

Overview of Cancer

Cancer is a disease in which cells escape the programs that normally regulate cellular growth and division. Abnormal cell growth can lead to new growth of tissue, termed neoplasia, which results in tumor formation. Tumors can be either benign (noncancerous) or malignant (cancerous).

Any cell type in the body is capable of becoming cancerous and all cancer cells share a number of basic characteristics. Cancer cells display abnormalities in their appearance, function, and growth. While the cell nucleus is increased in size, the cell cytoplasm is reduced. Cancer cells exhibit altered metabolism, as evidenced by their increased production of material required for cell division. Cellular growth and division is unregulated and there is a high rate of genetic mutation. In addition, cancer cells have a disorderly growth pattern and are able to invade surrounding tissues and tissues at distant sites.

Normal cell growth

The process of normal cell growth can provide a framework for understanding the development of cancer. In order to divide, a cell must enter what is called the cell cycle. The two major steps in the cell cycle include the synthesis (S) phase, where DNA is replicated, and mitosis (M) phase, where the cell divides, producing two new cells. These phases are interrupted by gaps in which the cell prepares for either DNA synthesis (G1 gap) or division (G2 gap). The cell cycle is under strict regulatory control, as alterations in this process may lead to abnormalities in cell growth and division that impact the initiation and development of cancer.

Cancer development

Cancer is often triggered by genetic abnormalities that can include gene mutations, deletions, or amplification. The following types of potentially cancer-causing genes play a major role in the cancer process: oncogenes, tumor suppressor genes, and DNA repair genes.

Oncogenes are often mutant forms of normal proto-oncogenes that function to regulate cell growth or division. Some examples of oncogenes include N-ras, which is associated with leukemia, and Bcl-1, which is seen in breast, head, and neck cancers.

Tumor suppressor genes prevent abnormal growth of new tissue; hence, their mutation can lead to unregulated cell growth and division. p53 is a tumor suppresser gene that is mutated in more than half of all cancers.

DNA repair genes function to correct errors that may occur during DNA synthesis. Alterations in these genes can result in higher levels of DNA mutation during cell division. Cancers associated with mutant DNA repair genes include Bloom's syndrome and hereditary nonpolyposis colon cancer.

Genetic abnormalities leading to cancer may also result from carcinogen exposure. Carcinogens are environmental cancer-causing agents that induce cell stress. Known carcinogens include chemicals (cigarette smoke), hormones (estrogens), physical agents (radiation), and viruses (human papilloma and Epstein-Barr viruses).

The generation of cancer from mutated cells, known as carcinogenesis, is a multistep

process beginning with the *initiation* of genetic mutation in a cell through carcinogen exposure. Continued carcinogen exposure promotes the growth and division of initiated cells. This *promotion* stage is followed by *conversion* in which the initiated cells become immortal and are able to proliferate on their own. These cells experience rapid growth and acquire new genetic features. It is during this *progression* stage that invasion of the tumor cells into local or distant sites occurs. Finally, *selection* of the fittest cells for growth and division occurs within the tumor.

In order for a tumor to grow larger than 1 mm in diameter, it requires a supply of blood and nutrients. The growth of new blood vessels from existing ones, a process known as angiogenesis, normally occurs during wound healing and reproduction. This process is co-opted by tumors in an effort to promote the growth of new blood vessels towards the tumor site, thereby supplying blood to the tumor. Tumor growth is also dependent on the type of tumor. For example, while testicular cancer grows rapidly (doubling monthly), prostate cancer grows slowly (doubling time may be one year).

As mentioned earlier, cancer cells have the ability to invade the surrounding tissue and can spread from the primary tumor to distant sites. This phenomenon is referred to as metastasis and is often the cause of cancer fatalities. Invasion of malignant cells into regional tissues permits their access to local blood and lymphatic vessels where they can enter into circulation. Cells that are able to survive in the circulation invade distant tissues and establish secondary tumors at these sites. These metastatic tumors may, in turn, lead to additional metastases.

Types of cancer

Cancers are classified according to the tissue and cell type from which they are derived. Epithelial cell tumors are termed carcinomas. These are the most common cancers, accounting for 80% of all human cancers. Mesenchymal tissue tumors are named sarcomas and gland or duct tumors are termed adenocarcinomas.

In contrast to a solid tumor localized at a specific site, cancer may also take the form of cells that circulate in the blood. Leukemias and lymphomas are malignant white blood cells. While leukemias arise in the bone marrow, lymphomas occur in lymphatic system cells. These cancers present as systemic diseases, with leukemias being associated with anemia, recurrent infections, and uncontrollable bleeding, and non-Hodgkin's lymphomas associated with fatigue, malaise, fever, weight loss, itching, sweating, and enlarged lymph nodes.

Cancer epidemiology

Although cancer mortality rates have decreased in recent years, 25% of Americans die from cancer and it is the second leading cause of death in the United States. Some risk factors for cancer development include smoking tobacco, exposure to tobacco smoke, high-fat diet, obesity, sun exposure, heavy alcohol consumption, exposure to ionizing radiation, and family history. Knowledge of these risk factors may be helpful in both the prevention and early detection of cancer.