

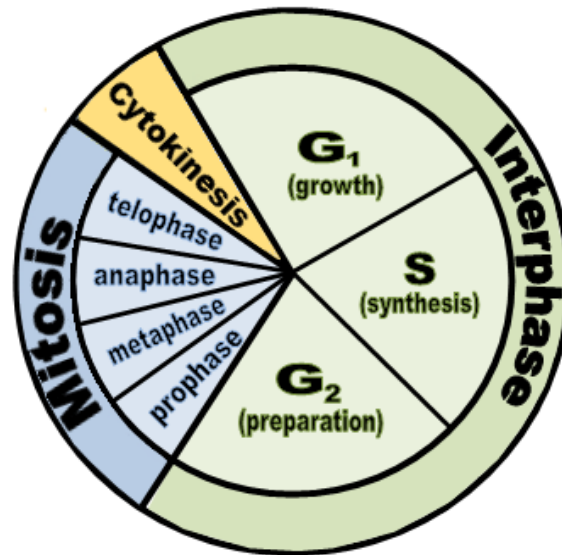


# Cell Growth and Reproduction

The Cell Cycle, Cell Division, and Meiosis

# The Cell Cycle

- The cell cycle includes the growth, replication and division of a eukaryotic cell



- ★ Note: The cell cycle includes mitosis, the **stages** of the cell cycle and mitosis are different!

# The Phases of the Cell Cycle

- Two main phases: **Interphase** and **M phase**
- Most of a cell's life is spent in **interphase**
- During **interphase** (S stage), the cell's chromosomes are copied but no cell division occurs

# Sample Question

Before a cell divides, what happens to the genetic information in that cell?

- A. The information is selectively mutated.
- B. The information is deleted.
- C. The information is completely changed.
- D. The information is duplicated.

# Answer: D

- Before a cell divides, the genetic information in that cell is **uplicated**.

This duplication occurs so that each of the two new cells receives all the necessary information to carry out its functions.

# The Phases of the Cell Cycle

- The first phase is **Interphase**:
  1.  $G_1$  = growth phase, preparation for DNA synthesis
  2. S = synthesis phase, DNA replication commences and proceeds until all the chromosomes have been replicated
  3.  $G_2$  = growth preparation for mitosis,  $G_2$  checkpoint that will stop process if not ready for mitosis

 Note: No cell division is occurring!

# Sample Question

During the cell cycle,

- A. DNA is replicated before mitosis begins.
- B. DNA is replicated directly after the completion of mitosis.
- C. DNA is replicated once before and once after mitosis.
- D. DNA is replicated during mitosis.

## Answer: A

- During the cell cycle, **DNA is replicated before mitosis begins**, in what is known as the S phase or synthesis phase.



# The Phases of the Cell Cycle

- The second phase is **M phase** – includes mitosis and cytokinesis
- Mitosis - the nucleus of a cell divides into two daughter nuclei that each contain the same number of chromosomes as the parent nucleus (only in eukaryotes because only eukaryotes have a nucleus!)
- Cytokinesis - the two nuclei are separated into two identical daughter cells

# Sample Question

The duck-billed platypus has 52 chromosomes in its body cells. When the platypus's body cells divide by mitosis, how many chromosomes will each daughter cell have?

- A. 52
- B. 104
- C. 156
- D. 26

# Answer: A

- Body cells undergo a type of division called mitosis. During mitosis, the daughter cells produced are identical to the parent cell. So, daughter cells resulting from mitosis in a duck-billed platypus will have **52** chromosomes.

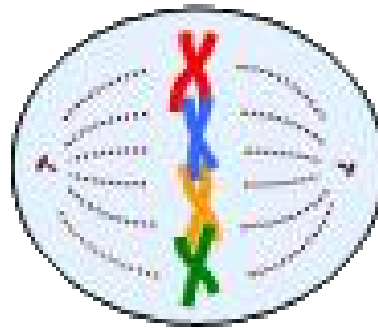
# Mitosis

- **Mitosis Begins:**
- **Prophase:** Genetic material (chromatin) condenses into rod-like structures called **chromosomes**



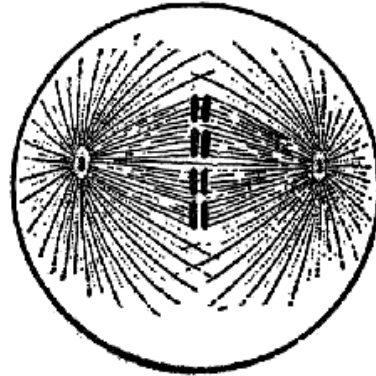
# Mitosis

- **Metaphase:** Chromosomes line-up along the equator of the cell.



# Sample Question

The diagram below represents a stage of mitosis in which the chromosomes line up in the middle of the cell.



What is the name of this phase of mitosis?

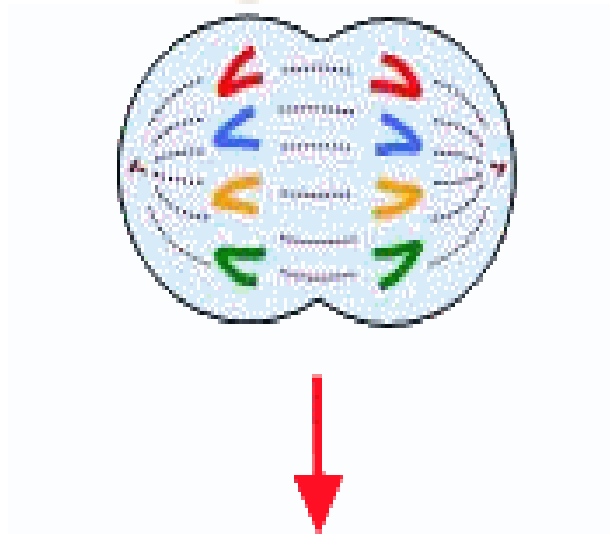
- A. metaphase
- B. anaphase
- C. telophase
- D. prophase

# Answer: A

- During *metaphase*, the pairs of sister chromatids line up in the middle of the cell.
- This question shows a diagram of **metaphase**.

# Mitosis

- **Anaphase:** Chromatids separate and move to opposite sides of the cell





# Sample Question

Which phase of mitosis is represented in the diagram below?



- A. prophase
- B. metaphase
- C. telophase
- D. anaphase

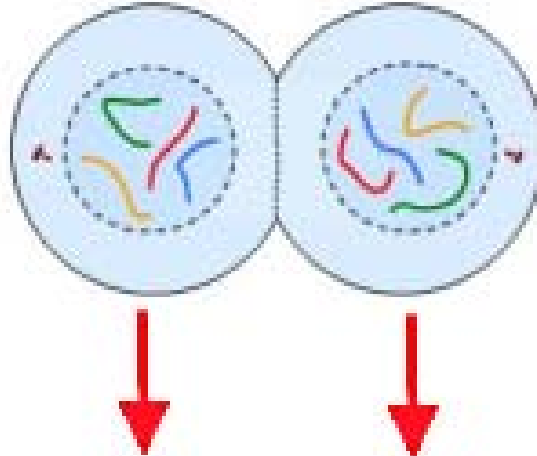
# Answer: D

- The diagram represents **anaphase**.

Anaphase is the stage of mitosis in which the chromosomes separate. This phase is preceded by prophase and metaphase and followed by telophase.

# Mitosis

- **Telophase:** A nuclear membrane forms around each set of chromosomes and mitosis is complete.



# Sample Question

Cellular reproduction in multicellular organisms occurs through the process of mitosis. What is the purpose of mitosis?

- A. to replace old cells such as red blood cells
- B. to form gametes (e.g. sperm and ova)
- C. to replace old chromosomes
- D. to form new somatic cells

# Answer: D

- Cellular reproduction in multicellular organisms occurs through the process of mitosis. The purpose of mitosis is **to form new somatic cells**. Somatic cells are those cells that form the body of an organism.

Germ cells (e.g. sperm and ova) are not somatic cells and are formed through the process of meiosis, not mitosis. Red blood cells also do not reproduce through mitosis because they do not have nuclei. Instead, red blood cells are produced by stem cells in bone marrow through a process called erythropoiesis.

# Cytokinesis

- During this stage of cell division the cytoplasm divides.
- In cells that lack a cell wall, the cell pinches in two. In cells that have a cell wall, a cell plate forms between the two new cells.
- The result is two identical daughter cells that are also identical to the parent cell.

# Sample Question

Cellular division involves the redistribution of the nuclear material, or DNA, as well as the cytoplasm and organelles. During which of the following processes is the cytoplasm and organelles divided?

I. cytokinesis

II. meiosis

III. mitosis

A. I only

B. I, II, and III

C. II only

D. III only

# Answer: A

- The nuclear material of a cell is divided during the processes of **mitosis** and **meiosis**.

The cytoplasm and the organelles of a cell are divided during the process of **cytokinesis**.



# Cell Division

- Key to growth, repair, and reproduction of organisms
- As a cell grows larger, its volume grows more rapidly than its surface area
- Cell division is triggered when cells become too large to import nutrients/export wastes efficiently
- As cells continue to divide they fill whatever medium they are in
- Once the cells have spread so that two cells contact each other, they signal to each other to stop dividing through a process called inhibition

# Meiosis

- Meiosis is a form of cell division in which a cell undergoes two successive nuclear divisions to produce **haploid** (N) daughter cells that contain only half of the species' usual number of chromosomes.
- These haploid cells are called **gametes**, or sex cells
- Meiosis is not directly involved in the cell cycle, it aids in sexual reproduction

# Sample Question

Which animal cell type undergoes meiosis?

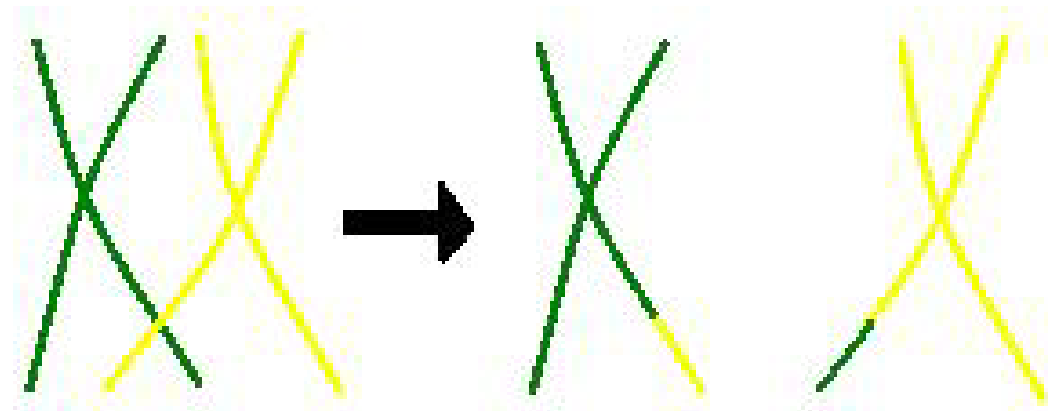
- A. heart cells only
- B. reproductive cells only
- C. non-reproductive cells only
- D. all cells

# Answer: B

- Meiosis is the process that **reproductive cells** undergo to reduce the number of chromosomes by half in order to produce a gamete, or sex cell.

# Genetic Variation

- During meiosis, crossing over can occur. Crossing over occurs during prophase I when two chromosomes pair up and *exchange parts of their DNA*.

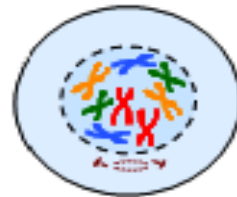


# Genetic Variation

- Genetic variation also occurs due to the random assortment of alleles
- Since each offspring receives a different combination of alleles from the parent organisms, phenotypic diversity (expression of genes) results.

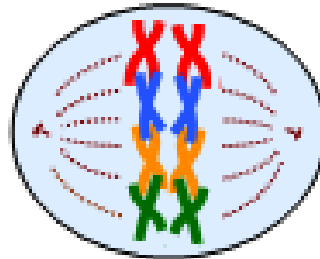
# The Stages of Meiosis

- Chromosomes are copied during interphase, *S phase*, prior to the start of meiosis.
- **Prophase I:** homologous chromosomes pair and become tetrads (two chromosomes or four chromatids).



# Meiosis

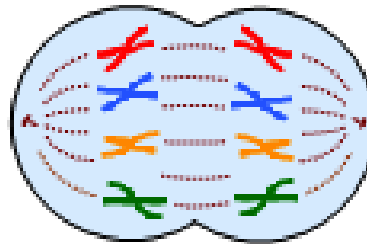
- **Metaphase I:** After crossing over occurs, homologous chromosomes line-up along the equator.





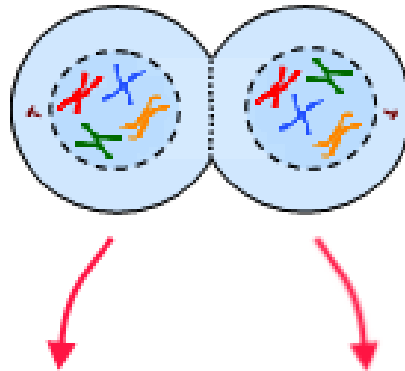
# Meiosis

- **Anaphase I:** Whole chromosomes separate from the tetrad formation and move to opposite sides of the cell. Each chromosome still has two sister chromatids.



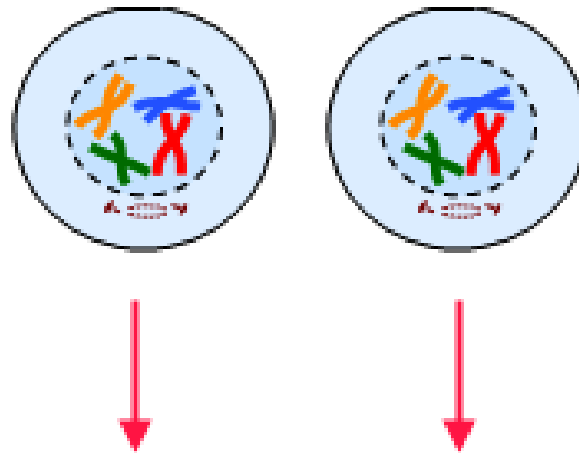
# Meiosis

- **Telophase I:** During telophase I, a nuclear membrane forms around each set of chromosomes. Each cell now has one set of chromosomes and is haploid (n).



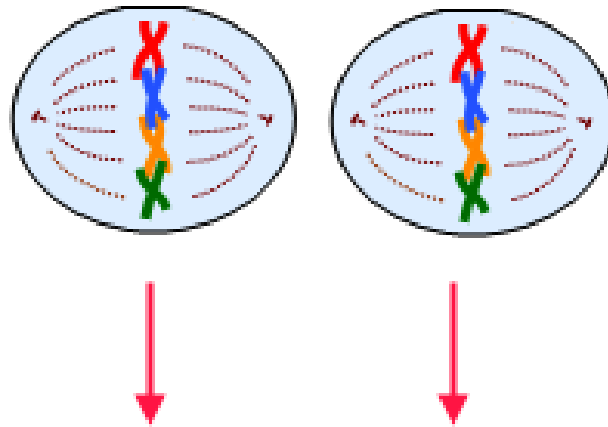
# Meiosis

- **Prophase II:** Sister chromatids become short and thick at the beginning of prophase II.



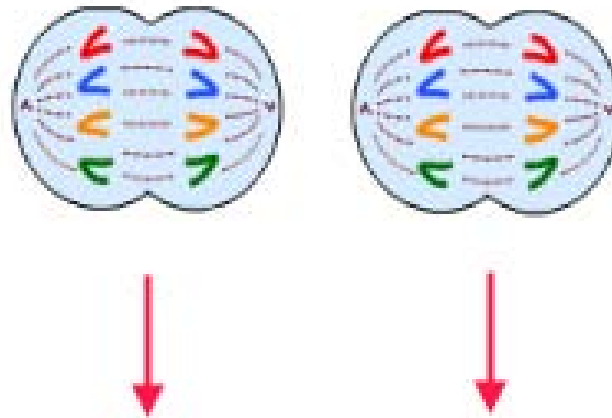
# Meiosis

- **Metaphase II:** The chromosomes migrate to the center of the nucleus and line-up along the equator by the end of metaphase II.



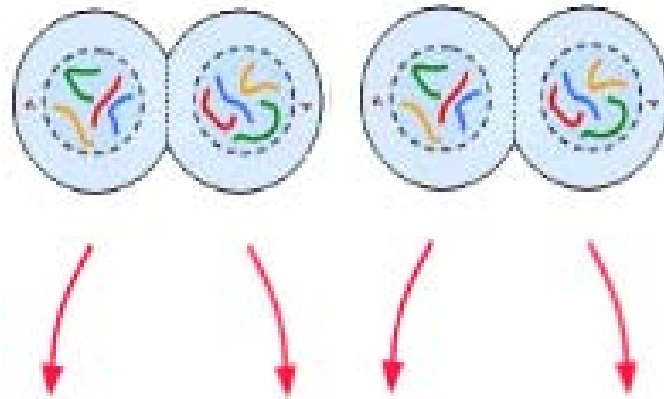
# Meiosis

- **Anaphase II:** During anaphase II, sister chromatids are pulled apart by microtubules to opposite poles.



# Meiosis

- **Telophase II:** A nuclear envelope forms around each set of chromosomes and meiosis II is complete.



# Cytokinesis

- The cells divide to create four haploid cells.



# Sample Question

Mitosis and meiosis are methods of cell division. Which of the following is true of these two methods?

- A. Meiosis involves two or more divisions, while mitosis involves exactly two divisions.
- B. Meiosis involves only one division, while mitosis involves two divisions.
- C. Mitosis involves only one division, while meiosis involves two divisions.
- D. Mitosis involves two or more divisions, while meiosis involves exactly two divisions.



# Answer: C

- Although mitosis and meiosis are both methods of cellular division, **mitosis involves only one division, while meiosis involves two divisions.** After mitosis there are two cells, each the same as the original cell. After meiosis there are four cells, each with half the number of chromosomes of the original cell.