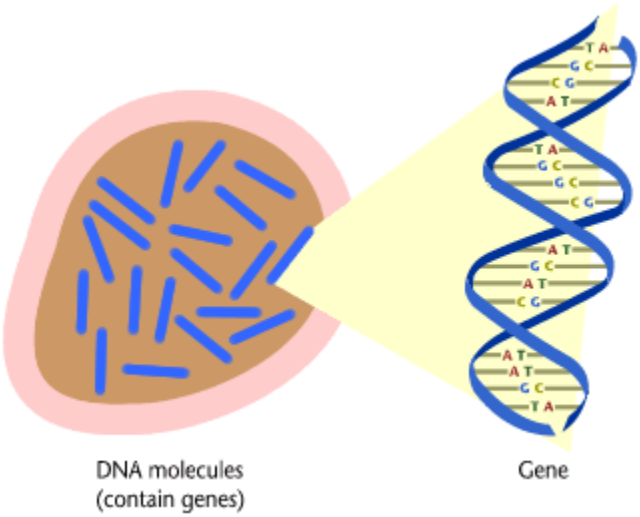
Cancer Risk and Aging

Because cancer usually requires a number of mutations, the chances of developing cancer increase as a person gets older because more time has been available for mutations to accumulate. For example, a person 75 years old is a thousand times more likely to develop and die of colon cancer than a person 25 years old. Because people are living longer today than they did 50 or 100 years ago, they have a longer exposure time to the factors that may start gene changes that lead to cancer.



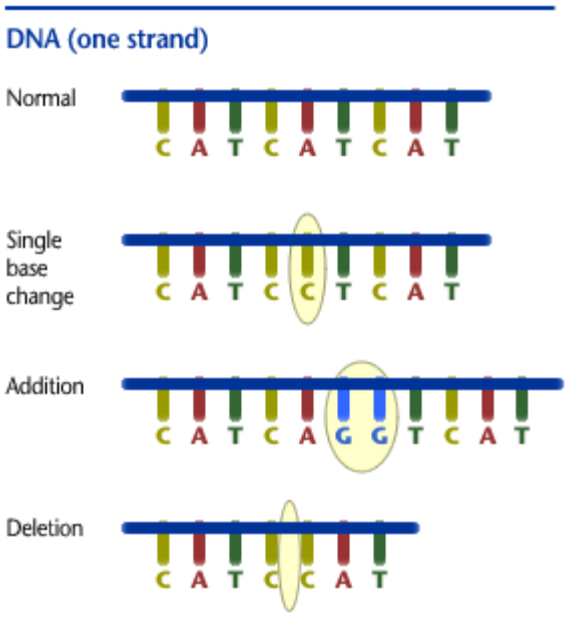
Genes and Cancer

Chemicals (e.g., from smoking), radiation, viruses, and heredity all contribute to the development of cancer by triggering changes in a cell's genes. Chemicals and radiation act by damaging genes, viruses introduce their own genes into cells, and heredity passes on alterations in genes that make a person more susceptible to cancer. Genes are inherited instructions that are regions within DNA molecules. Each gene allows a cell to make a specific product—in most cases, a particular kind of protein. Genes are altered, or "mutated," in various ways as part of the mechanism by which cancer arises.



DNA Structure

Genes reside within large DNA molecules, which are composed of two chemical strands twisted around each other to form a "double helix." Each strand is constructed from millions of chemical building blocks called "bases." DNA contains only four different bases (abbreviated A, T, G, and C), but they can be arranged in any sequence. The sequential order of the bases in any given gene determines the message the gene contains, just as the letters of the alphabet can be combined in different ways to form distinct words and sentences.



DNA Mutation

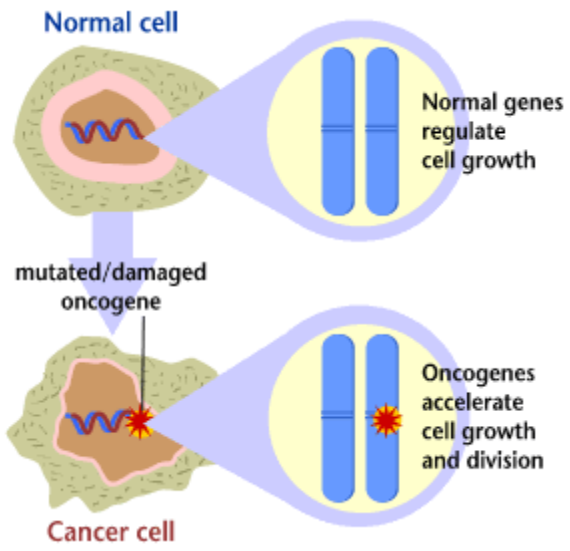
Genes can be mutated in several different ways. The simplest type of mutation involves a change in a single base along the base sequence of a particular gene—much like a typographical error in a word that has been misspelled. In other cases, one or more bases may be added or deleted. And sometimes, large segments of a DNA molecule are accidentally repeated, deleted, or moved.

Genes Implicated in Cancer

- Oncogenes
- Tumor suppressor genes
- DNA repair genes

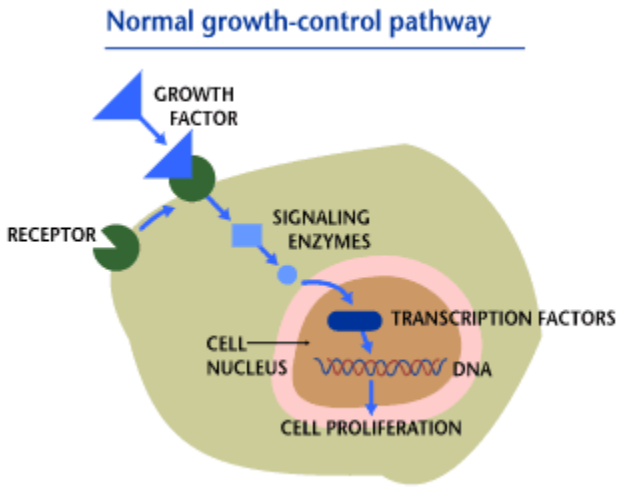
Gene Mutations and Cancer

Mutations in genes that control normal cell proliferation can lead to cancer. These mutations can be created by DNA-damaging carcinogens such as cigarette by-products and radiation. However, some cancer-causing mutations are simply spontaneous errors that appear in normal DNA molecules when cells duplicate their DNA prior to cell division. The mutations that contribute to the development of cancer affect three general classes of gene: oncogenes, tumor suppressor genes, and DNA repair genes.



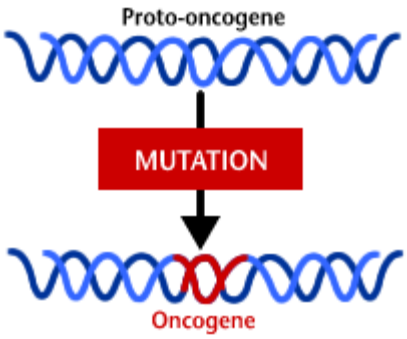
Oncogenes

The first group of genes implicated in the development of cancer are damaged genes, called "oncogenes." Oncogenes are genes whose PRESENCE in certain forms and/or overactivity can stimulate the development of cancer. When oncogenes arise in normal cells, they can cause the cells to become malignant. Oncogenes contribute to the development of cancer by instructing cells to make proteins that stimulate excessive cell growth and division.



Proto-Oncogenes and Normal Cell Growth

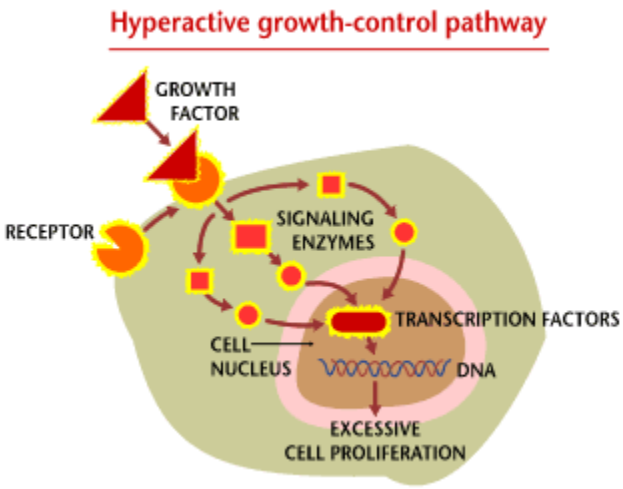
Oncogenes are related to normal genes called proto-oncogenes. Proto-oncogenes are a family of normal genes that code mainly for proteins involved in a cell's normal growth-control pathway. Cell growth and division is normally controlled by proteins called growth factors, which bind to receptors on the cell surface. This binding activates a series of enzymes inside the cell, which in turn activate special proteins called transcription factors inside the cell's nucleus. The activated transcription factors turn on genes required for cell growth and proliferation. Many components of this pathway, for example, growth factors signaling enzymes, receptors, and transcription factors, are encoded by proto-oncogenes.



Oncogenes are Mutant Forms of Proto-Oncogenes

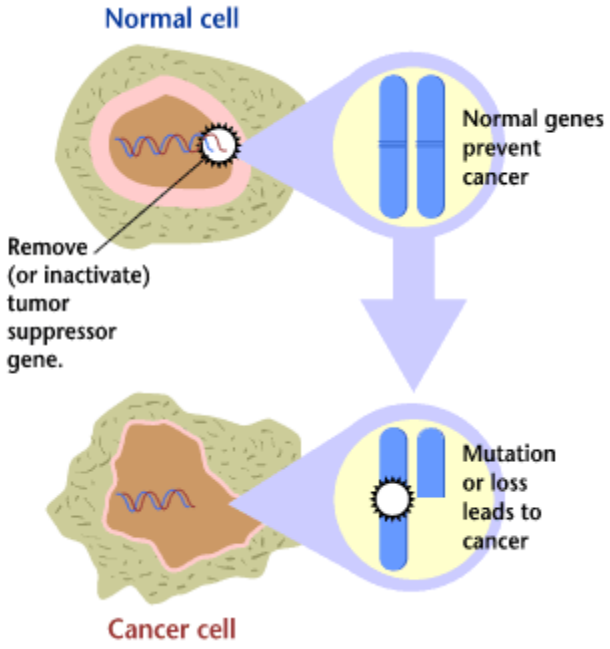
Oncogenes arise from the mutation of proto-oncogenes. Since they are mutant forms of proto-oncogenes, oncogenes resemble proto-oncogenes in that they code for the production of proteins involved in growth control. However, oncogenes code for an altered version (or excessive quantities) of these growth-

control proteins, thereby disrupting a cell's growth-signaling pathway.



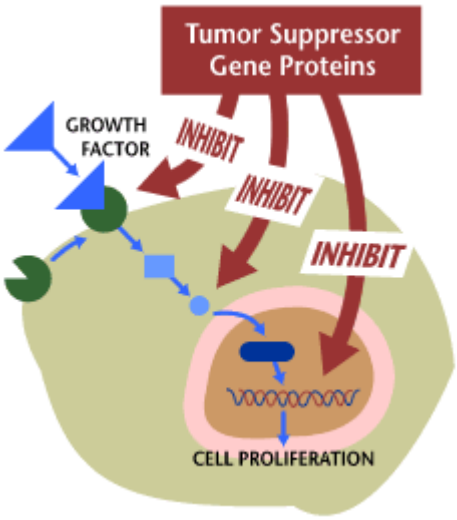
Oncogenes Act Like an Accelerator

By producing abnormal versions or quantities of cellular growth-control proteins, oncogenes cause a cell's growth-signaling pathway to become hyperactive. To use a simple metaphor, the growth-control pathway is like the gas pedal of an automobile. The more active the pathway, the faster cells grow and divide. The presence of an oncogene is like having a gas pedal that is stuck to the floorboard, causing the cell to continually grow and divide. A cancer cell may contain one or more oncogenes, which means that one or more components in this pathway will be abnormal.



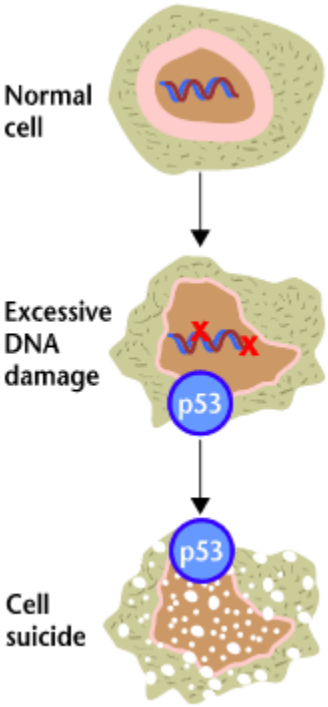
Tumor Suppressor Genes

A second group of genes implicated in cancer are the "tumor suppressor genes." Tumor suppressor genes are normal genes whose ABSENCE can lead to cancer. In other words, if a pair of tumor suppressor genes are either lost from a cell or inactivated by mutation, their functional absence can cause cancer. Individuals who inherit an increased risk of developing cancer often are born with one defective copy of a tumor suppressor gene. Because genes come in pairs (one inherited from each parent), an inherited defect in one copy will not cause cancer because the other normal copy is still functional. But if the second copy undergoes mutation, the person then may develop cancer because there no longer is any functional copy of the gene.



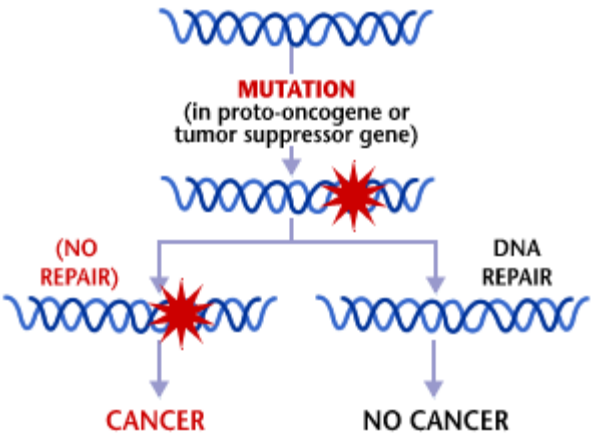
Tumor Suppressor Genes Act Like a Brake Pedal

Tumor suppressor genes are a family of normal genes that instruct cells to produce proteins that restrain cell growth and division. Since tumor suppressor genes code for proteins that slow down cell growth and division, the loss of such proteins allows a cell to grow and divide in an uncontrolled fashion. Tumor suppressor genes are like the brake pedal of an automobile. The loss of a tumor suppressor gene function is like having a brake pedal that does not function properly, thereby allowing the cell to grow and divide continually.



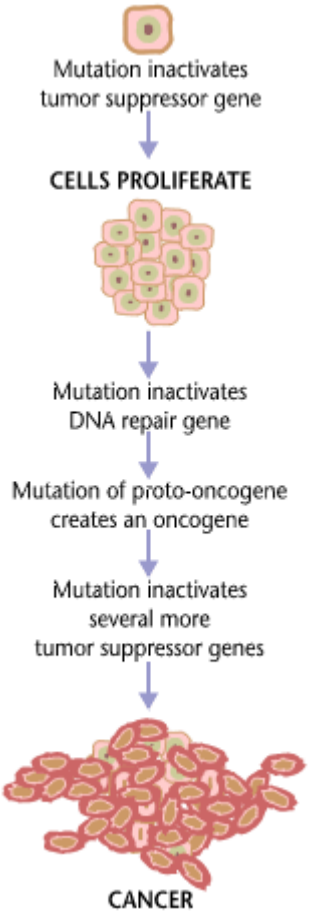
The p53 Tumor Suppressor Gene Triggers Cell Suicide

One particular tumor suppressor gene codes for a protein called "p53" that can trigger cell suicide (apoptosis). In cells that have undergone DNA damage, the p53 protein acts like a "brake pedal" and halts cell growth and division. If the damage cannot be repaired, the p53 protein eventually initiates cell suicide, thereby preventing the genetically damaged cell from growing out of control.



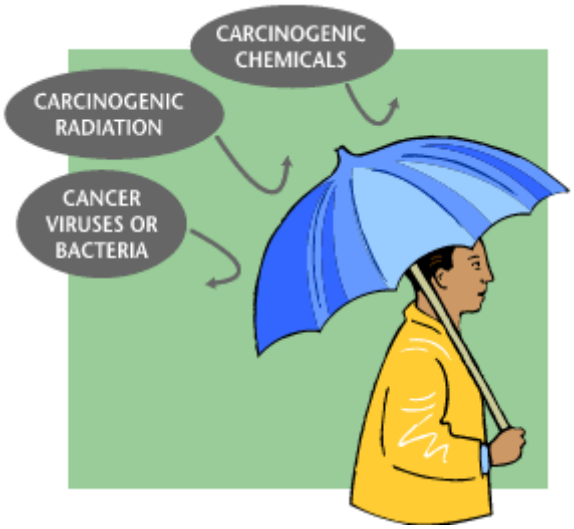
DNA Repair Genes

A third class of genes implicated in cancer are called "DNA repair genes." DNA repair genes code for proteins whose normal function is to correct errors that arise when cells duplicate their DNA prior to cell division. Mutations in DNA repair genes can lead to a failure in DNA repair, which in turn allows subsequent mutations in tumor suppressor genes and proto-oncogenes to accumulate. People with a condition called xeroderma pigmentosum have an inherited defect in a DNA repair gene. As a result, they cannot effectively repair the DNA damage that normally occurs when skin cells are exposed to sunlight, and so they exhibit an abnormally high incidence of skin cancer. Certain forms of hereditary colon cancer also involve defects in DNA repair.



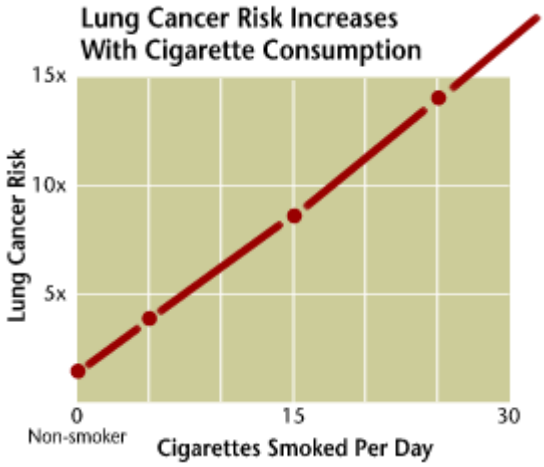
Cancer Tends to Involve Multiple Mutations

Cancer often arises because of the accumulation of mutations involving oncogenes, tumor suppressor genes, and DNA repair genes. For example, colon cancer can begin with a defect in a tumor suppressor gene that allows excessive cell proliferation. The proliferating cells then tend to acquire subsequent mutations involving a DNA repair gene, an oncogene, and several other tumor suppressor genes. The accumulated damage yields a highly malignant, metastatic tumor. In other words, creating a cancer cell requires that the brakes on cell growth (tumor suppressor genes) be released at the same time that the accelerators for cell growth (oncogenes) are being activated.



Cancer Prevention

Since exposure to carcinogens (cancer-causing agents) is responsible for triggering most human cancers, people can reduce their cancer risk by taking steps to avoid such agents. Hence the first step in cancer prevention is to identify the behaviors or exposures to particular kinds of carcinogens and viruses that represent the greatest cancer hazard.

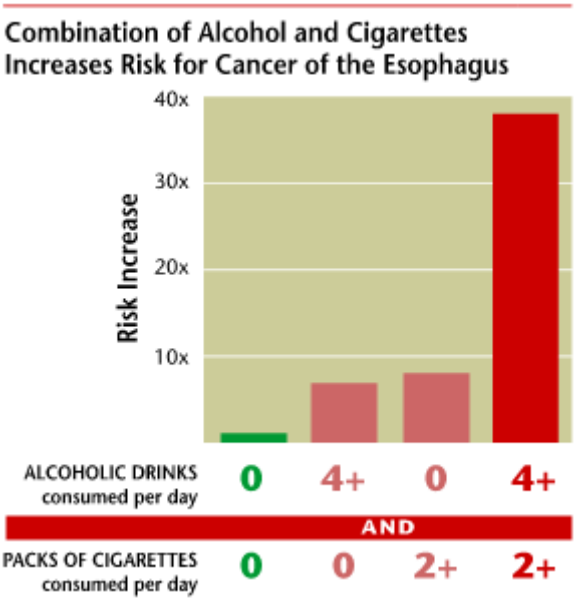


Avoiding Tobacco

The use of tobacco products has been implicated in roughly one out of every three cancer deaths, making it the largest single cause of death from cancer. Cigarette smoking is responsible for nearly all cases of lung cancer, and has also been implicated in cancer of the mouth, larynx, esophagus, stomach, pancreas, kidney, and bladder. Pipe smoke, cigars, and smokeless tobacco are risky as well. Avoiding tobacco is, therefore, the single most effective lifestyle decision any person can make in attempting to prevent cancer.

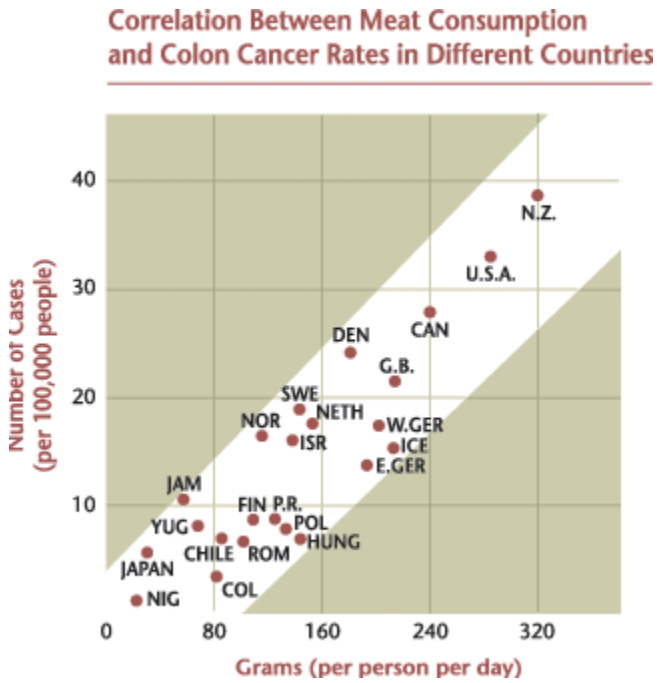
Protect Yourself Against Sunlight

Skin cancer caused by exposure to sunlight is the most frequently observed type of human cancer. Because skin cancer is often easy to cure, the danger posed by sunlight is perhaps not taken seriously enough. Therefore it is important to know that a more serious form of skin cancer, called melanoma, is also associated with sun exposure. Melanomas are potentially lethal tumors. Risk of melanoma and other forms of skin cancer can be significantly reduced by avoiding excessive exposure to the sun and wearing clothing to shield the skin from ultraviolet radiation. Sunscreen lotions may also protect against some forms of skin cancer, if sun exposure cannot be avoided.



Limiting Alcohol and Tobacco Consumption

Drinking excessive amounts of alcohol is linked to an increased risk for several kinds of cancer, especially those of the mouth, throat, and esophagus. The combination of alcohol and tobacco appears to be especially dangerous. For example, in heavy smokers or heavy drinkers, the risk of developing cancer of the esophagus is roughly 6 times greater than that for nonsmokers/nondrinkers. But in people who both smoke and drink, the cancer risk is more than 40 times greater than that for nonsmokers/nondrinkers. Clearly the combination of alcohol and tobacco is riskier than would be expected by just adding the effects of the two together.

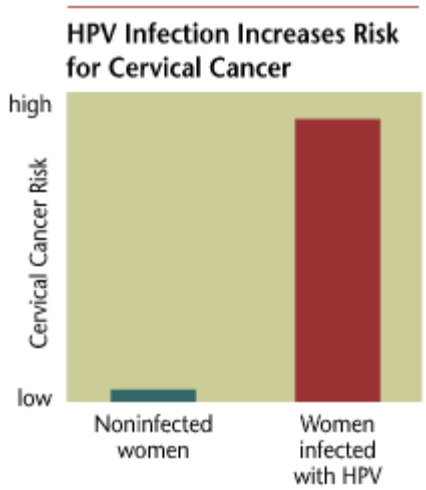


Diet: Limit Fats and Calories

Studies suggest that differences in diet may also play a role in determining cancer risk. But in contrast to the clear-cut identification of tobacco, sunlight, and alcohol, the exact identity of the dietary components that influence cancer risk has been difficult to determine. Limiting fat consumption and calorie intake appears to be one possible strategy to decrease risk of some cancers, because people who consume large amounts of meat (which is rich in fat) and large numbers of calories exhibit an increased cancer risk, especially for colon cancer.

Diet: Consume Fruits and Vegetables

In contrast to factors such as fat and calories, which appear to increase cancer risk, other components of the diet may decrease cancer risk. The most compelling evidence has been obtained for fruits and vegetables, whose consumption has been strongly correlated with a reduction in cancer risk. Although the chemical components in these foods responsible for this protective effect are yet to be identified, eating at least five servings of fruits and vegetables each day is recommended by many groups.



Avoid Cancer Viruses

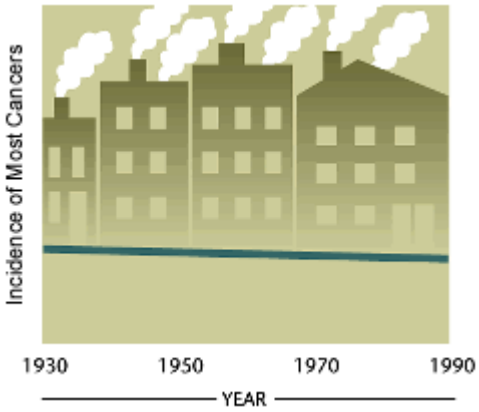
Actions can also be taken to avoid exposure to the small number of viruses that have been implicated in human cancers. The most common cancer-causing virus in the United States is the human papillomavirus (HPV), which is involved in the transmission of cervical cancer. Since this virus is sexually transmitted, its spread can be combatted using the same "safe sex" approaches that are recommended to prevent the spread of HIV—e.g., limiting exposure to multiple sexual partners.

Some Carcinogens in the Workplace

CARCINOGEN	OCCUPATION	TYPE OF CANCER
Arsenic	Mining, pesticide workers	Lung, skin, liver
Asbestos	Construction workers	Lung, mesothelioma
Benzene	Petroleum, rubber, chemical workers	Leukemia
Chromium	Metal workers, electroplaters	Lung
Leather dust	Shoe manufacturing	Nasal, bladder
Naphthylamine	Chemical, dye, rubber workers	Bladder
Radon	Underground mining (also in some homes)	Lung
Soots, tars, oils	Coal, gas, petroleum workers	Lung, skin, liver
Vinyl chloride	Rubber workers, polyvinyl chloride manufacturing	Liver
Wood dust	Furniture manufacturing	Nasal

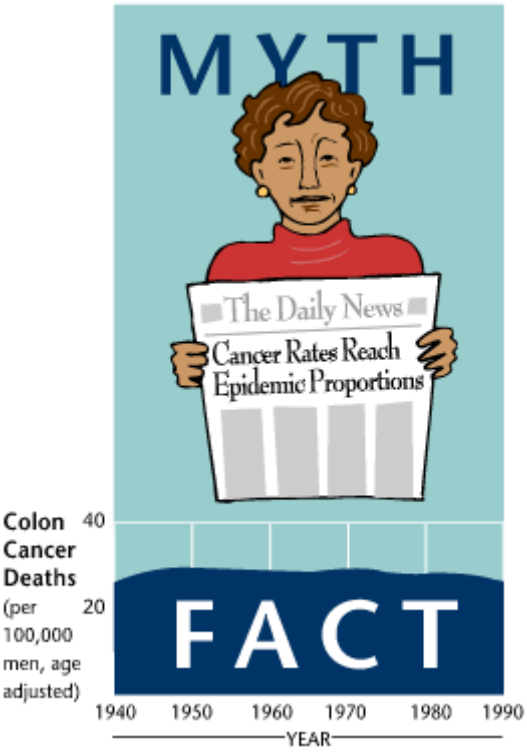
Avoid Carcinogens at Work and at Home

Because people spend so much time at work and at home, assessments should be made of possible carcinogens in these environments. Some occupational carcinogens have been identified because people who work together and have been exposed to the same substances have developed a particular kind of cancer at increased frequency. For example, cancer rates in construction workers who handle asbestos have been found to be 10 times higher than normal. A potential hazard in the home is radon, a radioactive gas that can seep into houses from underground rock formations found in certain areas of the country. Simple test kits for radon are available.



Industrial Pollution

The fact that many environmental chemicals can cause cancer has fostered the idea that industrial pollution is a frequent cause of cancer. However, the frequency of most human cancers (adjusted for age) has remained relatively constant over the past half century, in spite of increasing industrial pollution. Hence, in spite of evidence that industrial chemicals can cause cancer in people who work with them or in people who live nearby, industrial pollution does not appear to be a major cause of most cancers in the population at large.



Is There a Cancer "Epidemic"?

A related misconception arises from stories that sometimes appear in the news suggesting that we are now experiencing a cancer "epidemic." It is true that a person's chance of developing cancer within his or her lifetime is almost twice as great today as it was a half century ago, which means that doctors are seeing more cases of cancer than they did in the past. However, this increase is caused largely by the facts that people are living longer and cancer is more prevalent in older people.

Falling Cancer Rates

When corrected for the increasing average age of the population, cancer rates in the United States have actually been stable or even falling slightly in the past several years. Much of the rise prior to that was due to cigarette smoking, a well established and avoidable cause of cancer.