1

An Overview of Cancer

1.1 Introduction

Cancer originates at a cellular level and can occur almost anywhere in the body. Cells are the basic building blocks making up the body, with almost 37 trillion cells in an average human. Normal human cells grow and divide in an orderly process to form new cells as the body requires them. When cells grow old or become damaged, they die, and new cells take their place.

Cancer forms when normal cell processes break down. The safeguards that are characteristic of healthy cells fail, resulting in the cells becoming increasingly abnormal or out of control. Old or damaged cells survive when they should die, and new cells form when they are not required. These extra cells may divide without stopping, forming growths called tumors or cancers. The cancer cells continue to grow and make new cells, resulting in issues in the location where they began (Figure 1.1).

Of the almost 200 different diseases categorized as cancer, most form solid masses of tissue called *tumors*. Blood cancers, such as leukemias, normally do not form solid tumors. However, common to both tumor-forming and non-tumor-forming cancers is uncontrolled, abnormal growth.

Not all tumors are cancers. There are two types of tumors: malignant and benign. Malignant tumors are dangerous, as they can spread into, or invade, nearby tissues. When these tumors grow, a few cancer cells can break away and spread to other parts of the body through the blood or lymphatic system, resulting in the development of new tumors distant from the original tumor.

Benign tumors are not as dangerous. They do not spread into, or invade, nearby tissues or organs. Benign tumors can be large or small. When removed, they usually do not come back, whereas malignant tumors do. Nonetheless, if a benign tumor is located in a sensitive place like the brain, it can still cause some problems.

1.2 Cancer Statistics

Cancer is a major public health problem worldwide and the second leading cause of death after heart disease. Cancer has a huge impact on society in the United

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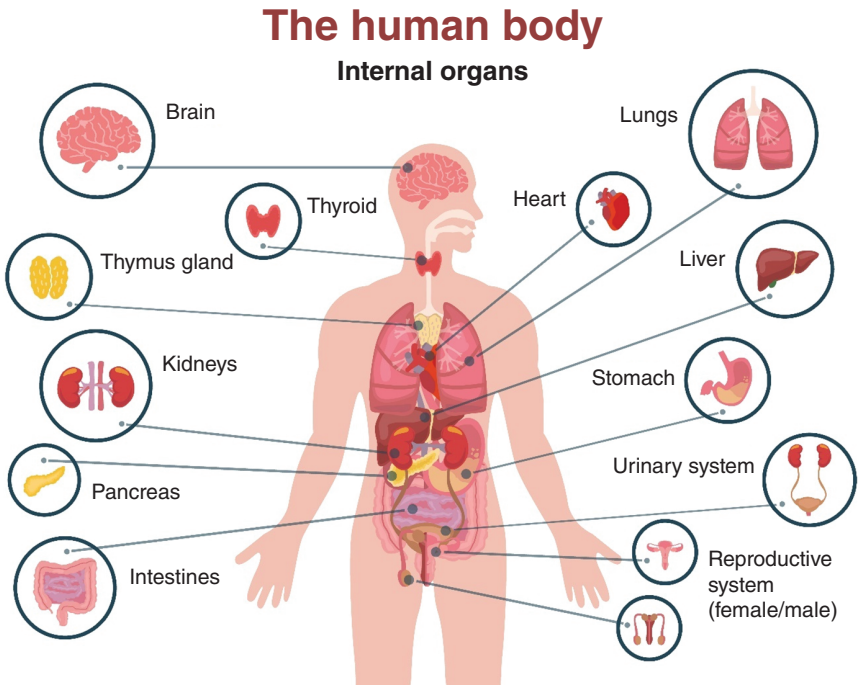

Figure 1.1 The human body contains internal organs and systems, any of which can be the origin of cancer.

States and across the world. Statistical data documents the tremendous numbers of people diagnosed with cancer each year, along with mortality rates. These numbers are further broken down to show the incidence and effects of cancer within various groups defined by age, sex, ethnicity, geographic location, diet, lifestyle, and other factors.

According to the World Health Organization:

- Cancer is the second leading cause of death globally, and is responsible for an estimated 10 million deaths in 2020, and an estimated 19.3 million new cancer cases.
- Globally, about 1 in 6 deaths is due to cancer.
- Approximately, 70% of deaths from cancer occur in low- and middle-income countries.

1.3 Differences Between Normal Cells and Cancer Cells

Cancer cells differ from normal cells (Figure 1.2) in many respects [1–3]:

Appearance: Under a microscope, normal cells and cancer cells look significantly different. Cancer cells often display much more variability in cell size, with some larger than or smaller than normal cells.

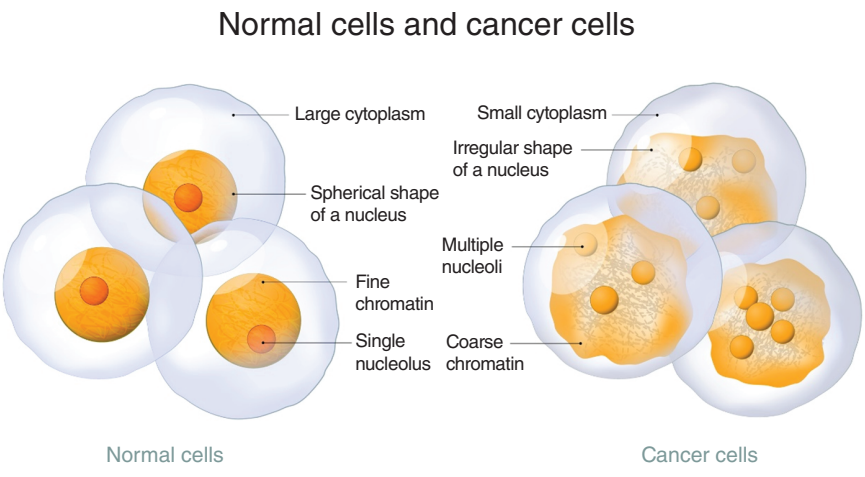

Figure 1.2 Cancer cells are less organized than normal cells and grow in an uncontrolled fashion.

Growth: Normal cells stop reproducing when enough are present. For instance, if cells are required to repair a cut in the skin, new cells are no longer produced when there are enough cells present to fill the gap. Cancer cells, however, do not stop growing and reproducing, and their continuous growth results in the formation of a tumor.

Communication: Cancer cells don't interact with other cells in the same way as normal cells. Normal cells respond to signals sent from other nearby cells to stop growing. Cancer cells do not respond to these signals.

Cell repair and cell death: Regular cells are repaired or die (in a process called *apoptosis*) when they are damaged or get old. Cancer cells either are not repaired or do not undergo apoptosis. The p53 gene regulates cell repair and apoptosis. When this gene is mutated or inactivated, a tumor begins.

Stickiness: Normal cells produce substances that keep them cohesive within a group, as opposed to cancer cells, which do not produce these substances and can therefore spread to other body locations via the bloodstream or lymphatic system.

Ability to metastasize (spread): Normal cells remain in the same area of the body where they serve a particular function, e.g. kidney cells remain in the kidneys. Due to their lack of cohesion, cancer cells are able to move through the bloodstream and lymphatic system to other locations of the body. In these new locations, they have the ability to metastasize, forming tumors distant from the original tumor.

Rate of growth: Normal cells reproduce themselves in a controlled, orderly process, but cease reproducing when enough cells are present. Cancer cells reproduce at abnormal rates, often rapidly and with no stopping mechanism.

Maturation: Normal cells mature with age, whereas cancer cells remain immature and continue to reproduce unchecked before they are fully mature.

Evade the immune system: The human body's immune system is a network of organs, tissues, and specialized cells that keeps the body protected from infections and other harmful conditions. When normal cells become damaged, the immune system identifies and removes them. Cancer cells are able to evade removal by the immune system, resulting in the formation of tumors.

Energy source: In the presence of oxygen, normal cells produce most of their energy supply. Cancer cells have changed, however, and are able to produce energy without oxygen. This capacity to generate energy for growth and survival without oxygen (a condition found inside a tumor) enables cancer cells to thrive where normal cells die.

1.4 Types of Cancer

There are more than 200 types of cancer, with researchers classifying them based on the location of origin [4]. Four major types of cancer are:

1.4.1 Carcinomas

This is the most common type of cancer. A carcinoma starts in the skin or in the tissue that covers the surface of internal organs and glands. Carcinomas normally form solid tumors. Examples include prostate cancer, breast cancer, lung cancer, and colorectal cancer.

1.4.2 Sarcomas

A sarcoma occurs in the tissues that support and connect the body, including fat, muscles, nerves, tendons, joints, blood vessels, lymph vessels, cartilage, or bone.

1.4.3 Leukemias

Leukemia is blood cancer that occurs when healthy blood cells change and develop uncontrollably. The four main types of leukemia include acute lymphocytic leukemia, chronic lymphocytic leukemia, acute myeloid leukemia, and chronic myeloid leukemia.

1.4.4 Lymphomas

Lymphomas start in the lymphatic system. The lymphatic system is a network of vessels and glands that protects the human body from infection. There are two main kinds of lymphomas: Hodgkin lymphoma and non-Hodgkin lymphoma.

1.5 The Role of Genes and Chromosomes

In the nucleus of each cell, there are the thread-like structures that package deoxyribonucleic acid (DNA) called **chromosomes**. Chromosomes are found in all living cells and consist of a single molecule of DNA bound to various proteins (Figure 1.3). They carry the **genes**, which are the basic units determining inherited traits. Genes control cell function, particularly how cells grow and divide, and when they need to stop this growth [5–14].

In the human body, there are 46 chromosomes, arranged in 2 sets of 23. We inherit one set from our mother and one from our father. Chromosomes contain all the information for the physical characteristics that make up an individual. One chromosome in each set determines whether a person is female or male. The other 22 chromosome pairs decide other physical characteristics in the human body. These chromosome pairs are also called autosomes.

Genes regulate protein production. Each protein functions on its own and also carries messages for the cell. Each gene follows specific instructions, encoded in their genetic material, for producing proteins; each protein performs specific functions for the cell (Figure 1.4).

Cancers start when one or more genes mutate. Mutations, however, are a normal occurrence. Their results may be beneficial, harmful, or neutral, depending on the location within the gene where the change has taken place. Most of the time the body corrects the mutations and nothing unusual happens.

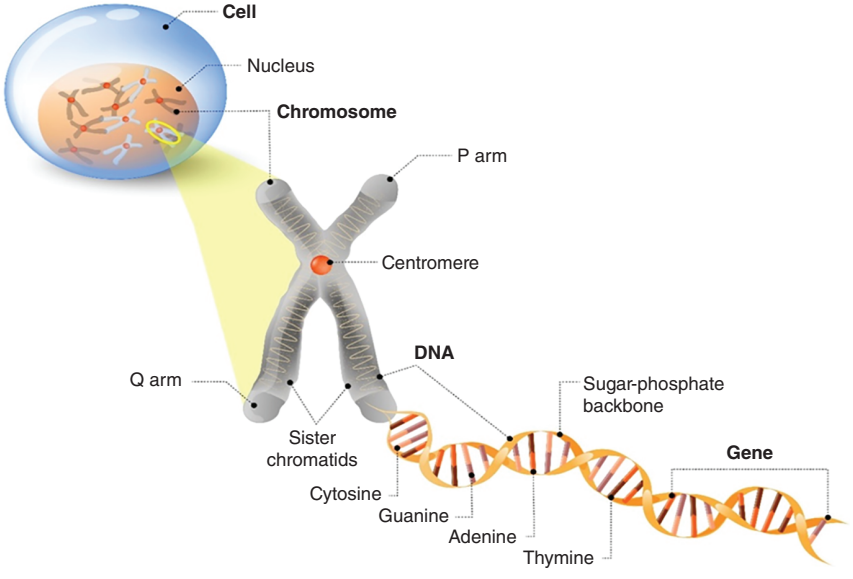

Figure 1.3 Cell structure showing DNA in the nucleus. The DNA molecule is a double helix. A gene is a length of DNA that codes for the manufacture of a specific protein.

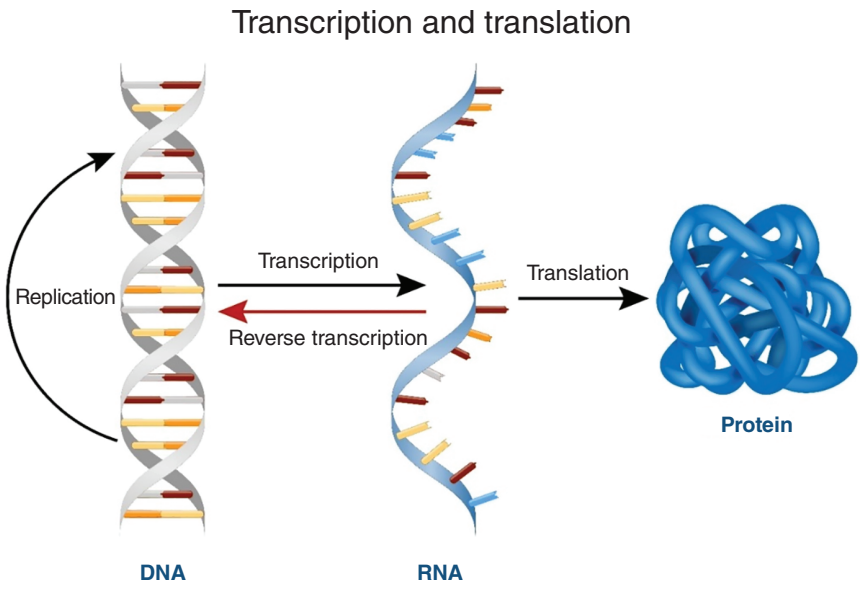

Figure 1.4 Information from DNA is used to make proteins from genes.

A single mutation will generally not produce cancer. Typically, cancer develops from multiple mutations over a lifetime, which is why cancer occurs more frequently in older people. Mutations have had more opportunities to occur the longer a person lives. Mutation of genetic material changes the instructions for protein formation, resulting in the production of an abnormal protein or sometimes prevention of a certain protein being formed. An abnormal protein cannot carry out its specific function correctly, possibly leading to uncontrolled cell multiplication and the start of cancer (Figure 1.5).

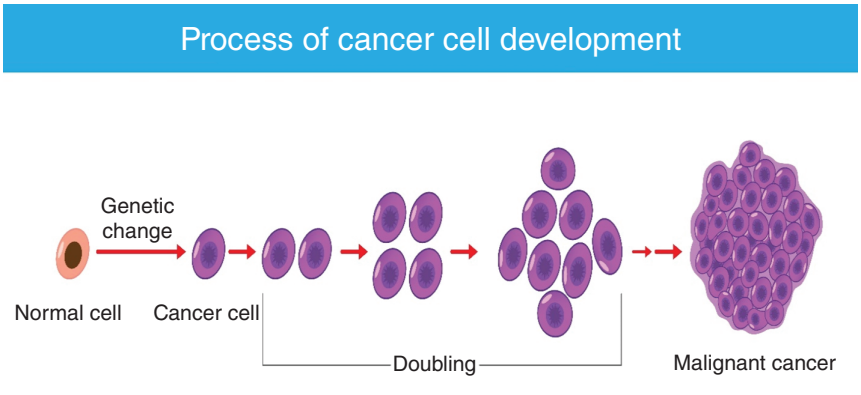

Figure 1.5 Cancer cells start as normal cells, which acquire mutations over time that change them to cancer cells.

1.6 Genetic Mutations

There are two basic types of genetic mutations:

1.6.1 Acquired Mutations

Mutations of this type are the most common cause of cancer, and when this occurs, it is called *sporadic cancer*. These mutations, initially affecting only a few cells in the body, damage the genes in these cells. Since these mutations are acquired, they do not pass from parents to children. Major factors contributing to acquired mutations include:

- Tobacco
- Ultraviolet (UV) radiation
- Viruses
- Age

1.6.2 Germline Mutations

Not as common as acquired mutations, germline mutations take place in reproductive cells, such as those in a female's egg or a male's sperm. Offspring resulting from the union of reproductive cells with germline mutation receive that mutation, which is copied into every cell in the body as it develops. Since these mutations are in the reproductive cells, they are carried from generation to generation and are known as **inherited cancers**. Germline cancers comprise between 5 and 20% of all cancers.

Germline cancers should not be confused, however, with **germ cell tumors**, which start in the cells that give rise to sperm or eggs. These tumors can develop almost anywhere in the body, and they can be either benign or malignant.

1.7 Genes Connected to Cancer

Certain types of genes have been linked to the development of cancer in the human body. Scientists categorize these genes in broad groups:

1.7.1 Tumor Suppressor Genes

The genes have the protective feature of controlling cell growth by:

- Monitoring new cell divisions
- Correcting DNA sequences that have mutated
- Controlling cell death (apoptosis)

Examples include *TP53* (tumor protein 53 or cellular tumor antigen p53, or referred to as *p53*), *PTEN*, *RB1*, and *APC*. When tumor suppressor genes mutate, cell growth is unchecked and may result in tumor formation.

In the case of germline mutations, if certain tumor suppressor genes – namely *BRCA1* or *BRCA2* – mutate, there is a higher chance of developing hereditary breast

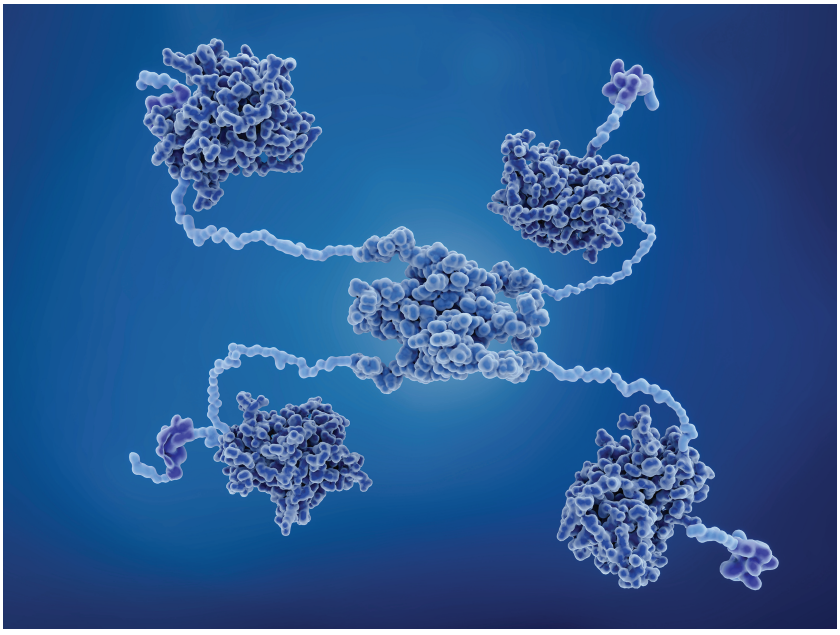

Figure 1.6 Structure of p53 tumor suppressor protein. p53 prevents cancer formation and acts as a guardian of the genome. Mutations in the *p53 gene* contribute to about half of the cases of human cancer. Source: Juan Gärtner/Adobe Stock.

or ovarian cancer for women, and prostate cancer for men. These specific mutations also have been linked to an increased risk of pancreatic cancer and melanoma.

More than half of diagnosed cancers are caused by mutations that damage or disable gene *p53* (Figure 1.6). This is a common acquired mutation. Much more rarely, germline *p53* mutations occur with subsequent greater risk for many types of cancer in family members.

1.7.2 Oncogenes

These genes change healthy cells into cancerous ones with acquired mutations. Examples of common oncogenes include *HER2* (human epidermal growth factor receptor 2) and genes in the *RAS family*. *HER2* is a specialized protein found in certain cancerous cells, including those in the breast and ovaries, where it oversees the growth and spreading of the disease. Another family of genes, referred to as *RAS*, manufactures proteins that interfere with cell communication pathways, as well as cells' growth and death.

1.7.3 DNA Repair Genes

These genes take care of mistakes that occur during the process of DNA replication. Usually, these are tumor suppressor genes. If an error occurs in a DNA repair gene itself, however, its important correction function ceases, and errors in DNA copies

can be mutations that might lead to cancer. Mutations in tumor suppressor genes (including *BRCA1*, *BRCA2*, and *p53*, which are all DNA repair genes) or oncogenes create the greatest likelihood of cancer occurring. *Lynch syndrome* is one of many genetic conditions originating from hereditary DNA repair gene mutations. Mutations of DNA repair genes can also be acquired.

Scientists know a lot about how cancer genes work. Many cancers, however, are not linked to one specific gene, but more likely result from multiple gene mutations. In addition, some studies suggest that genes interact with their environment, further complicating the current understanding of the role genes play in cancer. Each person's cancer has a unique combination of genetic changes, and as cancer develops, additional mutations occur. Even within same cancer, different cells may have different genetic alterations.

Given the earlier complexity, scientists continue to study how genetic changes affect cancer development. This information has led to improvements in cancer treatment, including early detection, risk reduction, the use of targeted therapy, and survival. Further research will provide additional understanding and a better overall outlook on the effects of this disease.

1.8 Tumors and Metastasis

As mentioned earlier, cancer starts when gene mutations interfere with the normal, orderly process of cell division. Cells begin to grow uncontrollably without stopping, sometimes forming a mass of tissue called a tumor. Tumors can be cancerous or benign. As previously mentioned, a cancerous tumor is malignant, meaning it can grow large and extend to other locations of the body. A benign tumor can become larger over a period of time, but will not spread to other parts of the body.

Metastasis is the medical term for cancer that appears in a different organ than where it originated from. When this occurs, scientists say the cancer has metastasized. Other terms referring to metastasis are metastatic cancer and stage 4 cancer. Some types of cancer do not form a tumor, including leukemias, most types of lymphoma, and myeloma.

One of the first places cancer often metastasizes to is the nearest lymph node(s). A *lymph node* is a tiny, bean-shaped organ that functions in the human body's defense against infection. Lymph nodes are located in clusters in different parts of the body, such as the neck, groin area, and under the arms. Due to lymph nodes being part of a system, which circulates about the entire body, called the *lymphatic system*, cancer cells that reach the lymph nodes can be further transported to other body areas.

Metastases to the bones, brain, liver, lymph nodes, and lungs are very common. Some cancers tend to spread to certain parts of the body. For example, unresolved breast cancer spreads to the bones, liver, lungs, chest wall, and brain, whereas lung cancer tends to extend to the brain, bones, liver, and adrenal glands. Prostate cancer mainly spreads to the bones. Colon and rectal cancers have the greatest chance of spreading to the liver and lungs.

1.9 Hereditary Cancer Risk

In 5–10% of cancers, the major factor are gene mutations, which have been inherited and predispose an individual to developing the disease. Individuals with these inherited genetic mutations, or hereditary cancer syndrome, are at a significantly greater risk of developing associated cancer. The following conditions suggest a possible increased risk:

- **Family history of cancer:** Having three or more relatives on the same side of the family with the same or related forms of cancer.
- **Cancer at an early age:** Having two or more relatives diagnosed with cancer at an early age. This factor may differ depending on the type of cancer.
- **Multiple cancers:** Having two or more types of cancer occurring in the same relative.

The possibility of heredity cancer is one reason why health screening questionnaires contain questions about cancer (and other illnesses) affecting extended family members.

Genetic Testing. If a person meets any of the criteria indicating they may have a heightened risk for developing cancer, an option they might wish to consider is genetic testing. Choosing to undergo genetic testing is a personal decision made for various reasons, but best made in collaboration with others, including other family members, one's physician, and a genetic counselor.

Currently, consideration of genetic testing is recommended in the following cases:

- A personal or family history suggests a genetic cause of cancer.
- A test will yield clear results regarding changes in a specific gene or genes.
- The results will help with the diagnosis or management of a condition. This might guide someone at higher risk to counteract it with such steps as surgery, medication, frequent screening, or lifestyle changes.

Genetic counselors are very instrumental both in deciding whether or not to undergo genetic testing, as well as conferring with about the test findings. The counselor can explain the pros and cons of genetic testing, help people cope with the process of completing the testing, and give advice regarding ways to lower cancer risk in the future.

1.10 Cancer Screening and Diagnosis

Screening tests to aid physicians in the detection and diagnosis of cancer fall into one of four general types. Doctors conduct a physical examination to check for signs of any health abnormalities or indicators of disease, such as external lumps or localized pain. A thorough physical exam includes a review of the patient's family history of the disease, health history, and lifestyle factors, all of which may contribute to the development of cancer [15–36].

Laboratory tests, both routine and specialized, consist of an analysis of samples of tissue, blood, urine, or other bodily substances, to check for the presence

of certain chemicals, abnormal cells, etc. A variety of **imaging procedures** are also available to give physicians a look at organs, bones, and other internal body structures. As mentioned earlier, **genetic testing** can provide information about specific gene mutations (changes) associated with certain types of cancer.

Before undergoing any screening tests, it is important to know the risks involved with the tests themselves, as some cancer screening tests pose more risk than the potential benefit. It should be ascertained whether the screening has actually been proven to reduce the chance of dying from cancer. Bleeding or other problems can result from certain types of screening procedures. For example, screening for colon cancer with sigmoidoscopy or colonoscopy can cause tears in the lining of the colon, leading to internal bleeding.

In addition, cancer screening test results may be abnormal even though there is no cancer present, which is called a **false-positive test result**. A false-positive result causes patient anxiety and usually follow-up with more tests and procedures, which may have additional risks. On the other hand, test results sometimes indicate no cancer even though the disease is present. A person who receives a **false-negative test result** may delay seeking medical care even if there are other abnormal symptoms.

Many screening tests have been shown to detect cancer at an early, more treatable stage and thereby reduce the risk of dying from this disease. The following is a list of a few types of cancer frequently encountered in modern societies, along with tests used to screen for them:

1.10.1 Colon Cancer

Colonoscopy, sigmoidoscopy, and *high-sensitivity fecal occult blood tests* (FOBTs) have all been proven to decrease deaths from colorectal cancer. Colonoscopy and sigmoidoscopy also help prevent colorectal cancer because they detect abnormal colonic growths (polyps), which can be removed at that time before they develop into cancer. In addition, there are screenings for colon cancer in low-risk patients using a stool sample, offering an alternative to the risks associated with, and the preparation for, a colonoscopy.

Virtual colonoscopy, also called *CT colonography* or *computed tomography*, is an imaging procedure in which a radiologist uses X-rays and a computer to create images of the rectum and colon from outside the body. Ulcers, polyps, and cancer can be detected using this test.

1.10.2 Lung Cancer

Low-dose *helical computed tomography* has been shown to decrease lung cancer deaths among heavy smokers aged 55–74 years.

1.10.3 Breast/Cervical/Ovarian/Endometrial Cancers

Mammography screening produces an X-ray image of breast tissue and has been shown to significantly reduce mortality from breast cancer among women aged 40–74, especially those aged 50 or older.

In addition to mammography, physicians recommend all adult women obtain regular *clinical breast examinations* and perform *breast self-examinations* at home, checking for unusual lumps or thicknesses in the breast tissue, or any other unusual breast symptoms. These physical exams have also been proven to reduce breast cancer mortality rates.

Regarding the possible presence of cervical cancer, Pap tests (or Pap smears) and human papillomavirus (HPV) testing decrease the risk of cancer by identifying and treating abnormalities in cells before they become cancerous. Overall, these tests have resulted in decreased deaths from cervical cancer. Testing is generally recommended starting at the age of 21 and continued at regular intervals until a female reaches 65 years, at which time they can be curtailed if recent results have been normal.

For females who have been identified as carrying a harmful mutation in the *BRCA1* or *BRCA2* gene, indicating an increased risk for breast and other types of cancer, physicians may recommend magnetic resonance imaging (MRI) of their breasts.

Mutations in *BRCA1* or *BRCA2* genes also predispose females to ovarian or endometrial cancer, and in cases where these mutations are evidenced, a *transvaginal ultrasound* is utilized to obtain an image of females' ovaries and/or uterus. The *CA-125 blood test* is sometimes used alongside a transvaginal ultrasound for early detection of ovarian cancer, particularly in those having an increased risk of developing this disease. CA-125 is a cancer antigen, which can be elevated in the presence of ovarian cancer. Furthermore, evidence of someone having an inherited cancer syndrome called *Lynch syndrome* makes them predisposed to endometrial cancer in particular, along with several other specific cancers.

1.10.4 Prostate Cancer

For early detection of prostate cancer, physicians perform a *digital rectal exam* and a blood test called a *prostate-specific antigen (PSA) test*. PSA is a chemical produced by the prostate gland, and elevated levels of it in the blood may indicate the presence of prostate cancer, although not definitely.

1.10.5 Liver Cancer

In people with increased risk for liver disease, doctors may suggest an ultrasound of the liver and possibly an *alpha-fetoprotein (AFP) blood test*. AFP is a protein produced by the liver, and an elevated level of it in the blood can indicate the presence of liver cancer.

1.10.6 Skin Cancer

People who are at risk for skin cancer, and those who live in climates with sunshine much of the year, are advised to examine their skin regularly or have this done by a health care provider. Prompt reporting of skin changes, such as a new mole

or change in the appearance of a preexisting mole, can lead to early detection of skin cancer.

1.11 Cancer Treatment Options

Currently, there are many kinds of cancer treatments available, depending on the type of cancer and how advanced it is. Some cancer patients only require one type of treatment, whereas others may need more than one – including surgery, chemotherapy, medication, or radiation therapy – provided in a variety of specific combinations and timings [37–82].

1.11.1 Surgery

It is the physical removal of cancer from the body. In some cases, this may be a simple outpatient procedure, requiring an hour or two in a specialist's office. In other cases, it may involve a major operation with a few nights in the hospital and intense therapy treatments afterward.

"Clear margins" is a term well known for its association with cancer surgery. When the cancerous tissue is taken out, it is ideal to have a "clear margin" (clear of cancerous matter) surrounding the affected area targeted during the surgery. Depending on the location of the cancer, specific measurements are used to define "clear" in this regard. Basically, since cancer cells may have been in contact with tissues around them, surgeons take a section of healthy tissue around the cancerous parts in order to be certain all of the cancer has been removed.

Preparation for cancer surgery varies depending on the procedure. The surgeon's office contacts patients well in advance to go over special instructions, not only for what to do beforehand, but also for what to expect on the day of surgery and during recovery afterward. Many large hospitals even provide cancer patients access to local networks offering counseling, housing, and other services for patients and their relatives during treatments.

1.11.2 Radiation Therapy

It is another modality of cancer treatment during which high-intensity radiation is used to kill cancer cells and shrink tumors [48, 49]. Depending on several factors, such as the location of cancer, and the age and health of the patient, radiation can be an effective therapy. It is often used in conjunction with other treatment methods, e.g. reducing the size of a tumor prior to surgery or irradiating diseased bone marrow before a transplant.

Radiation treatments take place in special facilities, with the number and length of each dose taking place in accordance with each individual's treatment plan. Specialists monitor patients' response to treatment and often adjust the plan to best meet an individual's needs.

Side effects of treatment also vary according to the individual, with hair loss, fatigue, nausea, and vomiting being among the most common. Some patients don't experience any of these, have different side effects, or even have none at all.

1.11.3 Chemotherapy

It uses drugs to kill cancer cells. The chemicals used are cytotoxic, i.e. capable of halting the replication or growth of cancer cells, resulting in cell death [47, 53, 56]. Depending on the type of cancer and how the chemotherapy is combined with other treatments, it can come in many forms – pills, liquids, or injectables administered at home or under supervision in a facility. The specific cancer-killing agent used, and the number and length of treatments, varies according to the type of cancer and the special circumstances of each patient, including their response to the therapy. Although chemotherapy drugs are designed to kill cancer cells, which reproduce more rapidly than normal cells, healthy tissues can also, unfortunately, be affected. This gives rise to certain side effects, which also vary by individual. The most common are hair loss, fatigue, nausea, and vomiting. Again, though, not all patients experience these particular effects, and may encounter different ones entirely or even none at all.

1.11.4 Targeted Therapy

It is similar to chemotherapy in that it utilizes drugs to attack and kill cancer cells; however, targeted therapy is designed to work specifically on mutated proteins found only in the cancer cells, thereby reducing the potential damage to other healthy tissues. Targeted therapy is often used in combination with other treatment modalities [53–55, 57, 60, 67]. Although a seemingly ideal method to eliminate cancer, it still requires exposure to powerful chemicals, which can result in side effects such as hair and skin problems and high blood pressure.

1.11.5 Immunotherapy

It is a relatively new treatment option compared to surgery, radiation, and chemotherapy. Over the past few decades, scientists have discovered new ways to boost the human body's immune response to cancer. Currently, immunotherapy consists of either stimulating the immune system to more effectively overcome cancer or supplementing the immune system with special synthetic proteins or other tools that work against cancer cells [47, 52, 53, 62, 63]. An example of immunotherapy is the development of the HPV vaccine, which is now recommended by the US Centers for Disease Control and Prevention (CDC).

1.11.6 Hormone Therapy

It is a consideration for some cancers, such as breast or prostate cancer, that are sensitive to hormones. Drugs are available, which block the body's normal signals to

produce certain hormones, preventing hormone-dependent cancers from continued growth. Although this sounds simple, any drugs that change the natural processes of the body include risk of side effects. Hormone therapy is frequently used with other treatments, and specialists work with each patient to determine when and how to administer it, the amount and duration of doses, and to gauge individual responses to treatment [65, 66].

1.11.7 Stem Cell Transplant

It is a method used to restore the body's ability to produce new blood cells after a patient has undergone other forms of aggressive cancer treatment [5]. For certain types of cancer, very high doses of chemotherapy or radiation are required to destroy the cancer cells, but cells that produce blood are also destroyed in the process. In this case, stem cells are administered along with a blood transfusion. Stem cells are collected either from the patient before cancer treatment or from a donor. After stem cell treatment, it takes two to four weeks for an individual's body to recover and begin producing blood cells again. As with other treatments, there are risks involved, including the possibility that the stem cells will not settle in the bone marrow and begin producing blood cells as intended. When that occurs, it is deemed a failed treatment, and the process may be repeated.

1.11.8 Precision Medicine

It differs from other forms of cancer treatment in that it is focused on genetic changes particular to each individual's cancer to determine the most effective treatment options for countering it. Although precision medicine may involve various forms of traditional cancer treatment, it considers the genetic particularities of each individual's cancer to offer a more specialized treatment plan [68–74].

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