**Lab: Mitosis & Meiosis – Some Comparisons**

**Purpose:**

To compare some of the significant events in mitosis and meiosis by using models to simulate these processes.

**Background:**

Mitosis and meiosis refer to events that occur in the nucleus of cells undergoing cell division. Prior to dividing, the cells are referred to as diploid (2n), each chromosome type have a homologue. Mitosis occurs during the formation of body (somatic) cells, maintaining the diploid number of chromosomes in the daughter cells produced. Meiosis is limited to the production of gametes (sperm and ova), undergoing two separate divisions resulting in cells with a haploid (n) number of chromosomes.

**Materials:**

Pencil

3 different colors of clay

2 sheets of unlined paper

**Procedure:**

*Part 1. Organizing the simulated cells and chromosomes.*

1. Since the main purpose of this exercise is to investigate the behavior of the chromosomes, other parts (organelles) of the cell will be ignored, along with details of the nucleus.
2. Place the sheets of unlined paper on the table in front of you. Each sheet will represent the outline of a cell. At the top of one sheet print MITOSIS. Print MEIOSIS on the other.
3. Draw a pencil line lengthwise down the center of each sheet to represent the “equatorial plate” in each cell.
4. Make a black dot half-way down both edges of each of the sheets. These dots will represent the “poles” of each cell.
5. Choose one color of clay and make 8 small balls. These will represent the centromeres

a) What is the function of the centromere?

1. Take some of another color of the clay and roll it between your hands to create a piece 10 cm long and about as thick as your finger. Make another piece with the same color that is about 5 cm long. (repeat so you have two of each length of this color)



*Part 2: Mitosis and Meiosis 1*

1. Repeat step 6 with the third color of clay.
2. Just prior to the commencement of both mitosis and meiosis, each chromosome in the nucleus forms an exact replica. To simulate this, make an identical copy of each piece of clay and then attach them with one of the centromere balls you made in step #5. These are the homologous chromosomes to the ones you made in step #6. (see figure 1 above)

b) What are homologous chromosomes?

c) What are the strands in each double chromosome known as?

1. The strands of the double chromosome, because they are attached at the centromeres, are now referred to as chromosomes.
2. Place one chromosome of each size and each color (ie, large red, large blue, small red, small blue) on each of the sheets of paper in any random location. This will represent the prophase of mitosis and prophase I of meiosis.
3. What is the diploid (2n) number of each cell?
4. What is the haploid (n) number of each cell?
5. Why is the meiotic prophase referred to as prophase I?
6. In the meiotic cell, pair up the homologous chromosomes to form “tetrads”. Demonstrate crossing over. Break off a piece of clay from one chromosome and attach it to the other chromosome. (figures 5 and 6). Repeat a few times if you like.
7. Compare the mitotic and meiotic cells at the end of prophase.

 

1. To simulate metaphase in both cells, move the chromosomes and chromosome tetrads so that they line up along the equatorial plate (pencil line).
2. In a living cell of the same species, how could you distinguish between a cell in metaphase of mitosis and one in metaphase of meiosis?
3. To simulate **mitotic** anaphase, split apart the centromere from each double chromosome. Holding each chromatid at the centromere, separate the double chromosomes by slowly pulling each towards opposite “poles” (dark marks) of the cell. The chromatids are now known as chromosomes
4. To simulate the **meiotic** anaphase I, pull apart the *tetrad* and pull the double chromosomestowards either pole.
5. What shape do the chromosomes take after they have been moved? Explain.
6. How do the two cells in anaphase differ from one another?
7. Now, move the chromosomes to opposite poles of each cell. This represents telophase. To simulate the division of the cytoplasm forming two new cells, darken the equatorial plate line. This will complete the simulation of mitosis.
8. What events usually follow telophase in mitosis?
9. from your model, how could you distinguish between mitosis and meiosis at this stage?
10. How many chromosomes are in the daughter cells of the mitotic division? How does this compare with the parent cell?
11. How many chromosome are in the daughter cells of the meiotic cells? How does this compare with the mother cell?
12. Are there any differences in the structure of the chromosomes themselves in the mitotic and meiotic cells at this stage?

*Part 3: Meiosis II events*

1. Draw a pencil line joining the two “poles” of the original cell. This line will represent a new equatorial plate in each of the daughter cells. Mark new poles at each end of each new cell.
2. Randomly spread the (double) chromosomes in the central region of each daughter cell, to complete Prophase II.
3. How does prophase I differ from prophase II
4. Simulate metaphase II by moving the chromosomes to the equatorial plate, placing the centromeres on the line.
5. Separate the centromeres and holding onto the centromere, pull the sister chromatids apart. The chromosomes can now be referred to as chromosomes. This represents anaphase II.
6. How do anaphases I and II compare.
7. To simulate telophase II, move the chromosomes to the poles of each new daughter cell. Darken the equatorial plate, representing the division of the cytoplasm into daughter cells.
8. How many chromosomes are in each final daughter cell? Compare this to the original cell from procedure #10.
9. How does telophase I differ from telophase II?
10. What is the total number of cells produced in Meiosis? Compare this with the number produced in Mitosis.
11. How many chromosomes are in a mitotic daughter cell compared with a meiotic daughter cell?
12. If the meiotic telophase II daughter cells were to mature in a female, what would they develop into? In a male?
13. Compare the volume of cytoplasm of the daughter cells in mitosis and meiosis with that of the original mother cell.

**Questions for Application and Further Research:**

1. Prepare a chart comparing mitosis and meiosis, using the following headings:

Number of divisions

Number of cells (daughter) produced

Pairing up of chromosomes – *[yes or no]*

Number of chromosomes in the mother cell

Number of chromosomes in the daughter cell

Body (somatic) cells produced - *[yes or no]*

Gametes (sperm or ova) produced - *[yes or no]*

1. What cell structures were not illustrated in this simulation, but are involved in normal mitotic and meiotic processes?
2. What special activity often occurs during the tetrad stage of meiosis? What is its significance?
3. What major differences occur in meiosis between the production of perm and the production of ova?
4. Why is it necessary to have haploid (n) number of chromosomes in gametes?
5. An organism has 20 types of chromosomes. How many chromosomes would be found in a body (somatic cell)? A gamete of the organism? Explain.