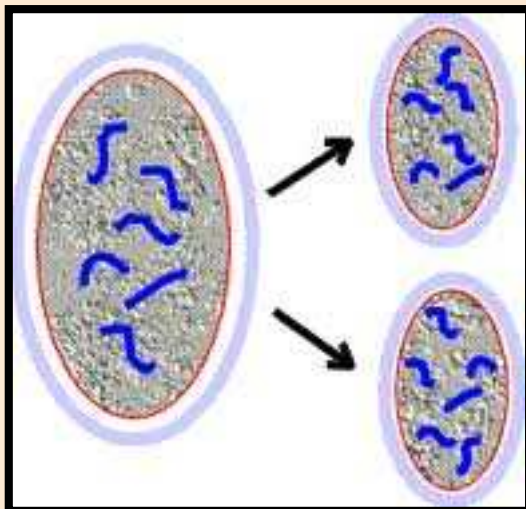
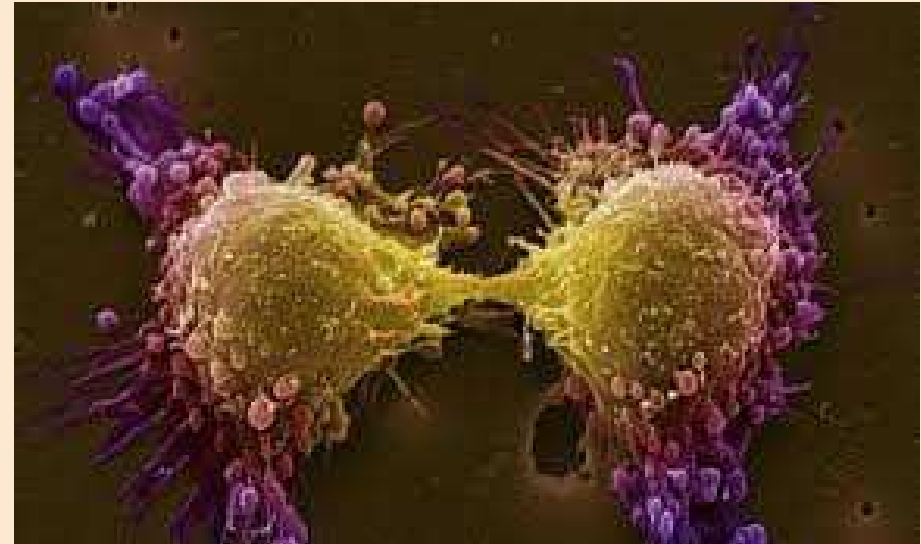


# Mitosis and Cellular Division

EQ: How do the cells in  
our body divide?

# Cell Division

Cell division is the process by which cellular material is divided between two new daughter cells.



**1 Mother Cell → 2 Daughter cells.**

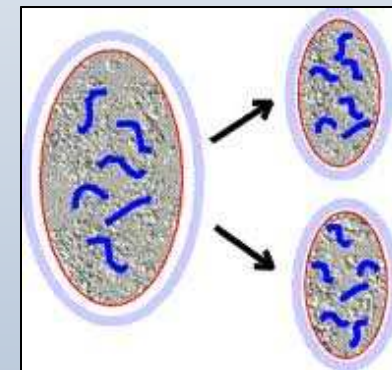
The two daughter cells will be....  
...identical to each other and to the mother cell.



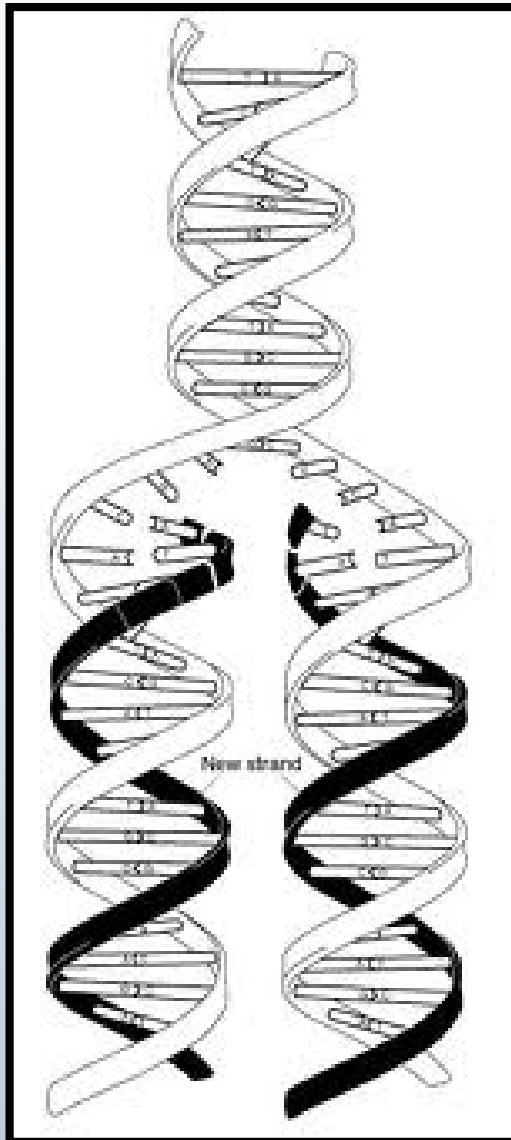
Each daughter is half the size of the parent cell, but immediately begins growing.

A typical human cell has about 2 meters of DNA. Before the cell can divide, all of this DNA must be copied and then the two copies separated so that each daughter cell ends up with a complete set of DNA.

Each species has a characteristic number of chromosomes in each cell nucleus; humans have 23 pairs or 46.



# Chromosomes During Eukaryotic Cell Division

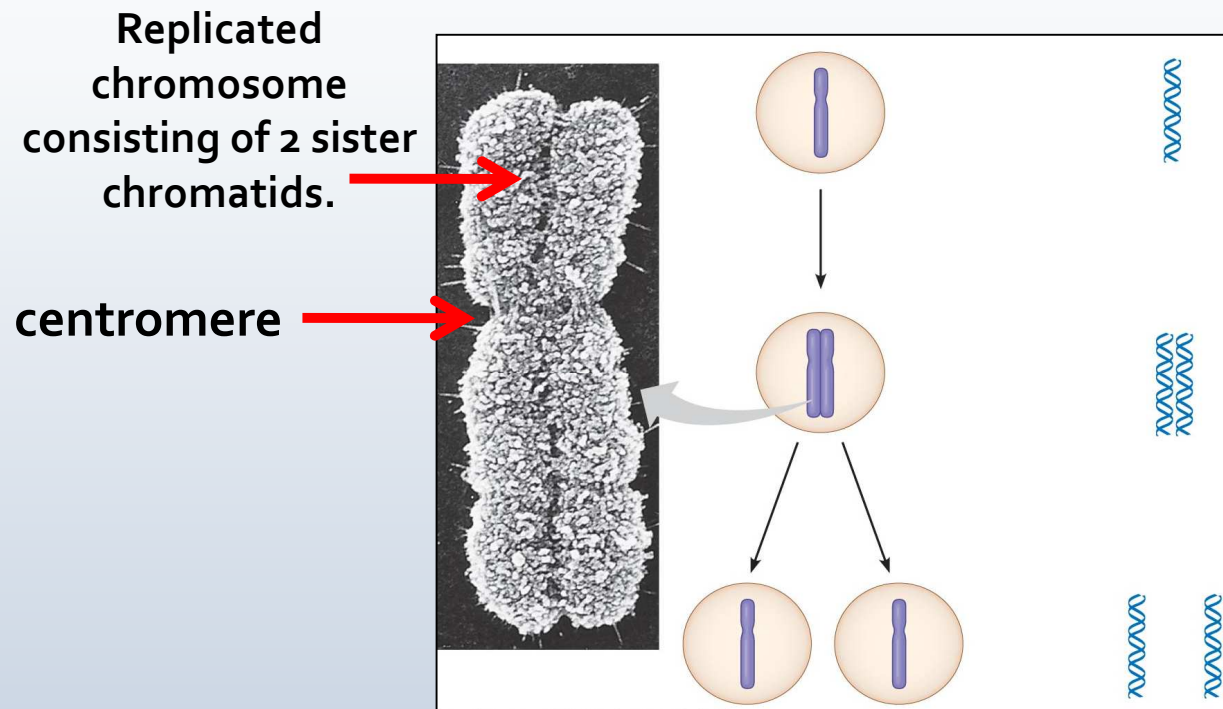


Each cell must first copy its chromosomes before cell division occurs.

Each daughter cell gets a complete copy of that information.

Cell division occurs in two main stages:  
Mitosis – The division of the nucleus  
Cytokinesis – The division of the cytoplasm

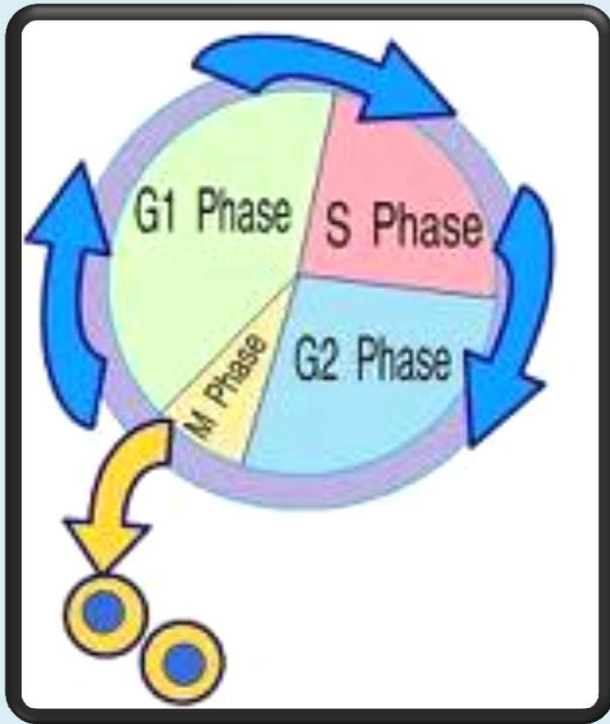
The chromosomes are not visible except during cell division. At the beginning of cell division, the chromosomes condense into compact, visible structures that are easily seen with a microscope.



Well before cell division takes place, each chromosome is replicated or copied.

At the beginning of cell division, each chromosome consists of two identical “sister chromatids”. These chromatids are connected at an area called a centromere.

# The Cell Cycle



The cell cycle is:

The series of events that cells go through as they grow and divide.

The cell cycle is the life of the cell from the time it is first formed from a dividing parent cell until its own division into two cells.

During the cell cycle:

1. A cell grows.
2. The cell prepares for division.
3. The cell divides to form two daughter cells.

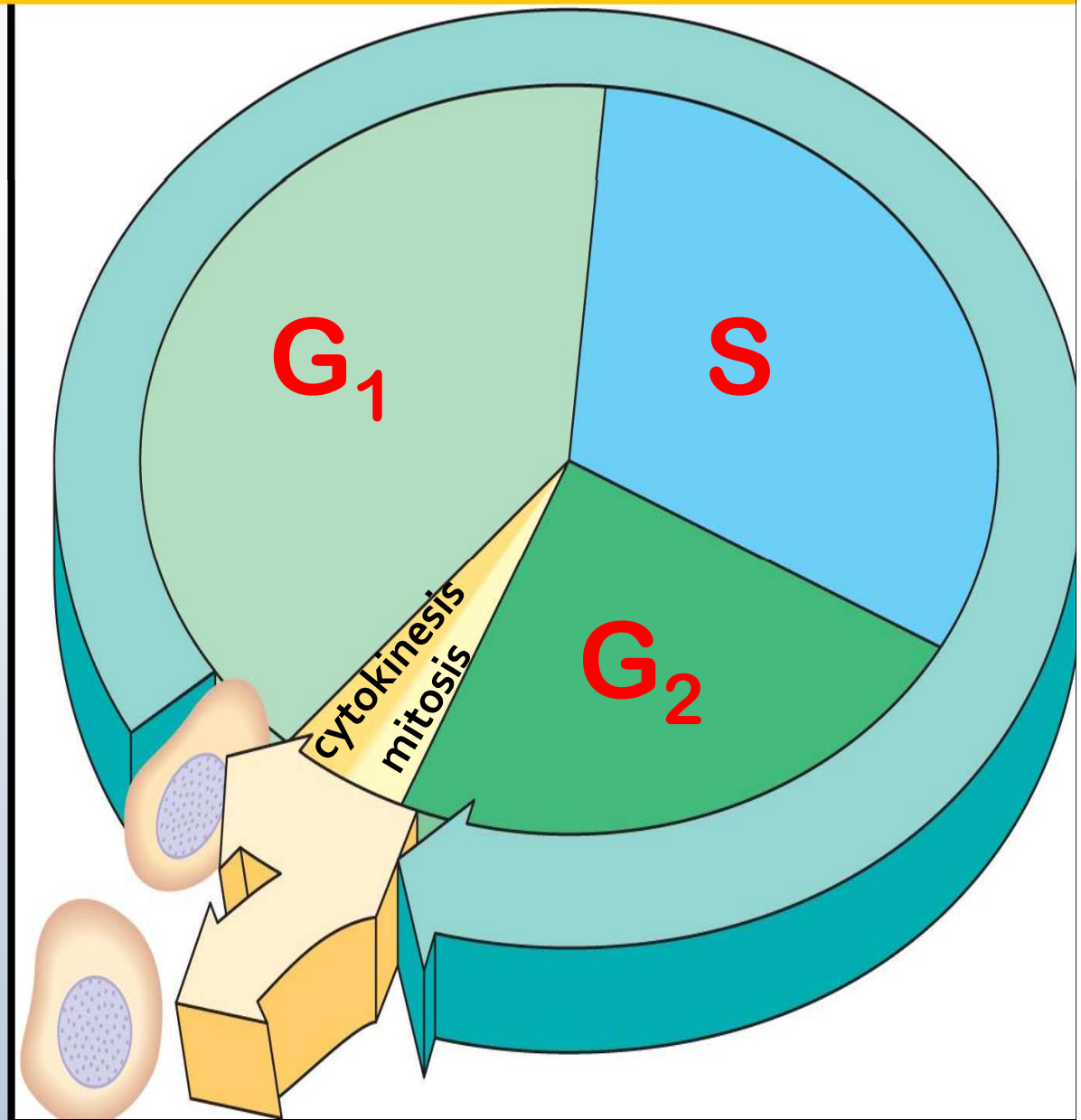
# The cell cycle consists of five major phases:

- $G_1$  (first gap)
- S (synthesis)
- $G_2$  (second gap)
- Mitosis
- Cytokinesis

Mitosis is the division of the nucleus.

Cytokinesis is the division of the cytoplasm.

Two new cells are produced.

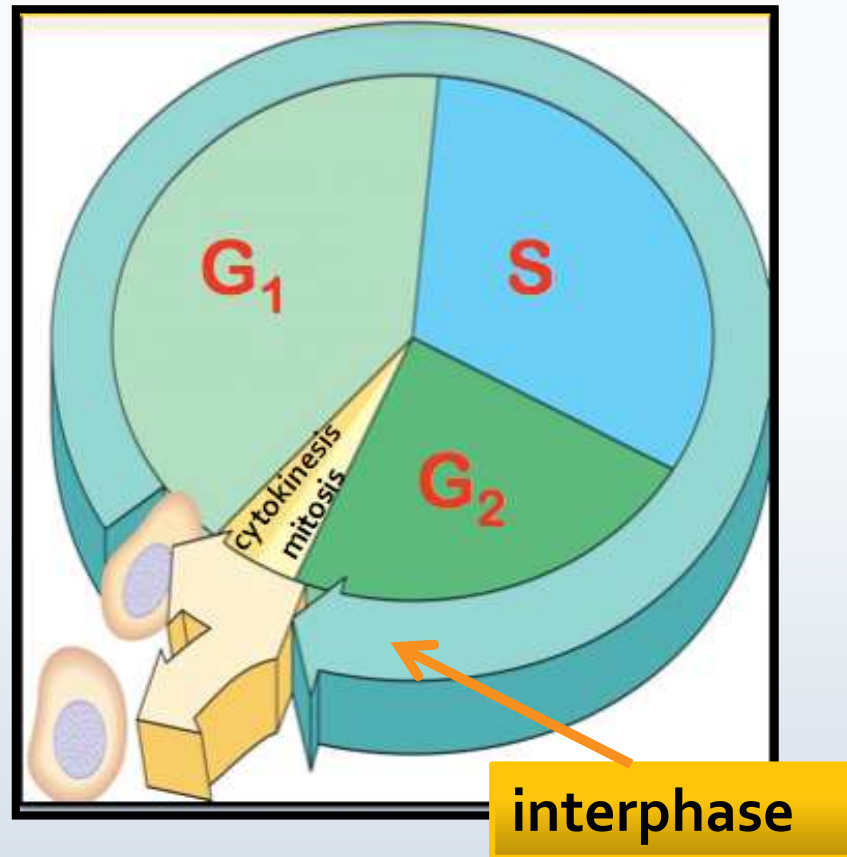


Before a cell can begin mitosis and actually divide, it must do two things:

- It must form duplicates of its chromosomes.
- It must produce a supply of organelles for the two daughter cells.

These preparations occur during the  $G_1$ , S, and  $G_2$  phases of the cell cycle.

These three ( $G_1$ , S, and  $G_2$ ) are collectively known as interphase.





## G<sub>1</sub> phase

- a) The cell doubles in size.
- b) The enzymes, cytoplasmic organelles and other molecules double in number.

## S phase

Replication of DNA occurs.

## G<sub>2</sub> Phase

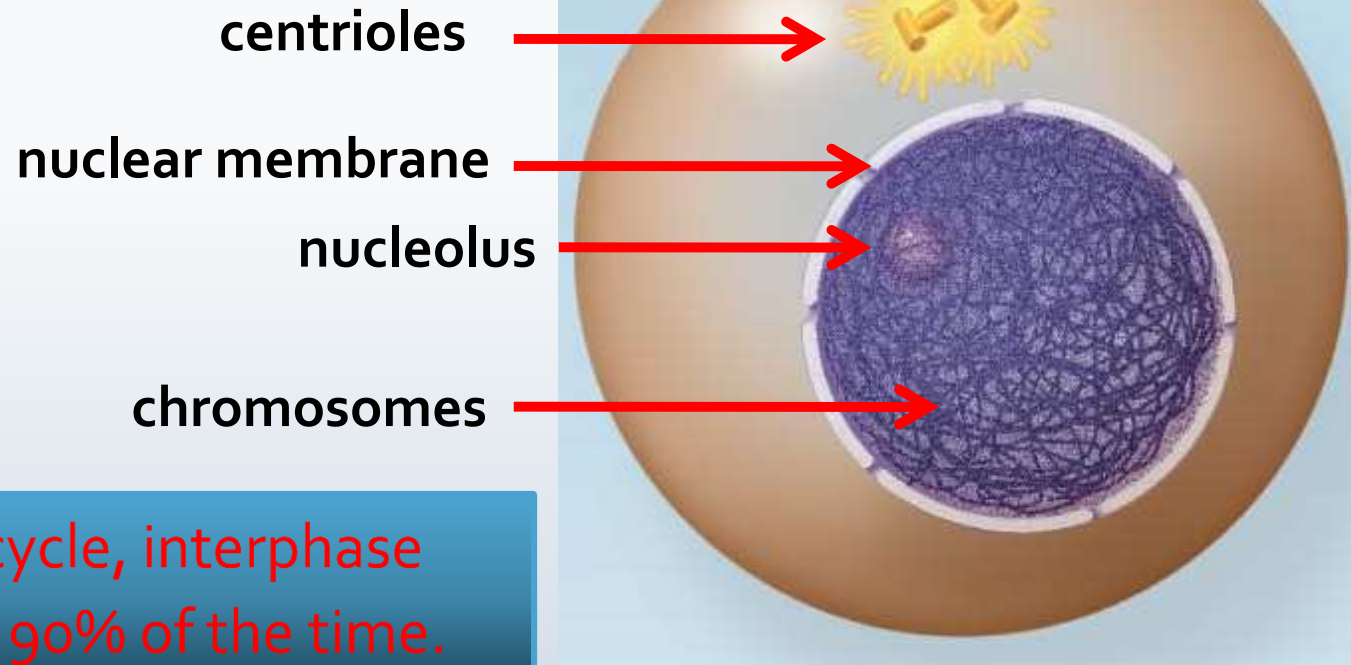
The cell assembles the special structures needed for cell division

When interphase (G<sub>1</sub>, S, G<sub>2</sub>) is complete, the cell is ready to begin the process of cell division.



“Let’s break mitosis down into its individual stages and see what is going on in each stage.”

# Interphase



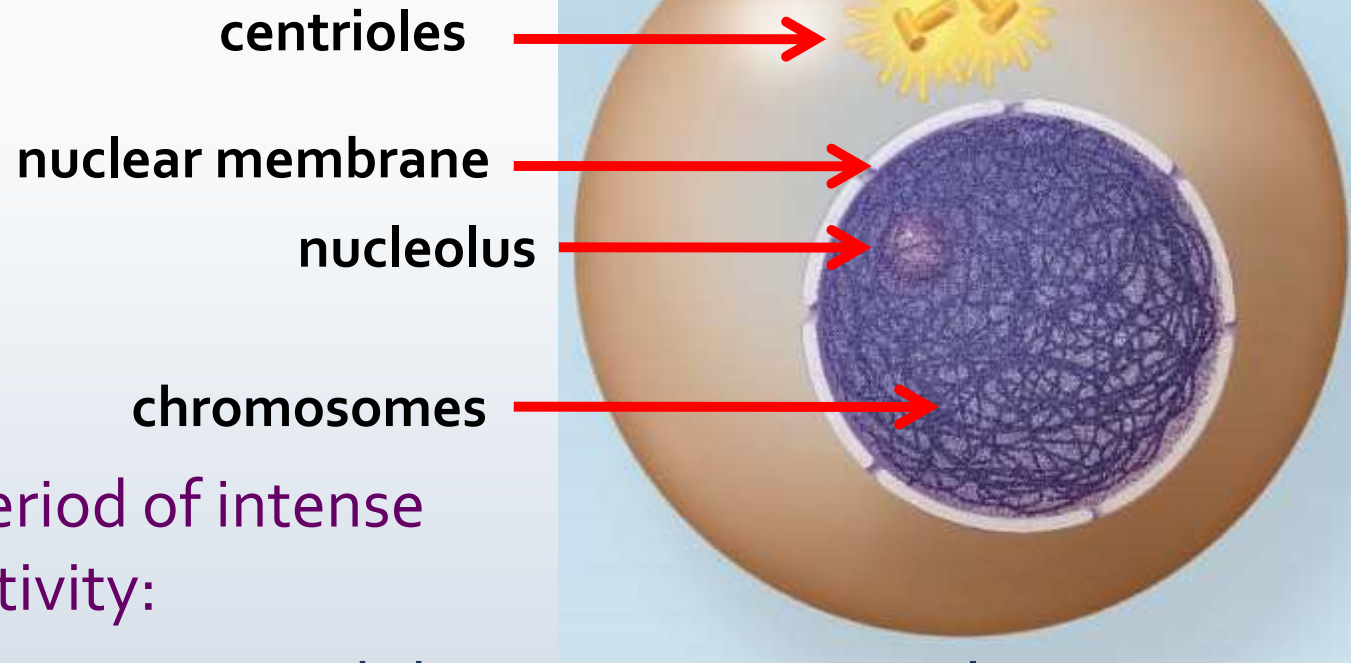
Of the cell cycle, interphase accounts for 90% of the time.

Nucleus is well defined and bounded by the nuclear membrane.

Outside of the nucleus are two centrioles. Their function is to:  
organize the microtubules into a spindle.

They will begin to move apart as spindle microtubules grow out of them.

# Interphase



$G_1$  phase is a period of intense biochemical activity:

The cell doubles in size and the enzymes, cytoplasmic organelles and other molecules double in number.

The chromosomes have duplicated during the S phase and they appear as a jumbled mass of fibers. They have not yet condensed.

$G_2$  Phase: The cell assembles the special structures needed for cell division



# Remember!

Interphase includes the  $G_1$  phase, the S phase, and the  $G_2$  phase. It is the period of time preceding mitosis.

Mitosis has 4 stages:

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

# Prophase

## Early prophase

The chromosomes coil and thicken and become distinct from one another. The chromosomes are now visible.

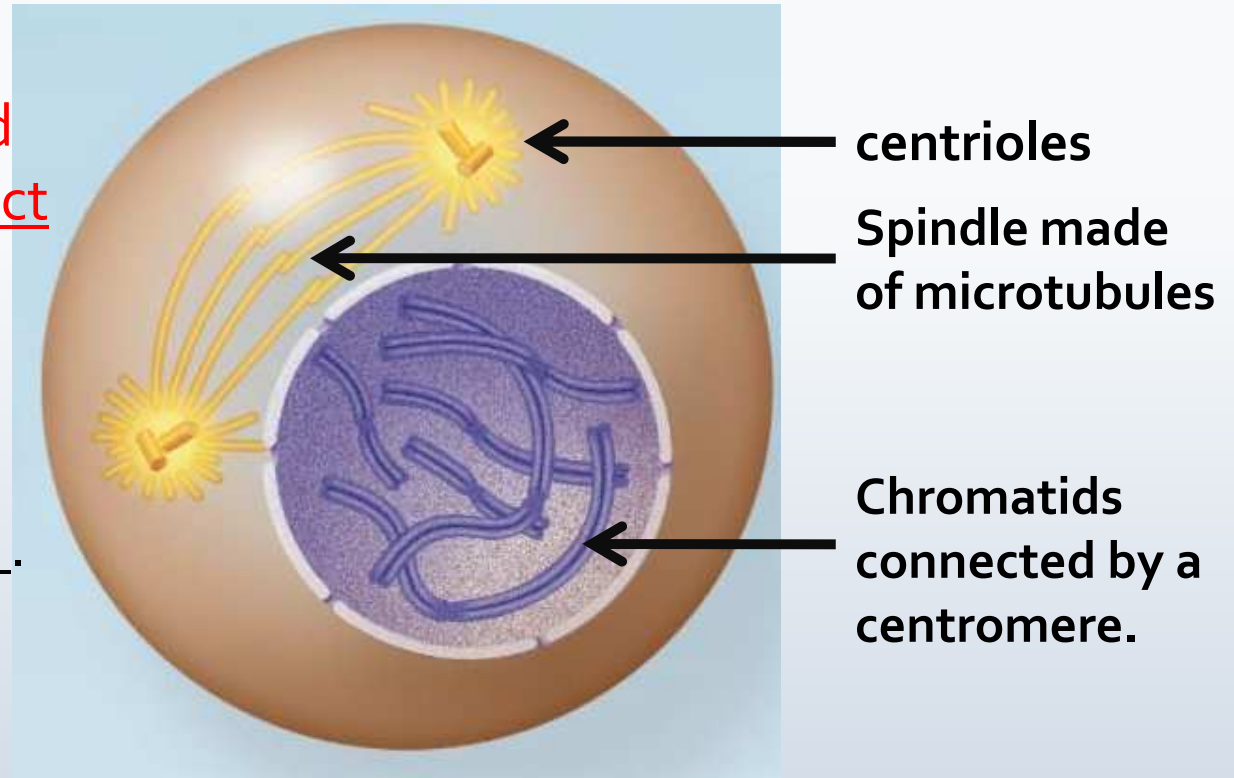
The nucleolus disappears.

The chromosomes are doubled throughout their length.

Each half of the double chromosome is a chromatid.

The chromatids are connected by a centromere.

The centrioles separate and start moving to opposite ends of the cell. A spindle made of microtubules begins to form.



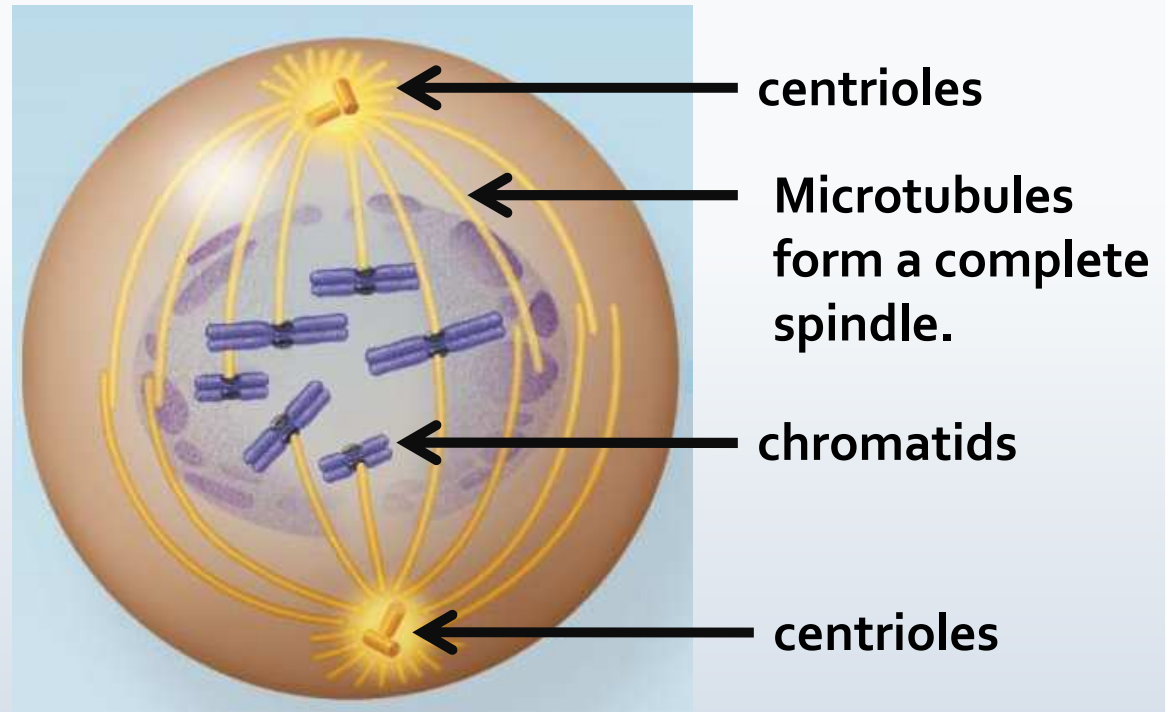
# Prophase

The nuclear membrane fragments and the microtubules invade the nuclear area. The spindle is completely formed.

The spindle is a structure that will help to separate the chromosomes.

During prophase the pairs of chromatids become attached to the fibers of the spindle.

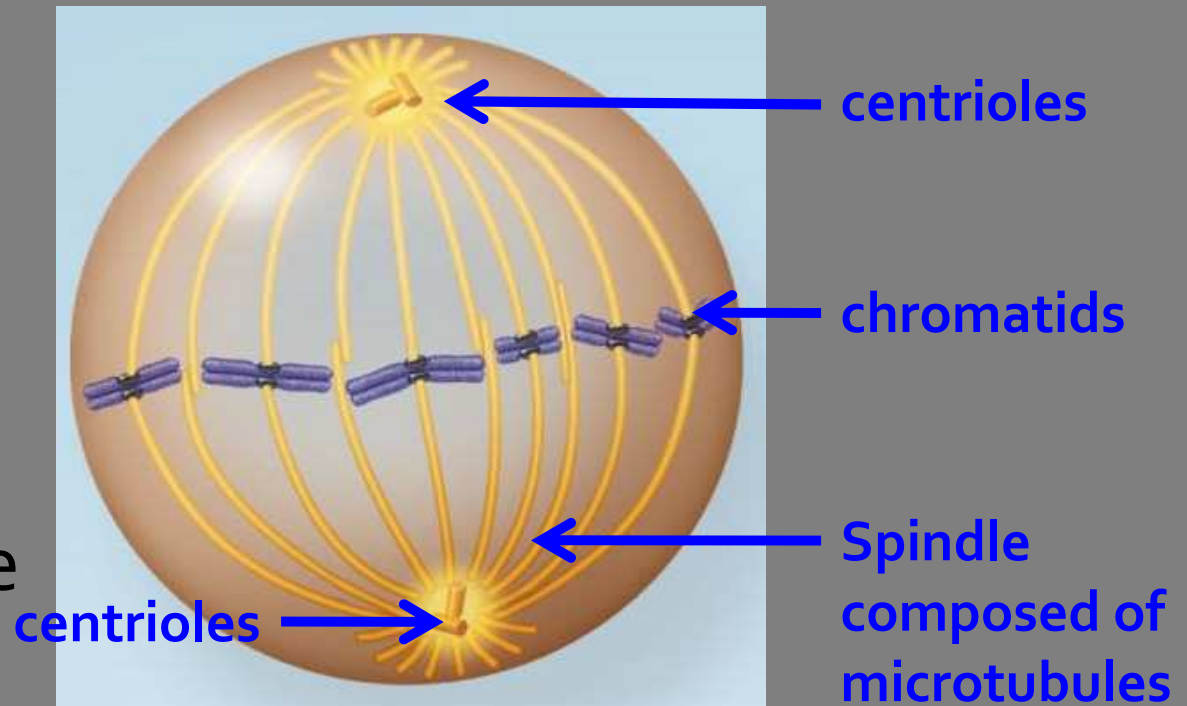
## Late prophase



The centrioles have moved to the opposite poles, forming the spindle as they go.

# Metaphase

- ★ The centrioles are now at opposite sides of the cell.
- ★ The spindle fibers will push and pull the chromosomes.
- ★ The chromosomes line up at the center of the cell called the metaphase plate.



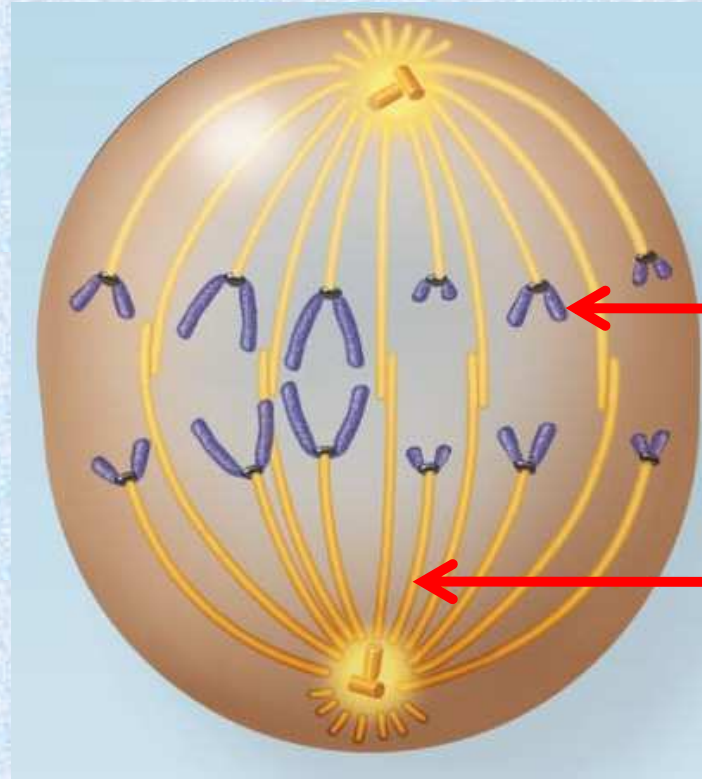
Each chromosome is connected to a spindle fiber at its centromere.



# Anaphase

The centromeres divide and the chromatids move to opposite sides of the cell.

The microtubules begin to shorten and this pulls the chromatids apart to opposite sides of the cell.



Chromatids are being pulled to opposite sides of the cell.

Shortening of the microtubules

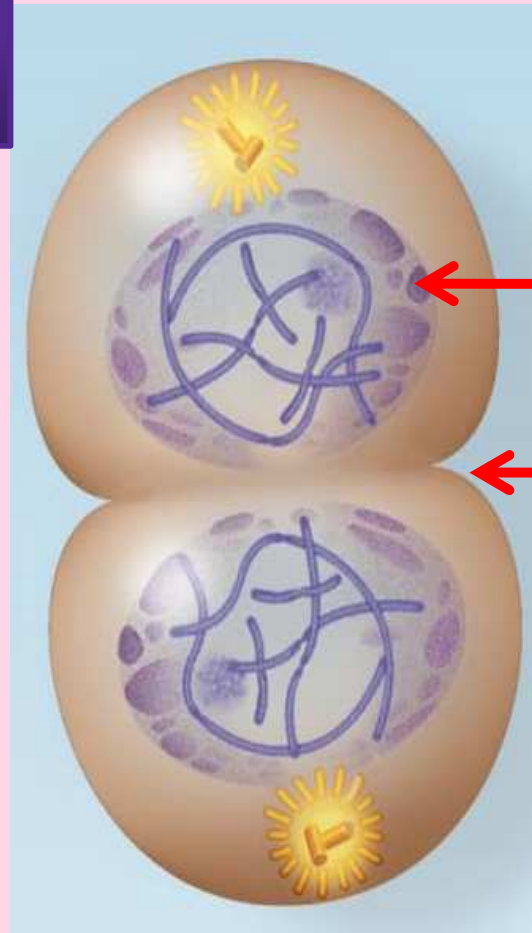
By the end of anaphase, the two ends of the cell have equivalent and complete sets of chromosomes.

# Telophase

Nuclear membrane begins to form.

Nucleolus returns.

The cell begins to pinch in. This is called a cleavage furrow.

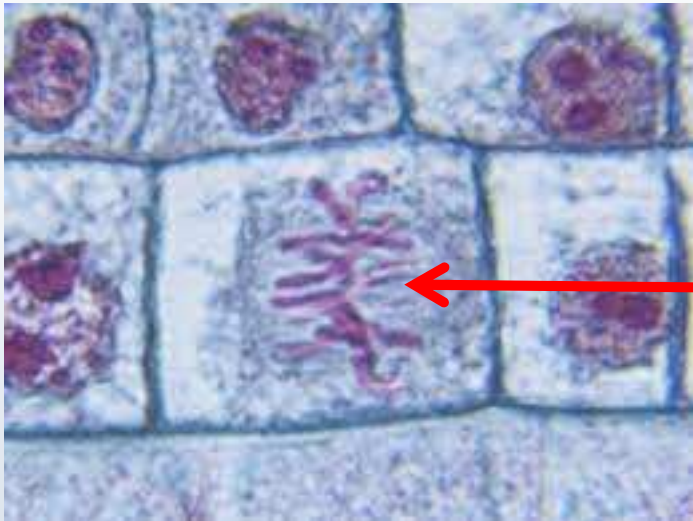


Nuclear membrane is returning.

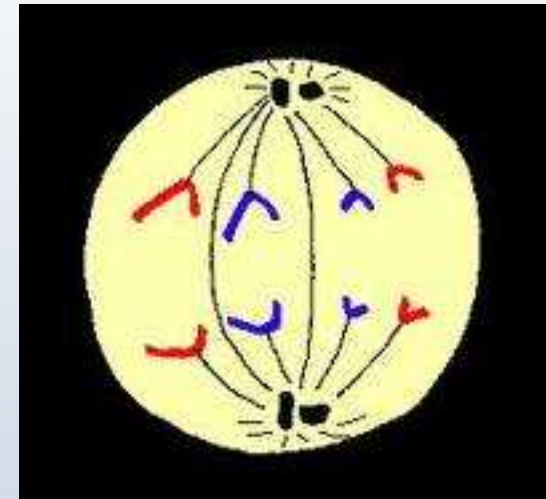
cleavage furrow

The end result is two cells that are exact copies of each other.

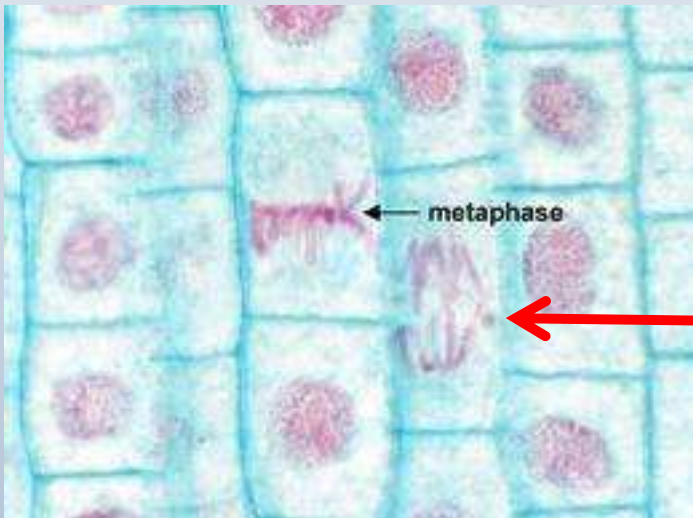
# Let's practice identifying the phases!



metaphase



anaphase

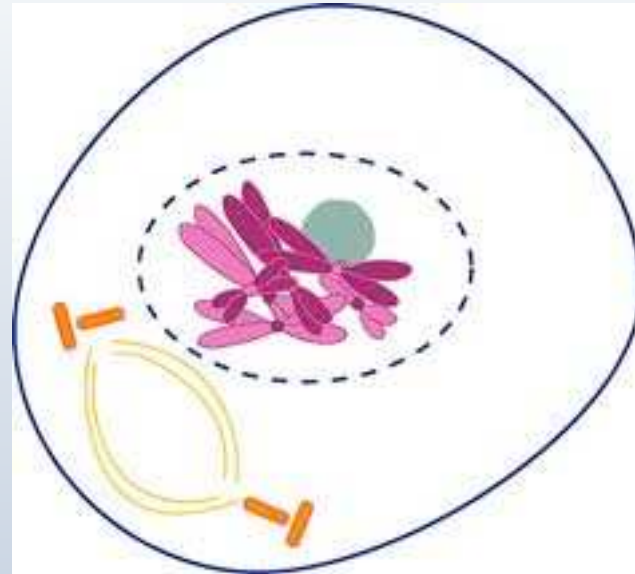


anaphase

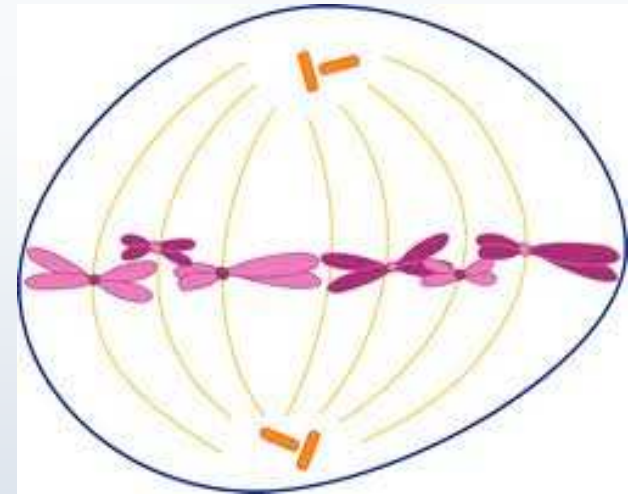
# Let's practice identifying the phases!



**Telophase**



**Prophase**

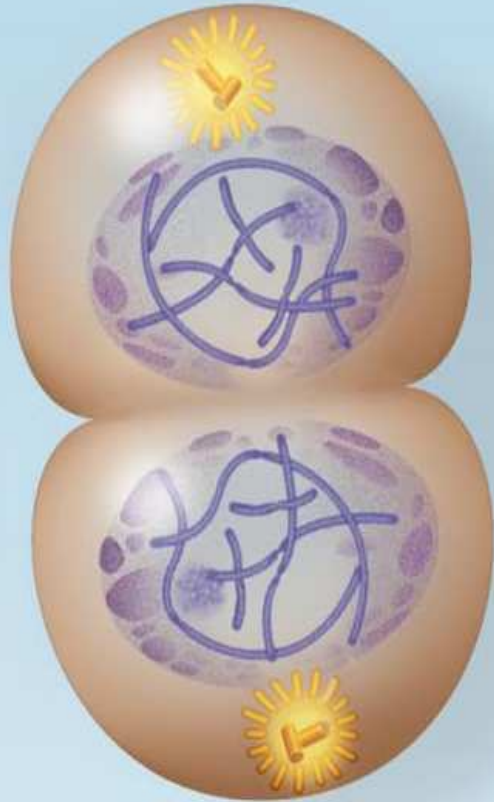


**Metaphase**

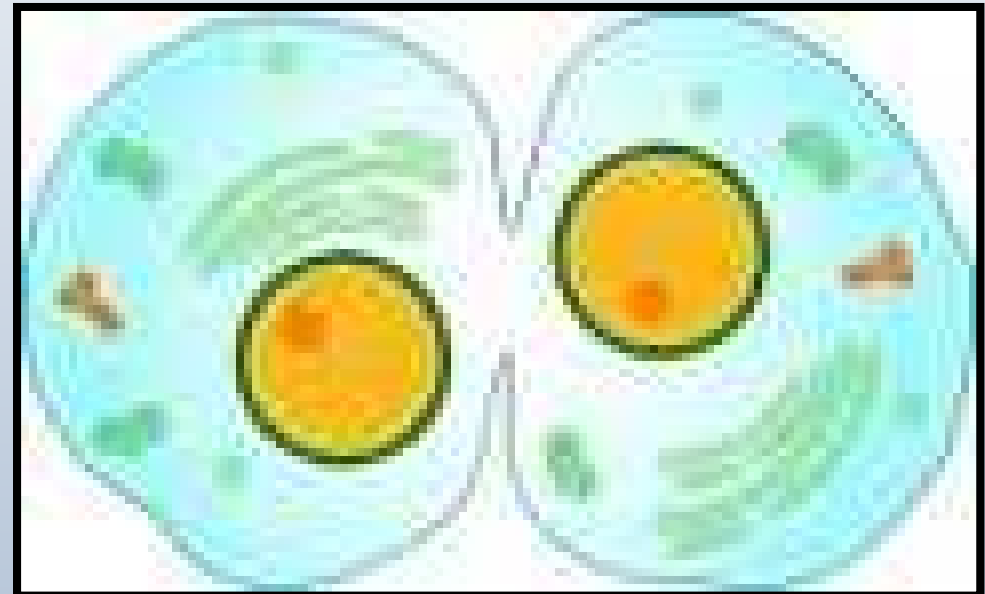
# Cytokinesis

At the end of mitosis, two nuclei have been formed. Each nucleus has an identical set of chromosomes.

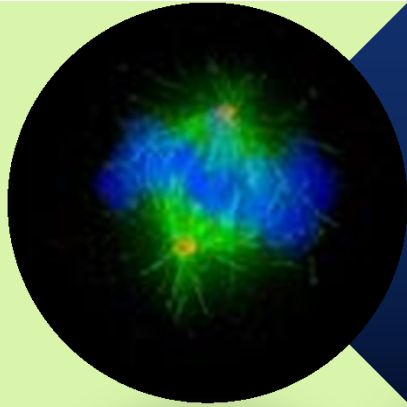
**Cytokinesis** is: the division of the cytoplasm.



**Cytokinesis usually occurs at the same time as telophase.**



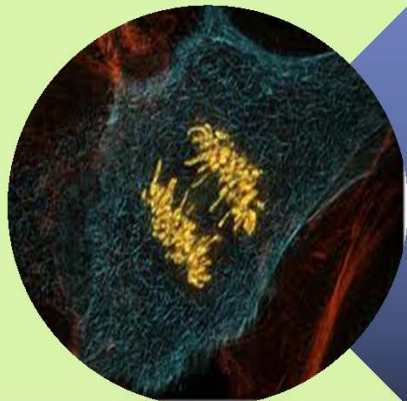
# M I T O S I S



Takes between 30 minutes and 2 hours.



One Mother Cell = Two Daughter cells.



The two daughter cells are identical to the mother cell.

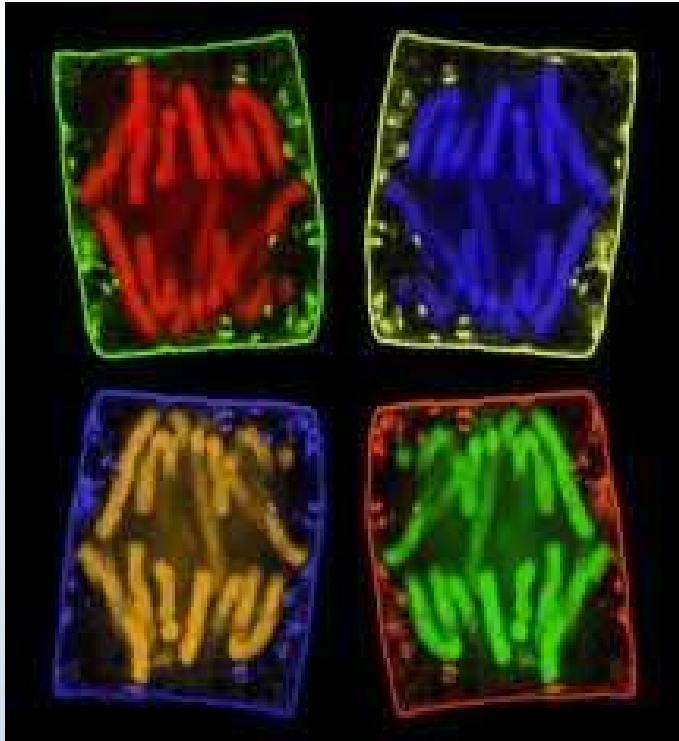
## Results of Mitosis

- In unicellular plants and animals, it results in new offspring by asexual reproduction.
- In multicellular organisms, it results in the growth and repair of the organism.

## Importance of Mitosis

- The two new cells are exact duplicates.
- Insures that the new cells will be able to carry on the same functions as the mother cell.

# Regulation of the Cell Cycle



The frequency of cell division varies with the type of cell.

Skin cells divide frequently throughout our lives.

Liver cells maintain the ability to divide but only do so on rare occasion - say to repair a wound.

The most specialized cells, such as muscle cells and nerve cells, do not divide at all.



# Controls on Cell Division



When cells come into contact with other cells, they respond by not growing.

When an injury, like a cut in the skin occurs, the cells at the edge of the injury begin to divide rapidly.



When the healing process nears completion, the rate of cell division slows down.

# Left Side Activity

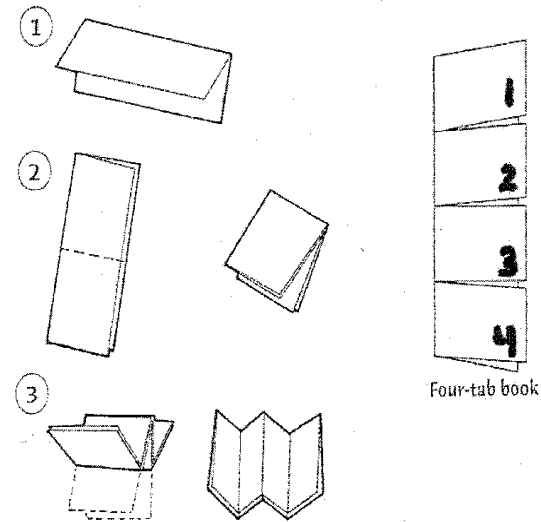
## Stages of Mitosis Foldable

Directions on how to make foldable:

### Four-Tab Book

1. Fold a sheet of paper (8 1/2" × 11") in half like a *hot dog*.
2. Fold this long rectangle in half like a *hamburger*.
3. Fold both ends back to touch the *mountain top* or fold it like an *accordion*.
4. On the side with two *valleys* and one *mountain top*, make vertical cuts through one thickness of paper, forming four tabs.

Use this book for data occurring in fours. For example: continental land, ocean shelf, ocean slope, and ocean floor.



#### Information on foldable:

**Tab 1** (outside)- Prophase

**Tab 1** (inside left)- List steps of prophase

**Tab 1** (inside right)- Draw, color and label prophase

**Tab 2** (outside)- Metaphase

**Tab 2** (inside left)- List steps of metaphase

**Tab 2** (inside right)- Draw, color and label metaphase

**Tab 3** (outside)- Anaphase

**Tab 3** (inside left)- List steps of anaphase

**Tab 3** (inside right)- Draw, color, and label anaphase

**Tab 4** (outside)- Telophase and Cytokinesis

**Tab 4** (inside left)- List steps of telophase and cytokinesis (animal and plant).

**Tab 4** (inside right)- Draw, color and label telophase and cytokinesis