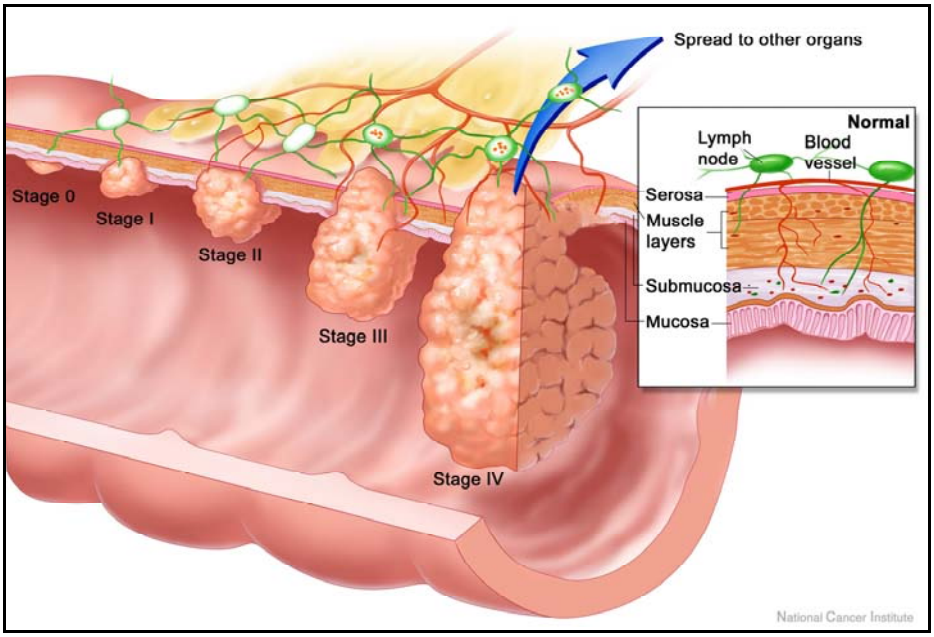
What is Cancer?



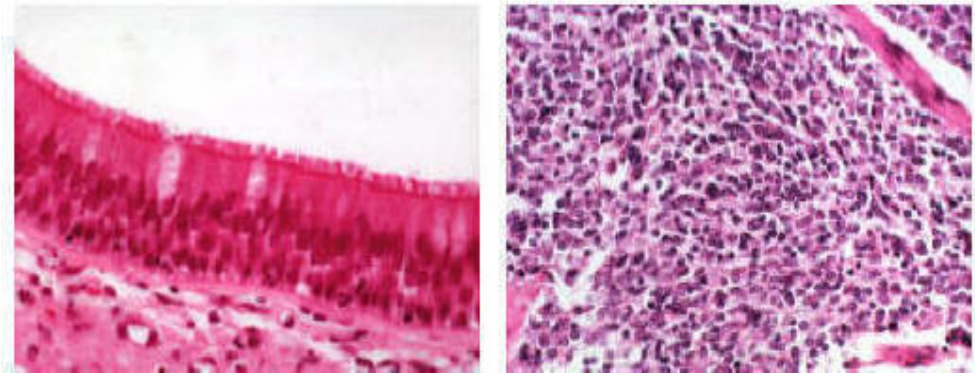
Stages in Colon Cancer Illustration NCI

Cancer is a disease characterized by abnormal cell proliferation and invasiveness. The combination of proliferation and invasiveness in an abnormal context defines the disease of cancer.

The human body is composed of about 50 trillion cells organized into a highly complex machine. During human development one single cell divides to become two. These cells divide to become four. The process continues until there are trillions and trillions of cells. Along the way cells become specialized. Heart cells, white blood cells, neurons, and thousands of other cell types arise. The different types of cells are spatially organized into tissues and organs like the brain and heart. Each cell has its function and proper place within the body. The whole process is like an incredibly orchestrated symphony.

In the human body cells are continuously dying and being replaced by new cells. The process is very tightly regulated. One cell dies and one cell arises to takes its place. The organization and architecture of the body is normally tightly controlled and highly ordered. In cancer this order and control breaks down. The rate of new cell formation exceeds the rate of cell death. The result is the formation of a tumor or abnormal mass of cells and loss of the normal tissue organization.

The Loss of Normal Tissue Organization



Normal Airway Lung Cancer

There are two basic kinds of tumors benign and malignant.

Benign tumors

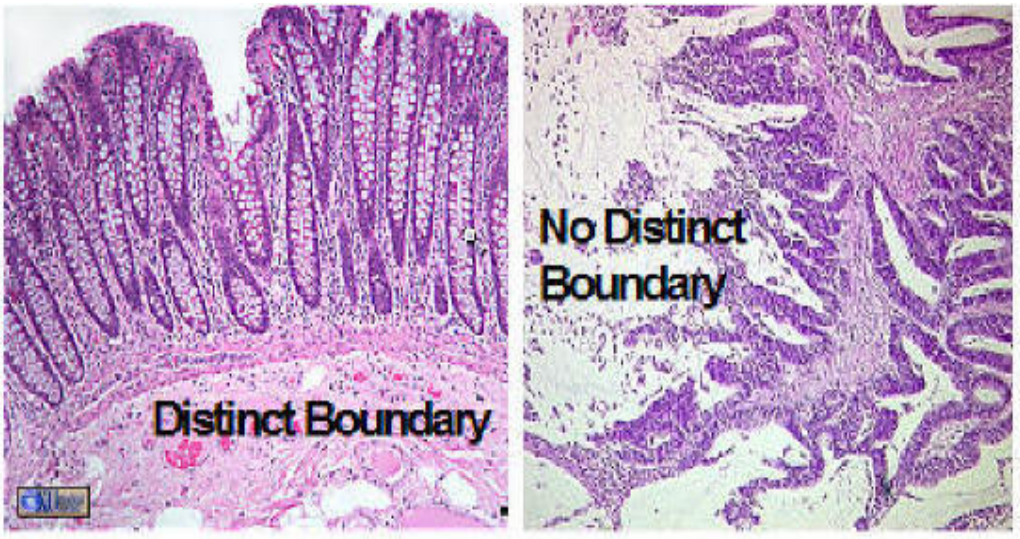
Benign tumors compress, but do not invade surrounding tissues. Typically, benign tumors are encapsulated or surrounded by a dense fibrous layer of connective tissue. The fibrous capsule that surrounds benign tumors is like a tough, fine-meshed screen that sharply separates the benign tumor cells from the surrounding normal tissue. Large benign tumors are accompanied by the formation of new blood vessels that supply oxygen and nutrients.

Benign tumors can become very large. One weighed 65 pounds at surgical removal. Cancers this large are incompatible with life. But benign tumors are a totally different story. Surgical removal is curative for benign tumors.

Malignant tumors

The key factor that distinguishes benign tumors from malignant cancers is invasiveness. Cancer cells invade or penetrate into surrounding tissues. Benign tumor cells are confined by a fibrous capsule. By contrast, malignant cancers cells destroy connective tissue barriers and can infiltrate like roots deep into the surrounding tissues. In addition malignant cells can spread by blood and lymphatic channels and establish colonies at distant sites in the body. When this occurs the cancer is said to be metastatic.

Invasiveness in Cancer



School of Medicine of the University of Kansas Institut für Pathologie Basel

Normal colon Invasive colon cancer

Malignant behavior

Cancer is defined by the combination of cell proliferation and invasiveness *in an abnormal setting*. The combination of proliferation and invasiveness does occur in other isolated processes that have nothing to do with cancer. Examples include wound healing and attachment of the placenta to the uterine wall during pregnancy. That's the reason for the qualification, *in an abnormal setting*.

Only cells that engage in malignant behavior can sustain the disease of cancer

If tumor cells do not proliferate and do not invade then by definition the cells are not malignant. Many tumor cells in a patient with cancer are dead end cells, destined to die before replication, or are senescent and lack the capacity to replicate. Only cells that engage in malignant behavior can sustain the disease of cancer.

Dead end cells can cause clinical problems by bulk effects, like pressing on a nerve. Dead end cells can produce growth factors, or stimulate new blood vessel formation, and thereby enhance the survival of malignant cells. Dead end cells on rare occasions can trigger autoimmune reactions or produce hormones that trigger rare complications. However, only cells that engage in malignant behavior can sustain cancer. Eliminating all tumor cells that engage in malignant behavior will cure cancer.

Other properties of cancer

Other properties generally considered among the hallmarks of cancer and described in a classic paper by Dr. Douglas Hanahan and Dr. Robert A. Weinberg include:

- Immortality (limitless cancer cell replicative potential)
- Evasion of programmed cell death (apoptosis)
- Sustained formation of new blood vessels (angiogenesis)
- Self-sufficiency of growth signals
- Insensitivity to anti-growth signals

It is true that some, and perhaps even *most* malignant tumors and cancer cells display these additional properties, but exceptions abound. For our purposes, *most* is not good enough. We need a theory or conceptual model of cancer that applies to all cancer cells.

All cancers proliferate. But focus on abnormal cell proliferation doesn't capture the essence of the problem. A microscopic cluster of breast cancer cells that weighs one millionth of a gram can ultimately prove fatal, while a 65-pound benign tumor weighing 100 billion times more can be readily cured by surgery. Both are characterized by abnormal cell proliferation.

The combination of abnormal proliferation and invasiveness defines the disease of cancer.

The driving force of cancer is tumor cell evolution.