How Do Cells Make More Cells?

Each of you started as a single cell. When your father's sperm met your mother's egg (more properly: an ovum), the fertilized egg or zygote was formed. That single cell had to make copies of itself many times over to produce the trillions of cells required to form all your organs and tissues. A cell makes copies of itself by duplicating its parts and dividing. A single cell can divide into two cells, and those two cells can divide into four cells, and those four cells into eight cells, and on and on.

Currently, most of you are almost fully grown. Still, many of the cells in your body will continue to divide until you die. Cells divide for the body to grow and to repair body parts that have been damaged. In your bodies right now, millions of new cells are forming every second! When you cut yourself, the cells of the skin and blood must divide to replace the damaged or lost cells.

Cell Division Requires DNA Replication and Mitosis

In cell division, one cell divides, forming two cells. These two cells are identical. Each has a nucleus containing identical amounts and sequences of DNA. The DNA is normally in the form of chromatin, which appears as a very grainy, unstructured substance in the nucleus. Both cells also have similar cytoplasms, and the cells are about the same size.

Because DNA is a double-stranded molecule it can make identical copies of itself. The rungs of the DNA ladder holding together the two strands are pairs of nitrogenous bases. The two bases in a pair are complementary. That is, they are different bases that mutually attract each other. Adenine always pairs with thymine, and cytosine always pairs with guanine. If the two strands of a DNA molecule are chemically separated in a test tube, they will reform the exact same double-stranded molecule as before because complementary bases attract all along the length of the DNA.

Before each division of a cell, the two strands of DNA molecule making up the chromatin of the nucleus become separated. But unlike DNA in a test tube, the strands are not allowed to come back together. Instead, each separated strand begins to attract "new," unattached nitrogenous bases entering the nucleus from the cell's cytoplasm. This attraction between "old" and "new" bases along the DNA of both strands produces two identical DNA molecules. The DNA in the cell has been doubled, or, as biologists say, the DNA has been replicated. Why must the cell double its amount of DNA before it divides?

A process called mitosis ensures that the new cells produced in cell division have identical DNA. Mitosis is the division of the cell nucleus. During mitosis, the chromosomes are separated evenly between the two nuclei. Each nucleus gets an identical set of chromosomes. After mitosis, the cytoplasm completes its division, forming two new cells. Because the chromosomes contain the DNA, the two cells will be alike.

Activity

- Obtain pipe cleaners, a piece of string, and scissors from your teacher.
- Form eight pairs of pipe cleaners by twisting two pipe cleaners of the same color together.

The twisted pairs of pipe cleaners now represent the eight chromosomes in the cell nucleus of a fly. Each chromosome (two twisted pipe cleaners) has a different sequence of DNA. Each pipe cleaner in a twisted pair is called a chromatid. Chromatids in the same pair carry identical copies of DNA. That is, they have exactly the same DNA sequence.

- Surround all eight pairs of pipe cleaners with a single loop of string to represent the membrane of the cell nucleus.
- Using the figures (p. 246) of a dividing (mother) cell, properly arrange the chromosomes to represent each stage of mitosis.
    - Use scissors to cut the string in half at the time when the membrane of the nucleus breaks.
    - Form loops of string to represent the membranes of the new nuclei.
- At the end of mitosis, compare the similarity of the DNA in each of the two daughter nuclei.
- How many chromosomes does each daughter nucleus have at the end of mitosis?

1. How do these chromosomes compare in terms of their DNA?
2. What must you do to return each nucleus to its original state?