Section: Meiosis

Read the passage below. Then answer the questions that follow.

Meiosis is a form of cell division that halves the number of chromosomes when forming specialized reproductive cells, such as gametes or spores. Meiosis involves two divisions of the nucleus—meiosis I and meiosis II.

The stages of meiosis I are as follows:

**Prophase I:** The chromosomes condense, and the nuclear envelope breaks down. Homologous chromosomes pair along their length and then cross over.

**Metaphase I:** The pairs of homologous chromosomes are moved by the spindle to the equator of the cell. The homologous chromosomes, each made up of two chromatids, remain together.

**Anaphase I:** The homologous chromosomes separate. As in mitosis, the chromosomes of each pair are pulled to opposite poles of the cell by the spindle fibers. But in meiosis, the chromatids do not separate at their centromeres.

**Telophase I:** Individual chromosomes gather at each of the poles. In most organisms, the cytoplasm divides, forming two new cells.

**SKILL: READING EFFECTIVELY**

Match each statement with the stage of meiosis I it describes by writing in the spaces provided, PI to represent Prophase I, MI to represent Metaphase I, AI to represent Anaphase I, or TI to represent Telophase I.

1. cytoplasm divides
2. nuclear envelope breaks down
3. homologous chromosomes separate
4. spindle moves homologous chromosomes to the cell's equator
5. crossing-over occurs
6. two new cells form
7. homologous chromosomes move to opposite poles of the cell
8. chromosomes condense
Read the passage below. Then answer the questions that follow.

The stages of meiosis II are as follows:

**Prophase II:** A new spindle forms around the chromosomes.
**Metaphase II:** The chromosomes line up along the equator, attached at their centromeres to spindle fibers.
**Anaphase II:** The centromeres divide, and the chromatids (now called chromosomes) move to opposite poles of the cell.
**Telophase II:** A nuclear envelope forms around each set of chromosomes. The spindle breaks down, and the cell undergoes cytokinesis. The result of meiosis is four haploid cells.

Match each statement with the stage of meiosis II it describes by writing in the spaces provided, PII to represent Prophase II, MII to represent Metaphase II, AII to represent Anaphase II, or TII to represent Telophase II.

1. centromeres divide
2. new spindle forms
3. cell undergoes cytokinesis
4. chromosomes line up at equator
5. spindle breaks down
6. chromosomes move to opposite poles of the cell
7. four haploid cells form

In the space provided, write the letter of the term or phrase that best completes the statement.

Between meiosis I and meiosis II, chromosomes do NOT

a. replicate.
b. change position.
c. divide.
d. Both (a) and (b)
SEQUENCING/ORGANIZING INFORMATION

In the space provided in the figure below, write the letter of the stage of meiosis from the list below (a–h) that matches each stage in the figure.

1. G  
2. B  
3. C  
4. F  
5. H  
6. D  
7. A  
8. E  

**Stages of Meiosis**

- a. anaphase II
- b. metaphase I
- c. anaphase I
- d. metaphase II
- e. telophase II and cytokinesis
- f. telophase I and cytokinesis
- g. prophase I
- h. prophase II

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Holt Biology 13 Meiosis and Sexual Reproduction
In the space provided, write the letter of the description that best matches the stage of meiosis.

9. metaphase I  a. A new spindle forms around the chromosomes.
10. prophase II  b. Chromatids remain attached at their centromeres as the spindle fibers move the homologous chromosomes to opposite poles of the cell.
11. telophase I  c. A nuclear envelope forms around each set of chromosomes, the spindle breaks down, and the cytoplasm divides, resulting in four haploid cells.
12. metaphase II  d. Chromosomes gather at the poles; the cytoplasm divides.
13. telophase II  e. The nuclear envelope breaks down; genetic material is exchanged through crossing-over.
14. anaphase II  f. Chromosomes line up at the equator.
15. prophase I  g. Pairs of homologous chromosomes line up at the equator.
16. anaphase I  h. Centromeres divide, enabling the chromatids, now called chromosomes, to move to opposite poles of the cell.
COMPARING MITOSIS AND MEIOSIS

Determine whether the following characteristics apply to mitosis, meiosis or both by putting a check in the appropriate column(s).

<table>
<thead>
<tr>
<th></th>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>no pairing of homologs occurs</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>two divisions</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>four daughter cells produced</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>associated with growth and asexual reproduction</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>associated with sexual reproduction</td>
<td>✓</td>
</tr>
<tr>
<td>6.</td>
<td>one division</td>
<td>✓</td>
</tr>
<tr>
<td>7.</td>
<td>two daughter cells produced</td>
<td>✓</td>
</tr>
<tr>
<td>8.</td>
<td>involves duplication of chromosomes</td>
<td>✓</td>
</tr>
<tr>
<td>9.</td>
<td>chromosome number is maintained</td>
<td>✓</td>
</tr>
<tr>
<td>10.</td>
<td>chromosome number is halved</td>
<td>✓</td>
</tr>
<tr>
<td>11.</td>
<td>crossing over between homologous chromosomes may occur</td>
<td>✓</td>
</tr>
<tr>
<td>12.</td>
<td>daughter cells are identical to parent cell</td>
<td>✓</td>
</tr>
<tr>
<td>13.</td>
<td>daughter cells are not identical to parent cell</td>
<td>✓</td>
</tr>
<tr>
<td>14.</td>
<td>produces gametes</td>
<td>✓</td>
</tr>
<tr>
<td>15.</td>
<td>synapsis occurs in prophase</td>
<td>✓</td>
</tr>
</tbody>
</table>
1. The chart below shows the steps of mitosis and meiosis in the correct order. Complete the chart by answering the questions beside the diagrams.

<table>
<thead>
<tr>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
<tr>
<td><img src="image3" alt="Diagram" /></td>
<td><img src="image4" alt="Diagram" /></td>
</tr>
<tr>
<td><img src="image5" alt="Diagram" /></td>
<td><img src="image6" alt="Diagram" /></td>
</tr>
<tr>
<td><img src="image7" alt="Diagram" /></td>
<td><img src="image8" alt="Diagram" /></td>
</tr>
</tbody>
</table>

### Mitosis Questions

a. Where are the chromosomes? **In the nucleus**
b. How many are present in each cell? **4**
c. What happened to the chromosomes in each diagram? **They replicated**
d. What part has faded away? **Nuclear membrane**
e. Where have the chromosomes moved? **Middle**
f. What guides the chromosomes as they move? **Spindle fibers + centrioles**
g. What cell part begins to form in mitosis? **Nuclear membrane**
h. How many cells are present in mitosis? **2**
i. How many chromosomes are in each of those cells? **4**

### Meiosis Questions

j. What happens in meiosis now? **The chromosomes are pulled apart**
k. Did the chromosomes double? **No**

l. How many cells are formed in meiosis? **4**
m. How many chromosomes are in each of those cells? **2**

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**What is the difference between the way the chromosomes line up in step 3 of mitosis + meiosis?**

- **Line up in parts**
  - Chromosomes
  - Homologous crossing over
- **Line up in parts**
  - Crossing over
  - Occurs in meiosis
<table>
<thead>
<tr>
<th>Name of Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prophase 1</td>
<td>Homologous chromosomes pair up and form tetrad</td>
</tr>
<tr>
<td>Anaphase 1</td>
<td>Spindle fibers move homologous chromosomes to opposite sides</td>
</tr>
<tr>
<td>Telophase 2</td>
<td>Nuclear membrane reforms, cytoplasm divides, 4 daughter cells formed</td>
</tr>
<tr>
<td>Metaphase 2</td>
<td>Chromosomes line up along equator, not in homologous pairs</td>
</tr>
<tr>
<td>Prophase 1</td>
<td>Crossing-over occurs</td>
</tr>
<tr>
<td>Anaphase 2</td>
<td>Chromatids separate</td>
</tr>
<tr>
<td>Metaphase 1</td>
<td>Homologs line up alone equator</td>
</tr>
<tr>
<td>Telophase 1</td>
<td>Cytoplasm divides, 2 daughter cells are formed</td>
</tr>
<tr>
<td>Prophase 2</td>
<td>(after cytokinesis)</td>
</tr>
<tr>
<td>Telophase 2</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of Phases of Meiosis](image)
1. What type of cell undergoes meiosis? **Gamete cells** or Somatic/body cells

2. What are homologous chromosomes?

   Each chromosome carries the same genes but not identical

3. For each of the following state if the cell is haploid or diploid.
   Sperm cell = **H**  Liver cell = **D**  Egg cell = **H**  Stomach cell = **D**

4. If the diploid number in a liver cell is 52, how many chromosomes are there in the egg of this organism? **26**

5. During meiosis, the chromosome number:
   a) is doubled  b) is reduced  c) remains the same  d) becomes diploid

6. Cells starting mitosis & meiosis begin with a (haploid or diploid) set of chromosomes.
   **Diploid**

7. How many times do cells divide during meiosis? **2**

8. What are the stages of meiosis called
   Meiosis I: **P1** **M1** **A1** **T1** / cytokinesis
   Meiosis II: **P2** **M2** **A2** **T2** / cytokinesis

9. Draw a tetrad: What phase do you first see this in?
   **XX - Prophase I**

10. Which of the following best describe the term "crossing over"?
    a.) An exchange of information between two homologous chromosomes
    b.) A molecular interaction between two sister chromatids
    c.) A molecular interaction between two non-sister chromatids
    d.) A separation of two sister chromatids

11. Crossing-over can be found in the stage of
    a) Prophase I  b) Prophase II  c) Anaphase I  d) Anaphase II

12. Which letter in figure #2 represents meiosis? Why?
    **D** - divides into 4 haploid cells

13. Which letter in figure #2 represents mitosis? Why?
    **A** - divides into 2 identical cells

14. Is DNA copied before Melosis II? **Yes**

15. How many cells form at the end of Meiosis II and how many chromosomes do they contain? **4 cells, half the chromosomes**
16. A sperm cell is a (gamete, zygote), and is (haploid, diploid).

**Gamete, haploid**

17. When a sperm cell and an ovum/egg merge, they undergo the process of fertilization, and give rise to a (gamete, zygote), which is (haploid, diploid).

**Zygote, diploid**

18. What is the ultimate goal/purpose of mitosis? What term do we use to describe the new cells?

Used for growth and repair - daughter cells (clones)

19. Describe cancer.

Abnormal cell growth (mitosis)

20. What is a centromere?

Holds sister chromatids together

21. What is the difference between a haploid, diploid, and zygote?

<table>
<thead>
<tr>
<th></th>
<th>Haploid:</th>
<th>Diploid:</th>
<th>Zygote:</th>
</tr>
</thead>
<tbody>
<tr>
<td># Chromosomes</td>
<td>1/2</td>
<td>Full # of chromosomes</td>
<td>46</td>
</tr>
<tr>
<td>Sperm + Egg</td>
<td>Fertilization</td>
<td>46</td>
<td></td>
</tr>
</tbody>
</table>

22. How does Meiosis differ from Mitosis?

**Meiosis** makes 4 sex cells

**Mitosis** makes 2 identical body cells

23. What does Meiosis create? Haploids or Diploids? Somatic/body cells or gametes?

→ Haploid gametes

24. What is a gamete? How do we represent the chromosome number: 2n or n?

→ Sex cell - sperm or egg

n

25. What is crossing over? When does it happen? Draw a picture.

→ Exchange of genes between homologous chromosome

- Prophase I

↔ ↔ → ↔ ↔