Chromosome Manipulative
Demonstrating Mitosis

Housed inside the nucleus of each cell, genetic information is carried in the form of chromosomes. **Chromosomes** transmit genetic information found in their DNA sequences to the next generation of cells through the process of mitosis. **Mitosis** produces offspring cells that contain the same kind and amount of genetic information found in the original cell.

Prior to mitosis, the cell undergoes an exact duplication of the chromosomal content of the parent cell’s nucleus. This ensures the two new cells, or **daughter cells**, will have an identical genetic makeup to the mother cell. For example, if the original parent cell’s nucleus contained 12 chromosomes, each of the new daughter cells produced through mitosis would contain 12 chromosomes.

Normal body cells in humans contain 46 chromosomes. The process of mitosis results in the production of two new daughter cells, each containing 46 chromosomes. These 46 chromosomes are actually 23 homologous pairs of chromosomes. A human receives one set of chromosomes from their father and one set from their mother.

Several different terms are used to describe the chromosome as it exists in the various stages of this division process. **Chromatin** is a term used to describe the relaxed state of the DNA and its proteins. **Replicated chromosome** is a term used to identify a chromosome that has completed the process of DNA replication and now exists in duplicates that are attached at an area called the **centromere**. Another term for a replicated chromosome is a double-stranded chromosome. Each duplicate or strand is referred to as a sister chromatid. **Homologous chromosomes** are two chromosomes that contain the same alleles in the same order.

Prior to the onset of mitosis during the interphase stage of the cell’s life cycle, the genetic information found within the nucleus of the cell is copied through a process known as **DNA replication**. During DNA replication each strand of DNA is duplicated, forming two copies of the chromosome. These copies, or **chromatids**, will remain attached to each other at the centromere region until they become separated from one another through the events of mitosis.

In human cells, where the original chromosome count is 46, the cell that has completed DNA replication will contain 46 chromosomes consisting of two sister chromatids for a total of 92 chromatids. The overall purpose of mitosis is to separate these replicated chromosomes, portioning them into two new daughter cells.
The entire cell cycle is generally broken down into different phases, with one phase gradually leading to the next.

The events of mitosis are divided into four main stages. The following events occur in each stage:

**Prophase** – The long, stringy, unwound chromatin fibers coil and condense into thick threads of visible genetic material called *chromosomes*. As the cell enters prophase, the chromosomes have already been replicated, forming sister chromatids. The sister chromatids are connected to each other at the centromere. The spindle apparatus begins to form and move to opposite poles. The spindle apparatus consists of the *centrosome* (centriole pairs) and the *microtubules* that extend from them. The nuclear membrane breaks down, and the nucleolus disappears.

**Metaphase** – The centromeres of the sister chromatids line up along the center, or *metaphase plate*, of the cell bringing the genetic material to the center. Microtubules connect the centromere of each chromosome to the centrosome.

**Anaphase** – The centromere of each double-stranded chromosome divides, separating the sister chromatids from each other. The chromosomes of each pair will be moved by the microtubules (spindle fibers) toward opposite poles of the cell. Once the chromatids have separated, they are now single-stranded chromosomes. This separation allows one copy of each chromosome to be placed on opposite sides of the dividing cell. The chromosomes continue to move toward the poles of the spindle apparatus, forming two separate groups.

**Telophase** – The final stage of mitosis occurs as new nuclear membranes are formed around both groups of chromosomes. The result is two separate nuclei, each containing the same genetic information as the original cell’s nucleus. The chromosomes will uncoil and relax to form chromatin threads. The spindle apparatus begins to break apart, and the nucleoli are reformed.
PURPOSE
The purpose of this activity is to demonstrate the stages of mitosis using chromosome models.

MATERIALS
Each lab group will need the following:
- aprons
- goggles
- paper towels
- 2 copies of chromosome #1
- 2 copies of chromosome #2
- pencils, colored, assorted
- scissors
- 4 straws, coffee, pieces
- string, approx. 1 m
- tape, clear
- beads
- yarn

Safety Alert!
Use care when handling sharp or pointed instruments.

PROCEDURE
1. Cut out two copies each of replicated chromosome #1 and two copies of replicated chromosome #2.

2. Color one copy of replicated chromosome #1 pink to represent the maternal copy of the chromosome. Color the second copy of replicated chromosome #1 blue—this will represent the paternal copy of the chromosome. This is the first homologous pair.

3. Color one copy of replicated chromosome #2 pink to represent the maternal copy. Color the second copy of replicated chromosome #2 blue to represent the paternal copy of the chromosome. This is the second homologous pair.

4. Using the piece of string, make a circular shape on the top of your desk to represent the cell membrane. Inside the string, make a smaller circle with the yarn to represent the nuclear membrane. Place two pieces of coffee stirrers between the string and the yarn to represent the centrioles that have not yet replicated. Place a bead inside the nuclear membrane to represent the nucleolus.

5. Fold each of the four chromosomes in half at the centromere.

6. Place the chromosomes inside the nuclear membrane you have made on your desk top.

7. Locate the data table on your student answer page. Complete the table by drawing pictures of the objects listed.

8. Listen carefully as your teacher describes the events of the stages of mitosis.

9. At the conclusion of your teacher’s description of the stages, go through the steps of mitosis once again with your partner using your models and draw the stages in the space provided on your student answer page.

10. Complete the questions on your student answer page.