

This PIP Digest provides key concepts about cancer, explains how it develops and spreads, and describes the major types of cancer.

UNDERSTANDING CANCER: What is Cancer and Types of Cancer

Key Concepts

- Cancer initiation
- Cancer progression
- Cancer types

Related PIP Digests

- Understanding Cancer: Tumour Grading and Cancer Staging
- Understanding Cancer: Hallmarks of Cancer

What is Cancer?¹

Cancer is a collection of related diseases where some cells divide without stopping and spread into surrounding tissues. Cancer can start almost anywhere in the body.

Normally, our cells grow and divide to form new cells as our body needs them. When cells grow old or become damaged, they die, and new cells take their place. When cancer develops, however, this orderly process breaks down. Cells become more and more abnormal. Old or damaged cells survive when they should die, and new cells form when they are not

needed. These extra cells can form growths called tumours.

Cancerous tumours are malignant, which means they can invade nearby tissues. In addition, as these tumours grow, some cancer cells can break off and travel to distant places in the body through the blood or the lymph system and form new tumours far from the original.

Solid tumours are masses of tissue named for the type of cells they formed from. Liquid tumours, such as leukemias, are cancers of the blood and bone marrow.

Unlike malignant tumours, benign tumours do not spread into nearby tissues and often don't grow back when they are removed. Benign tumours can sometimes be quite large and, in the case of benign brain tumours, can be life threatening.

Differences between Cancer Cells and Normal Cells

Cancer cells differ from normal cells in many ways that allow them to grow out of control and become invasive:

- Unlike normal cells that mature into very distinct types with specific functions, cancer cells are less specialized, which helps them divide without stopping.
- Cancer cells ignore signals that would otherwise stop them dividing or that begin the process known as "programmed cell death," or "apoptosis."
- Cancer cells influence surrounding normal cells, molecules, and blood vessels — an area known as the microenvironment. For instance, cancer cells can induce nearby normal cells to form blood vessels that supply tumours with oxygen and nutrients and remove waste products.
- Cancer cells often evade or hide from the immune system that would normally remove them. They

¹Adapted from: <https://www.cancer.gov/about-cancer/understanding/what-is-cancer>

can even co-opt the immune system to help them grow and stay alive.

How Cancer Arises

Cancer is a genetic disease—that is, it is caused by changes to genes that control the way our cells function, especially how they grow and divide.

Cancer:

- can be inherited
- can arise as a result of errors that occur as cells divide
- can be caused when DNA is damaged by exposure to environmental factors including chemicals in tobacco smoke and ultraviolet radiation from the sun.
- can be caused by epigenetic alterations, which affect the behaviour of genes without affecting the genetic structure itself. Epigenetic "marks" switch genes on or off in response to diet, stress, prenatal nutrition and a wide range of other environmental influences. Some epigenetic changes can be passed from one generation to the next.

Each person's cancer involves a unique combination of genetic changes. As a cancer continues to grow, additional changes occur. A single tumour may contain many different genetic variations. In general, cancer cells exhibit more genetic changes than normal cells. Some changes may be the result of the cancer rather than its cause.

"Drivers" of Cancer

The genetic origins of cancer tend to arise in two main types of genes—oncogenes and tumour suppressor genes. These mutations are sometimes called "drivers" of cancer.

Altered oncogenes stop regulating cell division, allowing cells to grow and survive when they should not. Tumour suppressor genes, which would normally stop cancer, are altered and enable cells to divide uncontrollably.

When Cancer Spreads

In metastasis, cancer cells break away from where they first formed (primary cancer), travel through the blood or lymph system, and form new tumours (metastatic tumours) in other parts of the body. Under a microscope, metastatic cancer cells generally share molecular features with the original cancer, including specific chromosome changes. For this reason, the original and metastatic tumours are considered the same type of cancer. For instance, breast cancer that metastasizes in the lung is metastatic breast cancer, not lung cancer.

Metastatic tumours can severely damage how the body functions. Most people who die of cancer die of metastatic disease. Most treatments for metastatic cancers are designed to relieve symptoms and control the size of tumours and their further spread. But reducing cancer deaths requires curing metastatic disease outright.

Tissue Changes that Are Not Cancer

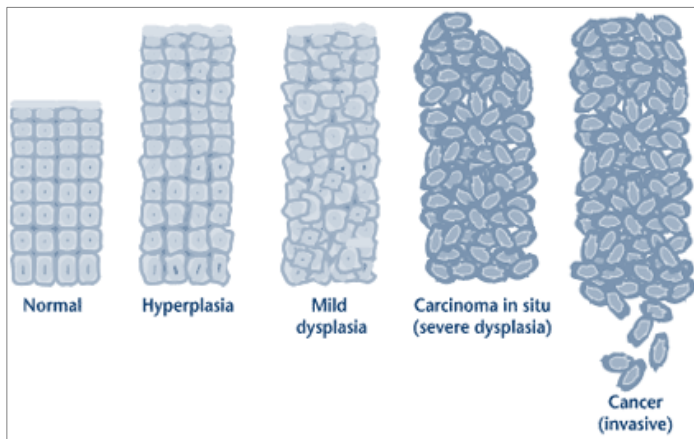
Not every change in the body's tissues is cancer, though many may develop into cancer if they are not treated. The diagram on the next page shows the progression of cellular changes that may lead to cancer.

Hyperplasia occurs when cells within a tissue divide faster than normal and build up or proliferate. The cells and the way the tissue is organized look normal under a microscope. Hyperplasia can be caused by chronic irritation or several other factors.

Dysplasia is more serious than hyperplasia. Dysplasia also involves a buildup of extra cells, but the cells look abnormal and there are changes in how the tissue is organized. In general, the more abnormal the cells and tissue look, the greater the chance that cancer will form.

Some types of dysplasia may need to be monitored or treated. For example, an abnormal skin mole called a dysplastic may turn into melanoma.

An even more serious condition is **carcinoma in situ**. Carcinoma in situ is not invasive cancer because the abnormal cells do not spread beyond the original tissue. But, because some carcinomas in situ become invasive, they are usually treated.



Cancer Progression

Source:

https://upload.wikimedia.org/wikipedia/commons/f/f6/Cancer_progression_from_NIH.png

Types of Cancer²

There are more than 100 types of cancer. Cancers are usually named for the organs or tissues where they form. For example, lung cancer starts in lung cells, and brain cancer in brain cells. Cancers also may be described by the type of cell that formed them, such as an epithelial cell or a squamous cell.

Carcinomas are the most common type of cancer. They are formed by epithelial cells, which are the cells that cover the inside and outside surfaces of the body. There are many types of epithelial cells, which often have a column-like shape when viewed under a microscope. Carcinomas that begin in different epithelial cell types have specific names:

- Adenocarcinoma forms in epithelial cells that produce fluids or mucus. Tissues with this type of epithelial cell are sometimes called glandular tissues. Most cancers of the breast, colon, and prostate are adenocarcinomas.
- Basal cell carcinoma begins in the lower or basal (base) layer of the epidermis, or outer layer of skin.
- Squamous cell carcinoma forms in squamous cells, which grow just beneath the outer surface of the skin. They also line many other organs, including the stomach, intestines, lungs, bladder, and kidneys. Under a microscope, Squamous cells look flat, like fish scales. Squamous cell carcinomas are sometimes called epidermoid carcinomas.
- Transitional cell carcinoma forms in a type of epithelial tissue called transitional epithelium, or urothelium. This tissue, made up of many layers of epithelial cells, lines the bladder, ureters, a part of the kidneys called the renal pelvis, and other organs. Some cancers of the bladder, ureters, and kidneys are transitional cell carcinomas.

²Adapted from: <https://www.cancer.gov/about-cancer/understanding/what-is-cancer>

Sarcomas are cancers that form in bone and soft tissues, including muscle, fat, blood vessels, lymph vessels, and fibrous tissue (such as tendons and ligaments). Osteosarcoma is the most common bone cancer. Common soft-tissue sarcomas include leiomyosarcoma, Kaposi sarcoma, malignant fibrous histiocytoma, liposarcoma, and dermatofibrosarcoma protuberans.

Leukemias are cancers that begin in the blood-forming tissue of the bone marrow (also called liquid tumours). Large numbers of abnormal white blood cells (leukemia cells and leukemic blast cells) build up in the blood and bone marrow, crowding out normal blood cells, and making it harder for the body to deliver oxygen, control bleeding, and fight infections.

The four common categories of leukemia are based on how quickly they progress (acute or chronic) and the type of blood cell they start in (lymphoblastic or myeloid).

Lymphoma begins in lymphocytes (T cells or B cells). These disease-fighting white blood cells are part of the immune system. With lymphoma, abnormal lymphocytes build up in lymph nodes and vessels, as well as in other organs. There are two main types of lymphoma:

- **Hodgkin lymphoma:** People with this disease have abnormal lymphocytes called Reed-Sternberg cells. These cells usually form from B cells.
- **Non-Hodgkin lymphoma:** This large group of cancers can grow quickly or slowly and can form from B or T cells.

Multiple myeloma is a cancer that begins in plasma cells, which are another type of immune cell. Abnormal plasma cells called myeloma cells build up in the bone marrow and form tumours in bones all through the body. Multiple myeloma is also called plasma-cell myeloma or Kahler disease.

Melanoma begins in cells that become melanocytes, which make melanin (the pigment that gives skin its color). Most melanomas form on the skin, but they can also form in other pigmented tissues, such as the eye (intraocular melanoma).

Brain and spinal cord tumours have different types. These tumours are named for the type of cell in which they form and for the place where the tumour first forms. For example, an astrocytic tumour begins in star-shaped brain cells called astrocytes, which help keep nerve cells healthy. Brain tumours can be benign (not cancerous) or malignant (cancerous). But because of the confined space of the skull, even benign brain tumours can be life-threatening.

Germ-cell tumours are a type of tumour that begins in the cells that give rise to sperm or eggs. These tumours can occur almost anywhere in the body and can be either benign or malignant.

Neuroendocrine tumours form from cells that release hormones into the blood in response to a signal from the nervous system. These tumours, which may make higher-than-normal amounts of hormones, can cause many different symptoms. Neuroendocrine tumours may be benign or malignant.

Carcinoid tumours are a type of neuroendocrine tumour. They are slow-growing tumours in the gastrointestinal system (most often in the rectum and small intestine). Carcinoid tumours may spread to the liver or other sites in the body, and may secrete substances such as serotonin or prostaglandins, causing carcinoid syndrome.

Moving Away from Anatomically-based Cancer Classifications

On May 9, 2016, the World Health Organization (WHO) published an official reclassification of Tumour Types of the Central Nervous System, which integrates molecular information with histology so that cancers can be more accurately diagnosed and treated.

Since the advent of new technology and capabilities for genomic sequencing, molecular studies on brain tumours have revealed the vast diversity of genetic and epigenetic alterations that exist between brain tumours. This biological heterogeneity often means tumours that may, at first blush, appear to be the same, may actually require a different approach to treatment – as well as the converse (i.e., tumours that may look different under the microscope may have common molecular alterations). Further studies have also shown that molecular signatures in tumour cells can define different groups of brain tumour types with distinctive characteristics, and that analyzing a tumour for mutations or deletions in certain genes or regions of chromosomes, can provide a deeper level of understanding of each tumour's make-up.

Thus, it was critical that molecular data be integrated into traditional histopathology approaches to reclassify brain tumour types more effectively. This moves the brain tumour field further into the era of precision medicine.

Abstracted from: <http://braintumor.org/brain-tumor-information/understanding-brain-tumors/tumor-types/#acoustic-neuroma>



View these videos to better understand cancer biology. They are ordered in sequence and, combined, take less than 15 minutes view.

- Canadian Cancer Society. *Cancer Basics – What is Cancer*. (YouTube) February 28, 2017 [1:53 minutes]
<https://www.youtube.com/watch?v=HANmCZeb4Z8>
- Healthguru, Suzanne Phillips, MD, Mount Sinai Hospital, New York, NY. *Understanding Cancer (Cancer #1)*. (YouTube) September 20, 2009 [4:01 minutes]
<https://www.youtube.com/watch?v=Q9cuEYSt0GE>
- PatientEdChannel, Anthony Komaroff, MD, Harvard Medical School. *How Cancer Starts*. (YouTube) February 27, 2013 [2:36 minutes]
<https://www.youtube.com/watch?v=3wHYOEeAsD8>
- PatientEdChannel, Anthony Komaroff, MD, Harvard Medical School. *How Cancer Spreads*. (YouTube) February 27, 2013 [2:29 minutes]
https://www.youtube.com/watch?v=_TxZttxpYKM
- Cold Spring Harbor Laboratory. *Disease & Mutation: Tumour Growth – 3D Animation Library*. (DNA Learning Centre) [0:50 minutes]
<https://dnlc.cshl.edu/resources/3d/31-tumor-growth.html>
- Cold Spring Harbor Laboratory. *Disease & Mutation: DNA Damage - 3D Animation Library*. (DNA Learning Centre) [1:05 minutes]
<https://www.dnalc.org/resources/3d/18-dna-damage.html>