Name _____ Date _____

Simulating Meiosis

Lab 29

Background

Gametes, the cells which join together during sexual reproduction in animals and begin the formation of a new individual, each contain a single set of chromosomes. When a male and a female gamete unite, forming a *zygote*, the two single sets of chromosomes come together, forming pairs of chromosomes. Thus the cells of the newly formed animal contain pairs of chromosomes, with one member of each pair from the male parent and the other from the female parent. These pairs of chromosomes are called *homologous chromosomes*, meaning that they are similar but not identical.

Somatic cells, or body cells (in general, all cells except gametes), contain homologous pairs of chromosomes. Somatic cells are *diploid* —they have two complete sets of chromosomes. The normal number of chromosomes in a somatic cell is called the *diploid number*, and is abbreviated as *2n*.

When the new individual prepares for sexual reproduction, gametes must be formed once again. Cells with a diploid number of chromosomes must form cells having only one chromosome from each homologous pair. Thus cells having a diploid number of cells give rise to cells having a *haploid number*, or *n* chromosomes. The cell division that forms gametes, halving the number of chromosomes per cell, is called *meiosis*.

Objectives

In this activity you will:

1. Illustrate the movement of chromosomes during meiosis.
2. Demonstrate, by means of a flip book, the separation of homologous chromosomes in meiosis.

Materials

2 handout sheets
lead pencil
2 contrasting color pencils
scissors
paper punch
paper fasteners

Procedures and Observations

Each species has a characteristic number of chromosomes. For example, a cat has 19 pairs of chromosomes, a mosquito has 3 pairs of chromosomes, and a human has 23 pairs of chromosomes. Thus the diploid number for a cat is 38, 6 for a mosquito, and 46 for a human.

For ease in understanding, this lab activity will use a cell that has only three pairs of chromosomes.

1. Examine Figure 1. Notice that each pair of homologous chromosomes is made up of a dark chromosome and a light chromosome—the dark color represents the chromosome from the male

parent and the light color represents the chromosome from the female parent. The letters on the chromosomes stand for genes. Notice that each pair of chromosomes carries a particular set of genes; that the same genes are found on each chromosome in a pair; and that a full set of genes, a–s, is contributed by each parent. The centromere of each chromosome is indicated by an asterisk (*). In this figure, and throughout this lab activity, each pair of chromosomes is a different length to make them easily identifiable.

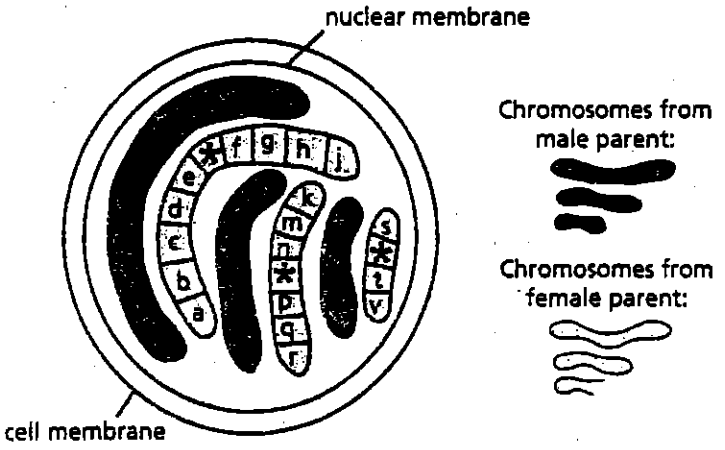

Figure 1

a. *What is the diploid number of the species shown in Figure 1?*

_____

b. *What is the haploid number of the species?*

_____

2. Examine the handout pages you will use to make your flip book. Notice that each page contains small rectangles which you will cut apart to form pages of your flip book. In the first rectangle, the title page, write your name in the space provided.
3. On page 1 of the flip book, the key, color in the chromosomes. Choose two colored pencils of bright, contrasting colors. Use one color for the chromosomes from the male parent, and the other color for the chromosomes from the female parent. You will use the same two colors throughout this lab activity, as you draw the chromosomes in the various stages of meiosis.

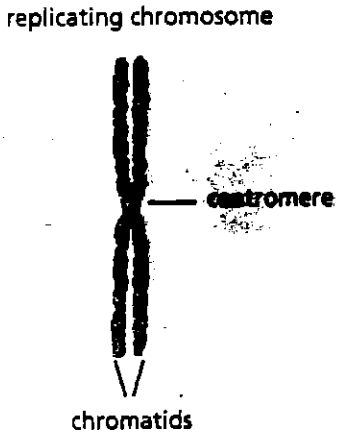

Figure 2

Meiosis is made up of two cell divisions—meiosis I and meiosis II. Each of these cell divisions is studied as a series of stages including prophase, metaphase, anaphase, and telophase. The two cell divisions follow a single replication, or copying, of chromosomes which takes place during *interphase,* before the start of meiosis. Thus at the start of meiosis, each chromosome is doubled in the parent cell. Two sister *chromatids*, or chromosome strands, now make up each chromosome. Chromatids are shown in Figure 2.

4. Figure 3 on the next page shows the positions of the chromosomes at late interphase before meiosis. In the circle on page 2 of your flip book, copy the diagram for late interphase.

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c. *How many chromosomes are in the cell at the start of meiosis?*

_____

d. *How many chromatids are in the cell?*

_____

During *prophase I,* the first stage of meiosis, each pair of homologous chromosomes joins together, and is linked at the centromeres. This joining of chromosomes is called *synapsis.* Because each chromosome has already doubled, synapsis results in the forming of *tetrads,* four chromatids joined together. See late prophase I in Figure 4.

5. Skip to page 5 of your flip book. On this page, copy the diagram for late prophase I. Notice that spindle fibers have now formed across the cell.

e. *What structures have the chromosomes formed on page 5?*

_____

f. *What has happened to the nuclear membrane in late prophase I?*

_____

6. Compare the positions of the chromosomes shown in your drawing on pages 2 and 5 of your flip book. Decide how the chromosomes would have to move to get from their positions in late interphase to their positions in late prophase I. On page 3 draw the chromosomes 1/3 of the way between late interphase and late prophase I. Show the early formation of the spindle fibers and the nuclear membrane beginning to break down.

7. On page 4 of your flip book, draw the chromosomes 2/3 of the way between early prophase I and late prophase I. Show the formation of the spindle fibers.

During *metaphase I,* the three pairs of homologous chromosomes line up along the equatorial plane.

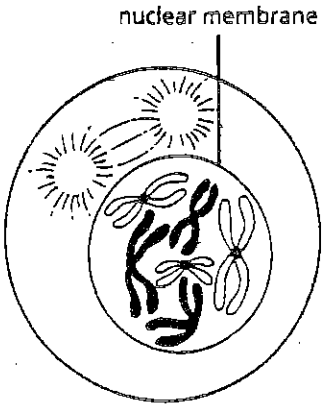
8. Skip to page 7 of your flip book. On this page, copy the diagram for metaphase I, shown in Figure 5.

g. *To what part of the chromosomes are the spindle fibers attached?*

_____

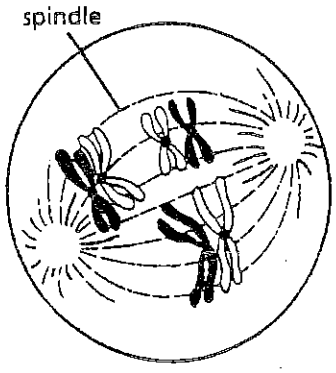
9. Compare the positions of the chromosomes shown in your drawings on pages 5 and 7. Decide how the chromosomes would have to move to get from their positions in late prophase I to metaphase I. In the circle on page 6 or your flip book, draw the chromosomes halfway between late prophase I and metaphase I.

During *anaphase I,* the homologous pairs of chromosomes separate and move apart. The chromosome pairs seem to be pulled apart by the spindle fibers.



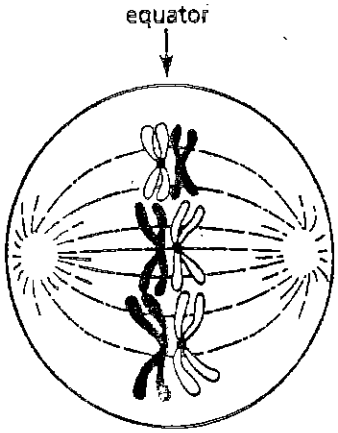
late interphase

Figure 3



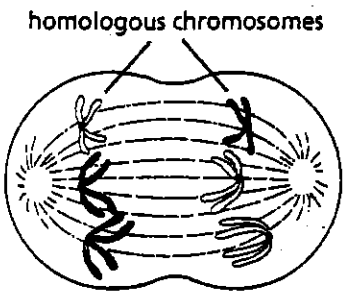
late prophase I

Figure 4



metaphase I

Figure 5



anaphase I

Figure 6

10. Skip to page 9 of your flip book. On this page, copy the diagram for anaphase I, shown in Figure 6.

    h. *Have sister chromatids separated from each other during anaphase I?*

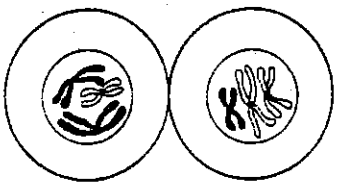
---

11. Compare the positions of the chromosomes shown in your drawings on pages 7 and 9. Decide how the chromosomes would look in early anaphase I. On page 8 or your flip book, draw the chromosomes in early anaphase I.

Telophase I is the last stage of meiosis I. At this point, the chromosomes are divided into two groups. Depending on the species, several things may happen—nuclear membranes may form, the cytoplasm may divide and cell membranes may form between two newly formed cells.

12. On page 10 of your flip book, copy the diagram for telophase I, shown in Figure 7.

    i. *Are spindle fibers present during telophase I?*



telophase I

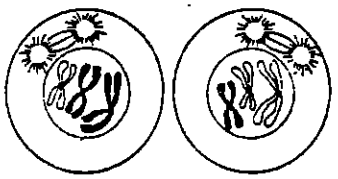
Figure 7

j. *What is happening to the cell membrane in this cell?*

Telophase I may be followed immediately by prophase II or it may be followed by a short interphase. Unlike the interphase preceding the start of meiosis, chromosomes are <u>not</u> replicated during this interphase. During *prophase II,* spindle fibers reappear—this time they are in each of the newly formed cells.

13. On page 11 of your flip book, copy the diagram for prophase II, shown in Figure 8.

    k. *How many chromosomes are found in each of the cells during prophase II?*



prophase II

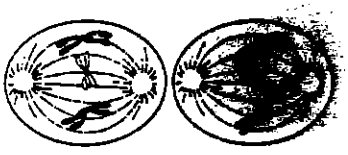
Figure 8

l. *How many chromatids are in each cell?*

During *metaphase II,* the chromosomes line up at the equator of each of the newly formed cells. Spindle fibers attach to the centromere of each sister chromatid.

14. Skip to page 13 of your flip book. On this page, copy the diagram for metaphase II, shown in Figure 9.

    m. *How is metaphase II different from metaphase I?*



metaphase II

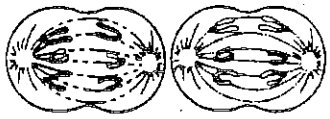
Figure 9

15. Compare the positions of the chromosomes shown in your drawings on pages 11 and 13. Decide how the chromosomes would have to move to get from their positions in prophase II to metaphase II. On page 12 of your flip book, draw the chromosomes halfway between prophase II and metaphase II.

During *anaphase II,* the sister chromatids divide and move apart. Because each sister chromatid has formed a separate centromere, the two sister chromatids are now considered separate chromosomes. The single-stranded chromosomes then move to opposite ends of each cell.

16. Skip to page 15 of your flip book. On this page, copy the diagram for anaphase II, shown in Figure 10.

    n. *How does anaphase II differ from anaphase I?*



anaphase II

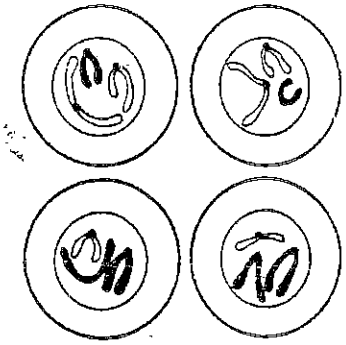
Figure 10

17. Compare the positions of the chromosomes shown in your drawings on pages 13 and 15. Decide how the chromosomes would have to move to get from their positions in metaphase II to anaphase II. Draw the chromosomes in this intermediate position on page 14.

During *telophase II,* the spindle fibers disappear and a nuclear membrane forms around each group of chromosomes. The cytoplasm divides around each newly formed nucleus, giving four new haploid cells.

18. On page 16 of your flip book, copy the diagram for telophase II shown in Figure 11.

    o. *How does the number of chromosomes in each newly formed cell compare to the number of chromosomes in the parent cell?*



telophase II

Figure 11

    p. *Are the chromosomes in the newly formed cells diploid or haploid?*

19. Cut apart the pages of your flip book. Stack the pages in order, with all the pages facing the same direction. Using a paper punch, make holes in the two small circles on the left-hand side of the book. Use paper fasteners to clip the pages together.
20. Flip through the pages of your book to see the major movements of chromosomes during meiosis.

Analysis and Interpretations

1. In the process of meiosis, how many nuclei are produced from the nucleus of each parent cell?

2. In mitosis, replication of chromosomes precedes each cell division. In meiosis, two cell divisions take place without a replication of chromosomes between them. What is the significance of this difference?

3. Meiosis is sometimes called reduction division. What does this mean and why is it important to a species?

4. Why is it significant that the four newly formed cells differ in chromosome content?

For Further Investigation

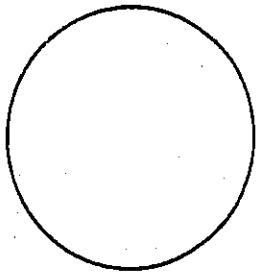
1. Look at your diagram from anaphase I. This diagram shows one of the possible ways the tetrads could be split to form haploid cells. Three other chromosome combinations are possible. Diagram the other possibilities and show the newly formed cells that would result.
2. Add more pages to your flip book by making drawings that show the actions of chromosomes between the stages you have drawn. Adding more pages will smooth out the movements in the flip book.

Flip Book For

MEIOSIS

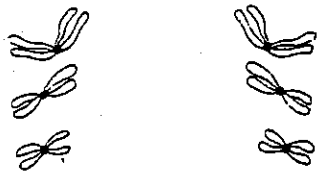
Name _____ Date _____

5



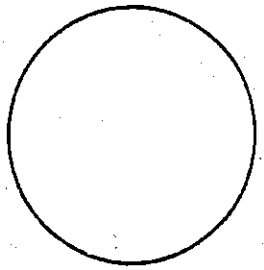
1

Chromosome Key



male parent female parent

6



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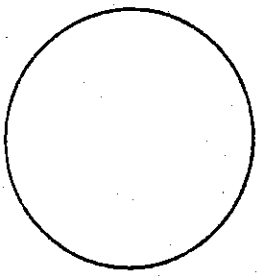

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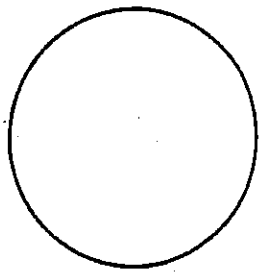

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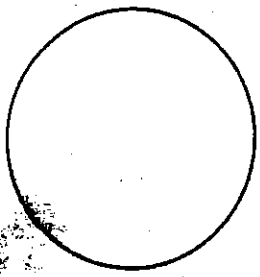

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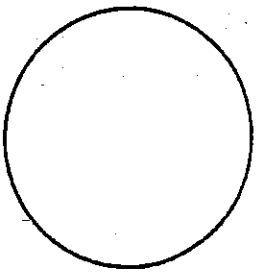

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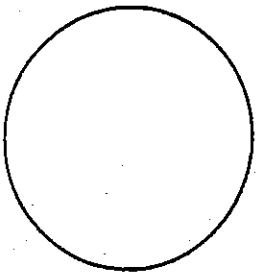

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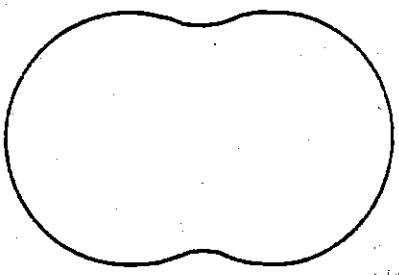

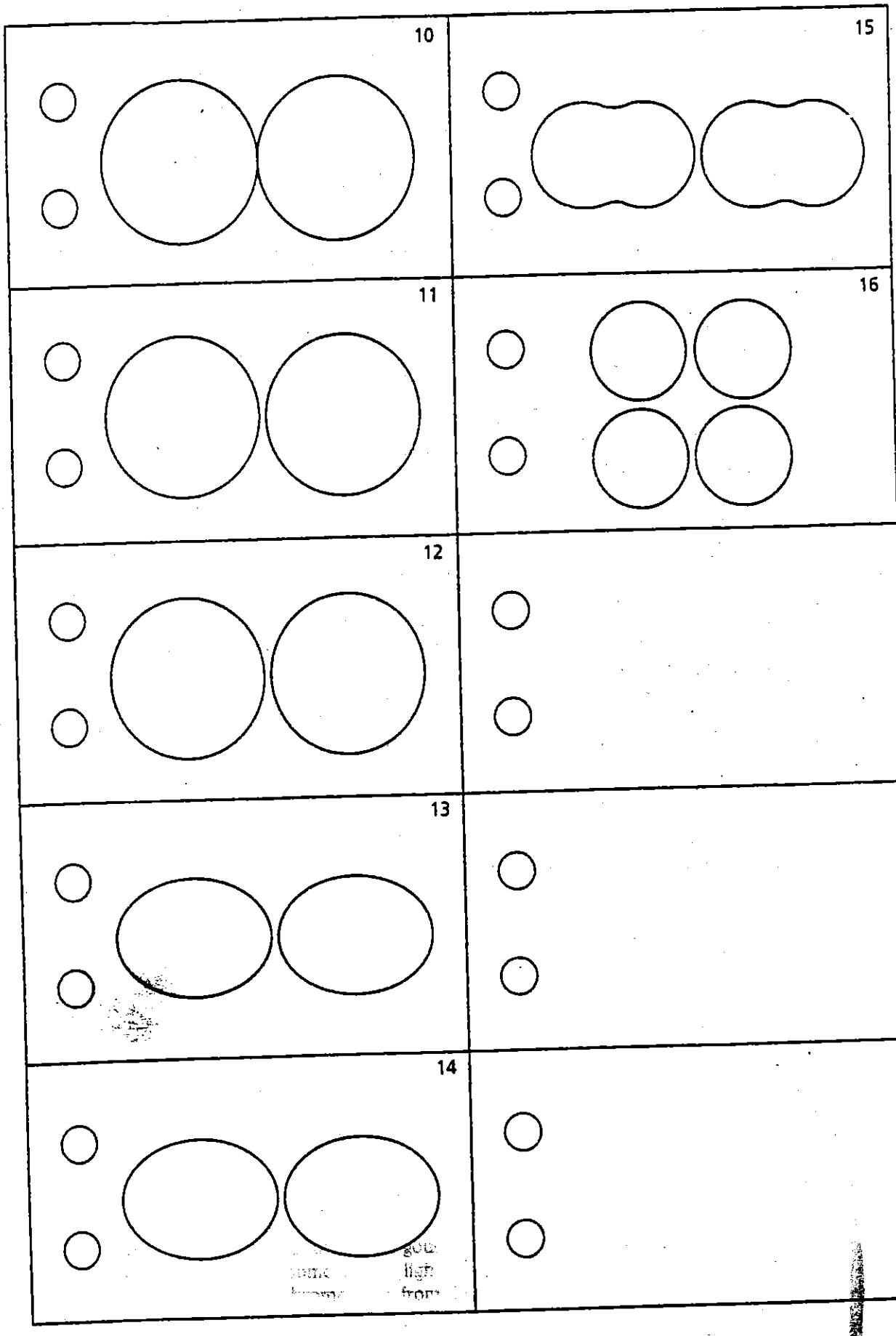
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