Mitosis and Meiosis
Presented by Kesler Science
Essential Questions:
1. What are mitosis and meiosis?
2. What occurs at different phases in cell division?
3. How are mitosis and meiosis similar and different?
Cell

- Smallest structural and functional unit of an organism
- Somatic cells are any cells other than germ cells
  - Found throughout the body
  - Contain 46 chromosomes in humans
- Germ cells contain half the number (23) of chromosomes
  - Only found in the ovaries and testes (sex organs)
Cell Division

Two types

1. **Mitosis** in somatic cells results in cells **exactly the same** as the parent cell. Involves one “set” of division stages.

2. **Meiosis** in germ cells results in a variety of **genetically different offspring**. Involves two “sets” of division stages (Meiosis I & II).
Copy the table and complete it

<table>
<thead>
<tr>
<th>Somatic Cells</th>
<th>Germ Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Reproduction ??</td>
<td>Type of Reproduction ??</td>
</tr>
<tr>
<td>Found where??</td>
<td>Found where??</td>
</tr>
<tr>
<td>Same or different from parent??</td>
<td>Same or different from parent??</td>
</tr>
<tr>
<td>Number of chromosomes in humans??</td>
<td>Number of chromosomes in humans??</td>
</tr>
<tr>
<td>Number of Stages?</td>
<td>Number of Stages?</td>
</tr>
</tbody>
</table>
Vocabulary

- **Chromosome** – tightly packed DNA found only during cell division
- **Chromatin** – unwound DNA
- **Chromatids** – each of 2 thread-like strands into which a chromosome divides during mitosis
- **Sister Chromatids** – 2 identical copies of a chromatid
- **Centromere** – a structure in a chromosome that holds the two chromatids together
Mitosis and Meiosis

Vocabulary

- **Spindle Fibers** – control the movement and separation of chromosomes during mitosis
- **Centriole** – helps in the formation of spindle fibers
- **Nuclear Envelope** – a membrane that separates the nucleus from the cytoplasm in eukaryotic cells
Mitosis and Meiosis

**Mitosis**
- Used for cell growth
- Asexual reproduction
  1. Binary Fission
  2. Budding
  3. Regeneration
  4. Vegetative Reproduction
  5. Fragmentation
  - Examples: some types of jellyfish, worms, and plants
Mitosis

• Four basic phases
  1. Prophase
  2. Metaphase
  3. Anaphase
  4. Telophase

• Occurs in a strict sequential order called the cell cycle

• Produces diploid cells (2) – same genetic makeup as parent cell

Mitosis and Meiosis

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Do Something

1. With a partner draw a quick diagram of chromatids, sister chromatids and a centriole.

2. Review the types of asexual reproduction and the offspring they produce.

3. List the four basic phases of the mitosis cell cycle. What is always true in any cycle?
Mitosis and Meiosis

Prophase

• First phase of mitosis
• Chromosomes become visible through a microscope.
• Spindles begin to form.
• Nuclear membrane disappears.
• Centrioles begin moving toward the poles.
• The chromosomes replicate and are seen as a pair of sister chromatids.
Metaphase

- Second phase of mitosis
- The chromosomes, guided by the spindle fibers, line up in the middle of the dividing cell.
- The centrosomes are at opposite ends (poles) of the cell.

Centrosome - an organelle near the nucleus of a cell that contains the centrioles (in animal cells) and from which the spindle fibers develop in cell division.
Anaphase

• Third phase of mitosis
• The two sister chromatids of each chromosome are pulled apart by the spindle fibers.
• Chromosomes move away from each other toward the poles.
• The cell elongates so that the poles are farther apart.
Telophase

• The last stage of mitosis.
• The chromosomes have reached the poles.
• Two new nuclear envelopes form around each of the two separated sets of unreplicated chromosomes.
• The cell has divided into two daughter cells exactly like the parent cell.
Mitosis and Meiosis

Interphase

• Mitosis is now over.
• Chromatin is unwound
• Here the cell grows in preparation for another round of cell division.
• Note the position of the centrioles.
• One complete cell cycle has occurred.
Quick Action – Mitosis and Meiosis

Find a partner on the other side of the room. Answer these questions orally.

In which phase of mitosis...

1. has the cell divided into two daughter cells?
2. do the chromosomes replicate themselves?
3. do the chromosomes line up in the middle of the cell?
4. do the chromosomes move toward the poles?

PMAT is a way of remember the phase order.
Meiosis

- This cell division occurs in two sets of stages, Meiosis I and II.
- Reduces the number of chromosomes in the parent cell by half.
- Produces four gamete cells (sex cells).
- Meiosis is required to produce egg and sperm cells for sexual reproduction.
Vocabulary

- **Homologous Chromosomes** – During meiosis, there is one paternal and one maternal chromosome pair inside a cell.

- **Crossing Over** – The process where homologous chromosomes pair up and exchange genetic material to form new chromosomes.

- **Haploid Cells** – Four cells as a result of meiosis, which are genetically different from each other and the parent cells.
Quick Action – Mitosis and Meiosis

Draw

Make a quick drawing of homologous chromosome pair crossing over. What does this tell you about the genetic makeup of the four gametes (sex cells – sperm or egg)?
Meiosis I – Prophase I

- First phase of Meiosis I
- Chromosomes become visible under a microscope.
- Duplication of homologous chromosome pair and cross-over occurs.
- Nuclear envelope disappears.
- Spindles enter nucleus.

This shows the crossing-over process, which occurs in the nucleus.
Meiosis I – Metaphase I

• Crossover is complete
• Chromosomes move toward the center and line up.
• Spindle fibers attach to the centromere of each chromosome.
Meiosis I – Anaphase I

- Cell starts to lengthen
- Two of each chromosome pairs separate and are pulled by the spindle fibers toward opposite poles
- In meiosis the chromatids remain together
- Contrast with mitosis, where sister chromatids separate
Meiosis I – Telophase I

• Complete haploid (4) sets of chromosomes
• A cleavage furrow appears
• By the end of the stage the parent cell has divided into two daughter cells.
• This separation of cytoplasm is called cytokinesis.
Interkinesis in Meiosis

- A period of rest called interkinesis
- No replication of DNA occurs during this phase.

Daughter cells
Quick Action – Mitosis and Meiosis

Find a partner on the other side of the room.
Answer these questions orally.
In which phase of meiosis...
1. is the cytoplasm divided by cytokinesis?
2. does the nuclear envelope begin to disappear?
3. do the chromosomes line up in the middle of the cell?
4. do the chromatids remain together instead of separate?

PMAT
Mitosis and Meiosis

Meiosis II – Prophase II
• First step in Meiosis II
• Begins with two daughter cells from Meiosis I.
• Chromosomes are condensed.
• Nuclear envelope begins to break down.
• Centrosomes have replicated and are moving toward the poles.

If you remember Mitosis, Meiosis II is a piece of cake.

Notice there are two cells now from Meiosis I.
Meiosis II – Metaphase II

- The second stage of Meiosis II
- The spindles draw the chromosomes to the center plate.
- The centromeres are bound to the spindle fibers from opposite sides.

Chromosomes line up **RANDOMLY** in the middle of each cell.
Meiosis II – Anaphase II

• The third step of Meiosis II
• Very similar to mitosis anaphase
• The two sister chromatids of each chromosome are pulled apart by the spindle fibers.
• Chromosomes move away from each other toward the poles.
• The cell elongates so that the poles are farther apart.
Mitosis and Meiosis

Meiosis II – Telophase II

• Chromosomes reach opposite poles.
• Cytokinesis occurs (separation of cytoplasm) and nuclear envelopes form.
• Meiosis is complete with four daughter cells (haploid) each different from each other and different from the parent cell.
Summary of Meiosis

- Form of cell division that results in half the number of chromosomes in gametes or sex cells (sperm and ova)
- Maintains the same number of chromosomes from generation to generation.
- Results in an assortment of genetic material passed on to offspring.
## Mitosis and Meiosis

### Comparison of Mitosis and Meiosis

<table>
<thead>
<tr>
<th></th>
<th>Mitosis</th>
<th>Same for Both</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happens in body cells</td>
<td>A type of cell division</td>
<td></td>
<td>Happens in sex organs (testes and ovaries)</td>
</tr>
<tr>
<td>One stage of division</td>
<td>Replicates DNA</td>
<td></td>
<td>Two stages of divisions (Meiosis I and II)</td>
</tr>
<tr>
<td>Create diploid cells (2)</td>
<td>Creates new cells</td>
<td></td>
<td>Creates haploid cells (4)</td>
</tr>
<tr>
<td>New cells are genetically the same as the parent cells</td>
<td></td>
<td></td>
<td>New cells are not genetically the same as each other or the parent cell</td>
</tr>
<tr>
<td>No genetic diversity</td>
<td></td>
<td></td>
<td>Increases genetic diversity</td>
</tr>
</tbody>
</table>
Can you…

1. Define mitosis and meiosis?
2. Identify what occurs at the different phases in cell division?
3. Recognize the similarities and differences between mitosis and meiosis?