Mitosis Verses Meiosis

Name_____

LT: I can compare mitosis and meiosis using various resources. Standards: 4.1b, 4.1c

Visit the following links:
https://www.youtube.com/watch?v=f-ldPgEfAHI
https://www.youtube.com/watch?v=VzDMG7ke69g

1. Describe the purpose of mitosis.
2. How many times does the cell divide during mitosis?
3. What kind of cells are produced at the end of mitosis?
4. What are sister chromatids?
5. Briefly describe what happens during prophase.
6. Draw and label picture of what a cell looks like during prophase.
7. Briefly describe what happens during metaphase.
8. Draw and label a picture of what a cell looks like during metaphase.
9. Briefly describe what happens during anaphase.
10. Draw and label a picture of what a cell looks like during anaphase.
11. Briefly describe what happens during telophase.
12. Draw and label a picture of what a cell looks like during telophase.
13. Briefly describe what happens during cytokinesis. Is cytokinesis part of mitosis.
14. Draw a picture of what a cell looks like during cytokinesis.
15. Describe the purpose of meiosis. What kind of cells are produced at the end of meiosis?
16. How many times does the cell divide during Meiosis?
17. Briefly describe the difference of prophase I & II.
18. Draw and label a picture of prophase I & II.
19. Briefly describe the difference of metaphase I & II.
20. Draw and label a picture of metaphase I & II.
21. Briefly describe the difference of anaphase I & II.
22. Draw and label a picture of anaphase I & II.
23. Briefly describe the difference of telophase I & II.
24. Draw and label a picture of telophase I & II.
25. Describe the following terms: autosome; sex chromosomes; diploid; haploid;

Modeling Mitosis and Meiosis

LT: I can follow a multistep procedure in order to model mitosis and meiosis.
Standards: 4.1b, 4.1c

During the following activities, you will use chromosome model pieces to visualize the cellular processes of mitosis and meiosis as they occur in most animal cells as well as to simulate processes of genetic variation by modeling crossing-over and independent assortment of chromosomes.

Background

Mitosis and **meiosis** are the means by which genetic information, the DNA contained within structures called **chromosomes**, is passed from one generation of cells to the next.

In order to understand these two processes, it is important to become familiar with the terms **diploid (2n)** and **haploid (n)**.

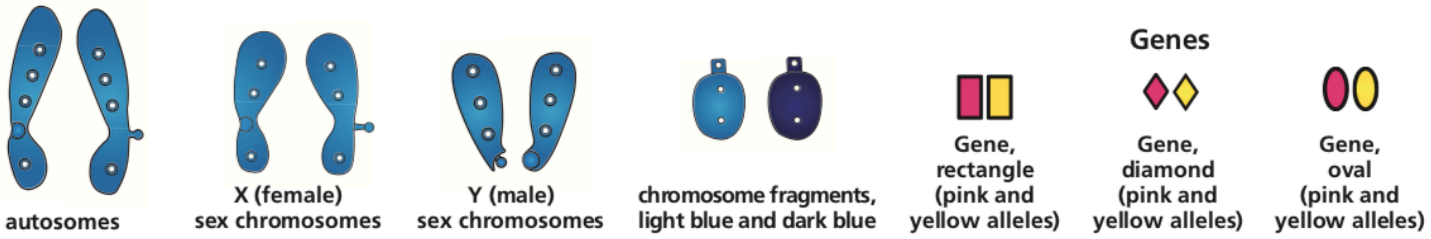
A diploid cell has two of each chromosomes, one from each parent. This is in contrast to a haploid cell, which only has one copy of every chromosome. Diploid cells comprise the majority of your body, while examples of haploid cells are eggs and sperm. If a haploid cell has n chromosomes, a diploid cell has 2n.

In mitosis, the nucleus of a **diploid** cell (containing replicated chromosomes) divides. The result of mitosis is two cells that are genetically identical, with the same (diploid) number of chromosomes as the parent cell.

In meiosis, the nucleus of a diploid cell, containing a complete set of chromosomes, divides twice. During the first of these two divisions, genetic information is exchanged between homologous chromosomes. The result of meiosis is four genetically diverse **haploid** cells, called **gametes**, each with half the number of chromosomes of the parent cell.

Chromosome Model Set Key

Each chromosome model set includes a number of different pieces representing different genetic materials. Before beginning any of the modeling activities, refer to the key below to familiarize yourself with the model pieces and the genetic materials that they represent. Remember that sex chromosomes are the chromosomes that determine the sex of an organism. All of the other chromosomes are referred to as autosomes.



Activity 1: Modeling Mitosis

Procedure

1. From the chromosome model set, obtain two autosomes and one 122-cm (48") piece of yarn or string and one 69-cm (27") piece of yarn or string.
2. Tie the ends of the pieces of yarn or string together to make two loops. The large loop represents the cell membrane. The small loop represents the nuclear membrane.
3. Place the two autosomes inside the nuclear membrane. At a corresponding point on each autosome, place the same gene. The genes should be the same shape but can be of different colors to represent different alleles of the same gene. This model represents a cell with one chromosome pair. **(a. Draw a diagram of your model including labels.)**
4. Cells prepare for mitosis by first replicating the chromosomes in their nucleus. This occurs before mitosis, during interphase. To model this process, create a duplicate of each autosome by making a matching autosome for each; each replica should possess the same gene and allele as the original autosome. Attach the corresponding replicated chromosome to each original chromosome. The point at which the two identical chromosomes are connected represents the centromere that joins the two identical sister chromatids. **(b. Draw a diagram of your model including labels.)**
5. During metaphase of mitosis, the chromosomes line up across the metaphase plate in the center of the cell. Line up the replicated chromosomes end-to-end in the center of the cell, with the centromeres aligned. **(c. Draw a diagram of your model including labels.)**
6. In addition, remove the string loop representing the nuclear membrane to represent the breakdown of the nuclear membrane.
7. Disconnect the identical sister chromatids from one another at the centromere and move each chromatid away from its sister chromatid to opposite sides of the cell. This step is representative of what occurs during anaphase of mitosis. **(d. Draw a diagram of your model including labels.)**
8. To simulate cytokinesis, pinch in the cell membrane to create two circles. This step simulates the division of one cell into two genetically identical cells during the final phases of mitosis. Compare the chromosomal material in each new cell. Each cell should possess the same two chromosomes and be identical to the original cell. **(e. Draw a diagram of your model including labels.)**

Conclusion Questions:

f. Describe interphase and how we modeled this.

g. Define mitosis in terms of the genetic material in the original and daughter cells. (haploid, diploid, n, 2n)

h. Did we model mitotic spindle action? How could we have done this?

i. Procedure step 6 describes how to model the breakdown of the nuclear membrane. When during mitosis, does the breakdown of the nuclear membrane take place? Place procedure step 6 in a different order from where it is now. Explain your rational for doing so?

Activity 2: Modeling Meiosis Procedure

Note: The nuclear membrane is involved in meiosis. However, for the sake of simplicity, the nuclear membrane will not be included in this activity.

Procedure

1. Obtain a piece of yarn or string about 240 cm (96") in length. Tie the ends of the yarn or string together to make a loop. This loop represents a cell membrane.
2. Using the chromosome model set and loop, model a cell that contains two autosomes (the paternal and maternal versions of the same chromosome) and two sex chromosomes: one X chromosome and one Y chromosome. **(a. Draw a diagram of your model including labels.)**
3. Place the same gene (indicated by shape—the genes can be different colors to indicate that they are different alleles) on each autosome. Place the autosomes and sex chromosomes side-by-side. **(b. Draw a diagram of your model including labels.)**
4. Create a duplicate of each chromosome (the autosome and the sex chromosome) by making a matching chromosome for each. Make sure that each replica possesses the same gene and allele as the original. Connect each of the replicated chromosomes to the chromosome from which it was replicated. This simulates the replication of chromosomes within the nucleus of a cell during interphase, which occurs prior to prophase I of meiosis. The connection between the chromosome copies represents the centromere that joins the two identical sister chromatids. **(c. Draw a diagram of your model including labels.)**
5. Line up the chromosomes side-by-side in the center of the cell. Connected pairs of autosomes should be together, and connected pairs of sex chromosomes should be together. Each side-by-side pair forms a tetrad, a paired chromosome structure comprised of four chromatids. This represents the alignment of tetrads during metaphase I of meiosis. Note that each tetrad is composed of two paternal copies and two maternal copies of each chromosome. **(d. Draw a diagram of your model including labels.)**
6. To simulate cell division, pinch in the sides of the loop until two loops are formed. Before you do this, move each pair of connected chromatids from each of the two tetrads to opposite sides of "the cell" (the loop). This represents the first cellular division in meiosis, which occurs during anaphase I, telophase I, and cytokinesis of meiosis I. You will end up with two daughter cells containing one connected pair of autosomal sister chromatids and one connected pair of sex chromosomes.
7. Cut the string into two pieces of equal length and retie those into two circles. The "cell membrane" now forms two distinct cells.
8. As the two daughter cells enter meiosis II, the chromosomes do not go through replication again. Instead, the paired chromosomes in each move toward the center of the cell, with their centromeres aligned. Place the chromosome pairs end-to-end in the center of each cell, with the centromeres aligned. This represents metaphase II. **(e. Draw a diagram of your model including labels.)**
9. Separate the connected pairs of sister chromatids in each cell at their centromere and move one chromatid from each pair in the cell toward the opposite sides of the cell. This represents the separation of chromatids during anaphase II of meiosis.
10. Repeat this procedure with the other loop (pinch in the cell membrane until you form two separate loops. This represents the division of two cells into four cells during telophase II and cytokinesis of meiosis II. You should now have four gametes, each with one autosome and one sex chromosome. **(f. Draw a diagram of your model including labels.)**

Questions

g. How is meiosis I different from meiosis II?

h. What are some specific differences in the processes of meiosis and mitosis? In your answer, be sure to compare the genetic material in the original and daughter cells. (haploid, diploid, n, 2n)

i. If the gametes of an organism have 14 chromosomes, how many chromosomes will the regular cells in the organism have? Explain your answer.

Modeling Mitosis and Meiosis Kit Activity 3: Modeling Crossing-Over

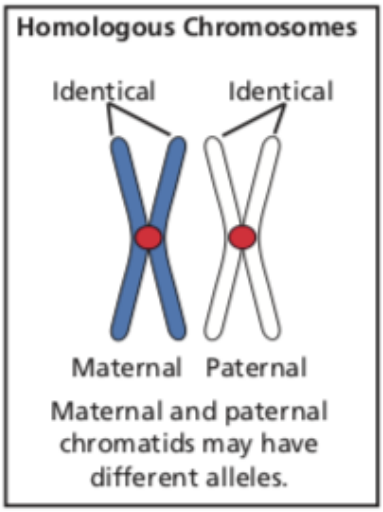


Figure 20

Note: Before starting this activity, remember that sister chromatids are copies of the same chromosome and are often attached via a centromere. In contrast, homologous chromosomes have the same genes, but since one is inherited from the father and one from the mother, they may have different alleles (versions of the same gene). Homologous chromosomes are not connected via the centromere.

Procedure:

1. Obtain a piece of yarn or string about 2.4 m (96") in length. Tie the ends together to make a loop. This loop represents a cell membrane. For simplicity, the nuclear membrane will not be included in this activity. Using the chromosome model set, assemble a cell that has two autosomes and two sex chromosomes (two X chromosomes). **(a. Draw a diagram of your model including labels.)**
2. Place the same type of gene (indicated by shape) on each autosome. These genes can be of different colors to indicate they are different alleles. Pair up the autosomes and the sex chromosomes, but do not connect them. **(b. Draw a diagram of your model including labels.)**
3. Obtain two chromosome fragments, one light blue and one dark blue. Attach one fragment to the top of each autosome. Place a differently colored allele of the same gene (shape) at corresponding locations on each chromosome fragment. **(c. Draw a diagram of your model including labels and label the color of the chromosome fragments and the shape and color of the genes on the autosomes.)**
4. To simulate the replication of chromosomes within the nucleus of a cell during interphase prior to meiosis, create a duplicate of each autosome and sex chromosome by making a matching chromosome for each. Make sure that each replica possesses the same gene as the original. Connect each of the replicated chromosomes to its original in the cell. Remember to attach fragments to the replicated autosomes, too. The connection between the chromosome copies represents the centromere that joins the two identical sister chromatids.
5. Line up the chromosomes side-by-side in the center of the cell. Connected pairs of autosomes should be together, and connected pairs of sex chromosomes should be together. Each side-by-side pair forms a tetrad, a chromosome structure comprised of four chromatids. This represents the alignment of tetrads during metaphase I of meiosis. **(d. Draw a diagram of your model including labels.)**
6. Crossing-over takes place during prophase I of meiosis, when two non-sister chromatids within a tetrad exchange similar pieces of genetic information. Crossing-over is one of several mechanisms that help ensure genetic variability within a species. To model crossing-over, exchange the chromosome fragments on the adjacent non-sister chromatids of the autosome tetrad. **(e. Draw a diagram of your model including labels.)**
7. To simulate cell division, pinch in the sides of the loop until two loops are formed. Move each pair of connected chromatids from each of the two tetrads to opposite sides of "the cell" (the loop). Cut the string forming each of the newly formed loops and retie the ends so that two completely separate loops are formed. This represents the first cellular division in meiosis, which occurs during anaphase I, telophase I, and cytokinesis of meiosis I. You should now have a model of two daughter cells, each containing one connected pair of autosomes with segments that have been exchanged between chromatids and one connected pair of sex chromosomes.
8. As the two daughter cells enter meiosis II, the chromosomes do not go through replication again. Instead, the paired chromatids in each move toward the center of the cell, with their centromeres aligned. Place the chromatid pairs end-to-end in the center of each cell, with the centromeres aligned. This represents metaphase II.
9. To simulate cell division, pinch in the sides of the loop until two loops are formed. Each newly formed loop should have one of the sister chromatids (now called chromosomes) from each pair. Repeat this procedure with the other loop. This represents the division of two cells into four cells during telophase II and cytokinesis of meiosis II. You should now have four gametes, each with one autosome and one sex chromosome. **(f. Draw a diagram of your model including labels.)**
10. Examine each of the autosomes in the four gametes that you have modeled and compare them with your original autosome pair. **g. How many are different from the original autosome pair? How are they different?**
11. Take two gametes from your model and simulate fertilization by pairing up the autosomes and the sex chromosomes from the two gametes. **h. Does the new, fertilized cell have chromosomes and alleles identical to those of the original cell? If not, explain how and why it is different.**