9.3D: Cell Signaling and Cell Growth

Learning Objectives

• Explain how cell growth is affected by growth factors.

Cell Growth

Cell signaling pathways play a major role in cell division. Cells do not normally divide unless they are stimulated by signals from other cells. The ligands that promote cell growth are called growth factors. Most growth factors bind to cell-surface receptors that are linked to tyrosine kinases. These cell-surface receptors are called receptor tyrosine kinases (RTKs). Activation of RTKs initiates a signaling pathway that includes a G-protein called RAS, which activates the MAP kinase pathway described earlier. The enzyme MAP kinase then stimulates the expression of proteins that interact with other cellular components to initiate cell division. In addition, uncontrolled cell growth leads to cancer; mutations in the genes encoding protein components of signaling pathways are often found in tumor cells.
Cancer Biologists & Uncontrolled Cell Growth

Cancer biologists study the molecular origins of cancer with the goal of developing new prevention methods and treatment strategies that will inhibit the growth of tumors without harming the normal cells of the body. Signaling pathways control cell growth. These pathways are controlled by signaling proteins, which are, in turn, expressed by genes. Mutations in these genes can result in malfunctioning signaling proteins. This prevents the cell from regulating its cell cycle, triggering unrestricted cell division and cancer. The genes that regulate the signaling proteins are one type of oncogene: a gene that has the potential to cause cancer. The gene encoding RAS is an oncogene that was originally discovered when mutations in the RAS protein were linked to cancer. Further studies have indicated that 30 percent of cancer cells have a mutation in the RAS gene that leads to uncontrolled growth. If left unchecked, uncontrolled cell division can lead tumor formation and metastasis, the growth of cancer cells in new locations in the body.

Cancer biologists have been able to identify many other oncogenes that contribute to the development of cancer. For example, HER2 is a cell-surface receptor that is present in excessive amounts in 20 percent of human breast cancers. Cancer biologists realized that gene duplication led to HER2 overexpression in 25 percent of breast cancer patients and developed a drug called Herceptin (trastuzumab), a monoclonal antibody that targets HER2 for removal by the immune system. Herceptin therapy helps to control signaling through HER2. Its use, in combination with chemotherapy, has helped to increase the overall survival rate of patients with metastatic breast cancer.

Key Points

- Normally, cells do not divide unless they are stimulated by signals from other cells.
- Most growth factors, which promote cell growth, bind to cell-surface receptors that are linked to tyrosine kinases.
- MAP kinase stimulates the expression of proteins that interact with other cellular components to initiate cell division.
- Uncontrolled cell growth leads to cancer.
Key Terms

- **receptor**: a protein on a cell wall that binds with specific molecules so that they can be absorbed into the cell in order to control certain functions

- **growth factor**: a naturally-occurring substance capable of stimulating cellular growth, proliferation, and cellular differentiation

- **oncogene**: any gene that contributes to the conversion of a normal cell into a cancerous cell when mutated or expressed at high levels