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Commentary

Cellular Oncogenes: Principal Mediators of Cancer Development and Progression

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DESCRIPTION

Oncogenes are important to understanding the molecular basis of cancer. These genes, often mutated or overexpressed, have the potential to drive the uncontrolled proliferation of cells, a hallmark of cancer. Originally discovered as part of viral genomes, oncogenes have since been identified as normal genes (proto-oncogenes) present in the genomes of all cells. When these proto-oncogenes are altered or mutated, they become oncogenes that can contribute to tumorigenesis. In this article, we will examine the role of cellular oncogenes in cancer development, their mechanisms of action and the implications for cancer therapy. Oncogenes are genes that have the potential to cause cancer when they are mutated or abnormally activated. In their normal, unmutated form, they are called proto-oncogenes. Proto-oncogenes are involved in normal cellular processes such as growth, division and differentiation. However, when these genes undergo mutations, amplification or translocation, they can become oncogenes, which in turn, may lead to abnormal cellular behavior such as excessive cell division, evasion of apoptosis (programmed cell death) and sustained growth signaling.

The transformation of proto-oncogenes into oncogenes often involves genetic mutations that lead to the production of a constitutively active protein. This altered protein may stimulate continuous cell division even in the absence of normal regulatory signals. Oncogenes are typically dominant in their effects, meaning that a single copy of the mutated gene is sufficient to induce cancerous characteristics in a cell.

Types of cellular oncogenes

Oncogenes can be categorized based on their function in the cell. Broadly, they can be grouped into several classes, including growth factor genes, receptor tyrosine kinases, signal transducers, nuclear proteins and cell cycle regulators. Below, we study some well-known examples of cellular oncogenes:

Growth factor oncogenes: Growth factors are proteins that bind to receptors on the surface of cells to stimulate cell division and growth. In some cases, the overproduction or misregulation of growth factors can lead to oncogene activation. For instance, the Platelet-Derived Growth Factor (*PDGF*) gene can act as an oncogene when overexpressed, leading to uncontrolled growth of cells, particularly in cancers like glioblastomas and soft tissue sarcomas.

Receptor tyrosine kinase oncogenes: Receptor Tyrosine Kinases (RTKs) are cell surface proteins that mediate signals from growth factors, leading to cellular responses such as growth, survival and differentiation. When these receptors are mutated, they can become constitutively active, triggering excessive cell division. One of the most well-known examples is the Epidermal Growth Factor Receptor (EGFR), where mutations or amplification can lead to lung cancers and other epithelial cancers. Another key example is the Human Epidermal Growth Factor Receptor 2 (*HER2/neu*) gene, a receptor tyrosine kinase involved in the development of breast cancer. Overexpression of *HER2* can lead to enhanced cell growth and proliferation, contributing to aggressive tumor growth in breast cancer.

Signal transducer oncogenes: Oncogenes can also arise through alterations in proteins involved in intracellular signaling. One such gene is Rat Sarcoma (RAS), which encodes a small Guanosine Triphosphatase (GTPase) that regulates key signaling pathways involved in cell growth and survival. Mutations in RAS, particularly in the Kirsten Rat Sarcoma (KRAS), Neuroblastoma Ras (NRAS) and Harvey Rat Sarcoma (HRAS) genes, are found in a variety of cancers, including pancreatic, lung and colorectal cancers. These mutations lead to the continuous activation of downstream signaling pathways, promoting uncontrolled cell growth and survival.

CONCLUSION

Cellular oncogenes are significant in the development and progression of the cancer. These genes, when mutated or dysregulated, drive uncontrolled cell division and the formation of tumors. Oncogenes can be categorized based on their roles in growth factor signaling, receptor tyrosine kinases, intracellular signal transduction, cell cycle regulation and transcriptional control. Advances in our understanding of the oncogenes have led to the development of targeted therapies that can effectively treat certain types of cancer. However, the complexity and adaptability of cancer cells mean that the continued research into oncogenes is essential for the developing more effective and durable cancer treatments.

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