Hallmarks of Cancer

Hallmarks of cancer are a collection of characteristics often seen in tumor cells. These include growth signal self-sufficiency, anti-growth signal insensitivity, evasion of apoptosis, limitless replication, angiogenesis, tissue invasion, and metastasis. Cancerous cells often exhibit the Warburg effect, and are capable of immune system evasion.

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Growth Signals

Growth Signal Self-sufficiency

Growth Cell-signal Selfie

Under normal conditions, cells require signals to proliferate. Whether this is VEGF for blood vessels or EGFR for mammary glands, all cells require these for continued growth. Certain mutations, however, can cause cells to grow independently from signals. This is called growth signal self-sufficiency.

Anti-growth Signal Insensitivity

Ant-tie-growth Cell-signal Insensitive

Similarly to proliferation, cells also require signals to halt division. Cancer cells can mutate to become independent of these signals. A cell that replicates without growth signals and doesn't respond to halting signals has a high potential for malignant development.

Control of Replication

Evasion of Apoptosis

Evading A-popping-cell

Cancer cells may also evade apoptosis. Under normal conditions, the immune system can recognize mutated cells via MHC complex presentation. Cells with nonviable MHC complexes undergo apoptotic induction. However, certain mutations allow malignant cells to avoid these built-in checkpoints.

Limitless Replication

Infinity-symbol and Replicating-people

Under normal conditions, expression of telomerase in cells prevents limitless replication. Telomere length provides a defiinite lifespan for cells. However, mutations in telomerase or other related enzymes can lead to defective expression. This, in turn, can lead to unlimited replication.

Progression/Spread

Angiogenesis

Angel-jeans Generating Capillaries

As tumors grow in size, they require more than just passive diffusion for nutrients. Tumors that grow to sufficient size require vascularization. In order to promote blood vessel formation, tumor cells must express angiogenic factors such as VEGF.

Tissue Invasion

Tissue-box Invader-alien

Tissue invasion is a hallmark of cancer progression. The primary cellular mediator of this process is e-cadherin. Under normal conditions, e-cadherin is responsible for cell to cell adhesion. Decreased expression of e-cadherin allows cancerous cells to break off from their host lineage, penetrate basement membranes, and become metastatic.

Metastasis

Metastasis-mit

Depending on the cancer cells in question, metastasis may occur earlier or later. Most often, metastases occur trough hematogenous or lymphatic spread. Metastasis can be recognized by multiple, focal lesions within organs.

Warburg Effect

War-burger

When compared with normal cells, cancerous cells preferentially generate energy through anaerobic respiration and lactic acid fermentation. This effect can be visualized on a PET scan as malignant cells uptake glucose at a higher rate compared to healthy cells.

Immune Evasion

Moon Tax-evasion

In addition to neutralizing bacteria, viruses, and fungi, immune cells also patrol the body for potentially malignant cells. White blood cells, particularly natural killer cells, do this through identification of MHC complexes. Cells that fail to present proper MHC molecules undergo apoptotic induction.
