Name______________________________ Class__________________ Date ______________

Summary

10–1 Cell Growth

The larger a cell becomes, the more demands the cell places on its DNA—the molecule that contains information that controls cell functions. As a cell increases in size, it usually does not make copies of DNA. If a cell were to grow without limit, an "information crisis" would occur. In addition, as a cell increases in size, the more trouble it has moving enough nutrients (food) and wastes across its cell membrane. The rate at which materials move through the cell membrane depends on the surface area of the cell—the total area of its cell membrane. However, the rate at which food and oxygen are used up and waste products are produced depends on the volume of the cell.

If a cell were a cube, you could determine surface area by multiplying length $\times$ width $\times$ number of sides. You could determine volume by multiplying length $\times$ width $\times$ height. You then could determine the cell's ratio of surface area to volume by dividing the surface area by the volume. As a cell grows, its volume increases more rapidly than its surface area. That is, as a cell becomes larger, its ratio of surface area to volume decreases.

Before a cell becomes too large, a growing cell divides, forming two "daughter" cells. The process by which a cell divides into two new daughter cells is called cell division.

10–2 Cell Division

Each cell has only one set of genetic information. For that reason, a cell must first copy its genetic information before cell division begins. Each daughter cell then gets a complete copy of that information. In most prokaryotes, the rest of cell division is a simple matter of separating the contents of the cell into two parts. In eukaryotes, cell division occurs in two main stages. The first stage is division of the nucleus, called mitosis. The second stage is division of the cytoplasm, called cytokinesis.

In eukaryotes, genetic information is passed on by chromosomes. Well before cell division, each chromosome is replicated (copied). When copying occurs, each chromosome consists of two identical "sister" chromatids. Each pair of chromatids is attached at an area called a centromere.

The cell cycle is a series of events that cells go through as they grow and divide. During the cell cycle, a cell grows, prepares for division, and divides to form two daughter cells, each of which then begins the cycle again. The cell cycle consists of four phases. The M phase includes mitosis and cytokinesis. The other three phases are sometimes grouped together and called interphase. Interphase is divided into three phases: G_1, S, and G_2. During the G_1 phase, cells increase in size and make new proteins and organelles. During the next phase, the S phase, the replication (copying) of chromosomes takes place. When the S phase is complete, the cell enters the G_2 phase. During the G_2 phase, many of the organelles and molecules required for cell division are produced.

Mitosis consists of four phases: prophase, metaphase, anaphase, and telophase. The first and longest phase is prophase. During prophase, the chromosomes condense and become visible. The centrioles separate and take up positions on opposite sides of the nucleus. Centrioles are two tiny structures located in the cytoplasm near the nuclear envelope. The centrioles separate and take up positions on opposite sides of the nucleus. The centrioles lie in a region called the centrosome that helps to organize the spindle, a fanlike microtubule structure that helps separate the chromosomes. During the second phase, called metaphase, chromosomes line up across the center of the cell. During the third phase, called anaphase, the centromeres that join the sister chromatids split and the sister chromotids become individual chromosomes.

The two sets of chromosomes move apart. During the fourth and final phase, called telophase, the chromosomes gather at opposite ends of the cell and lose their distinct shapes. Two new nuclear envelopes form.

Cytokinesis usually occurs at the same time as telophase. In most animal cells, the cell membrane is drawn inward until the cytoplasm is pinched into two nearly equal parts. In plant cells, a structure known as a cell plate forms midway between the divided nuclei. A cell wall then begins to appear in the cell plate.

10–3 Regulating the Cell Cycle

In a multicellular organism, cell growth and cell division are carefully controlled. For instance, when an injury such as a cut in the skin occurs, cells at the edge of the cut will divide rapidly. When the healing process nears completion, the rate of cell division slows down and then returns to normal.

Cyclins—a group of proteins—regulate the timing of the cell cycle in eukaryotic cells. There are two types of these regulatory proteins: internal regulators and external regulators.

Internal regulators are proteins that respond to events inside the cell. They allow the cell cycle to proceed only when certain processes have happened inside the cell. External regulators are proteins that respond to events outside the cell. They direct cells to speed up or slow down the cell cycle. Growth factors are important external regulators. Growth factors stimulate growth and division of cells, such as during the development of the embryo or when a wound is healing.

Cancer is a disorder in which some of the body's own cells lose the ability to control growth. Cancer cells do not respond to the signals that regulate the growth of most cells. As a result, they divide uncontrollably and form masses of cells called tumors. Cancer cells may break lose from tumors and spread throughout the body. Cancer cells damage tissues and disrupt normal activities. Some cancers can even lead to death. Cancer is a disease of the cell cycle, and conquering cancer will require greater understanding of the processes that control cell division.