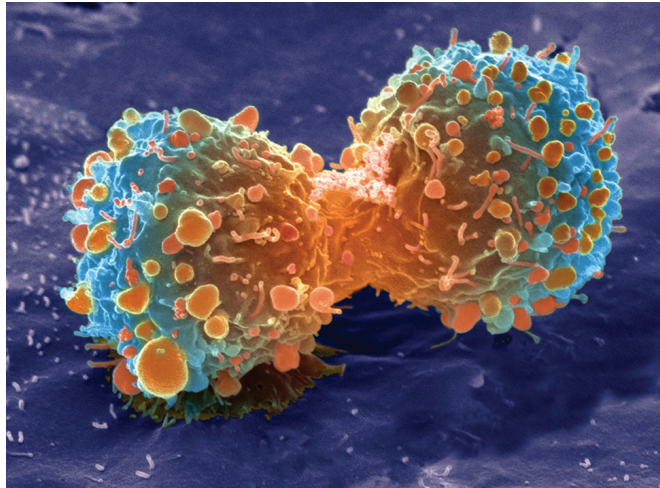


Ch. 5 Cell Growth & Division

Section 5.1 The Cell Cycle

Cells have distinct phases of growth, reproduction, and normal functions.



I. The Cell Cycle

*Cell Cycle = *is the sequence of growth and division of a cell.*

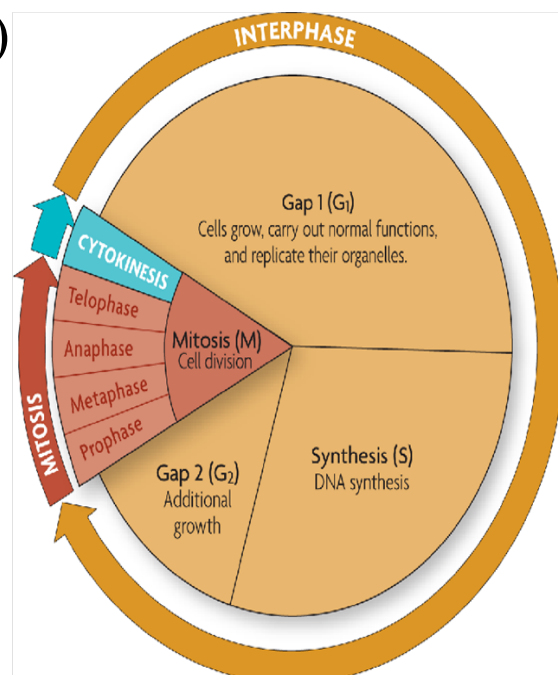
1. As a cell proceeds through its cycle, it goes through three **general** periods.
 - a. ***Interphase*** - period of growth
 - b. ***Mitosis*** - period of nuclear division
 - c. ***Cytokinesis*** - following mitosis the cytoplasm divides separating two daughter cells

II. Interphase: A Busy Time

- a. During interphase a cell grows in *size* and carries on *metabolism*.
- b. Chromosomes are *duplicated* in preparation for division.
- c. Interphase makes up the *bulk* of the cell cycle
- d. Interphase is divided into three stages.
 1. **Gap1 phase (G_1)** - the cell undergoes intense *growth*; centrioles, mitochondria or other *organelles replicate*,
 2. **Synthesis phase (S)** - *genetic material copied*
 3. **Gap2 phase (G_2)** - cell continues to grow & *prepares for division*

III. Mitosis (M) - includes *division of the cell nucleus* (mitosis) and division of the cell *cytoplasm* (cytokinesis)

- **Mitosis occurs only if the cell is large enough and the DNA undamaged.**



IV. Cells divide at different rates.

- The rate of *cell division varies with the need* for those types of cells.
- There are some cells are unlikely to divide (G_0), ex: white blood cells.

CELL TYPE	APPROXIMATE LIFE SPAN
Skin cell	2 weeks
Red blood cell	4 months
Liver cell	300–500 days
Intestine—internal lining	4–5 days
Intestine—muscle and other tissues	16 years

V. Cell Size Limitations

*Cells come in a wide variety of *sizes and shapes*.

Ex: **Red blood cells** only 8 μm (micrometers), **nerve cells** can reach up to one meter in length.

A. Diffusion limits cell size

*Within the cell, nutrients and wastes move by *diffusion*.

*Diffusion becomes *slow and inefficient* as the distances become *larger*.

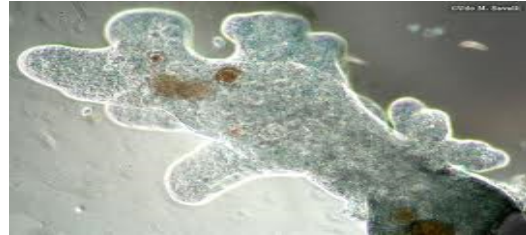
B. DNA limits cell size

* **Proteins** are used throughout the cell perform critical cell functions.

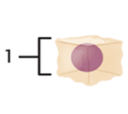
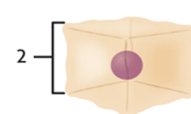

* There is a **limit** to how quickly these directions for protein production can be copied.

* In many larger cells there will be **more than one nucleus**.

Ex: *Pelomyxa*

**C. Surface area-to-volume ratio**

1. As a cell's size increases, its **volume** increases much faster than its **surface area**.
2. Because cell size can have a dramatic effect on a cell, cells divide before they become **too large to function properly**.

Relative size	1 []	2 []	3 []
Surface area (length × width × number of sides)	6	24	54
Volume (length × width × height)	1	8	27
Ratio of surface area to volume	$\frac{6}{1} = 6:1$	$\frac{24}{8} = 3:1$	$\frac{54}{27} = 2:1$

5.2 Mitosis & Cytokinesis

I. Cell Reproduction

*Cell division = *process by which new cells are produced from one cell.*

*Cell division results in two cells that are *identical* to the original parent cell.

Ex: Old cells on the soles of your feet are being shed and replaced.

A. The discovery of chromosomes

**Chromosomes* = cell structures that carry the genetic material that is copied and passed from generation to generation of cells.

1. Early biologists observed that just *before* cell division, several short stringy structures suddenly appeared in the nucleus.

2. These structures seemed to *vanish* soon after division of a cell.

3. These structures are called *chromosomes*.

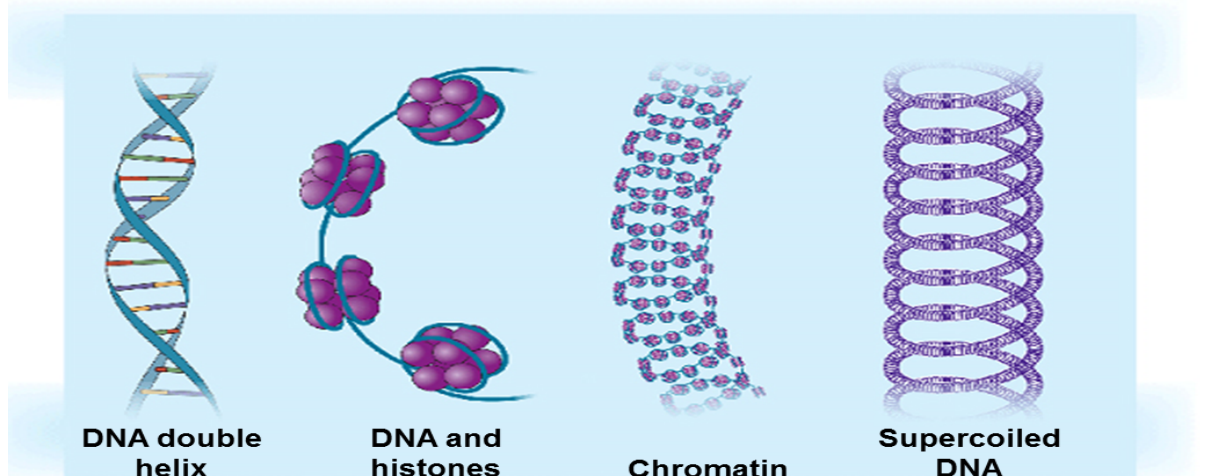
*Accurate transmission of chromosomes during cell division is *critical*.

B. The structure of eukaryotic chromosomes.

*For the most of a cell's lifetime, chromosomes exist as *chromatin*.

***Chromatin** = long strands of DNA wrapped around proteins called *histones*.

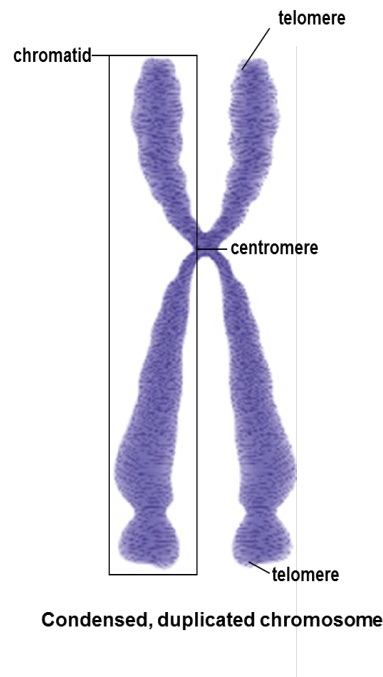
-The **chromosomes** of a eukaryotic cell undergo changes in *shape and structure during the different phases* of the cell cycle.



Add to notes:

Telomeres are at the ends of chromosomes & protect DNA; genes are not included.

Helps protect chromosomes from attaching to each other & losing needed genes.

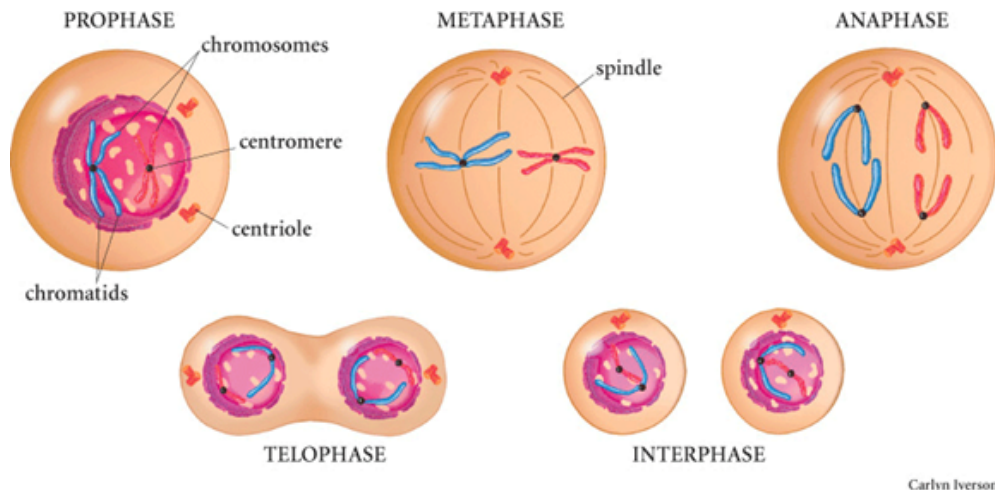
**II. The Phase of Mitosis**

*Following interphase, a cell enters its period of *nuclear* division

*This process by which two daughter cells are formed, each containing a *complete set of chromosomes*

*Although cell division is a *continuous* process, biologists recognize four distinct phases of mitosis.

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



A. Prophase: The first phase of mitosis

1. The chromatin *coils* to form visible chromosomes

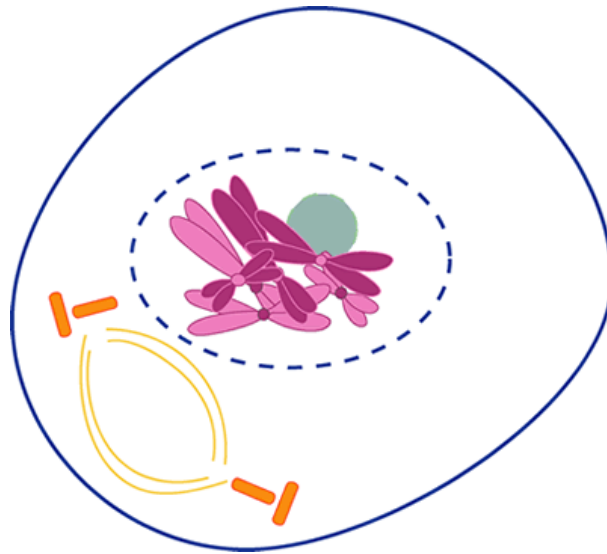
*Each *duplicated* chromosome is made up two halves.

*The two halves are called *sister chromatids*, and they are exact *copies* of each other.

*They are held together by a **protein** structure called a *centromere*, which help scientist identify chromosomes.

2. *Nucleus* begins to disappear (*nuclear envelope* and *nucleolus* disintegrate).

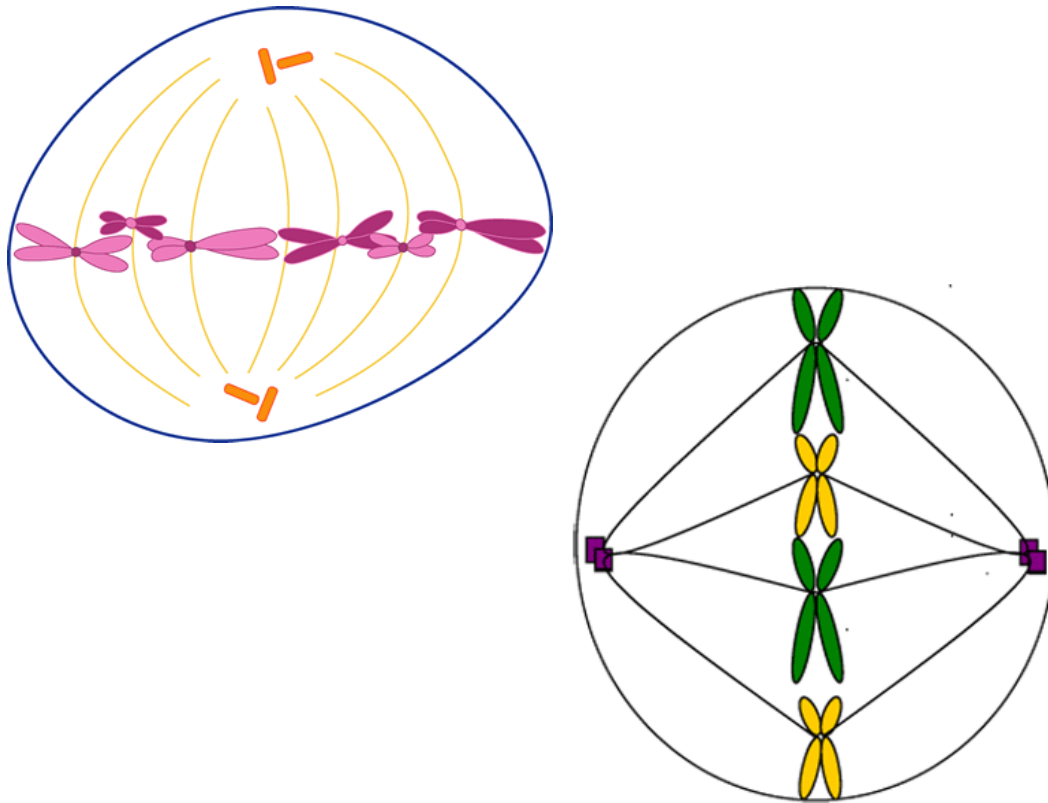
3. In animal cells the *centrioles* begin to migrate to opposite ends of the cell.
4. Spindle fibers begin to *appear* (in both plant and animal cells).



B. Metaphase: The second stage of mitosis

- a. Doubled chromosomes become attached to the spindle fibers by their *centromeres*.
- b. Chromosomes begin to line up on the midline, or *equator*.
- c. Each sister chromatid is attached to its own *spindle fiber*.

*This ensures that each new cell receives **an identical and *complete set of chromosomes***.

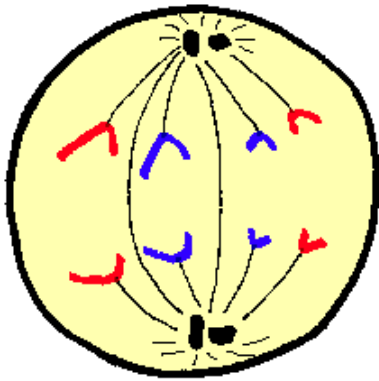


C. Anaphase: The third stage of mitosis

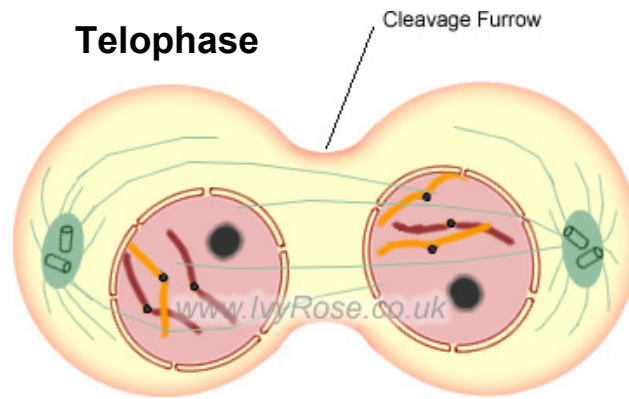
*The centromeres split and the sister chromatids are pulled apart to *opposite poles of the cell*.

D. Telophase: The fourth phase of mitosis

1. Spindle fibers start to break down, the *nucleolus* reappears and new *nuclear envelope* forms around each set of chromosomes.
2. A new membrane begins to form between the *two new nuclei*.



Anaphase

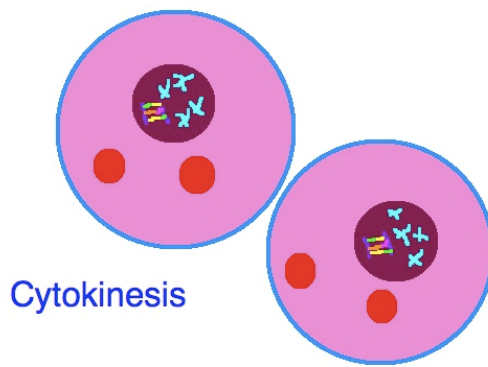


Telophase

III. Cytokinesis

*Cytokinesis differs between plants and animal.

1. Animal cells - *the plasma membrane pinches in and the two new cells are separated.*
2. Plant cells - the *cell plate* is laid across the cell's equator, a cell membrane forms around each cell and new *cell walls* form on each side of the cell plate.



STOP

IV. Results of Mitosis

*Levels of Organization in multicellular organisms.

1. In multicellular organisms cell growth and reproduction results in *groups of cells that work together as tissue*.
2. Tissues organize in various combinations to form *organs*.
3. Multiple organs that work together to form an *organ system*.
4. All organ systems work together for the *survival* of the organism.

Section 8.3 Control of the Cell Cycle

I. Normal Control of the Cell Cycle

*Some cells divide rapidly, while others divide slowly.

A. Proteins and Enzymes Control the Cell Cycle.

1. Proteins called *cyclins* and a set of *enzymes* that attach to the cyclin control the cell cycle.
2. Cancer = *is a result of uncontrolled cell division*.
3. The loss of control may be caused by *environment factors or by changes in enzyme production*.
4. Enzyme production is directed by *genes*, which are segments of DNA.

B. Cancer: A Mistake in the Cell Cycle

1. Currently, scientists consider cancer to be a result of changes in *one or more of the genes* that aid in controlling the cell cycle.
2. These changes are *expressed* as cancer when something prompts the damaged genes into *action*.
3. Cancerous cells *form masses of tissue called tumors*. If the cancer remains in one location and doesn't spread it is *benign*.
4. In later stages, cancer cells enter the *circulatory system* and spread throughout the body forming new tumors. This is when cancer is considered *malignant*.
5. *Metastasis* is the process by which cancer spreads, from the place at which it first arose, to distant locations in the body.

C. The Cause of Cancer

*It is difficult to pinpoint the cause of cancer because both *genetic and environmental* factors are involved.

Ex: environment factors include *cigarette smoke, air and water pollution, and exposure to ultraviolet radiation.*

D. Cancer Prevention

**Healthy diet and not using tobacco* are recommended to reduce the risk of cancer.

