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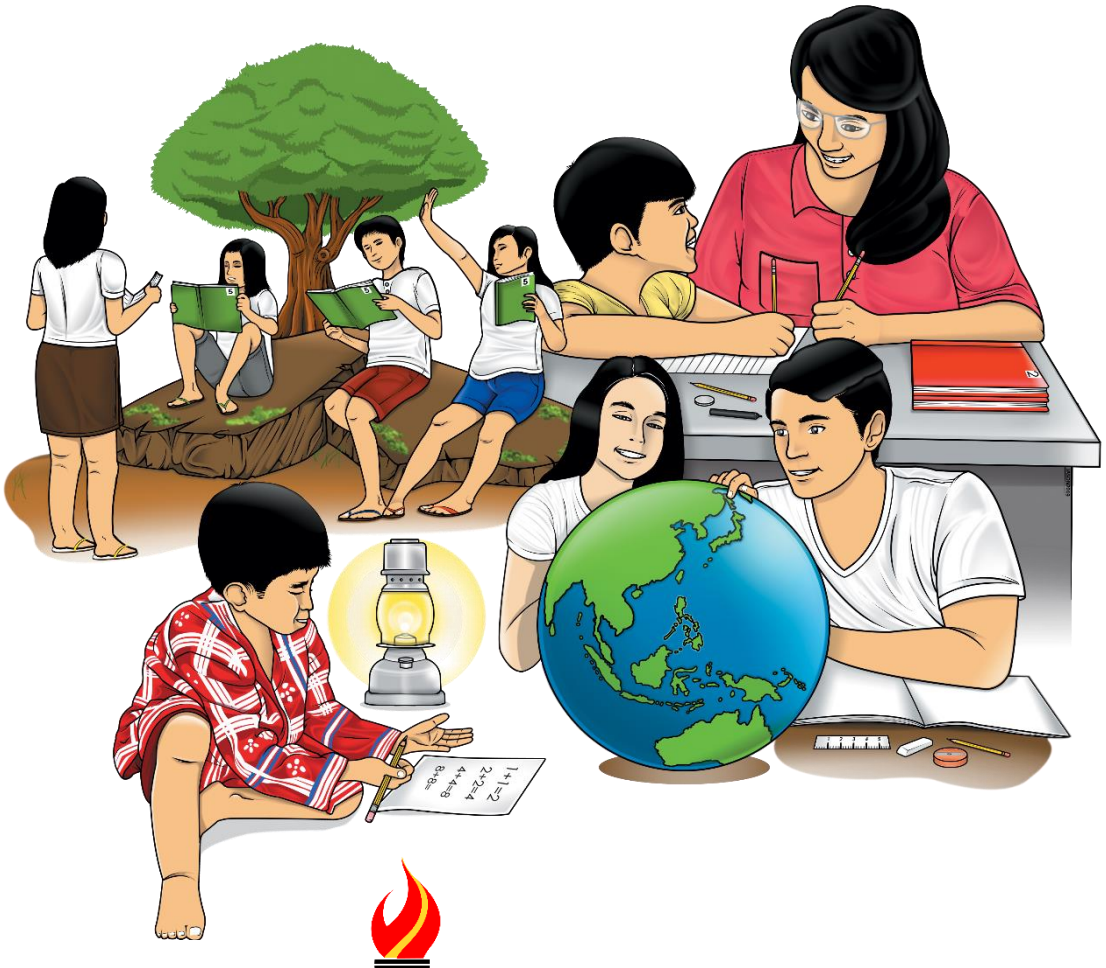
DepED
DEPARTMENT OF EDUCATION

Science

Quarter 4 – Module 2:
Cellular Reproduction



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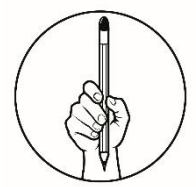


What I Know

Directions: Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. Which statement about mitosis is INCORRECT?
   A. The first phase is prophase.
   B. It forms four daughter cells.
   C. It makes diploid or haploid nuclei.
   D. Separation of sister chromatids occurs.

2. What is the form of reproduction whose benefit is variability of the offspring?
   A. asexual
   B. binary fission
   C. mitosis
   D. sexual

3. The diploid (2N) chromosome number in an organism is 42. What is the normal chromosome number of its sex cells?
   A. 21
   B. 42
   C. 63
   D. 84

4. These activities of the cell occur in both mitosis and meiosis EXCEPT:
   A. cytokinesis
   B. DNA replication
   C. karyokinesis
   D. synapsis

For items 5 -10, answer each statement using the given choices.
Write the letter only.

A. Meiosis I B. Meiosis II

5. Occurrence of synapsis between tetrads.
6. Separation of homologous chromosomes.
7. Results in four sperm cells in human males.
8. Daughter cells have chromosomes with two sister chromatids.
9. Daughter nuclei have chromosomes with single chromatids.
10. Occurrence of crossing-over of homologous chromosome.

For items 11-15, match the cell phase to its description. Write the letter only.

A. DNA replication occurs
B. last phase of nuclear division
C. condensed chromosomes become visible
D. chromatids separate at the centromere
E. chromosomes line up at the equatorial plane

11. Metaphase
12. Telophase
13. Anaphase
14. Prophase
15. Interphase

Lesson 1 Cellular Reproduction

What's In

Directions: Recall the previous lesson about digestive system. Rearrange the parts of digestive system in correct sequence during digestion process. Write the letter of the correct answer on a separate sheet of paper.

Digestion Process

A. anus	1. _____
B. esophagus	2. _____
C. large intestine	3. _____
D. mouth	4. _____
E. rectum	5. _____
F. small intestine	6. _____
G. stomach	7. _____

Have you ever watched a tadpole turn into an adult frog? If so, you are perhaps familiar with the idea of a life cycle. Frogs go through some interesting life cycle transitions: from egg to larva (tadpole), then finally, to an adult frog. Other organisms, such as humans, plants, and bacteria, also have **life cycles**, a series of

developmental steps that an individual goes through from birth until the time it reproduces.

The same thing happens with the living cells. The **cell cycle** can be compared to as the life cycle of a cell, a series of growth and developmental steps a cell undergoes between its "birth" and reproduction.

Every living thing undergoes reproduction. The nutrients taken by an individual will provide energy for metabolic processes, for growth and development as well as for reproduction.

In this module you will learn the importance of cell division for growth, repair, and reproduction of eukaryotic organisms. During mitosis, the resulting two new daughter cells have the same type and number of genes as the original parent cell, thereby preserving and maintaining the stability of genetic material of a particular population. But in more complex organisms, meiotic division produces gametes that possess half of the genetic information. During fertilization, these gametes unite allowing genes from each parent to combine which results to differences in the DNA composition or genotypes resulting to genetic variability of offspring.

What's New?

Activity 1 – Puzzle Solving

Directions: Locate ten (10) words that are associated to cellular reproduction in the puzzle. They can be read horizontally, vertically, or diagonally. Write your answers on a separate sheet of paper.

E	L	C	Y	C	E	F	I	L	N
A	C	O	W	B	U	C	I	E	O
T	G	A	M	E	T	E	S	F	I
R	E	F	I	A	G	H	F	I	S
E	L	O	T	M	U	S	G	N	I
P	P	A	O	R	P	I	R	E	V
R	S	I	S	R	T	S	O	O	I
O	U	V	I	A	W	O	W	X	D
D	Y	N	S	A	Z	I	T	E	L
U	G	E	N	E	S	E	H	B	L
C	A	C	E	D	O	M	U	F	E
E	E	L	C	Y	C	L	L	E	C

Note to the Teacher

Provide extra copies of the puzzle for students' use.

What is It

The Chromosome

All living things contain a self-replicating genetic material that directs the activities and functions of the cells. **Deoxyribonucleic acid** or DNA is the genetic material located inside a chromosome in the nucleus of the cell. The DNA from the parents is transmitted to the offspring to ensure the continuity of life. The DNA is a helical structure consisting of two strands as shown in Figure 1. Figure 1 also shows the organization or packaging of DNA molecules by proteins or histones to form different levels of chromosome packaging. This is necessary so that the long and numerous DNA molecules can be organized and be accommodated inside the nucleus of a eukaryotic cell. The DNA helix illustration in Figure 1 shows a structure called nucleosomes which is composed of globular structures known as histones where the DNA strands are attached, and coiled looking like beads attached on a string in a form of chromatin measuring up to 11 nm. The next level of organization is a series of chromatin molecules forming a 30-nanometer chromatin fiber of packed coiled nucleosomes called solenoid. This solenoid level of packaging becomes supercoiled forming loops that are visible and are usually called chromatin loops which further leads to condensation of the chromosomes up to 700 nm. When the DNA molecules is replicated and undergoes also packaging and coiling, it would form the entire mitotic chromosome or metaphase chromosome which measures up to 1,400 nm which is illustrated at the bottom of the diagram in Figure 1.

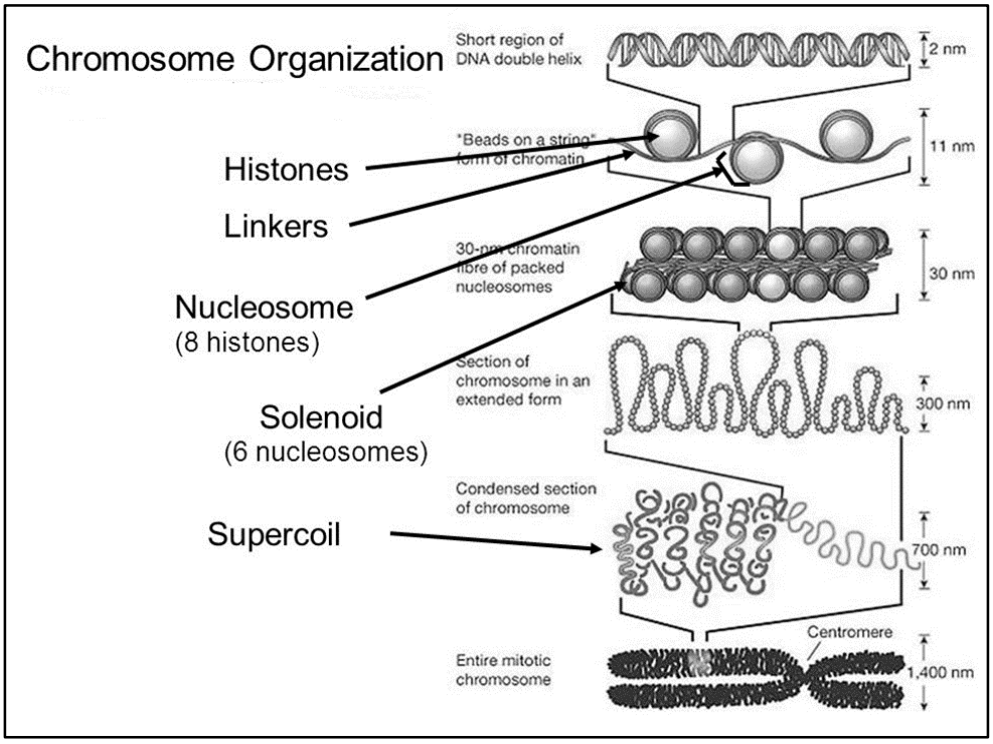


Figure 1. The Organization/Packaging of the DNA into Chromosomes
Illustrated by: Rosa Mia L. Pontillo

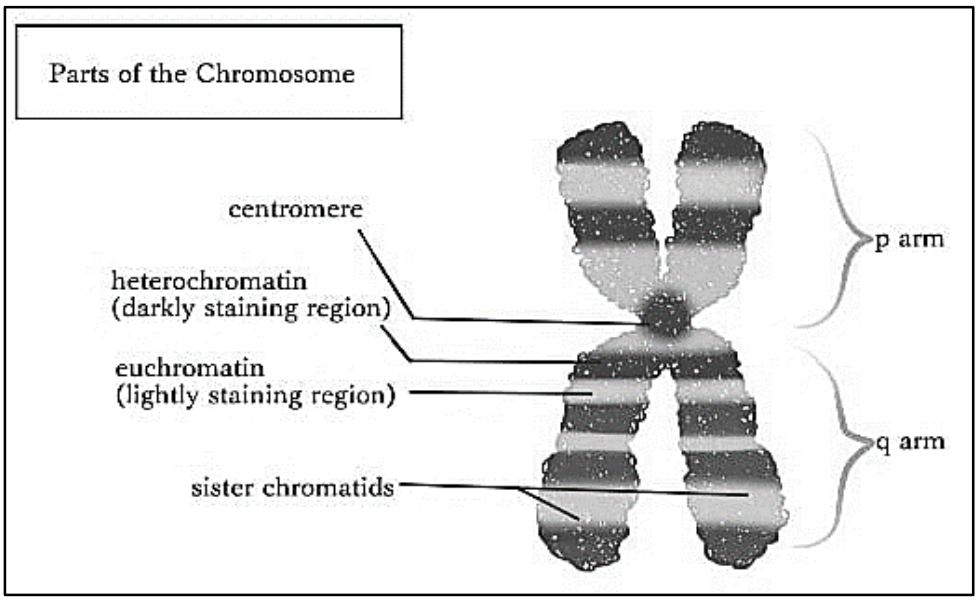


Figure 2. Parts of the Chromosome
Illustrated by: Rosa Mia L. Pontillo

Parts of the Chromosome

1. Chromatids – two identical halves of a replicated chromosome after the Synthesis phase or the S phase of the cell cycle.
2. Centromere – the attachment points of the two chromatids of a chromosome. It is also described as the constriction point which divides the chromosome into two sections, or "arms."
3. Short arm – or p arm - upper arms of the chromosome which is usually shorter.
4. Q arm - lower arms of the chromosome which is usually longer.

The number of chromosomes in a cell is a characteristic of the species to which it belongs. For example, fruit flies have 8 chromosomes while sunflowers have 34. Table 1 summarizes the chromosome numbers of some organisms.

Table 1. Chromosome Number of Selected Organisms

Organism	**Chromosome number**
Drosophila melanogaster (fruit fly)	8
Canis familiaris (dog)	78
Homo sapiens (man)	46
Oryza sativa (rice)	24
Zea mays (corn)	20

The Cell Cycle

The chromosomes of a cell change their form as they undergo cell transitions from one stage to another in a typical cell cycle as shown in Figure 3. The cell cycle may be divided into two stages: the **interphase** where the chromosomes are long, and extended, and the **cell division** or **mitotic** phase where the chromosomes become condensed or thickened.

Interphase is the interval between two cell divisions. During this stage, the cell is not dividing; it merely grows. The chromosome doubles or replicates itself because the DNA molecule contained in the chromosome produces a precise copy of itself.

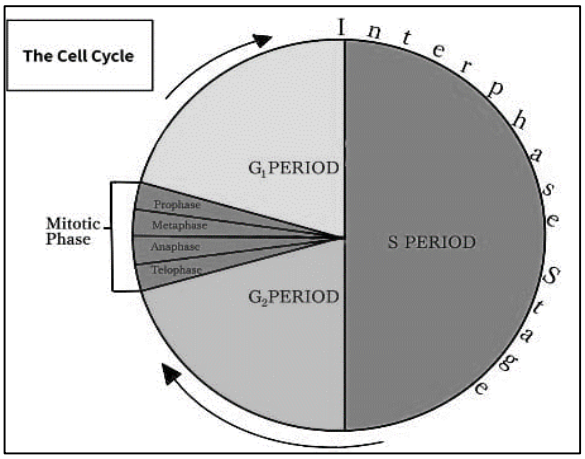


Figure 3. The Cell Cycle
Illustrated by: Rosa Mia L. Pontillo

Interphase is the interval between two cell divisions. During this stage, the cell is not dividing; it obtains nutrients and metabolizes, grows, replicates its DNA in preparation for mitosis.

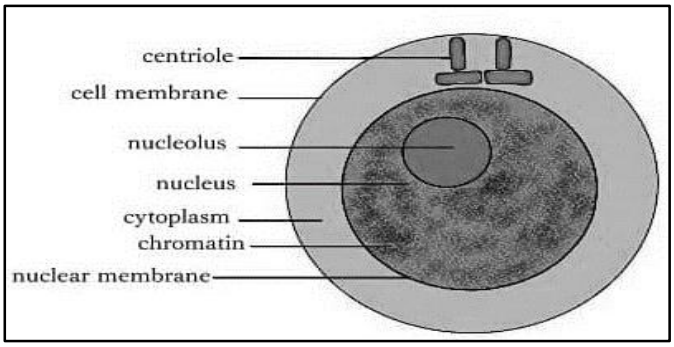


Figure 4. The Cell in the Interphase Period
Illustrated by: Rosa Mia L. Pontillo

The interphase is divided into three sub-stages, namely:

1. First gap period or **G_1** where
   - cell grows initially
   - synthesis of protein and ribonucleic acid or RNA occurs
   - mitochondria increase in number

2. Synthesis stage or **S phase** where
   - DNA are synthesized thus replicating the chromosomes in preparation for the next cell division.

3. Second gap period or **G_2** where
   - cell grows rapidly
   - cell prepares for the actual cell division

Cell Division

Cell division phase occurs every after interphase. In eukaryotic cells, these types of cell division occur: **mitosis** and **meiosis**.

1. Mitosis

Each time a child goes to the doctor, a nurse measures his height and mass. A child's height and mass increases because the number of cells in his body increases as he develops. Our body cells increase its number through the process known as mitosis.

Mitosis is a cellular process wherein two nuclei and two cells are produced due to the division of the original nucleus, each of which contains the same chromosome number as the parent cell. Mitosis is divided into four stages namely: prophase, metaphase, anaphase, and telophase. Figure 5 shows the different stages of mitosis.

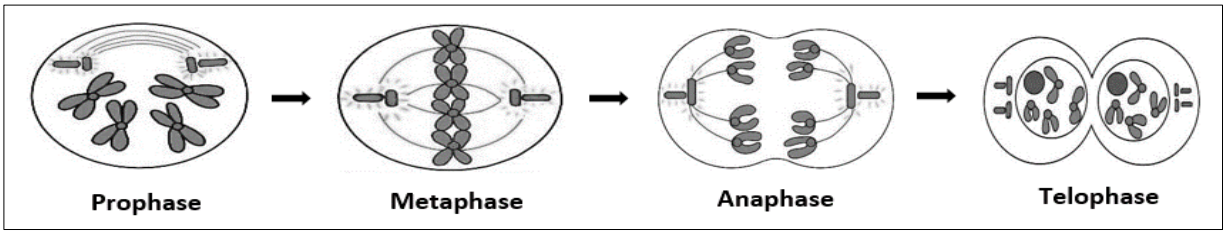


Figure 5. The Stages of Mitosis
Illustrated by: Rosa Mia L. Pontillo

Prophase Stage

- The repeated coiling of chromosomes occurs resulted to its thicker and shorter structure. These are made up of two sister chromatids that are identical to each because of the replication of DNA during the S phase.
- The two chromatids are still attached at the centromere.
- The nuclear membrane breaks down.

Metaphase Stage

- Chromosomes align at the equatorial plane.
- Each spindle fiber from both centrosomes connects to each chromosome through its kinetochore.

Anaphase Stage

- Spindle fibers begin to contract and become shorter. Continued contraction causes the separation of the genetically identical sister chromatids.
- Centromeres divide.
- The single chromatids move towards the opposite poles.

Telophase Stage

- The chromosomes are now at the opposing poles of the spindle.
- The microtubules disappear.
- Two sets of chromosomes are surrounded by new nuclear membranes, completing the nuclear division process known as karyokinesis.
- Cytoplasmic division called cytokinesis occurs concurrently, splitting the cell into two.

What happens after telophase?

Two new nuclear membranes are formed, and two new nuclei are seen. There are two new daughter cells that are produced from one dividing parent cell. Thus, mitosis has come to an end.

In animal cells, two grooves or indentations known as **cleavage furrows** form at both ends of the metaphase plate during telophase. These grooves deepen and lengthen and meet, to separate and form the two new daughter cells. This event is shown in the illustration below in Figure 6.

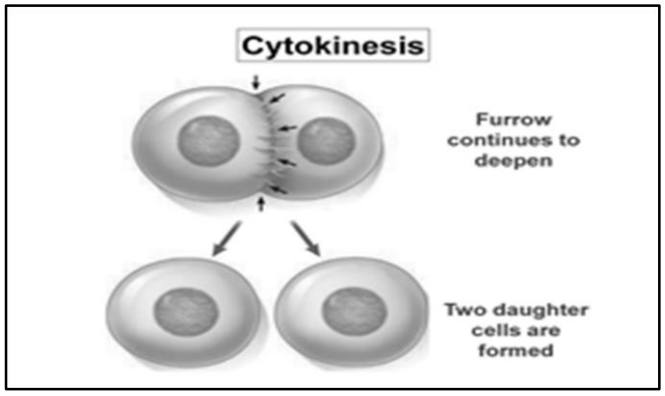


Figure 6: Formation of two new daughter cells in animal cells

Illustrated by: Rosa Mia L. Pontillo

Plant cells do not form cell furrows. Instead, a new cell wall known as **cell plate** forms between the two new nuclei.

Figure 7 shows the formation of a cell plate in plant cells. During telophase, membrane-enclosed vesicles from the Golgi complex of the cell move towards the center where the metaphase plate of the cell is located and become part of the cell plate.

In telophase, the cell plate continues to grow and gets attached with the cell membrane. This results to the formation of two daughter cells. Each cell is bounded with cell membrane. New cell walls form between the two cell membranes at the area where the cell plate was formed earlier.

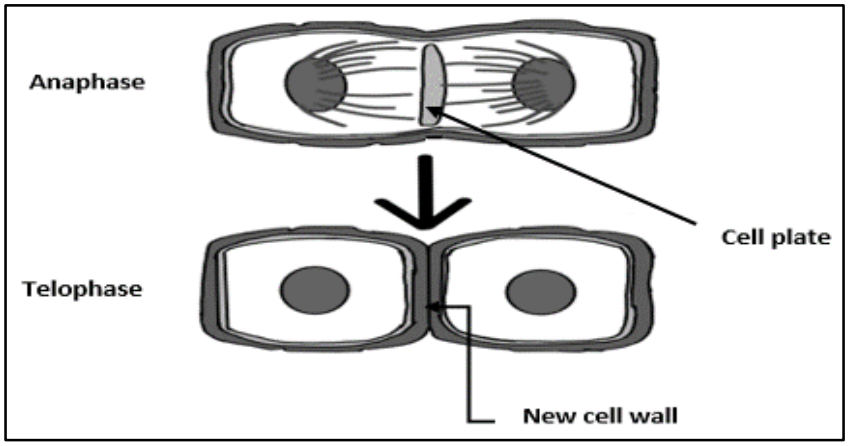


Figure 7. Cell Plate Formation
Illustrated by: Rosa Mia L. Pontillo

2. Meiosis

There are two main types of cells possessed by multicellular eukaryotic organisms: somatic, or body cells and gametes, or sex cells. Majority of the cells are called somatic or body cells. These consist of two complete sets of chromosomes, making them diploid in number (2N).

Multicellular eukaryotic organisms that undergo sexual reproduction use gametes, or sex cells, to produce offspring. Gametes are haploid cells, union of which result to creation of a new organism with diploid number of chromosomes in all its somatic or body cells hence, to create new individuals for the species, two parents are very necessary to provide the gametes.

How are sex cells, the sperms and eggs, formed? Another form of cell division known as meiosis produces sex cells. In meiosis, the nucleus will undergo two divisions: Meiosis I and Meiosis II. The cell divides twice in these processes.

All human somatic cells have forty-six chromosomes. When human cells reproduce through mitosis, each new cell will also have forty-six chromosomes. But in reproductive cells or gametes, each of these cells produced has only twenty-three chromosomes. Thus, meiosis decreases the chromosome number by half.

Why must meiosis take place to produce sperm and egg?

When a sperm unites with an egg, each of them contributes only one half of the total number of chromosomes (twenty-three chromosomes) to the new zygote which is diploid in number of chromosomes (forty-six chromosomes). Meiosis creates cells that are destined to become gametes (or reproductive cells), this reduction in chromosome number is critical — without it, the union of two gametes during fertilization would result in offspring with twice the normal number of chromosomes.

Thus, in humans, a new life originates with the normal diploid number (2N) of forty-six chromosomes. Then the zygote undergoes the process of mitosis, producing cells with forty-six chromosomes each.

Meiosis involves two divisions, Meiosis I and Meiosis II. Each follows similar stages as mitosis (prophase, metaphase, anaphase, and telophase). Before meiosis, the reproductive cell is in the interphase stage whereby DNA replicates to produce chromosomes having two sister chromatids. Then, the cell will undergo second growth phase called **interkinesis**. This stage happens between Meiosis I and II, however, DNA does not replicate in this stage.

Meiosis I.

The first meiotic division, also known as Meiosis I, is a reduction division phase (diploid - haploid). There are two daughter cells produced after Meiosis 1, each daughter cell is carrying haploid number of chromosomes. This consists of four stages, namely, prophase I, metaphase I, anaphase I, and telophase I.

Prophase I Stage

Meiosis starts with this stage and includes the following substages: leptotene, zygotene, pachytene, diplotene, and diakinesis. Figure 8 shows the different substages of prophase I.

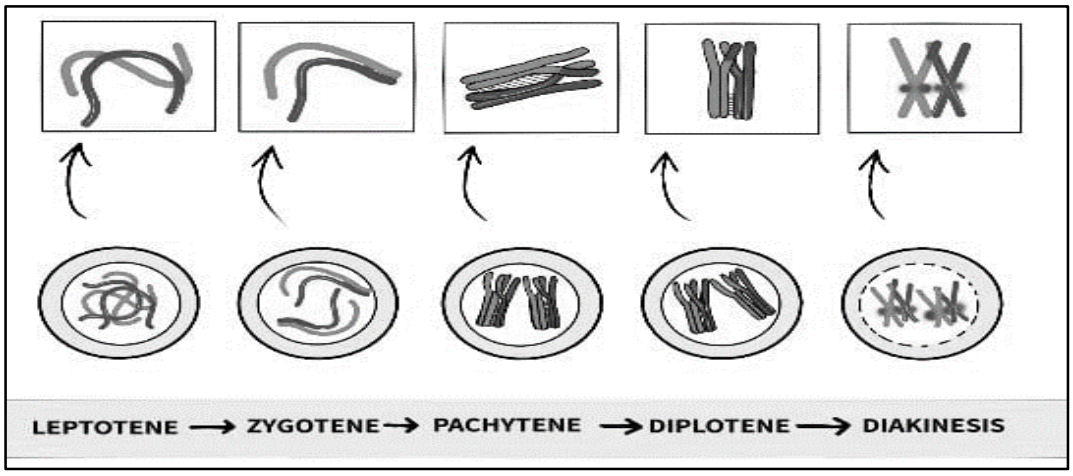


Figure 8. Substages of Prophase I
Illustrated by: Rosa Mia L. Pontillo

Substage 1: Leptotene

Each chromosome is made up of sister chromatids. These are long threadlike structures which result from the replication of DNA during the Synthesis or S phase of the cell cycle.

Substage 2: Zygotene

The homologous chromosomes start to pair off through the process known as synapsis. Pairs of chromosomes that are similar in size and shape are called homologous chromosomes or tetrads.

Substage 3: Pachytene

The repeated coiling of chromosomes occurs resulting to its contraction and thickening making the homologous pair of chromosomes to be very close to each other. At this stage, the process called crossing over happens. Here, the exchange of segments between

the sister chromatids of the homologous chromosomes occurs. The exchanging process form a cross-linkage called a chiasma. After crossing over, the sister chromatids of each chromosome may not be identical with each other based on the genetic material they contain. Crossing-over is a complicated process that results to genetic variability.

Figure 9 shows the pairing of two homo-logous chromosomes during synapsis. The paired chromosome then exchanges DNA segments during crossing over which results to exchange of genetic material. Chiasma shows the place where the two sister chromatids of the paired homo-logous chromosomes touched each other.

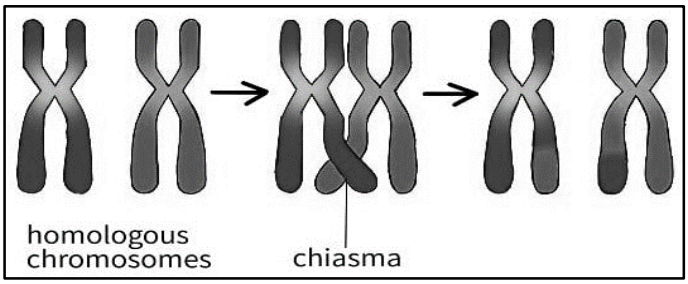


Figure 9. Crossing Over of Homologous Chromosomes during Meiosis
Illustrated by: Rosa Mia L. Pontillo

Substage 4: Diplotene

The two homologous chromosomes forming a tetrad begin to repel one another and move apart. They are held only by the chiasma.

Substage 5: Diakinesis

This is the last stage of meiosis prophase 1. Diakinesis stage is characterized by chiasmata terminalization. After diakinesis, the dividing cell enters metaphase.

At this stage, bivalents or homologous pair chromosomes distribute them evenly in the nucleus. The nuclear membrane breaks down and the nucleolus disappears. Chiasma moves towards the end, which is called terminalization. Chromatids remain attached only at the terminal chiasmata and enter the metaphase stage.

Metaphase I Stage

- Spindle fibers from the centrosomes of each pole connect to bivalents or tetrads through the kinetochores. Homologous chromosomes line up at the equatorial plane. There is double alignment of the chromosomes.

Anaphase I Stage

- Spindle fibers begin to contract and separate the bivalent or tetrads.
- Homologous chromosomes separate and migrate to each pole of the cell.

Telophase I Stage

- Chromosomes decondense.
- Nuclear membranes reform.
- Cytokinesis or the cytoplasmic division occurs and two haploid (N) daughter cells with chromosomes with two sister chromatids are formed.

Meiosis II.

The second meiotic division forms four daughter cells, each carrying haploid number of chromosomes. This consists of the following stages, namely, prophase II, metaphase II, Anaphase II, and telophase II.

Prophase II Stage

- Chromosomes (chromatids) condense to form metaphase chromosomes.
- Nuclear membrane dissolves and nucleolus disappears.
- Centrosomes move towards each pole of the cell.

Metaphase II Stage

- Spindle fibers attach to chromatids at the kinetochores.
- Chromosomes line up at the equatorial plane. (Single alignment of chromosomes).

Anaphase II Stage

- Spindle fibers shortened and separated the sister chromatids.
- Chromatids that are now called chromosomes move towards each pole of the cell.

Telophase II Stage

- Single-stranded chromosomes decondense.
- Nuclear membrane and nucleolus reforms.
- Cytoplasm divides (cytokinesis).
- Four haploid (n) daughter cells are formed.

Figure 10 shows the stages in Meiosis I and Meiosis II. In meiosis I, the two homologous chromosomes separate which results to two haploid (n) daughter cells with chromosomes with two chromatids each. In meiosis II, four haploid (n) daughter cells are formed. Each cell is carrying haploid number of chromosomes.

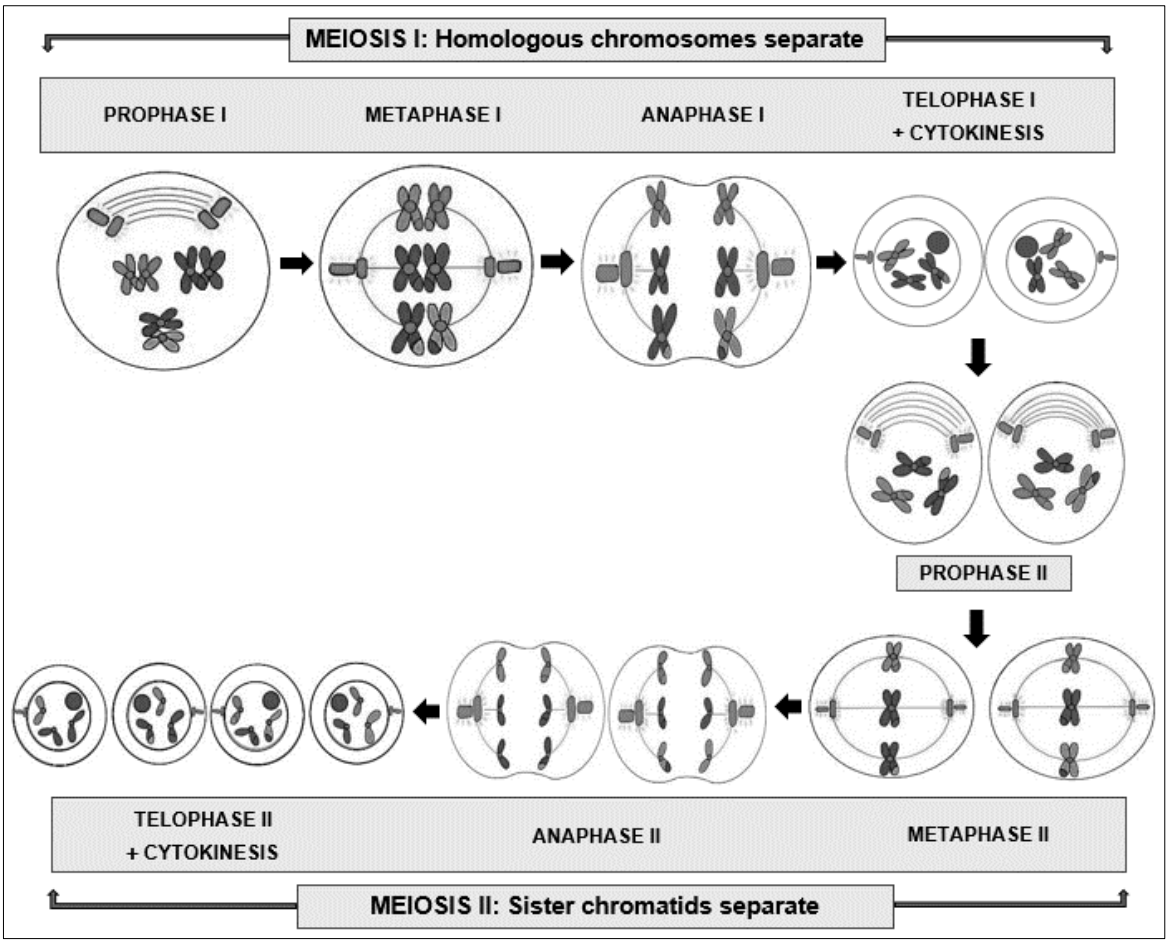


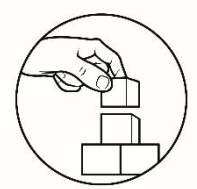
Figure 10. Stages in Meiosis I and Meiosis II
Illustrated by: Rosa Mia L. Pontillo

Table 2. Differences in Characteristics between Mitosis and Meiosis

Characteristics	**Mitosis**	**Meiosis**
Location	Somatic cells	Reproductive cells
Chromosome number of parent cell	Diploid (2n) or haploid (n)	Diploid (2n)
Chromosome number of daughter cell	Diploid (2n) or haploid (n)	Haploid (n)
Number of daughter cells produced	Two	Four
Number of nuclear divisions	One	Two
Steps required to complete the cell division phase	Prophase Metaphase Anaphase, and Telophase	Prophase I, Metaphase I, Anaphase I, Telophase I, Prophase II, Metaphase II, Anaphase II, and Telophase II
Occurrence of synapsis	None	Yes
Occurrence of crossing over	None	Yes
Presence of chiasma	Absent	Present
Kind of reproduction associated with	Asexual	Sexual

Table 3. Roles of Mitosis and Meiosis in the Cell Division

Mitosis	Meiosis
1. For somatic or body cell production - The repeated cell division through mitosis increases the number of somatic cells which is important for the growth of organisms.	**1. For gametes or sex cell production** - The diploid parent sex cells divide twice resulting to four genetically different haploid (N) daughter cells.
2. For asexual reproduction - Unicellular (single-celled) organisms reproduce fast and easily by mitosis that will result to the production of genetically identical offspring. Among plants, reproduction is also possible through cloning, grafting and marcotting, all of which do not involve gametes.	**2. For sexual reproduction** - Most multicellular organisms start as a single cell – a fertilized egg known as zygote. This zygote is the result of fertilization or the union of a female gamete, an egg, with a male gamete, a sperm that are produced through meiotic cell division.
3. For genetic stability - During mitosis, the resulting two daughter cells have the same type and number of genes as the original parent cell, thereby preserving and maintaining the genetic composition of a particular population.	**3. For genetic diversity** - Complex or multicellular organisms produce gametes that contain only one half of the information carried by the parent gamete. During fertilization, these gametes unite allowing genes from each parent to combine which results to differences in the DNA sequences of offspring.
4. For the repair of damaged cells/ tissues - Mitosis helps in the repair of worn-out body cells and replaces damaged cells and tissues through repeated cell division.	**4. Aids in the repair of genetic defects** - Meiotic recombination is also used in DNA repair, whereby pieces of DNA are broken and recombined to produce new combination of alleles (form of gene). Recombination replaces defective gene with the healthy allele giving way to healthy offspring.



What's More

Activity 2 – Cellular Activities in Mitosis

Directions: From the choices given below, complete the table by writing the letter corresponding to the cellular activity that describes the phase indicated. Write your answers on a separate sheet of paper.

Stages	Phases	Cellular Activities
Interphase	G_1 phase	1.
	S phase	2.
	G_2 phase	3.
Mitosis	Prophase	4.
	Metaphase	5.
	Anaphase	6.
	Telophase	7.
Cytokinesis		8.

A. DNA replicates.

B. Nuclear membrane reforms.

C. Cytoplasm completely divides.

D. Protein and RNA synthesis occur.

E. Cell prepares for the actual cell division.

F. Chromosomes align at the equatorial plane.

G. Chromosomes condense and become visible.

H. Sister chromatids separate and migrate to the opposite pole.

Activity 3 – Cellular Activities in Meiosis

Directions: Match the cellular activities with their appropriate phases in meiosis. The stages can be used more than once or not at all. Write your answers on a separate sheet of paper.

A. Prophase I	D. Telophase I	G. Anaphase II
B. Metaphase I	E. Prophase II	H. Telophase II
C. Anaphase I	F. Metaphase II	I. Interphase

1. Synapsis occurs.
2. Crossing over occurs.
3. DNA replication occurs.
4. Homologous pairs separate.
5. Two daughter cells are created.
6. Chromatids align along equator.
7. Chromatids move to opposite poles.
8. Daughter cells divide forming four haploid cells.
9. Homologous chromosomes or tetrads align at the equator.
10. Spindle fibers attach to tetrads through their kinetochores.

Activity 4. Comparing Mitosis and Meiosis

Directions: Put a check mark (√) in the appropriate column to tell whether the characteristics and roles describe mitosis or meiosis or both. Write your answers on a separate sheet of paper.

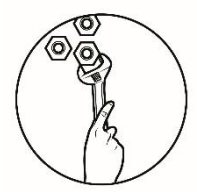
Characteristics and Roles	Mitosis	Meiosis	Both
1. Produces body cells			
2. Ensures genetic stability			
3. Divides the parent cell once			
4. Divides the parent cell twice			
5. Produces four daughter cells			
6. Gives way to genetic diversity			
7. Produces gametes or sex cells			
8. Produces daughter cells with same number of chromosomes like the mother cell			
9. Aids in the repair of genetic defects			
10. Associated with sexual reproduction			
11. Associated with asexual reproduction			
12. Produces two identical daughter cells			
13. Occurs in the gonads (testes and ovaries)			
14. Produces diploid or haploid daughter cells			
15. Helps in the repair of damaged cells/tissues			

What I Have Learned

Activity 5. Fill in the Blank

Directions: Complete the statement by writing the appropriate word or phrase on the blank. Write your answers on a separate sheet of paper.

1. Genes consist of _____.
2. Chromosomes are structures found in the cell _____ that contain a person's genes.
3. Every normal human somatic cell contains 23 pairs of chromosomes, or a total of _____ chromosomes.
4. The cell undergoes a cycle that may be divided into two stages, the _____ and the cell division or mitotic phase.
5. The interphase is divided into three phases namely: the gap one phase (G_1), the _____ phase, and the gap two phase (G_2).
6. There are four distinct stages of mitosis namely: prophase, _____, anaphase, and telophase.
7. During mitosis, two things occur. These are the nuclear division and the cytoplasmic division called _____.
8. Each spindle fiber from both _____ connects to the kinetochore of each chromosome.
9. In plant cells, _____ forms and becomes a new cell wall dividing the cytoplasm into two parts.
10. The outcome of meiosis is the production of four _____ (N) daughter cells.

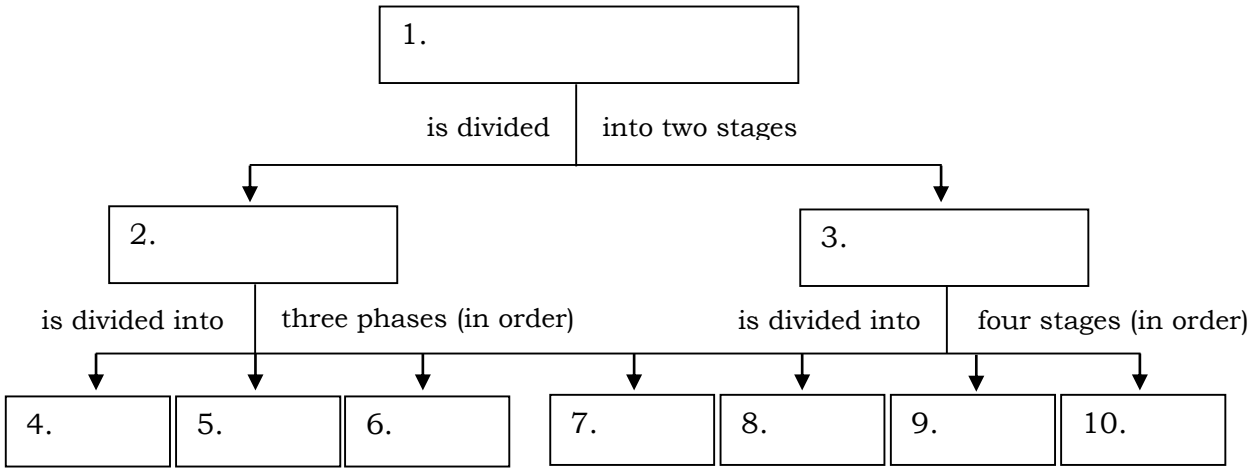


What I Can Do

Activity 6. Concept Mapping

Directions: Select from the word bank the appropriate word/s that will complete the concept map below. Each word should be used only once. You may not copy the boxes. Write your answers on a separate sheet of paper.

Anaphase	Interphase	Synthesis phase
Cell cycle	Metaphase	Telophase
G_1 phase	Mitotic phase	
G_2 phase	Prophase	



Assessment

Directions: Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. Which factor controls hereditary traits?
   A. cells
   B. chromosomes
   C. genes
   D. parents

2. Which phase of the cell cycle does DNA replication occur?
   A. G_1 phase
   B. G_2 phase
   C. S phase
   D. M phase

3. Which stage in the life of a cell is spent most?
   A. cytokinesis phase
   B. interphase
   C. mitotic phase
   D. synthesis phase

4. Which statement describes what happens during karyokinesis?
   A. DNA replication
   B. division of nucleus
   C. doubling of cell size
   D. synthesizing enzymes for mitosis

5. Humans have diploid chromosome number (2N) which is equal to 46 chromosomes. What is the chromosome number of each daughter cell produced during meiosis?
   A. 1
   B. 23
   C. 46
   D. 92

For items 6 – 7, refer to the statement below.
Solanum tuberosum or potato has a chromosome number of 24 (2N).

6. How many chromosomes are there during metaphase?
   A. 12
   B. 24
   C. 36
   D. 48

7. How many daughter cells are there by the end of telophase?
   A. 1
   B. 2
   C. 12
   D. 24

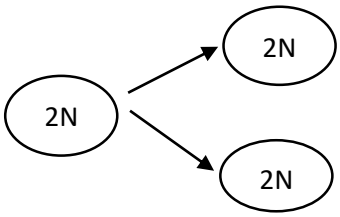
8. Which stage of mitosis where the chromatids of chromosomes separate and begin to move away from each other?
   A. anaphase
   B. metaphase
   C. prophase
   D. telophase

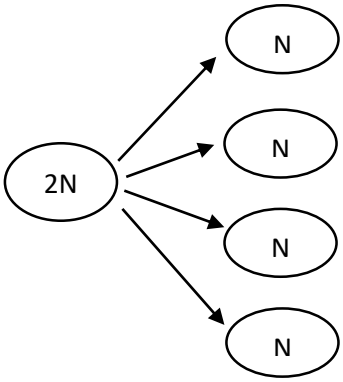
9. There are 64 chromosomes of a fern plant. After mitosis, each daughter cell formed will have how many chromosomes?
   A. 2
   B. 4
   C. 32
   D. 64

10. Which diagram correctly represents the process of meiosis?

A. 

B. 

C. 

D. 

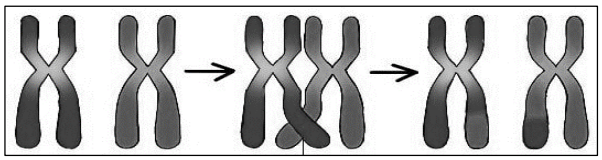
11. The following statements are true about meiosis EXCEPT:
    A. It occurs in reproductive cells.
    B. It results in four haploid (N) daughter cells.
    C. Exchanging of genetic material does not occur.
    D. Pulling apart of homologous pairs of chromosomes occurs.

For item 12, refer to the table below.

Basis of Comparison	Mitosis	Meiosis
Number of daughter cells	2	
Chromosome number	2N or N	

12. What information is provided to complete column 3 under meiosis?
    A. 2 – 2N or diploid
    B. 2 – 2N or haploid
    C. 4 – 2N or diploid
    D. 4 – N or haploid

13. What process is shown in the illustration of chromosomes below?



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    A. synapsis only
    B. crossing over only
    C. synapsis and crossing over
    D. pulling apart of chromosomes

14. What is the substage of prophase I where the pairing of chromosomes begins?
    A. diplotene
    B. leptotene
    C. pachytene
    D. zygotene

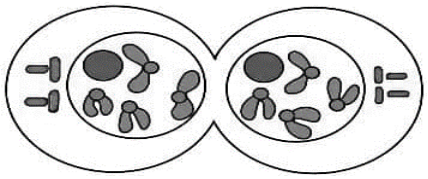
15. Which stage of your development as a human being when you were just one cell?
    A. baby
    B. fetus
    C. infant
    D. zygote

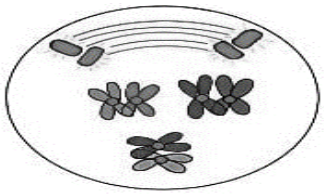
Additional Activities

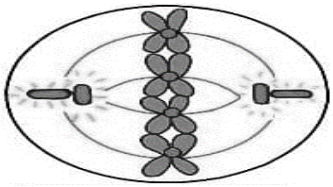
Activity 7. Learn More!

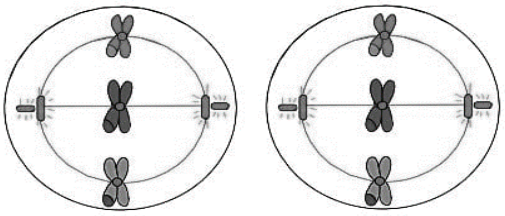
Directions: Use the correct word from the word bank to tell the correct stages of cell division shown below. Each word should be used only once. Write the letter of your answers on a separate sheet of paper. (Hint: Notice the traces of synapsis and crossing over in the chromosomes during meiosis.)

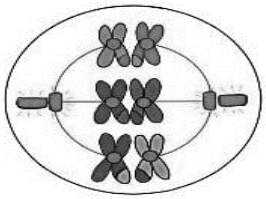
A. Anaphase	D. Metaphase	G. Prophase	J. Telophase
B. Anaphase I	E. Metaphase I	H. Prophase I	K. Telophase I
C. Anaphase II	F. Metaphase II	I. Prophase II	L. Telophase II

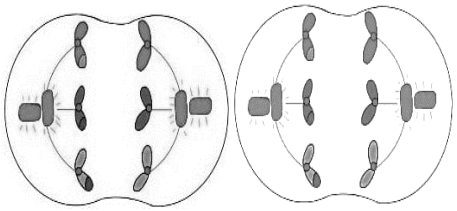
1. 

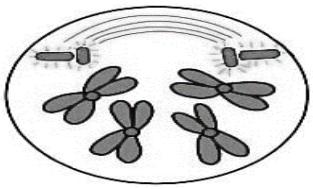
2. 

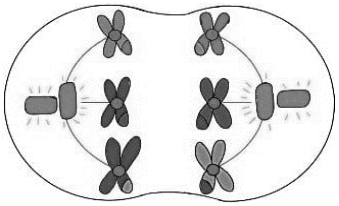
3. 

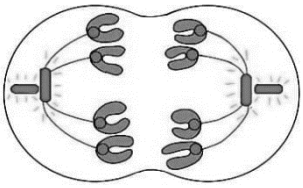
4. 

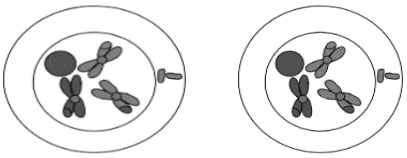
7. 

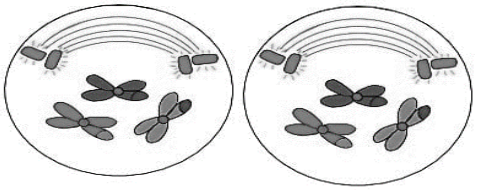
8. 

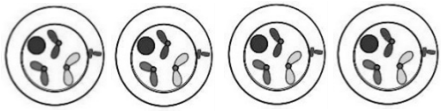
9. 

10. 

5. 

6. 

11. 

12. 

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