

Health Reference Series

Seventh Edition

Cancer

SOURCEBOOK



Basic Consumer Health Information about Major Forms and Stages of Cancer, Featuring Facts about Head and Neck Cancers, Lung Cancers, Gastrointestinal Cancers, Genito-Urinary Cancers, Lymphomas, Blood Cell Cancers, Endocrine Cancers, Skin Cancers, Bone Cancers, Metastatic Cancers, and More.

Along with Facts about Cancer Treatments, Cancer Risks and Prevention, a Glossary of Related Terms, Statistical Data, and a Directory of Resources for Additional Information.



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Editorial Services provided by Omnigraphics, Inc.,
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ISBN 978-0-7808-1355-7

E-ISBN 978-0-7808-1396-0

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Printed in the United States

Chapter 1

Cancer Defined

What is Cancer?

There are many texts and references that attempt to define cancer. The simplest definition is from the American Cancer Society (ACS). According to the ACS, cancer is a group of diseases characterized by uncontrolled growth and spread of abnormal cells. If the spread is not controlled, it can result in death.

A group of diseases

Although cancer is often referred to as a single condition, it actually consists of more than 100 different diseases. These diseases are characterized by uncontrolled growth and spread of abnormal cells. Cancer can arise in many sites and behave differently depending on its organ of origin. Breast cancer, for example, has different characteristics than those of lung cancer. It is important to understand that cancer originating in one body organ takes its characteristics with it even if it spreads to another part of the body. For example, metastatic breast cancer in the lungs continues to behave like breast cancer when viewed under a microscope, and it continues to look like a cancer that originated in the breast.

This chapter includes excerpts from “What is Cancer; Cancer Terms; and Cell Biology of Cancer,” National Cancer Institute at the National Institutes of Health (NIH).

Characteristics of Cancer

Abnormality

Cells are the structural units of all living things. Each of us has trillions of cells, as does a growing tree. Cells make it possible for us to carry out all kinds of functions of life: the beating of the heart, breathing, digesting food, thinking, walking, and so on. However, all of these functions can only be carried out by normal healthy cells. Some cells stop functioning or behaving as they should, serving no useful purpose in the body at all, and become cancerous cells.

Uncontrollability

The most fundamental characteristic of cells is their ability to reproduce themselves. They do this simply by dividing: one cell becomes two, the two become four, and so on. The division of normal and healthy cells occurs in a regulated and systematic fashion. In most parts of the body, the cells continually divide and form new cells to supply the material for growth or to replace worn-out or injured cells. For example, when you cut your finger, certain cells divide rapidly until the tissue is healed and the skin is repaired. They will then go back to their normal rate of division. In contrast, cancer cells divide in a haphazard manner. The result is that they typically pile up into a non-structured mass or tumor.

Invasiveness

Sometimes tumors do not stay harmlessly in one place. They destroy the part of the body in which they originate and then spread to other parts where they start new growth and cause more destruction. This characteristic distinguishes cancer from benign growths, which remain in the part of the body in which they start. Although benign tumors may grow quite large and press on neighboring structures, they do not spread to other parts of the body. Frequently, they are completely enclosed in a protective capsule of tissue and they typically do not pose danger to human life like malignant tumors (cancer) do.

Cancer Terms

Cancer, Neoplasia, Tumor, Neoplasm

The word cancer comes from the Latin (originally Greek) derived term for crab, because of the way a cancer adheres to any part that

it seizes upon in an obstinate manner like the crab. Hippocrates first described cancer as having a central body with the tendency to reach out and spread like “the arms of a crab.” Besides the popular, generic term “cancer” used by most people, there is another more technical term: neoplasia. Neoplasia (neo = new, plasia = tissue or cells) or neoplasm literally means new tissue in Greek. This indicates that cancers are actually new growths of cells in the body.

Another term for cancer is “malignant.” Tumor literally means “swelling” or “mass.” In this case, it refers to a mass of non-structured new cells, which have no known purpose in the physiological function of the body.

There are two general types of tumors: benign (non-cancerous) tumors and malignant (cancerous) tumors. A benign tumor is composed of cells that will not invade other unrelated tissues or organs of the body, although it may continue to grow in size abnormally. A malignant tumor is composed of cells that invade the basement membrane and invade or spread to other parts of the body. This occurs either by direct extension to neighboring organs and/or tissues or by metastasizing to distant sites by means of the vascular system (the blood stream), the lymphatic system, or by seeding or implantation of cancer cells in body cavities.

Terms such as “mass” and “lump” are used to describe any over-growth of tissue. However, these terms may not necessarily mean that such growths contain cancer cells.

Types of Abnormal Cell Growth

In addition to neoplasia, there are several other terms referring to abnormal cell growth. These include the following:

Hyperplasia refers to an abnormal increase in the number of cells, which are in a normal component of that tissue and are arranged in a normal fashion with subsequent enlargement of the affected part. One example is thyroid hyperplasia, an enlargement of the thyroid gland caused by an abnormal rapid growth of the epithelial cells lining the follicles. Another example is: Guitar strumming leads to hyperplasia of the cells on the thumb (a callus is formed). The callus on the thumb is a hyperplastic growth.

Hypertrophy refers to an abnormal increase in the size of each cell, for example, the increase in cell size of cardiac muscle.

Metaplasia refers to the replacement of one mature cell type with another mature cell type: for example, squamous metaplasia of the respiratory columnar epithelium—as evidenced by the metaplastic cough of a smoker.

Dysplasia refers to the replacement of one mature cell type with a less mature cell type: for example, dysplasia of the cervix epithelium.

Hyperplasia, metaplasia, and dysplasia are reversible because they are results of a stimulus. Neoplasia is irreversible because it is autonomous.

Tumor Terminology Generalizations

Names of benign tumors usually end with “oma” regardless of their cell type. For example, a benign glandular tumor (epithelium tissue) is called adenoma and a benign bone tumor is called osteoma, while a

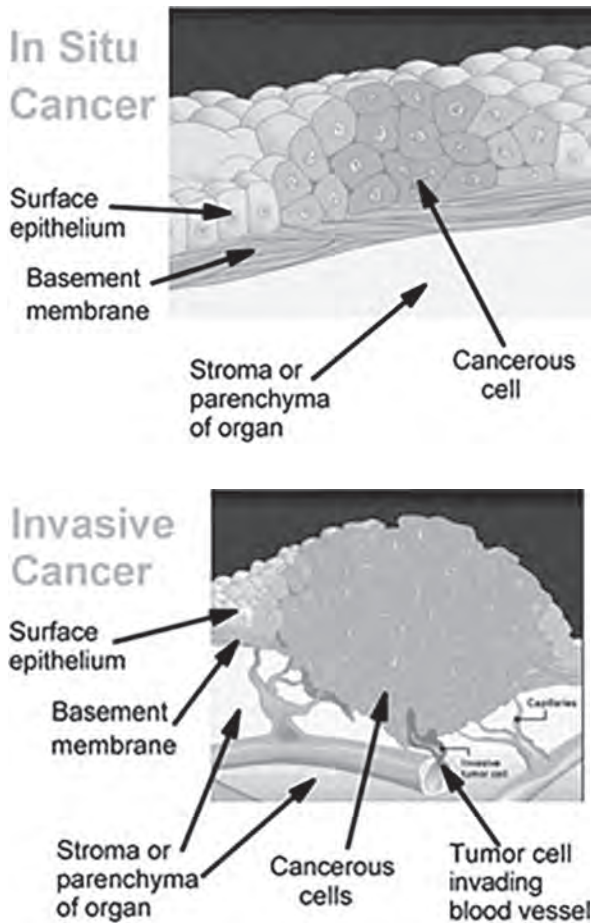


Figure 1.1. Representation of In Situ and Invasive cancer

malignant glandular tumor is called adenocarcinoma and a malignant bone tumor is called osteosarcoma.

In addition to benign tumors, there are in situ tumors and invasive tumors. In situ tumors do not invade the basement membrane, whereas invasive tumors do invade the basement membrane.

Cell Biology of Cancer

The cell is the fundamental unit of life. It is the smallest structure of the body capable of performing all of the processes that define life. Each of the organs in the body, such as the lung, breast, colon, and brain, consists of specialized cells that carry out the organ's functions such as the transportation of oxygen, digestion of nutrients, excretion of waste materials, locomotion, reproduction, thinking, etc.

To assure the proper performance of each organ, worn out or injured cells must be replaced, and particular types of cells must increase in response to environmental changes. For example, the bone marrow increases its production of oxygen-carrying red blood cells sevenfold or greater in response to bleeding or high altitude. Certain white blood cells are produced more rapidly during an infection. Similarly, the liver or endocrine organs frequently respond to injury by regenerating damaged cells.

As stated in the previous section, reproduction of cells is a process of cell division. The division of normal cells is a highly regulated process. The cell growth, inheritance and containment is controlled by its DNA (deoxyribonucleic acid).

DNA is a highly complex molecule manufactured in the cell nucleus and serves as the cell's "brain." DNA is the blueprint for everything the cell does. In a human cell, the DNA is arranged in 46 distinct sections called chromosomes. They are arranged in pairs, 23 chromosomes from each biological parent.

Together, the 46 chromosomes contain more than 100,000 genes. A gene is a segment of DNA that determines the structure of a protein, which is needed for development and growth as well as carrying out vital chemical functions in the body. Like the chromosomes, genes are arranged in pairs—one gene from the mother and one from the father.

Each gene occupies a specific location on a chromosome. Through a number of biochemical steps, each gene tells a cell to make a different protein. Some genes instruct the cell to manufacture structural proteins, which serve as building blocks. Other genes tell the cell to produce hormones, growth factors or cytokines, which exit the cell and communicate with other cells. Still other genes tell the cell to

produce regulatory proteins that control the function of other proteins or tell other genes when to turn “on” or “off.” When a gene is turned on, it manufactures another complex molecule called ribonucleic acid (RNA), which contains all the information the cell needs to make new proteins.

Cells divide only when they receive the proper signals from growth factors that circulate in the bloodstream or from a cell they directly contact. For example, if a person loses blood, a growth factor called erythropoietin, which is produced in the kidneys, circulates in the bloodstream and tells the bone marrow to manufacture more blood cells.

When a cell receives the message to divide, it goes through the cell cycle, which includes several phases for the division to be completed. Checkpoints along each step of the process make sure that everything goes the way it should.

Many processes are involved in cell reproduction and all these processes have to take place correctly for a cell to divide properly. If anything goes wrong during this complicated process, a cell may become cancerous.

A cancer cell is a cell that grows out of control. Unlike normal cells, cancer cells ignore signals to stop dividing, to specialize, or to die and be shed. Growing in an uncontrollable manner and unable to recognize its own natural boundary, the cancer cells may spread to areas of the body where they do not belong.

In a cancer cell, several genes change (mutate) and the cell becomes defective. There are two general types of gene mutations. One type, dominant mutation, is caused by an abnormality in one gene in a pair. An example is a mutated gene that produces a defective protein that causes the growth-factor receptor on a cell’s surface to be constantly “on” when, in fact, no growth factor is present. The result is that the cell receives a constant message to divide. This dominant “gain of function gene” is often called an oncogene (onco = cancer).

The second general type of mutation, recessive mutation, is characterized by both genes in the pair being damaged. For example, a normal gene called p53 produces a protein that turns “off” the cell cycle and thus helps to control cell growth. The primary function of the p53 gene is to repair or destroy defective cells, thereby controlling potential cancerous cells. This type of gene is called an anti-oncogene or tumor suppressor gene. If only one p53 gene in the pair is mutated, the other gene will still be able to control the cell cycle. However, if both genes are mutated, the “off” switch is lost, and the cell division is no longer under control.

Cancer Defined

Abnormal cell division can occur either when active oncogenes are expressed or when tumor suppressor genes are lost. In fact, for a cell to become malignant, numerous mutations are necessary. In some cases, both types of mutations—dominant and recessive—may occur.

A gene mutation may allow an already abnormal cell to invade the normal tissue where the cancer started or to travel in the bloodstream (metastasize) to remote parts of the body, where it continues to divide.

A normal cell can become damaged in different ways. A cell can become abnormal when part of a gene is lost (deleted), when part of a chromosome is rearranged and ends up in the wrong place (translocation), or when an extremely small defect occurs in the DNA, which results in an abnormal DNA “blueprint” and production of a defective protein occurs.

Abnormal cell division can also be caused by viruses. In this case, genes may be normal, but the protein may not function normally because the cell contains a cancer-producing virus.

How a specific cancer cell behaves depends on which processes are not functioning properly. Some cancer cells simply divide and produce more cancer cells, and the tumor mass stays where it began. Other cancer cells are able to invade normal tissue, enter the bloodstream, and metastasize to a remote site in the body.

In summary, cancer cells have defects in normal cellular functions that allow them to divide, invade the surrounding tissue, and spread by way of vascular and/or lymphatic systems. These defects are the result of gene mutations sometimes caused by infectious viruses.

Chapter 2

Cancer Classification

Cancers are classified in two ways: by the type of tissue in which the cancer originates (histological type) and by primary site, or the location in the body where the cancer first developed. This section introduces you to the first method: cancer classification based on histological type.

From a histological standpoint there are hundreds of different cancers, which are grouped into six major categories:

- Carcinoma
- Sarcoma
- Myeloma
- Leukemia
- Lymphoma
- Mixed Types

Carcinoma

Carcinoma refers to a malignant neoplasm of epithelial origin or cancer of the internal or external lining of the body. Carcinomas, malignancies of epithelial tissue, account for 80 to 90 percent of all cancer cases.

Epithelial tissue is found throughout the body. It is present in the skin, as well as the covering and lining of organs and internal passageways, such as the gastrointestinal tract.

Text in this chapter is excerpted from “Cancer Classification,” National Cancer Institute at the National Institutes of Health (NIH).

Carcinomas are divided into two major subtypes: adenocarcinoma, which develops in an organ or gland, and squamous cell carcinoma, which originates in the squamous epithelium.

Adenocarcinomas generally occur in mucus membranes and are first seen as a thickened plaque-like white mucosa. They often spread easily through the soft tissue where they occur. Squamous cell carcinomas occur in many areas of the body.

Most carcinomas affect organs or glands capable of secretion, such as the breasts, which produce milk, or the lungs, which secrete mucus, or colon or prostate or bladder.

Sarcoma

Sarcoma refers to cancer that originates in supportive and connective tissues such as bones, tendons, cartilage, muscle, and fat. Generally occurring in young adults, the most common sarcoma often develops as a painful mass on the bone. Sarcoma tumors usually resemble the tissue in which they grow.

Examples of sarcomas are:

- Osteosarcoma or osteogenic sarcoma (bone)
- Chondrosarcoma (cartilage)
- Leiomyosarcoma (smooth muscle)
- Rhabdomyosarcoma (skeletal muscle)
- Mesothelial sarcoma or mesothelioma (membranous lining of body cavities)
- Fibrosarcoma (fibrous tissue)
- Angiosarcoma or hemangioendothelioma (blood vessels)
- Liposarcoma (adipose tissue)
- Glioma or astrocytoma (neurogenic connective tissue found in the brain)
- Myxosarcoma (primitive embryonic connective tissue)
- Mesenchymous or mixed mesodermal tumor (mixed connective tissue types)

Myeloma

Myeloma is cancer that originates in the plasma cells of bone marrow. The plasma cells produce some of the proteins found in blood.

Leukemia

Leukemias (“liquid cancers” or “blood cancers”) are cancers of the bone marrow (the site of blood cell production). The word leukemia means “white blood” in Greek. The disease is often associated with the overproduction of immature white blood cells. These immature white blood cells do not perform as well as they should, therefore the patient is often prone to infection. Leukemia also affects red blood cells and can cause poor blood clotting and fatigue due to anemia. Examples of leukemia include:

- Myelogenous or granulocytic leukemia (malignancy of the myeloid and granulocytic white blood cell series)
- Lymphatic, lymphocytic, or lymphoblastic leukemia (malignancy of the lymphoid and lymphocytic blood cell series)
- Polycythemia vera or erythremia (malignancy of various blood cell products, but with red cells predominating)

Lymphoma

Lymphomas develop in the glands or nodes of the lymphatic system, a network of vessels, nodes, and organs (specifically the spleen, tonsils, and thymus) that purify bodily fluids and produce infection-fighting white blood cells, or lymphocytes. Unlike the leukemias which are sometimes called “liquid cancers,” lymphomas are “solid cancers.” Lymphomas may also occur in specific organs such as the stomach, breast or brain. These lymphomas are referred to as extranodal lymphomas. The lymphomas are sub-classified into two categories: Hodgkin lymphoma and Non-Hodgkin lymphoma. The presence of Reed-Sternberg cells in Hodgkin lymphoma diagnostically distinguishes Hodgkin lymphoma from Non-Hodgkin lymphoma.

Mixed Types

The type components may be within one category or from different categories. Some examples are:

- adenosquamous carcinoma
- mixed mesodermal tumor
- carcinosarcoma
- teratocarcinoma

Chapter 3

Cancer Symptoms

Cancer can cause many different symptoms. These are some of them:

- Skin changes, such as:
 - A new mole or a change in an existing mole
 - A sore that does not heal
- Breast changes, such as:
 - Change in size or shape of the breast or nipple
 - Change in texture of breast skin
- A thickening or lump on or under the skin
- Hoarseness or cough that does not go away
- Changes in bowel habits
- Difficult or painful urination
- Problems with eating, such as:
 - Discomfort after eating
 - A hard time swallowing
 - Changes in appetite

Text in this chapter is excerpted from “Symptoms,” National Cancer Institute at the National Institutes of Health (NIH), March 5, 2015.

- Weight gain or loss with no known reason
- Abdominal pain
- Unexplained night sweats
- Unusual bleeding or discharge, including:
 - Blood in the urine
 - Vaginal bleeding
 - Blood in the stool
- Feeling weak or very tired

Most often, these symptoms are not due to cancer. They may also be caused by benign tumors or other problems. If you have symptoms that last for a couple of weeks, it is important to see a doctor so that problems can be diagnosed and treated as early as possible.

Usually, early cancer does not cause pain. If you have symptoms, do not wait to feel pain before seeing a doctor.