

# CELL BIOLOGY

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4<sup>th</sup> stage

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## Lecture 12: Cancer Cell

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**Cancer** is a term used to describe a large group of diseases that are characterized by a cellular malfunction.

Healthy cells are programmed to know what to do and when to do it while cancerous cells do not have this programming and therefore grow and replicate out of control. They also serve no physiological function.

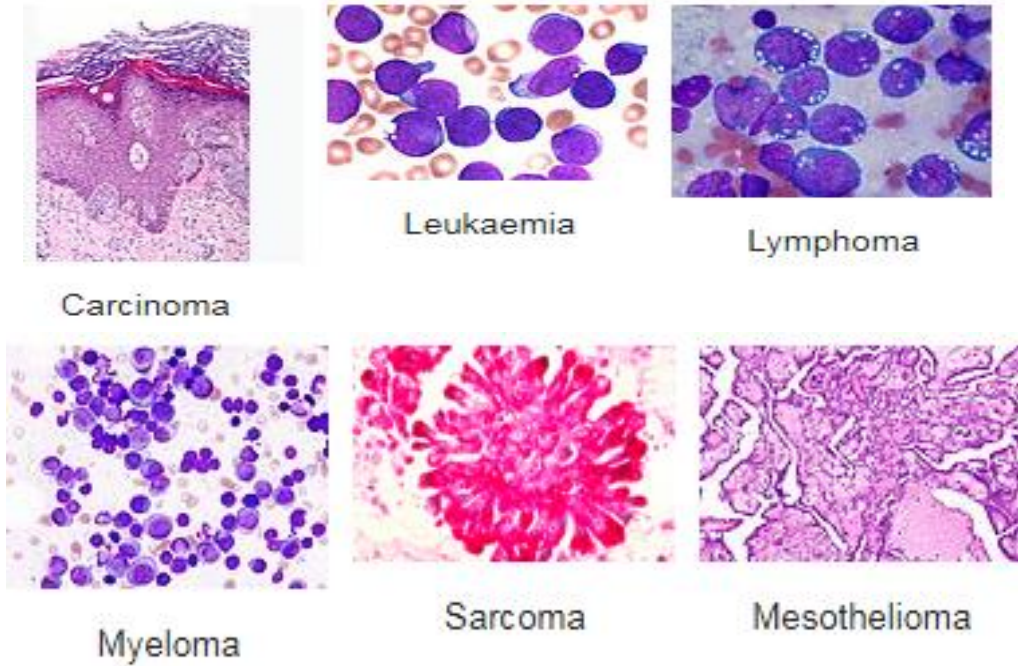
**Cancer** is the uncontrolled growth of abnormal cells anywhere in the body.

### CANCER

- An **uncontrolled division** of abnormal cells in a part of the body is called cancer.
- When good cells go bad.
- Loss of **Cell-cycle Control**.
- Before a cell divides, the DNA is checked to make sure it has replicated correctly. (If DNA does not copy itself correctly, a **gene mutation** occurs.)

There are different categories of cancer cell, defined according to the cell type from which they originate

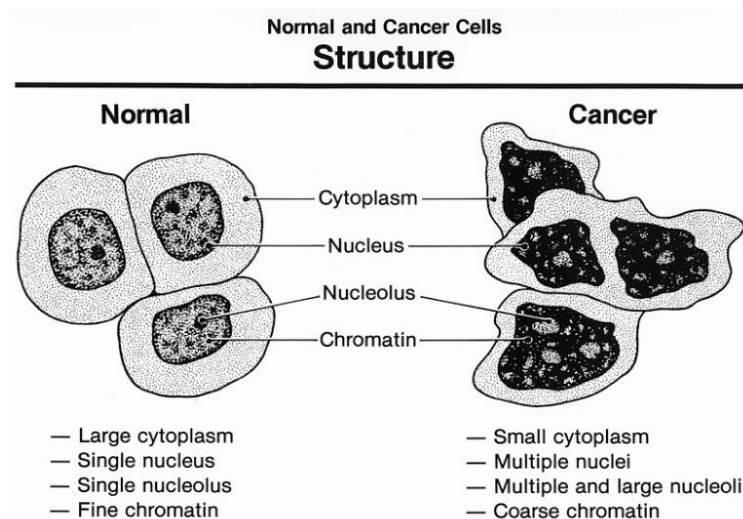
- **Carcinoma**, the majority of cancer cells are **epithelial** in origin, beginning in the membranous tissues that line the surfaces of the body.
- **Leukaemia**, originate in the tissues responsible for producing new **blood cells**, most commonly in the **bone marrow**.
- **Lymphoma** and **myeloma**, derived from cells of the **immune system**.
- **Sarcoma**, originating in **connective tissue**, including fat, muscle and bone.
- **Central nervous system**, derived from cells of the brain and spinal cord.
- **Mesothelioma**, originating in the **mesothelium**; the lining of body cavities.



Cancer cells have distinguishing [histological](#) features visible under the microscope. The [nucleus](#) is often large and irregular, and the [cytoplasm](#) may also display abnormalities.

**Nucleus:** The shape, size, protein composition, and texture of the nucleus are often altered in malignant cells. The nucleus may acquire grooves, folds, [chromatin](#) may aggregate or disperse, and the [nucleolus](#) can become enlarged.

In normal cells, the nucleus is often round in shape, but in cancer cells the outline is often irregular. Different combinations of abnormalities are characteristic of different cancer types, to the extent that nuclear appearance can be used as a marker in cancer diagnostics and [staging](#)



- Cancer cells are created when the genes responsible for regulating [cell division](#) are damaged.
- Carcinogenesis is caused by mutation of the genetic material of normal cells, which upsets the normal balance between proliferation and cell death. This results in uncontrolled cell division in the body.
- The uncontrolled and often rapid proliferation of cells can lead to benign or malignant tumours (cancer)
- More than one mutation is necessary for carcinogenesis. In fact, a series of several mutations to certain classes of genes is usually required before a normal cell will transform into a cancer cell.

Damage to [DNA](#) can be caused by exposure to radiation, chemicals, and other environmental sources, but mutations also accumulate naturally over time through uncorrected errors in [DNA transcription](#), making age another risk factor. [Oncoviruses](#) can cause certain types of cancer, and genetics are also known to play a role.

## **Telomerase**

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Cancer cells have unique features that make them "immortal" according to some researchers. The enzyme [telomerase](#) is used to extend the cancer cell's life span. While the telomeres of most cells shorten after each division, eventually causing the cell to die, telomerase extends the cell's telomeres. This is a major reason that cancer cells can accumulate over time, creating tumors.

There are many important [differences between cancer cells and normal cells](#). Some of these include:

- **Growth:** Normal cells grow as a part of growth and development such as during childhood, or to repair injured tissue. Cancer cells continue to grow (reproduce) even when further cells are not needed. Cancer cells also fail to listen to signals that tell them to stop growing or commit cell suicide (apoptosis) when the cells become old or damaged.
- **Ability to invade nearby tissues:** Normal cells respond to signals from other cells which tell them they have reached a boundary. Cancer cells do not respond to these signals and extend into nearby tissues often with finger-like projections. This is one reason why it is difficult at times to surgically remove a cancerous tumor. The

word cancer, in fact, is derived from the Greek word *carcinus* for crab, referring to these claw-like extensions into neighboring tissues.

- **Ability to spread (metastasize) to other regions of the body:** Normal cells make substances called adhesion molecules that cause them to stick to nearby cells. Cancer cells, lacking the stickiness caused by these adhesion molecules, can break free and float to other regions of the body. They may travel to nearby tissue, or through the bloodstream and [lymphatic system](#) to areas of the body far from the original cancer cell—for example, a lung cancer cell may travel ([metastasize](#)) to the lymph nodes, brain, liver, or the bones.
- **Immortality:** Normal cells, like humans, have a lifespan. When they reach a certain age, they die. Cancer cells, in contrast, have developed a way to “defy” death. On the end of our chromosomes is a structure known as a [telomere](#). Every time a cell divides, its telomeres become shorter. When the telomeres become short enough, the cells die. Cancer cells have figured out a way to restore their telomeres so that they don’t continue to shorten as the cell divides, thus, in a way, making them immortal.

### **Cancer Cell**

May keep growing

May invade nearby tissues

May spread to other regions of the body

Can be immortal

### **Normal Cell**

Grows when needed

Stays within tissue boundaries

Sticks to nearby cells

Has defined lifespan

## TUMOR

- Tumor is an abnormal mass of tissue resulting from uncontrolled division (cancer).
- Tumor is of two types;
  - (1) Malignant tumor (cancerous)
  - (2) Benign tumor (non-cancerous)

## (1) Malignant Tumor

- Invade or spread to other parts of the body.
- High rate of division.
- Spread by forming **Metastasis**.
- Cells travel through circulation.
- Very difficult to treat.

## (2) Benign Tumor

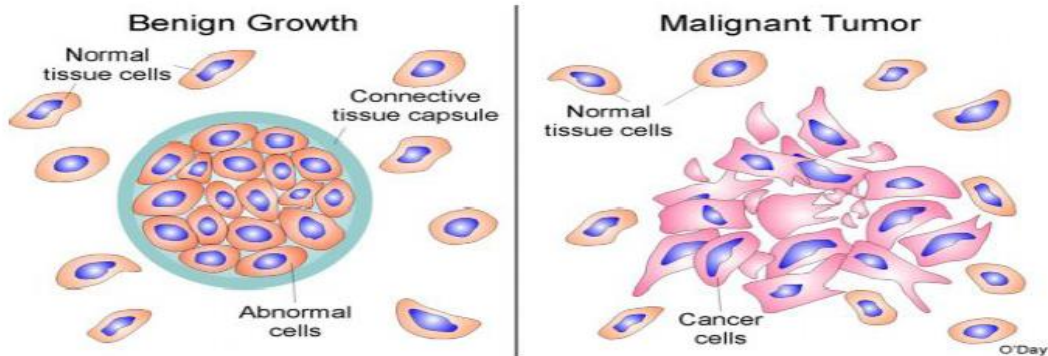
- Do not spread to other part of the body.
- Generally localized and of small size
- Slow rate of division.
- Cells that closely resemble, and may function, like normal cells.
- Do not break out of originating organ.
- Easily to removed by surgery.

### Benign Growths

1. Encapsulated
2. Non-invasive
3. Limited growth
4. Doesn't metastasize
5. Rarely lethal

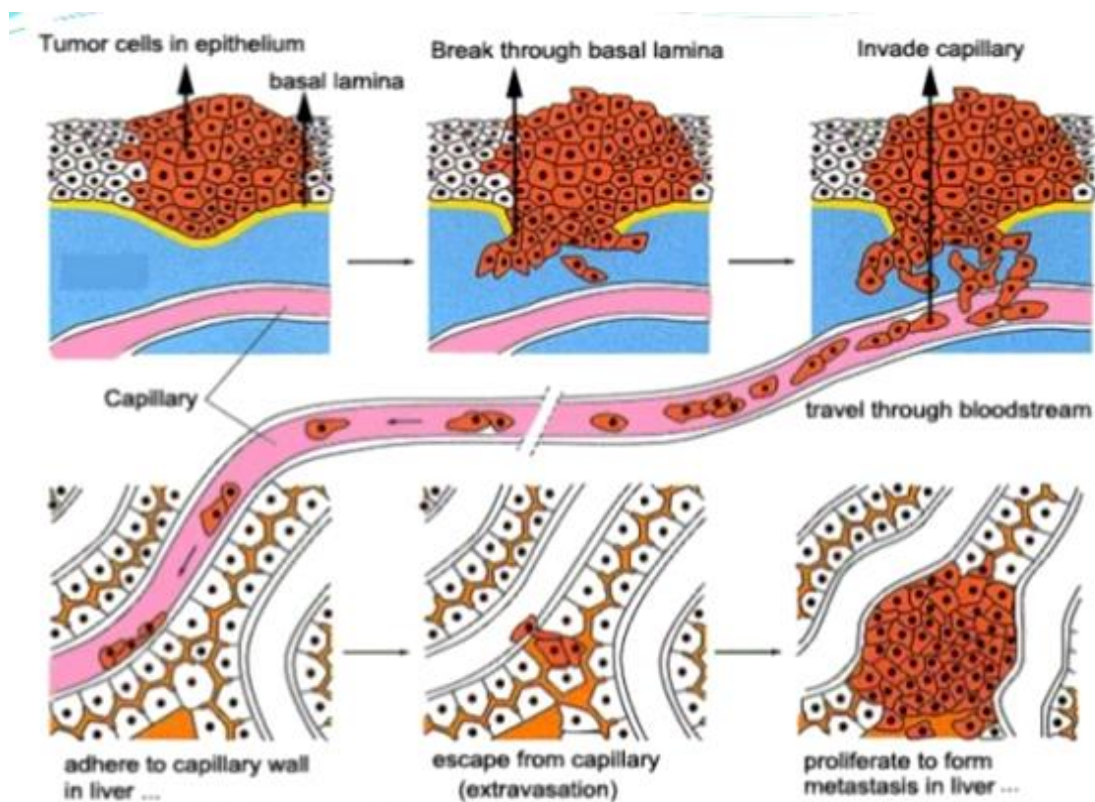
### Malignant Tumors

1. Not-encapsulated
2. Invasive
3. Uncontrolled growth
4. May metastasize
5. Often lethal



# Cancer Metastasis

- Metastasis is the spread of cancer to other location in the body.
- The new tumors are called metastatic tumors, while the original site is called primary tumor.
- Basal lamina of epithelium normally provides barrier.
- Malignant tumor cells break, free of attachments to adjoining cells.
- Attach to basal lamina.
- Secrete enzymes that digest extracellular proteins.
- Migrate into circulatory system.



Schematic diagram of cancer cells hematogenous metastasis

# Oncogenes

- ▶ Genes which can cause cancer are known as **oncogenes**.
- ▶ Oncogenes are present in normal cells also and in normal cells they are known as **proto-oncogenes**
- ▶ We have more than 100 proto-oncogenes on various chromosomes

## Anti-oncogenes / onco-suppressor gene

- ▶ The genes which prevent cancer are known as **anti-oncogenes** or **onco-suppressor** genes
- ▶ The products of these genes act as breaks and regulate cell proliferation
- ▶ When these genes are deleted / mutated then it leads cancer

## Etiology of cancer

### (1) Environmental Factors

- Environmental factors include;
  - (1) Tobacco (25-30%)
  - (2) Diet and obesity (30-35%)
  - (3) Infections (15-20%)
  - (4) Radiation (both ionizing & non-ionizing, upto 10%)
  - (5) Stress and
  - (6) Environmental pollutants

### (2) Inherited Genetics

- Cancer is fundamentally a disease of tissue growth regulation failure.
- In order for a normal cell to transform into a cancer cell, the genes that regulate cell growth and differentiation must be altered.