

Oncology

OUTLINE

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 Cancer
 Pathophysiology
 Etiology
 Risk Factors
 Signs and Symptoms
 Diagnosis
 Treatment
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LEARNING OBJECTIVES

After completion of the chapter the reader should be able to

1. Contrast benign and malignant tumors.
2. List the warning signs of cancer.
3. Describe the local and systemic effects of cancer.
4. Explain common diagnostic tests.
5. Discuss metastasis and spread of malignancy.
6. Describe cancer staging.
7. List common risk factors for cancer.
8. Discuss possible treatments for malignant tumors.

KEY TERMS

Anemia: A decrease in the normal number of red blood cells or less than the normal quantity of hemoglobin.
Angiogenesis: The growth of new blood vessels from preexisting vessels.
Antineoplastic: Inhibiting or combating the development of cancer.

Atypical: Not common in form, as in the symptoms of a disease.

Biopsies: Medical tests that involve the removal of cells or tissues for examination.

Cachexia: Wasting syndrome, which includes loss of weight, muscle atrophy, fatigue, weakness, and significant loss of appetite.

Chromosomes: Organized structures of DNA and proteins found in cells.

Deoxyribonucleic acid (DNA): A nucleic acid that contains genetic instructions needed for development and normal functioning of living organisms.

Differentiation: The process by which a less specialized cell becomes a more specialized cell type.

Hematopoietic: Related to hematopoiesis, the formation of blood cellular components.

Leukemia: A cancer of the blood or bone marrow characterized by an abnormal increase of white blood cells.

Metastasis: The spread of a disease from one organ or body part to another that is not adjacent.

Micrometastases: Multiple metastases too small in size to be detected.

Mutations: Sudden changes in the nature of genes as opposed to gradual genetic changes that develop over the course of generations.

Oncology: The medical specialty that deals with tumors and cancers.

Palliative: Improving patient comfort but not treating the underlying condition.

Prognosis: A prediction of the course and outcome of a disease.

Prophylactic: Used to prevent rather than to treat or to cure.

Recurrence: The returning of a disease state.

Remission: The state of absence of disease activity in patients with a chronic illness.

Seeding: A final cancer process, wherein the disease spreads via body fluids or membranes.

Overview

Cancer is the second leading cause of death in the United States. It affects all age groups, but the risk of developing cancer increases greatly with age. Cancer is actually a collection of many different diseases, all caused by an accumulation of genetic alterations. It can originate in almost any organ, with skin cancers being the most common site in persons in the United States. Excluding skin cancers, the prostate is the most common site in men, and the breast is the most common site in women (Table 7-1). Environment and heredity interact, modifying the risk of developing cancer as well as the response to treatment. Increased understanding of the basic pathophysiology of cancer has contributed to the many effective therapies available today.

Benign and Malignant Tumors

A *neoplasm* is an abnormal tissue that grows by cellular proliferation more rapidly than normal. It continues to grow after the stimuli that initiated the new growth cease. A neoplasm is also called a *tumor*. This unneeded cellular growth deprives other cells of needed nutrients. Neoplasms usually have no useful function and consist of immature or **atypical** (abnormal) cells. Tumor growth depends on the cells from which the tumor develops, each with unique growth patterns and appearances. Surrounding structures are affected by pressure as a tumor expands in size.

Names of Tumors

Oncology is the study of malignant tumors, also referred to as the study of cancer. Tumors are named according to their related body system. Table 7-2 shows tumor classifications and lists roots, suffixes, and examples of tumors. The root word specifies the cell of origin, with the suffix indicating whether it is benign or malignant and the type of tissue involved. Numerous specialized names have arisen as well, such as *leukemia*, *Hodgkin's disease*, and *Wilms' tumor*.

Characteristics of Tumors

Depending on the cell of origin, tumor characteristics differ. Table 7-3 summarizes benign and malignant tumors.

TABLE 7-2 Tumor Classifications

Root	Suffix	Example
Adeno- (glandular tissue)	-carcinoma (malignant epithelial tissue)	Adenocarcinoma: Malignant tumor of the epithelial lining of a gland
Fibro- (fibrous tissue)	-sarcoma (malignant connective tissue)	Fibrosarcoma: Malignant tumor of the fibrous tissue
Lip- (fatty tissue)	-oma (benign)	Lipoma: Benign tumor of the fatty tissue

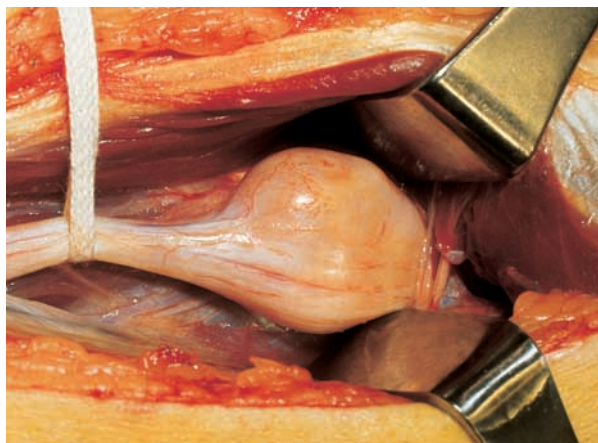
TABLE 7-3 Benign and Malignant Tumors

Focus Area	Benign Tumors	Malignant Tumors
Cells	Differentiated, fairly normal mitosis, similar to normal cells	Many undifferentiated, increased and atypical mitosis, varied sizes and shapes with large nuclei
Growth	Expanding mass, often encapsulated, relatively slow-growing	Cells infiltrate tissue and are not adhesive, with no capsule and rapid growth
Life-threatening potential	Only in the brain and other certain locations	Yes, due to tissue destruction and spread of tumors
Spread	Localized	Invades nearby tissues, or metastasizes to distant sites via the lymph vessels and blood
Systemic effects	Rare	Commonly present

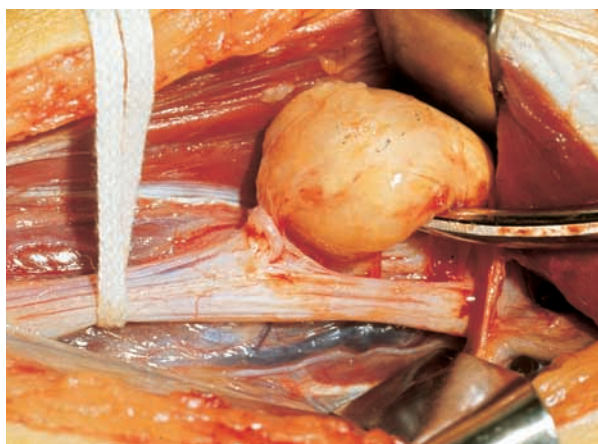
Benign, or *nonmalignant*, tumors are often encapsulated. They expand without spreading and usually consist of differentiated cells that reproduce more quickly than normal cells (Figure 7-1). These tumors may damage tissues because of compression of adjacent structures. They are not considered life threatening unless in an area where increased pressure

TABLE 7-1 Common Sites of Cancer in Males and Females

Males		Females	
New Cases	Deaths	New Cases	Deaths
Prostate (29%)	Lung/bronchus (31%)	Breast (26%)	Lung/bronchus (26%)
Lung/bronchus (15%)	Prostate (9%)	Lung/bronchus (15%)	Breast (15%)
Colon/rectum (10%)	Colon/rectum (9%)	Colon/rectum (11%)	Colon/rectum (10%)
Urinary bladder (7%)	Pancreas (6%)	Uterine corpus (6%)	Pancreas (6%)
Non-Hodgkin's lymphoma (4%)	Leukemia (4%)	Non-Hodgkin's lymphoma (4%)	Ovary (6%)
Melanoma of the skin (4%)	Liver/intrahepatic bile duct (4%)	Melanoma of the skin (4%)	Leukemia (4%)
Kidney and renal pelvis (4%)	Esophagus (4%)	Thyroid (4%)	Non-Hodgkin's lymphoma (3%)
Leukemia (3%)	Urinary bladder (3%)	Ovary (3%)	Uterine corpus (3%)
Oral cavity/pharynx (3%)	Non-Hodgkin's lymphoma (3%)	Kidney/renal pelvis (3%)	Brain/other nervous system (2%)
Pancreas (2%)	Kidney/renal pelvis (3%)	Leukemia (3%)	Liver/intrahepatic bile duct (2%)
All other sites (19%)	All other sites (24%)	All other sites (21%)	All other sites (23%)



(A)



(B)

Figure 7-1 (A) Benign tumor (neuroma) arising from the sciatic nerve. (B) Tumor dissected from surrounding nerve. The cleavage plane is easily established, indicating that the tumor is sharply circumscribed and does not infiltrate the adjacent nerve.

may have serious effects, such as in the brain. A benign tumor of the blood vessels is referred to as an *angioma* (Figure 7-2).

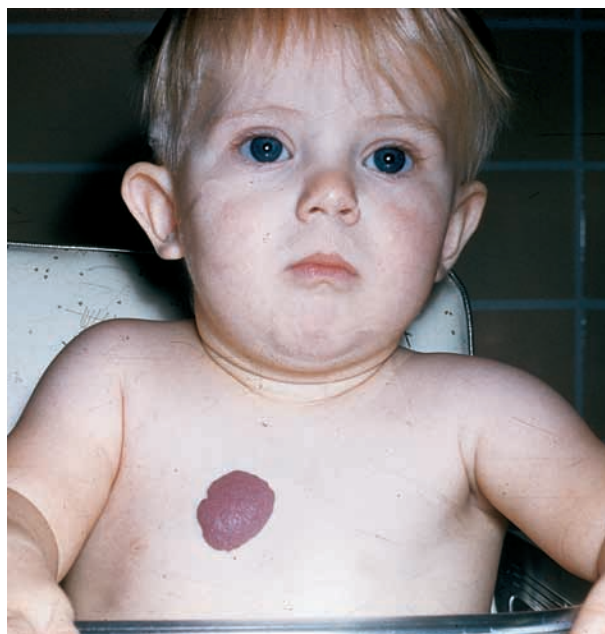
Malignant tumors usually consist of nonfunctioning, undifferentiated cells that reproduce quickly. Tumor cells penetrate into surrounding tissue. They can easily break away and spread to other tissues and organs (Figure 7-3). This process is known as *metastasis*.

Cancer

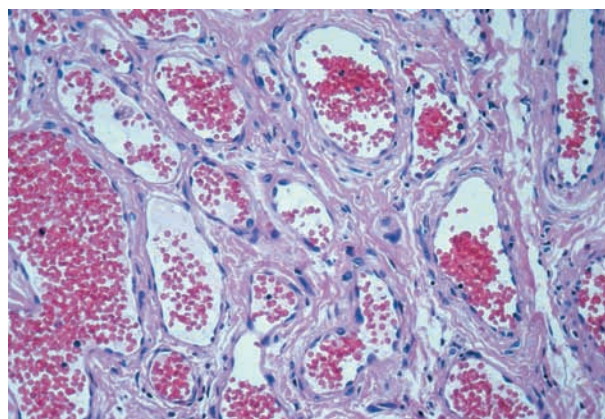
Malignant neoplasms are commonly called cancers. Cancer affects all ages of people, but overall risk increases with age.

Pathophysiology

Tumors are usually composed of more primitive cells than other body structures. They proliferate because growth, inhibition, and cell-to-cell communications are no longer occurring normally. Expansion of a tumor compresses blood vessels, causing inflammation, increased pressure, and tissue necrosis. Tumor cells often secrete enzymes that break down proteins and normal cells. As inflammation and growth increase, organ function progressively becomes reduced.



(A)



(B)

Figure 7-2 Benign blood vessel tumor (angioma) of skin. (A) Clinical appearance. (B) Histologic appearance revealing well-formed mature blood vessels (original magnification X 400).

Enlargement of a tumor deprives its inner cells of blood and nutrients, resulting in continued necrosis, inflammation, and localized infection. Certain tumor cells secrete growth factors that stimulate **angiogenesis**, promoting tumor development. Tumor cells may prevent normal cells from receiving nutrients so they cannot regenerate normal tissues.

Tumors vary widely in the speed of their growth and development. The term *in situ* refers to neoplasms that exist in a preinvasive stage of cancer that can last for months or years. When neoplasms are *in situ*, the possibility of early diagnosis is increased, as seen in some oral cancers and cervical cancer.

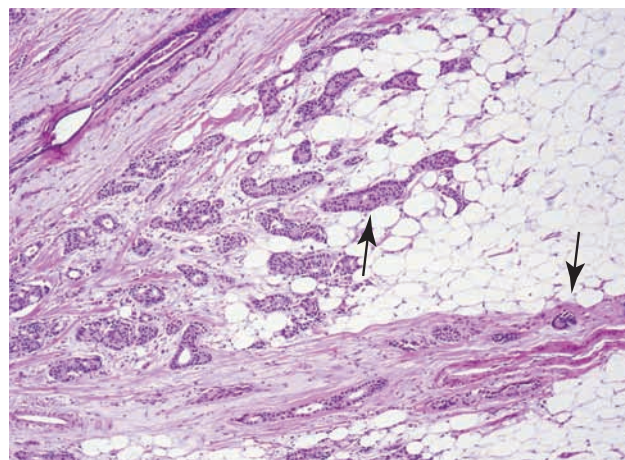
Tumors are *graded* based on the amount of **differentiation** of malignant cells (G1 is well-differentiated and G4 is undifferentiated and highly malignant).

RED FLAG

Progression of cancer involves the mutated cell's exposure to factors that affect its growth. Promoters may be hormones (such as estrogen), food additives (such as nitrates), or drugs (such as nicotine).

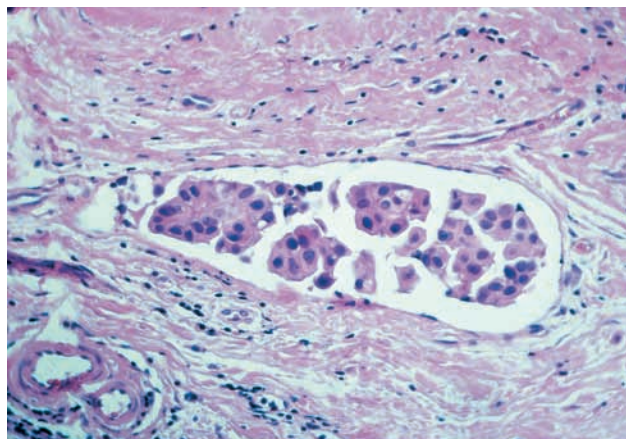


(A)

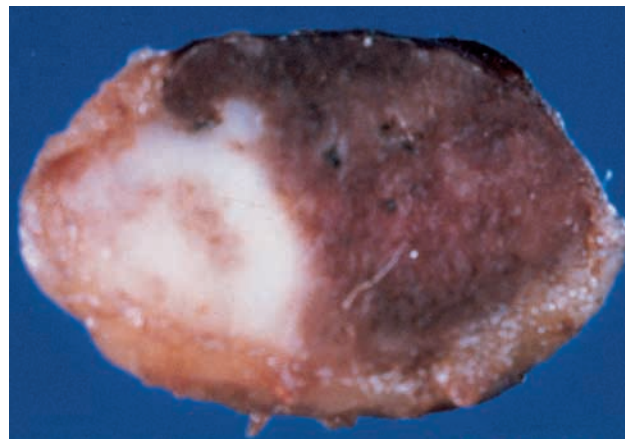


(B)

Figure 7-3A Breast carcinoma. (A) Breast biopsy illustrating breast carcinoma (arrow) infiltrating adjacent fatty tissue of breast. There is no distinct demarcation between tumor and normal tissue. (B) Low-magnification photograph illustrating the margin of infiltrating breast carcinoma. Small clusters of tumor cells (arrows) infiltrate adipose tissues of breast (original magnification X 20).



(A)



(B)

Figure 7-3B Lymphatic spread of carcinoma. (A) Cluster of tumor cells in lymphatic vessel (original magnification X 400). (B) Deposit of metastatic carcinoma (white mass within node) that has spread via lymphatic channels into a small regional lymph node.

Tumor grade should not be confused with the stage of a cancer. Cancer *stage* refers to the extent or severity of the cancer, based on factors such as the location of the primary tumor, tumor size, number of tumors, and lymph node involvement (spread of cancer into lymph nodes) (**Table 7-4**). It is

important to remember that staging of different types of cancers varies widely in prognoses.

Warning Signs of Cancer

It is important, as a health care professional, to understand all early indicators and warning signs of possible malignancies. It is possible to save a patient's life by critically observing and reporting warning signs of cancer. The following are nine important warning signs of cancer:

- Unusual bleeding or discharge from any area
- Changes in bowel or bladder function, such as discomfort or diarrhea
- Changes in the color, size, and shape of moles or warts
- Sores that do not heal, in any body area
- Unexplained weight loss
- Anemia or low hemoglobin

TABLE 7-4 General Cancer Staging

Stage	Comments
0	Precancerous state
I	Confined to the organ where it originated
II	Has invaded nearby tissues or organs
III	Has spread to lymph nodes or other tissues
IV	Has metastasized to distant locations

- Persistent fatigue
- Persistent cough or hoarseness without a real reason
- A solid, often painless lump, in any body area

These are just a few, as there are other warning signs of cancer as well. In oncology, *evidence-based practice* is used to identify, appraise, and use evidence to solve clinical problems.

Localized Effects of Tumors

Tumors have many localized effects, including pain, obstruction, tissue necrosis, and ulcerations. There is often no pain when a tumor is in its early stages. Although not always present, pain often occurs when a tumor has developed to an advanced stage. Pain may occur due to direct pressure upon sensory nerves, such as in bone cancer. If pain is dull and aching, it may be because of the stretching of a visceral capsule, such as with kidney or liver cancer. Pain may also be caused by inflammation, irritation of nerve endings by chemical mediators, infection, ischemia, and bleeding. In some malignant tumors there may be marked enlargement of the cervical lymph nodes, such as with malignant lymphoma.

When tumors compress ducts or passageways or grow inside or around body structures, *obstruction* may result. For example, an obstruction of the digestive tract leads to ulceration or edema. Obstructions often cause serious complications in all stages of their development.

If tissue necrosis or ulceration occurs, an infection may develop around the tumor. This often occurs in areas when the normal body flora can become *opportunistic*, such as in the oral cavity. Cancer often causes the host to have reduced resistance to microbial invasion.

Systemic Effects of Tumors

When malignant tumors have metastasized, systemic (general) effects may appear. These include weight loss, pain, **cachexia**, anemia, infections, bleeding, and paraneoplastic syndromes.

Weight loss and severe tissue wasting (*cachexia*) are commonly caused by many malignancies. Factors that contribute to these symptoms include anorexia, fatigue, pain, trapping of nutrients from normal cell use, stress, and altered metabolism of carbohydrates and proteins. Macrophages may produce cachetic factors in response to tumors. Cachexia leads to added fatigue, weakness, and tissue breakdown.

In the early stages of cancer pain is usually absent or mild. As cancer progresses, however, the severity of pain usually increases. It results most often from pressure or compression, obstruction, inflammation, and visceral surface stretching.

Anemia commonly results from anorexia and decreased food intake, bone marrow depression, and chronic bleeding with iron loss. It decreases the oxygen that is available to cells. This leads to poor tissue regeneration and fatigue. As host resistance declines, infections occur frequently. The immune system becomes less effective as tissue breakdown develops. Immobility contributes to lung infections because of the stoppage of normal movement of lung secretions and a reduced cough effort.

When tumor cells erode blood vessels or cause tissue ulceration, bleeding may occur. Poor clotting may be caused by bone marrow depression and hypoproteinemia. Often, chronic bleeding is seen in the digestive tract due to the slow regeneration of the mucosa, leading to iron deficiency anemia. *Paraneoplastic syndromes* are related to conditions such as *bronchogenic carcinoma* in the lungs. Hormonal-type effects may occur from substances released by tumor cells that affect blood clotting or neurologic functions. In bronchogenic carcinoma, *adrenocorticotropic hormone* may be produced, causing Cushing's syndrome, which can confuse diagnosis and complicate monitoring of the patient.

Infection is common in the patient with advanced cancer. This is particularly true with myelosuppression from treatment, direct invasion of bone marrow, the development of fistulas, or immunosuppression from hormone release in response to chronic stress.

Diagnostic Tests

Diagnostic tests, when conducted regularly and early enough in the development of cancer, can save a patient's life. Self-examination programs and routine screening tests can never be promoted enough. During treatment for cancer, as well as during follow-up treatment, frequent monitoring is required to assess treatment effectiveness and provide warnings about possible **recurrence**. Although the only 100 percent accurate test for malignant tumors is examination of tumor cells, diagnostic tests are still greatly helpful in discovering warning signs. Diagnostic tests for cancer are as follows:

RED FLAG

Several important characteristics of the host affect tumor growth. These include age, gender, overall health status, and immune system function.

- Blood tests: Low hemoglobin and erythrocytes are a general sign of cancer.
- Tumor marker tests: Examination of various body fluids may indicate enzymes, antigens, hormones, or other substances produced by malignant cells; these tests are commonly used to diagnose colon cancer, testicular cancer, liver cancer, ovarian cancer, prostate cancer, and certain types of leukemia. When tumor markers are found in abnormal amounts in blood, urine, or tissues, they are often (but not always) indications of the presence of cancer. They cannot be used alone to diagnose cancer but must be combined with other tests. Research about tumors is ongoing, because these tumor marker tests are not currently consistently reliable indicators of cancer.
- Radiographic and imaging tests: These include x-rays, ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT) scans; these tests look for changes in tissues or organs. In some tests *radioisotopes* may be incorporated to trace metabolic pathways and functions.
- Histologic and cytologic tests: Bone marrow examination confirms certain types of cancer (such as leukemia); these tests evaluate **biopsies** of tissues, cells, and

tumors and are the most accurate methods of diagnosing cancers such as cervical and bone cancers.

Spread of Malignancy

Tumors spread in a variety of ways, producing *secondary* tumors that are identical to the parent (*primary*) tumor. Unfortunately, many cancers have already spread before being diagnosed. **Metastasis** must be diagnosed before beginning

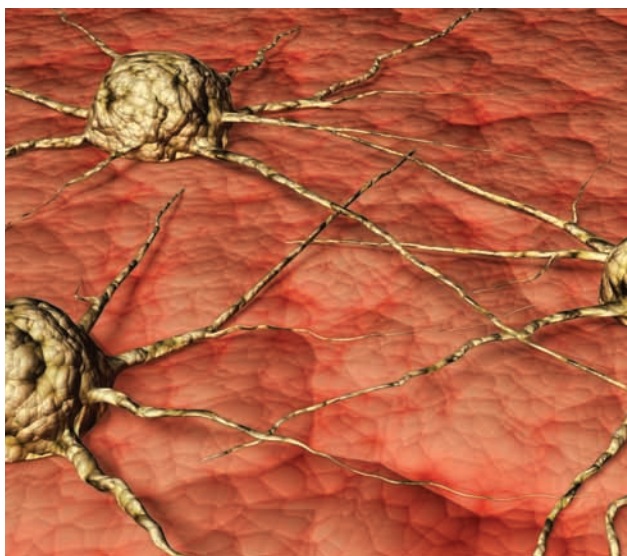


Figure 7-4 “Crablike” shape of invading tumor cells.

treatment. There are three basic mechanisms for the spread of malignancy:

- **Invasion:** The localized spread of tumor cells into adjacent tissue, which destroys normal cells. Tumor cells are attached loosely to other cells, secreting enzymes that break down tissue. Tumor cells often have a “crab-like” image, and the origin of the word *cancer* comes from the Latin word for “crablike” (**Figure 7-4**).
- **Metastasis:** The spread of cancer from the primary tumor (**Figure 7-5**) to distant sites via the lymph or blood; tumor cells erode into a vein or lymphatic vessel, eventually traveling and lodging in another body area that is hospitable to their growth. Only a few tumor cells are required for this to occur, with regional lymph nodes often being the first site of metastasis.

Often, lymph nodes may be removed or treated to eradicate any **micrometastases** of early-stage-metastasizing cancers such as breast cancer. Because many cancers spread via venous and lymphatic flow, the lungs and liver are common secondary tumor sites.

- **Seeding:** This final process refers to cancer that spreads via body fluids or membranes (usually in body cavities). Tumor cells break off to travel easily with fluid and tissue movements (as in ovarian cancer). Diagnostic procedures or surgery are more dangerous with this type of cancer spread because they can increase the spread of the tumor cells.

RED FLAG

Most commonly, metastasis occurs through the blood vessels and lymphatic system.

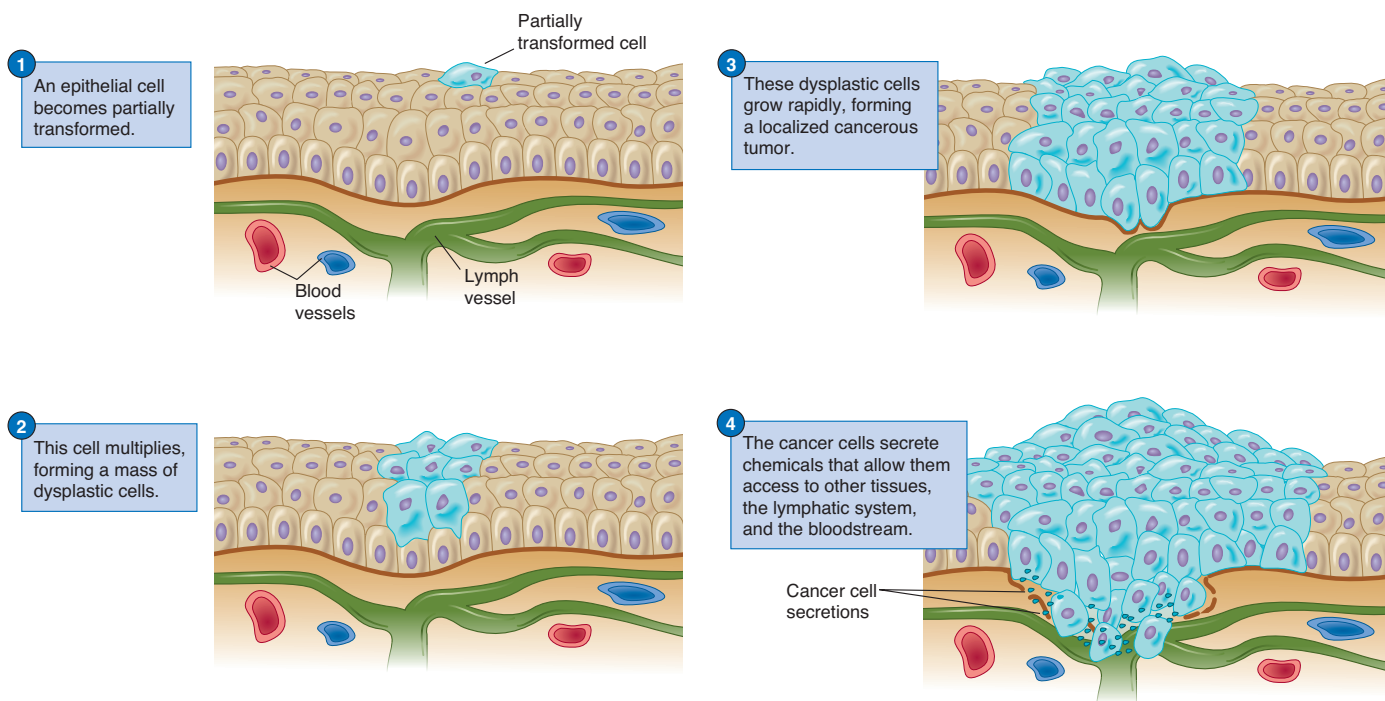


Figure 7-5 Cancer growth and metastasis. Cancers grow by cell division. Cells can break free from the tumor and spread in the blood and lymphatic systems to other parts of the body where they establish secondary tumors. Secondary tumors often develop in the liver, lungs, and lymph nodes.

Cancer Staging

Cancer staging is used to describe the extent of the disease and provides a basis for treatment and **prognosis**. It is applied to a specific malignant tumor when it is diagnosed and may be repeated at critical points in the disease progress. The components of cancer staging are size of the primary tumor (T), extent of regional lymph node involvement (N), and invasion or metastasis of the tumor (M). **Table 7-5** clearly explains cancer staging as it relates to breast cancer. More complex subgroups for each cancer stage have been established for a wide variety of cancers.

Etiology

The etiology of cancer is based on carcinogenesis, risks and prevention methods, and host defenses. Various genes may be responsible for cell growth and replication. Those that cause cancer are called *oncogenes*. Changes in cell **deoxyribonucleic acid (DNA)** are a base cause of malignant transformation.

Viruses are capable of producing many different types of tumors, including certain types of leukemias and lymphomas. HIV can produce Kaposi's sarcoma, as seen in AIDS patients. Certain papilloma viruses may cause genital condylomas, predispose certain women to cervical carcinoma, and may cause various squamous cell carcinomas. Chronic viral hepatitis may lead to primary carcinoma in the liver. The Epstein-Barr virus, which causes mononucleosis, may lead to certain types of carcinomas and lymphomas.

Other etiologic factors include gene and chromosomal abnormalities. When genes mutate they may function differently, and altered function plays a part in the formation of

tumors. *Proto-oncogenes* are normal genes that regulate some normal cellular growth but may mutate or translocate and develop derangements in functions. *Tumor*

suppressor genes may mutate or become disrupted, causing unrestrained cellular growth to occur. *DNA repair genes* may become altered in structure, which increases the likelihood of DNA **mutations** in body cells.

Chromosomal abnormalities play a part in the development of certain cancers, such as leukemias. When certain

RED FLAG

Some cancers and precancerous lesions may result directly or indirectly from genetic predisposition.

TABLE 7-5 Breast Cancer Staging

Stage	Size	Lymph Node Involvement	Metastasis
I	T1: tumor 2 cm or less in diameter	N0: no lymph nodes involved	M0: no metastasis
II	T0 to T2: tumor less than 5 cm in diameter	N1: nodes involved	M0: no metastasis
III	T3: tumor larger than 5 cm in diameter	N1 or N2: nodes involved, tumor may be fixed	M0: no metastasis
IV	T4: tumor any size, but fixed to chest wall or skin	N3: clavicular nodes involved (spread)	M1: metastasis present

components of **chromosomes** become translocated, they may fuse with different genes and form composite genes that allow for uncontrolled cellular growth.

When immunologic defenses fail, mutations and cellular growth may become uncontrolled. Evidence shows that patients with congenital immunologic deficiencies have a higher than normal incidence of tumors. This is because the body cannot identify and destroy abnormal cells as readily as when the immune system is functioning normally. Heredity also plays a role in some common tumors, including those of the breasts, colon, ovaries, or lungs.

Risk Factors

One of the most significant risk factors for cancer is advancing age, though predisposing factors influence susceptibility to the disease. Risk factors for cancer include previous cancer, lifestyle or personal behaviors such as smoking, exposure to certain viruses, exposure to certain hormones, geographic location and related environment, previous cancer treatments, gender, ethnicity, socioeconomic status, type of occupation, family history, presence of precancerous lesions or polyps, stress, and inflammatory bowel disease. More than one-third of cancer deaths in the world are related to one or more of nine modifiable risk factors: tobacco use, excessive alcohol use, inactivity, diet and nutrition, obesity, unsafe sex, urban air pollution, household fuels that cause indoor smoke, and contaminated injections.

Signs and Symptoms

Although signs and symptoms differ based on the type of cancer and its staging, there are general manifestations of the disease. These are listed in **Table 7-6**.

TABLE 7-6 General Signs and Symptoms of Cancer

- Abnormal bleeding
- Anemia
- Anorexia
- Cachexia
- Coagulation disorders
- Decreased immunity
- Fever
- Gastrointestinal obstruction
- Growing lumps or masses
- Hoarseness
- Muscle wasting
- Nausea
- Pain
- Paraneoplastic syndromes
- Pulmonary obstruction
- Retching
- Secondary infections
- Stroke-like symptoms
- Tissue damage, necrosis, ulceration
- Vascular obstruction
- Visible changes in lesions
- Vomiting
- Weight loss

Carcinogenesis

Carcinogenesis is the process wherein normal cells are transformed into cancer cells, developing from sequenced changes over a fairly long period of time. Either a combined group of risk factors or repeated exposure to a single risk factor may be causative. Although some cancers, such as lung cancer, have direct risk factors (such as smoking), many are less defined. Oncogenic viruses may play a role, such as the *human papillomavirus* triggering cervical cancer. Radiation exposure is linked to **leukemia**, whereas ultraviolet radiation is linked to skin cancer. There are three stages of carcinogenesis:

- Initiating factors (procarcinogens): Those that cause the first irreversible cell DNA changes, including genetic changes or exposure to environmental risks (**Figure 7-6**).
- Exposure to “promoters” (including hormones or chemicals): Causes later DNA changes, less differentiation, and increased mitosis, with possible changes in cell development. This process leads to tumor development, and promoters and prolonged time intervals complicate the establishment of cancer risk factors.
- Continued exposure and DNA changes: Result in malignant tumors.

Risks and Prevention Methods

Risks for cancer include geographic areas, ethnic background and genetics, environment, and diet. Risk factors are described in **Table 7-7**. Prevention methods for cancer include regular medical examinations, regular dental examinations, limiting sun exposure, and eating a healthy diet.

High fiber intake, regular consumption of fresh fruits and vegetables, and eating foods that contain antioxidants are all recommended.

Host Defenses

Neoplastic growth is inhibited in the body by *cancer suppressor genes*. The immune system reacts to changes in tumor cell membranes, which it determines are “foreign” to the body. Cell-mediated and humoral immunity are used in the immune response. The immune surveillance and destruction of foreign or abnormal cells involves cytotoxic T lymphocytes, natural killer cells, and macrophages. Cancer risk is increased when the body is immunodeficient. Therefore, conditions that reduce immunity, such as HIV and AIDS, often lead to the development of cancers such as Kaposi’s sarcoma and lymphomas. This is due to the decreased number of T lymphocytes because of the immunodeficient state.

RED FLAG

Research suggests that cancer cells develop continually but that the immune system recognizes these cells as foreign and destroys them.

Diagnosis

Diagnosis of cancer, as early as possible, greatly improves prognosis. Any early changes in appearance of a body structure, its function, and the way it feels may all be indicative of cancer. Examples of changes that may signify cancer include “lumps,” ulcers, changes in warts or moles, bleeding, sudden changes in bowel habits, and so on. A physician should be consulted, who will first take a complete medical history and

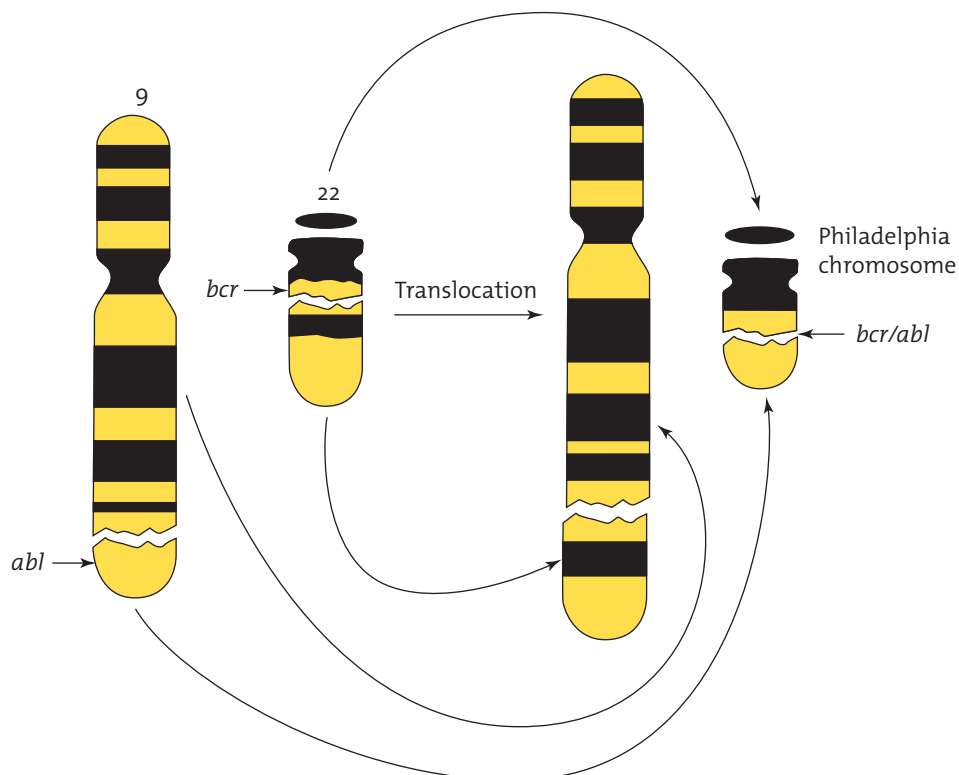


Figure 7-6 Reciprocal translocation between broken pieces of chromosomes 9 and 22, forming the Philadelphia chromosome containing the composite gene that disrupts normal cell functions.

TABLE 7-7 Risk Factors for Cancer

Risk Factors	Descriptions	Examples
Genetic factors	Oncogenes that regulate all growth	Breast cancer: high family incidence Retinoblastoma: inherited Leukemia: chromosomal abnormalities
Viruses	Oncogenic viruses alter host cell DNA	Cervical cancer: papilloma virus (HPV) or herpes simplex II Kaposi's sarcoma: HIV Hepatic cancer: hepatitis virus
Radiation	Ultraviolet rays from the sun, x-rays, gamma rays, and radioactive chemicals cause cumulative chromosomal damage in cells	Leukemia: radiation exposure Skin cancer: sun exposure
Chemicals	Exposure to both natural and synthetic products in excess may be hazardous: the effects of carcinogens depend on amount and duration of exposure	Bladder cancer: aniline dyes and rubber Leukemia: solvents such as benzene Lung cancer: asbestos, nickel
Biologic factors	Chronic irritation and inflammation with increased mitosis	Colon cancer: ulcerative colitis Oral cancer: leukoplakia
Age	Increasing	Many cancers are more common in the elderly
Diet	Natural substances, additives, or processing methods	Colon cancer: high-fat diet Gastric cancer: smoked foods
Hormones	Various	Endometrial cancer: estrogen

conduct a physical examination. This may include localized examinations based on the signs and symptoms. Common studies include rectal and colon exams, vaginal exams, Pap smears, gastrointestinal exams, and various types of x-ray studies. If a tumor is found, a biopsy or complete removal may be indicated. Histology will provide an exact diagnosis. If the tumor is malignant, additional surgery and other treatments may be needed.

As cells are shed from tumor cells, they may be seen in the blood and other body fluids. The widespread use of procedures that examine surface cells, such as the Pap smear, has allowed for much earlier detection of various cancers than ever before in history. Another procedure used for cytologic diagnosis is fine-needle aspiration. A very fine needle, attached to a syringe, is used to aspirate material from organs or tissues. Most commonly, this method is used for breast or thyroid cancer screening. Other organs for which fine-needle aspiration may be used include the lungs, liver, kidneys, and pancreas.

Sometimes, *frozen sections* of resected neoplasms are used, wherein a portion is examined after being frozen solid at subzero temperatures. Only a thin section of the frozen tissue is cut and used for the preparation of microscope slides. This method is very quick and extremely accurate. *Tumor-associated antigen tests* are another method of cancer diagnosis. Some cancers secrete *tumor-associated antigens* such as *carcinoembryonic antigen*. Other substances that may be secreted by tumor cells include *alpha-fetoprotein* and *human chorionic gonadotropin*. While these two substances are normally released in the body at various times, when they are released by tumor cells it is in much higher quantities.

RED FLAG

Because lymphangiography is invasive and may be difficult, utilizing x-rays, CT scans, and MRI have largely replaced this method.

RED FLAG

Ultrasound helps differentiate cysts from solid tumors and is commonly used to provide information about abdominal and pelvic cancer.

Treatment

Treatment for cancer includes chemotherapy, radiation, and surgery. Each type of cancer is treated with its own specified treatment regimen. For example, leukemia is treated by chemotherapy because the cancer cells are dispersed in the blood and are **hematopoietic**. Solid tumors often are removed surgically, and the patient is then treated with chemotherapy, radiation, or both depending on the sensitivity of these cells to each type of therapy.

If a tumor is small and localized, treatments often cure the condition. However, if the cancer is advanced, treatments may only be **palliative**. This type of treatment is focused on reducing the manifestations and complications of the cancer to prolong life. Patients may be made more comfortable and less symptomatic with palliative care. Types of palliative care for cancer include the following:

- **Physical:** Common problems include pain, nausea, fatigue, loss of appetite, shortness of breath, vomiting, and insomnia. Physical symptoms may be treated with medications, nutrition therapy, physical therapy, deep breathing techniques, chemotherapy, radiation therapy, or surgery.
- **Emotional:** Depression, anxiety, and fear are treated with coping methods that include counseling, support groups, family meetings, and referrals to mental health professionals.
- **Practical:** Concerns about finances, legalities, insurance, employment, and advance directives are handled by professionals in each of these areas for the best benefit of the patient and his or her family.
- **Spiritual:** Palliative care experts can discuss concerns about the disease, outcomes, reasoning, and other issues and contact spiritual and religious authorities to ease the patient and family.

Adjuvant therapy is additional **prophylactic** treatment used when a cancer is known to metastasize early. For example, after a localized breast tumor that has not spread is removed, chemotherapy and radiation are often administered to kill any cancer cells that may have broken away and traveled to a lymph node or nearby tissue. Additional treatments

for cancer include nutritional counseling, physiotherapy, psychotherapy, and other methods that may last for the lifetime of the patient.

Surgery may involve removal of a tumor as well as surrounding tissue and lymph nodes. Tumor cells and their boundaries must be verified to ensure complete removal. Occasionally, removal of enough surrounding tissue can affect function of organs or other body structures. Complete tumor removal may not be possible in certain situations, although reduction in its size may help to reduce symptoms and prevent complications.

Radiation and chemotherapy are usually administered repeatedly at specific intervals to kill tumor cells but not greatly harm normal cells. Usually, not all tumor cells are destroyed in just one treatment. Therefore, tumors may grow slightly in between treatments, requiring long-term, repeated treatments.

Radiation

Radiation is used alone or in combination with other therapies. It often causes DNA alterations or mutations that kill cancer cells while not harming normal cells. Radiation also damages blood vessels that carry blood supply to tumor cells. This type of treatment is most effective on cells that are undergoing DNA mitosis or synthesis. However, some cancers are unresponsive to radiation. Also, radiation may be used before tumor surgery or 6 weeks after surgery to help ensure reduction of any remaining tumor cells.

The most serious negative effect of radiation is *bone marrow depression*. The blood cell counts of the patient must be continually monitored, with decreased leukocytes increasing the risk of infection. Because platelets are also decreased, there may be excessive bleeding. Fatigue and tissue breakdown occur because erythrocytes become reduced by radiation as well. Blood transfusions may be required, and treatment may need to be postponed until these conditions are resolved. Potentially life-threatening complications include septicemia and pneumonia.

Radiation also damages epithelial cells in the blood vessels, causing *vasculitis*, and in the skin. When the skin is damaged in this manner, it resembles the effects of a sunburn, with alopecia (hair loss) occurring. In the digestive tract the mucosa is damaged, causing nausea, vomiting, diarrhea, and possible malnutrition and dehydration. Potential inflammation and ulcerations in this tract may cause bleeding. Radiation to the head or neck may cause oral mucosa ulceration, dry mouth (xerostomia), difficulty swallowing, tooth damage, and respiratory problems. When radiation is directed at the abdomen, there may be ovary or testis damage, leading to sterility or increasing the risk of teratogenesis.

Overall, radiation usually causes fatigue, lethargy, and mental depression. Long-term effects include inflammation, necrosis, and localized scar tissue. It is possible for scar tissue to cause adhesions, obstructions, and other “secondary” problems.

Chemotherapy

Different cancer cells respond uniquely to **antineoplastic** drugs. Therefore, chemotherapy is sometimes combined with surgery or radiation to treat specific tumors. Small tumors

and those that reproduce most quickly are best treated with antineoplastic drugs. Most commonly, 6 weeks after tumor removal surgery, antineoplastics are begun. Often, two to four different types of antineoplastics are used at periodic intervals.

Classifications of antineoplastic drugs include antimetabolites, antimitotics, antibiotics, and alkylating agents, which interfere with DNA replication and protein synthesis. These agents work best when used at the proper times in the tumor cell cycles. Each type of cancer is matched to specific drugs so the maximum number of tumor cells is destroyed.

Bone marrow depression is the most significant adverse effect of chemotherapy because very low blood counts may require transfusions or the stopping of the treatment until the bone marrow can recover. Blood tests are taken before each treatment. Each drug causes a specific *nadir* (point of lowest cell count, referred to as *neutropenia* or *leukopenia*) at different points in the cycle. If *thrombocytopenia* occurs, hemorrhaging is a major risk. Neutropenia commonly causes infections, whereas septicemia causes gastrointestinal tract tumors. Lung cancers often cause pneumonia.

Nausea and vomiting may occur around the time of each chemotherapy treatment because these agents stimulate the emetic (vomiting) center in the brain. Vomiting may continue after treatment because the digestive tract and mucosa are often irritated by the agents that are used.

Ongoing mitosis easily damages epithelial cells, with hair loss and breakdowns of mucosa and skin being common. Oral stomatitis and diarrhea often lead to malnutrition. Oral candidal infections are often seen. Some antineoplastic drugs have very specific damaging effects such as lung fibrosis.

Other Treatments

Additional treatments for various cancers include hormones such as prednisone, which decreases mitosis and increases erythrocyte counts. Hormones usually improve appetite and the attitude of the patient while decreasing tumor-related swelling and inflammation. If tumor growth depends on hormone levels, sex hormones may be administered. For example, prostate cancer may be treated with estrogens. Hormone-blocking agents such as tamoxifen may help to reduce tumors and prevent recurrences. Newer drugs such as exemestane block the conversion of androgens to estrogens and have been used to treat postmenopausal, hormone-dependent breast cancer.

Nutrition

Advanced stages of cancer usually result in malnutrition. This may be caused by anorexia, vomiting, tooth loss, soreness in the mouth, fatigue, pain, malabsorption, altered metabolism, and nutrient trapping by tumor cells. Both the cancer itself and the effects of chemotherapy and radiation can cause malnutrition.

To treat mouth discomfort, ice and mouthwashes may be used. Smaller meals with nonirritating foods are generally preferred. They should be adequate in vitamin and protein levels. Appetite may increase when pain is controlled and antiemetic drugs are used. Total parenteral nutrition may be required, wherein nutrients are injected directly into a peripheral vein.

Prognosis

Cancer is usually considered to be “cured” when a patient has survived for 5 years without recurrence after diagnosis and treatment. **Remission** is defined as having no clinical signs of a disease. It has been documented that several periods of remission may occur before a disease becomes terminal.

Early diagnosis and treatment may be beneficial, although certain cancers involve prolonged illness with very acute episodes occurring intermittently. The prognosis for various types of cancer differs widely. Lung cancer treatment has not improved prognosis even with aggressive treatment plans. Survival rates, however, have been greatly improved for specific childhood leukemias, as well as for Hodgkin’s lymphoma. Prognosis for any type of cancer depends on many different factors and the overall health of the patient before the development of the disease. **Table 7–8** lists the prognoses for various types of cancers, according to the American Cancer Society.

Screening

To help detect cancer early in its development, regular cancer *screening* is recommended. This can be performed in a variety of ways:

- Observation: External genitalia, mouth, skin
- Palpation: Breast, lymph nodes, prostate, rectum and anus, thyroid
- Laboratory tests and procedures: Pap smear, colonoscopy, mammography

Cancer screening is designed to detect early cancers or premalignancies. Ideally, it is cost effective and improves therapeutic outcomes. Most cancers are more readily curable when detected in their early stages. When a tumor is small and has not metastasized, the chance of a successful

treatment is heightened. However, in certain types of cancer even a small primary tumor will metastasize early.

The unfortunate aspect of cancer screening is that for some cancers no screening methods are available (for example, pancreatic cancer). Development of screening for these types of cancer using tumor markers is ongoing. Screening or early detection is usually relatively successful for breast, cervical, colorectal, prostate, and malignant melanoma skin cancers. Screening is advised during periodic health examinations for thyroid, testicular, ovarian, lymph node, and mouth cancers.

SUMMARY

Tissue growth and repair involves cell proliferation and differentiation. Cell proliferation is the process wherein tissue acquires new or replacement cells through cell division. A new growth or neoplasm is called a tumor. Benign neoplasms are well-differentiated tumors that resemble the tissue of origin but have lost the ability to control cell proliferation. They grow by expansion and are enclosed in a fibrous capsule. Malignant neoplasms are less well-differentiated tumors that have lost the ability to control both cell proliferation and differentiation. They travel to distant sites to form metastases.

Various diagnostic tests for cancer include blood tests, tumor marker tests, radiographic and imaging tests (including CT scan and MRI), and tissue biopsy. The prognosis of cancer depends on cancer staging. Various carcinogens, genes, and viruses may be risk factors for the development of cancer. Cancer treatments include chemotherapy, radiation, and surgery. Each type of cancer requires its own specific treatment regimen. Adjuvant therapy is additional prophylactic treatment that is used when a cancer is known to metastasize early.

TABLE 7–8 Cancer Prognoses

Cancer Type	Prognosis (percentage of patients who will survive for 5 years or more)	Comments
Lung	Varies widely: 1–67%	Kills more Americans than any other type, more than 130,000 annually
Colorectal	63–70%	Kills more than 55,000 Americans annually but produces about 150,000 new cases per year
Breast	Varies widely: 14–99%	The most common type affecting women; nearly 150,000 women develop breast cancer in the United States annually, with 35% dying from the disease
Stomach	Varies widely: 15–65%	One of the more frequently diagnosed types of cancer, with nearly 10 of every 100,000 Americans dying from the disease; men are more than twice as likely than women to have stomach cancer
Prostate	Varies widely: 33–99%	The most common type of cancer in men, and second only to lung cancer in male deaths from cancer; about 30,000 American men die from it annually
Bladder	53–84%	Associated with industrial growth; new cases number 40,000 per year, with 15,000 Americans dying from this disease annually
Oral	55–90%	25,000 Americans contract oral cancers annually, and 9,000 die from the disease
Skin	Varies widely: 15–99%	The largest source of malignancy in the United States; new cases of skin cancers number 500,000 annually, with about 6,000 Americans dying from these every year
Uterine	61–86%	The most common type of reproductive system cancer
Ovarian	39–44%	The fifth most common type of cancer in women, with 21,000 new cases per year

REVIEW QUESTIONS

Select the best response to each question.

- A sudden change in the nature of a gene as opposed to a gradual genetic change that develops over the course of generations is referred to as
 - oncology
 - metastasis
 - differentiation
 - mutation
- A benign tumor of the fatty tissue is known as a
 - liposarcoma
 - lipoma
 - lipoatrophy
 - lipoid
- The growth of new blood vessels from preexisting vessels is called an
 - angioma
 - angioid
 - angiogenesis
 - angioglioma
- A cellular growth that no longer responds to normal body controls is called a
 - papule
 - osteoblast
 - cytotoxin
 - neoplasm
- Exposure to radiation may be linked to
 - leukemia
 - cervical cancer
 - breast cancer
 - hepatic cancer
- Tumors are graded based on the amount of
 - risk factors related to age
 - cell-to-cell communication
 - differentiation of malignant cells
 - pain they cause
- If a malignant tumor is advanced, treatment may only be
 - prophylactic
 - palliative
 - radiation
 - surgery
- The most serious adverse effect of radiation is
 - oral mucosa ulceration
 - xerostomia
 - bone marrow depression
 - lethargy
- How long after a malignant tumor is removed by surgery should antineoplastic drugs be started?
 - 2 days
 - 2 weeks
 - 4 weeks
 - 6 weeks
- Prostate cancer may be treated with which of the following hormones?
 - estrogen
 - growth hormone
 - testosterone
 - progesterone

CASE STUDIES

Karen Coupe, PT, DPT, MSEd

Case 1

A 58-year-old woman was admitted to the hospital secondary to shortness of breath and coughing up blood. Chest x-ray, bronchoscopy, mediastinoscopy, and positron emission tomography scan indicate stage IV non-small-cell lung cancer with metastasis to the brain. Patient medical history: Chronic bronchitis, chronic fatigue, 30-lb weight loss, coughing up blood, which she attributed to the bronchitis. Social history: Three pack a day smoker, employed as a desk clerk. Prior level of function: Independent in ambulation short distances (10–20 ft), patient required frequent assistance with other activities of daily living secondary to fatigue. Physical therapist evaluation reveals generalized weakness, shortness of breath, and mod assist of one w/ bed mobility, transfers, and ambulation x 5 ft. Frequent rests secondary to low O₂ saturation rates.

- This patient is in stage IV lung cancer. What does this mean? Is it common to find lung cancer in the early stages?
- Are there any indications in the patient's medical history that she may have had cancer? Did this patient have any contributing factors in her lifestyle?
- What are other general indications, for anyone, to watch for that may indicate cancer?
- Briefly describe the purpose of the diagnostic testing used to confirm the diagnosis in this case.
- Based on lung physiology, what effects will lung cancer have on the physical therapy plan of care? How could the metastasis to the brain affect the plan of care?

Case 2

A 46-year-old man was diagnosed with a brainstem glioma, underwent radiation therapy, and is currently in remission in an inpatient rehabilitation setting. Prior level of function: Independent in all activities of daily living, mechanical engineer. Physical therapist evaluation reveals a nonambulatory patient secondary to severe ataxia, dysphagia, and generalized weakness.

- What is a brainstem glioma? Is a patient in remission considered to be cured?
- List all functions and/or pathways controlled by the brainstem. Based on those functions, what are some other clinical manifestations that could be possible with a brainstem lesion?
- What are the effects of radiation on the glioma? Does the radiation have any effect on the surrounding areas?
- Why would this patient be nonambulatory secondary to severe ataxia? What other activities of daily living would be difficult for a patient with ataxia?
- Many patients with neurologic pathology present with dysphagia. What would be some important precautions during treatment for any patient with dysphagia?

WEBSITES

<http://www.cancer.gov/cancertopics/types/alphalist/a-d>

<http://www.cancer.org/>

<http://www.newsweek.com/2009/07/22/a-death-sentence-reexamined.html>

<http://www.oncolink.org/treatment/>

<http://www.oncologystat.com/index.html>

<http://www.scienceclarified.com/Ti-Vi/Tumor.html>

