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Meiosis

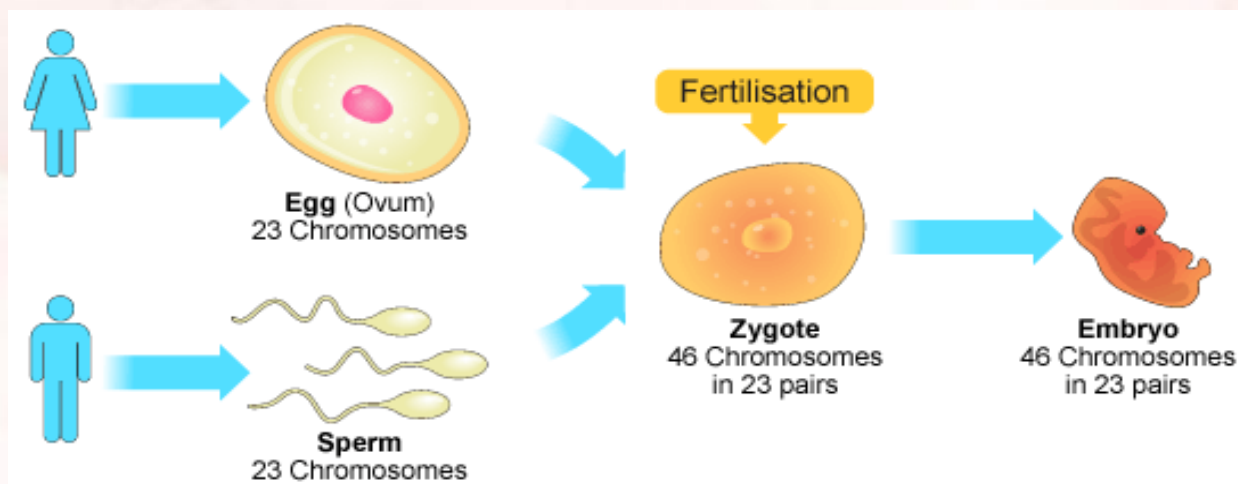
Objectives :

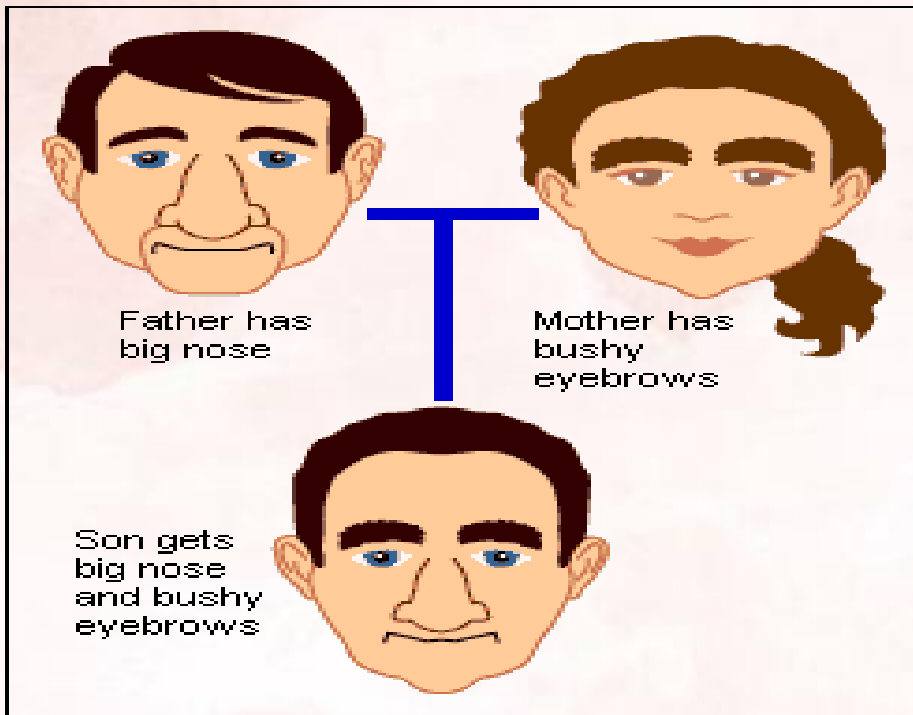
- **To explain how reduction in chromosome number occur during meiosis.**
- **To descuss the stages of meiosis .**
- **To describe the importance of meiosis in providing genetic variation .**

MAIN Idea Meiosis produces haploid gametes.

MAIN Idea Meiosis produces haploid gametes.

Real-World Reading Link Look around your biology class. You might notice that the students in your class do not look the same. They might be different heights and have different eye color, hair color, and other features. This variety of characteristics is a result of two sex cells combining during sexual reproduction.





Each person has characteristics that have been passed on to him by his parents and are called **Traits**.

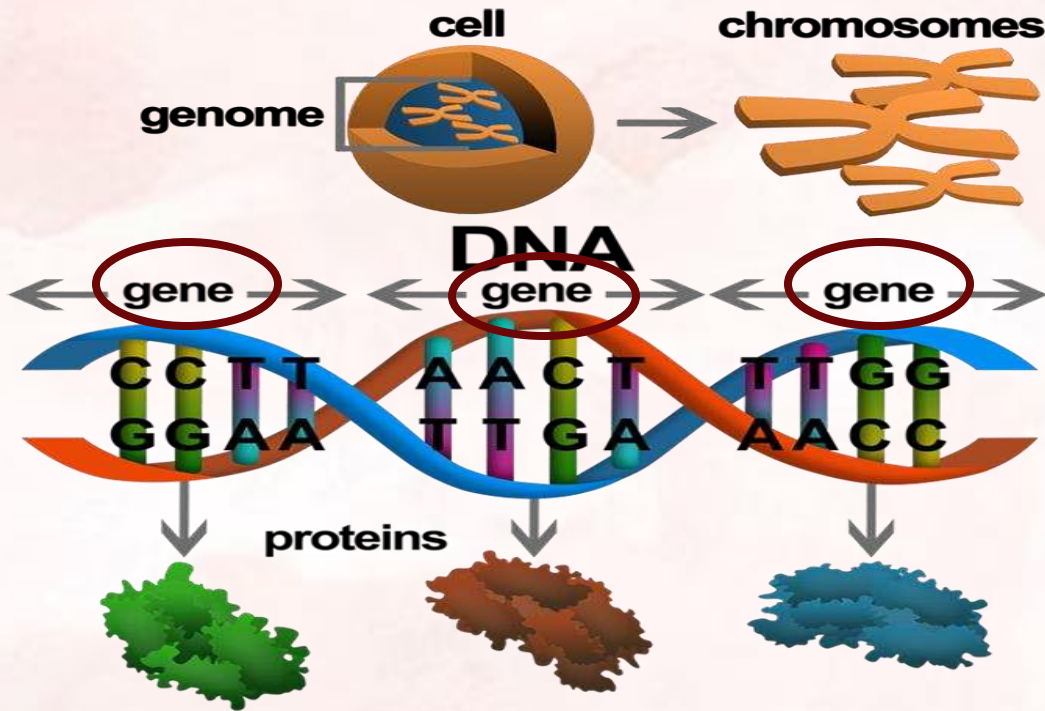
Q1: on the figure: list the inherited characteristics which the person get it from each father? (father, mother)

Where are the instructions for each genetic characteristic?

On chromosomes



Chromosomes are found in the nucleus of cells



Chromosomes are made of DNA

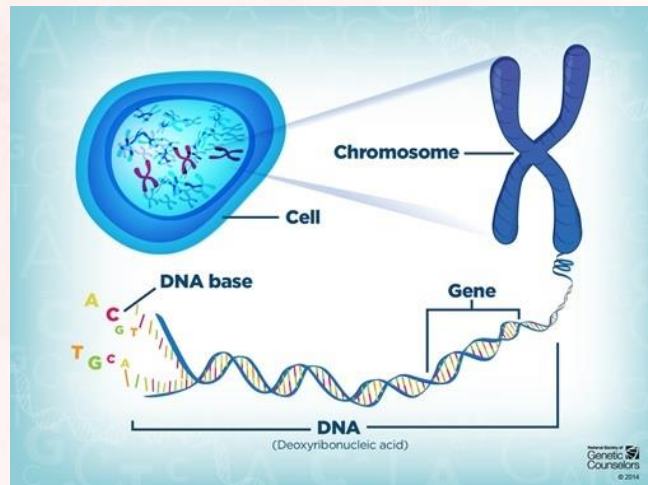


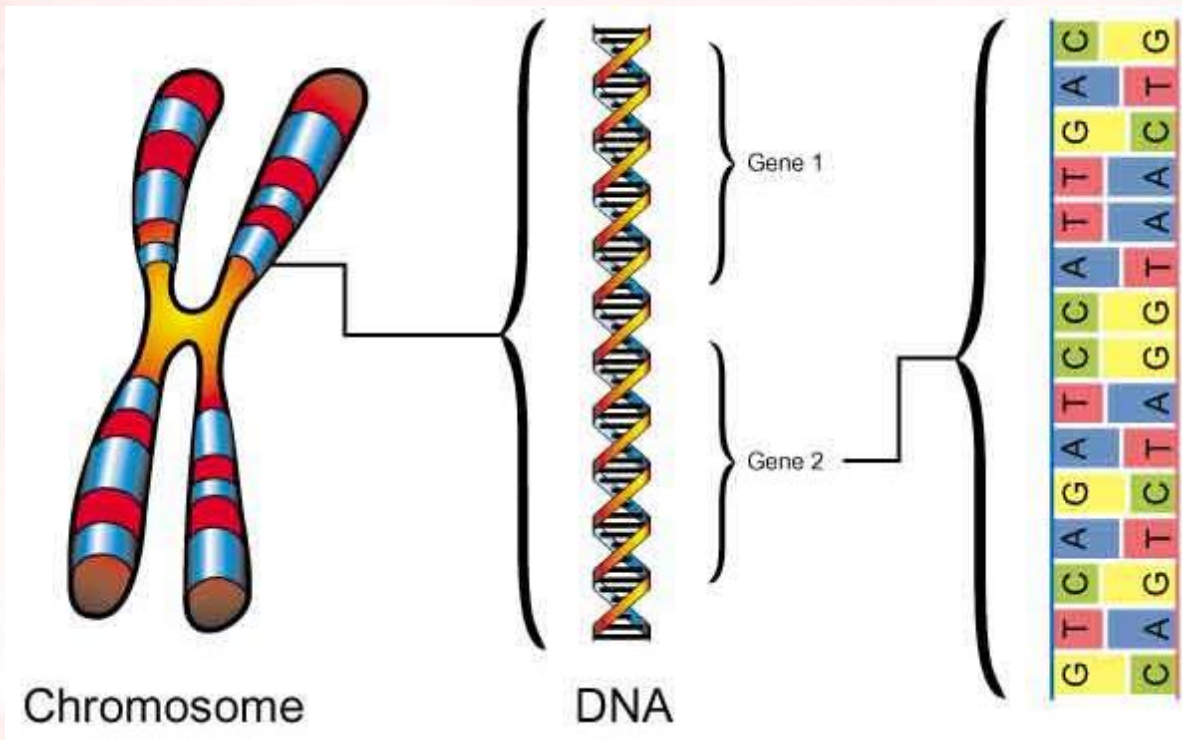
DNA is arranged in segments called

Genes



Control the production of **proteins**



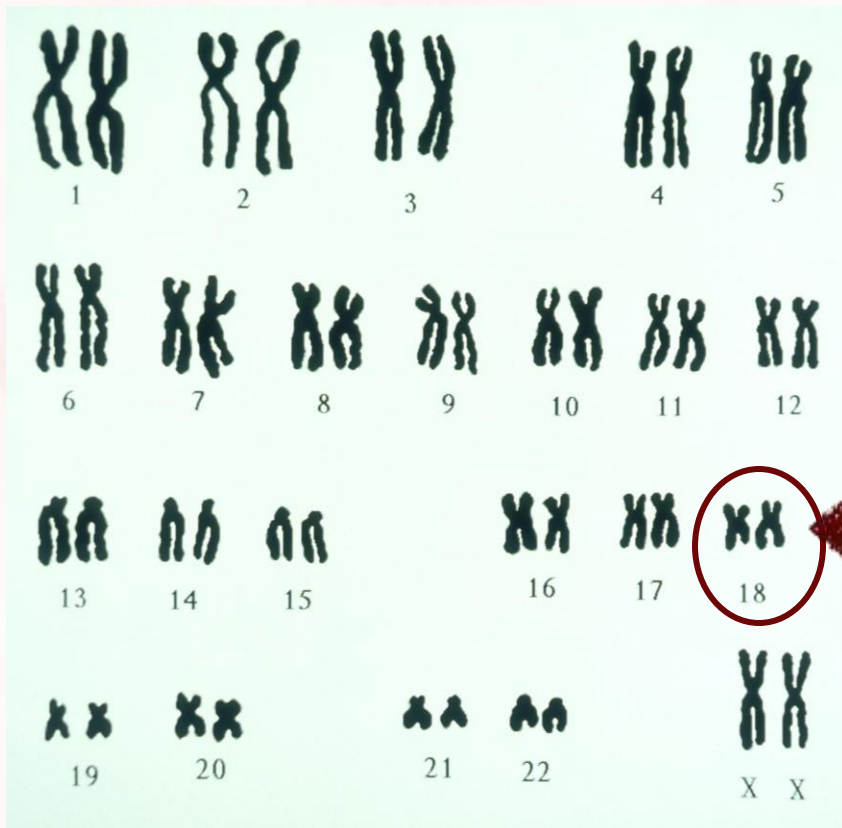


consists of hundreds of genes

Each gene playing an important role in determining the characteristics and functions of the cell

➤ Human body cells contain**46** chromosomes.

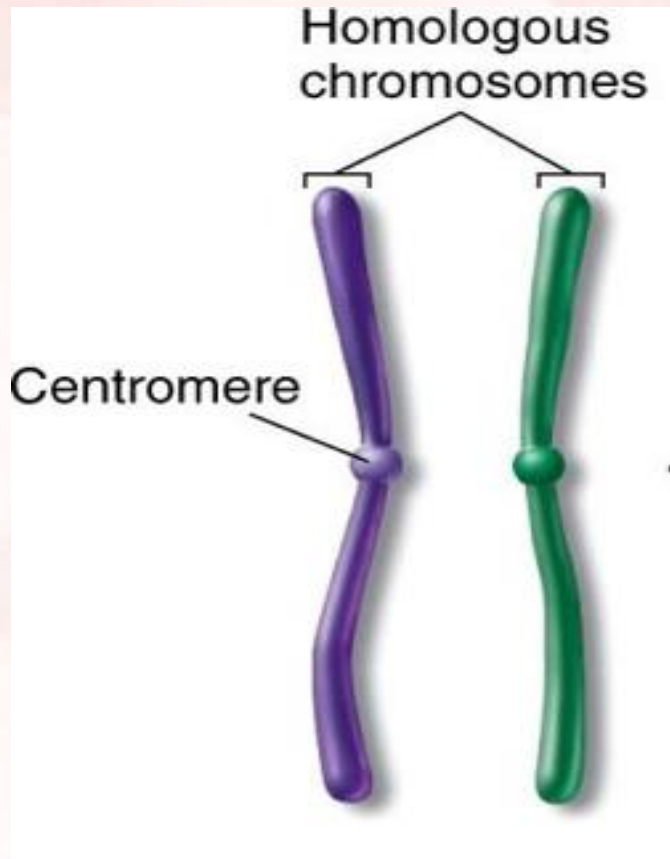
➤ The source of chromosomes in human body cells:
23 chromosomes from **mother**
and**23** chromosomes from**father**.



The chromosomes that make up a pair one chromosome from each parent, are called

Homologous chromosomes

Homologous chromosomes



- 1- The chromosomes that make up a pair
- 2- have the same length
- 3- the same centromere position
- 4- they carry genes that control the same inherited traits.

■ **Figure 1** Homologous chromosomes carry genes for any given trait at the same location. The genes that code for earlobe type might not code for the exact same type of earlobe.

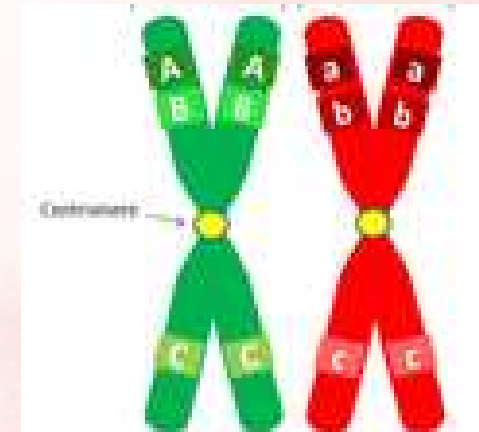


the gene for ear **lobe type**



located at the same position on both homologous chromosomes.

these genes that code for earlobe type, they might not code for the exact same type of earlobe.



Haploid & diploid cells

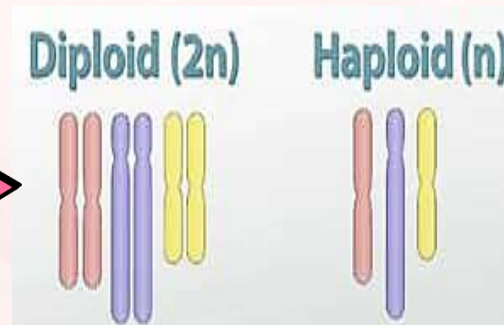
Why organism produce gametes?

to maintain the same chromosome number from generation to generation

- Gametes are...**sex**... cells.
- Gametes contain....**(half)** all) number of chromosomes.
- The symbol that use to represent the number of chromosome in cell. ($N - m - n - x$)

The number of chromosomes varies from one species to another

A cell with $2n$ number of chromosomes
Or the number of pairs

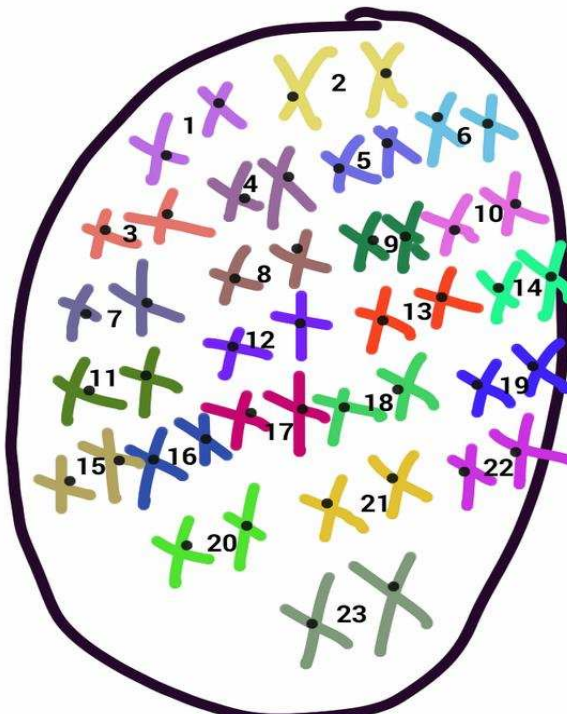
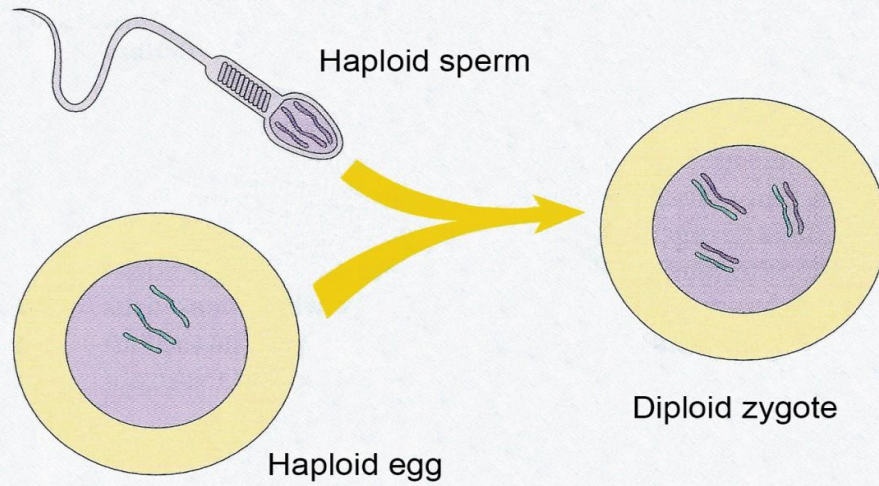


A cell with n number of chromosomes

What the difference between them?

What is fertilization?

The process by which one haploid gamete combines with another haploid gamete

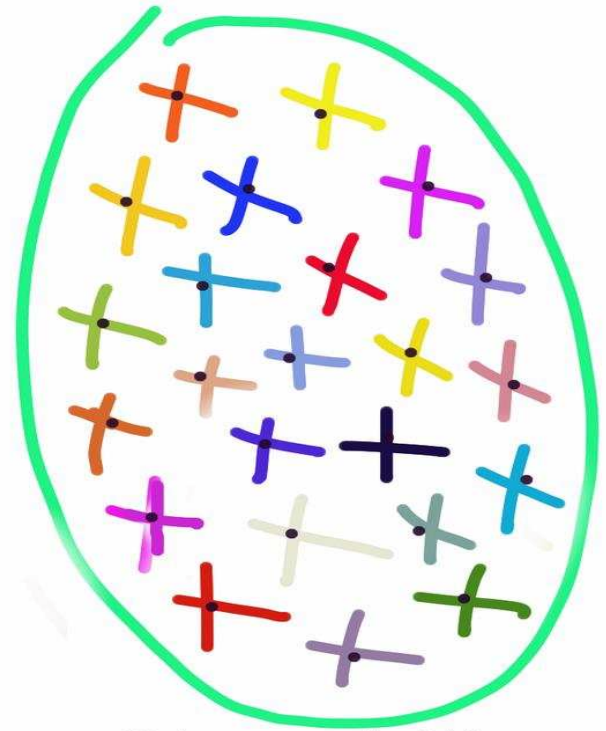


23 homologous pairs and 46 chromosomes(diploid cell)

Produce gametes

By meiosis

fertilization



23 chromosomes (haploid)

Meiosis

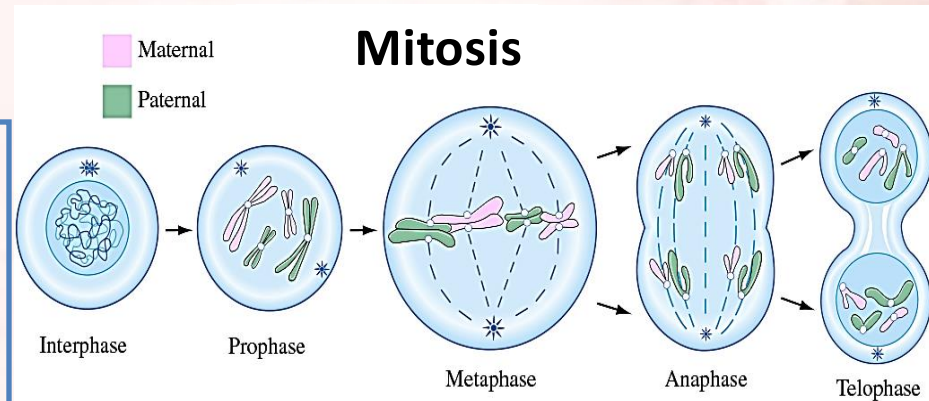
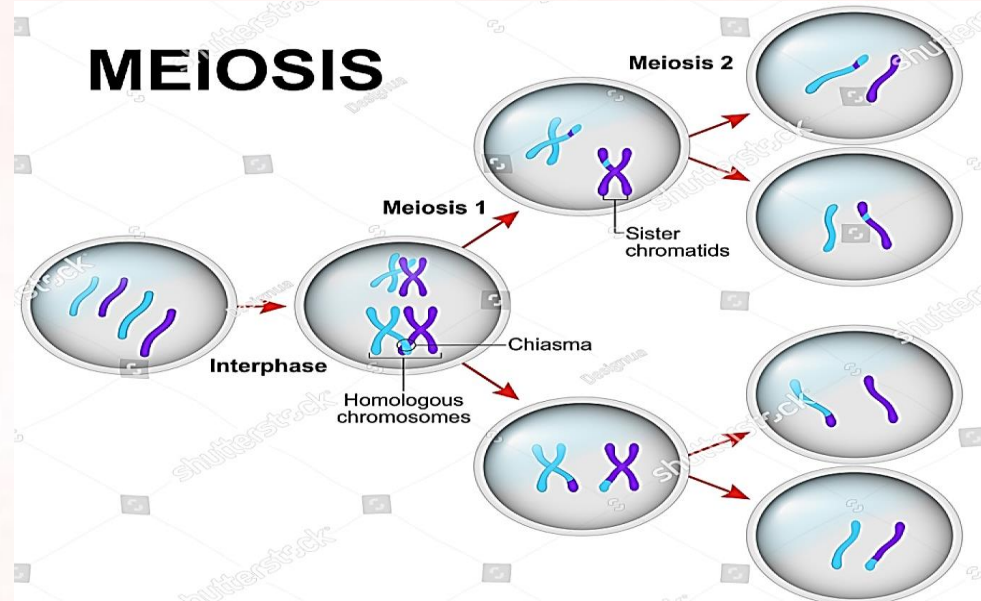
What is the process which produce gametes
meiosis division

What will happen to the number of chromosome during meiosis?
It will reduces

Where will occurs this process?
in the reproductive structures of organisms that reproduce sexually.

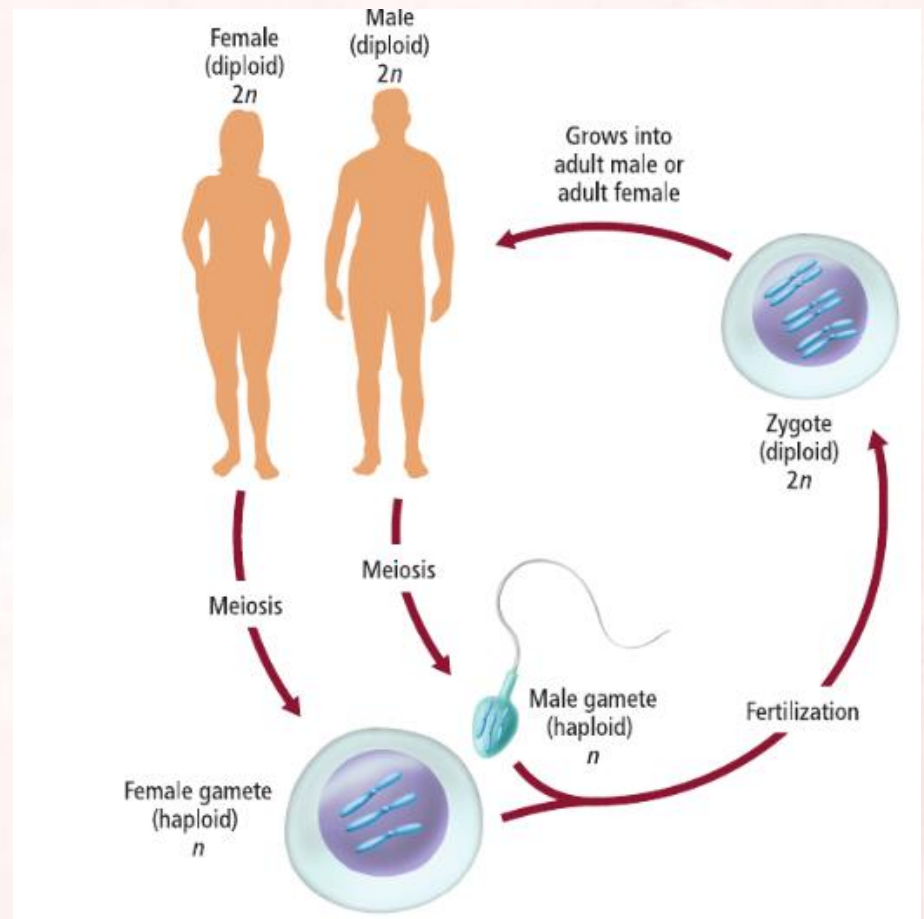
Compare the number of chromosomes in a cell resulting from an mitosis division and a cell resulting from meiosis division?

mitosis maintains the chromosome number, **meiosis reduces** the hromosome number by half



A cell with 2n number of chromosomes will have gametes with n number of chromosomes after meiosis.

■ **Figure 2** The sexual life cycle in animals involves meiosis, which produces gametes. When gametes combine in fertilization, the number of chromosomes is restored.



Describe what happens to the number of chromosomes during meiosis.

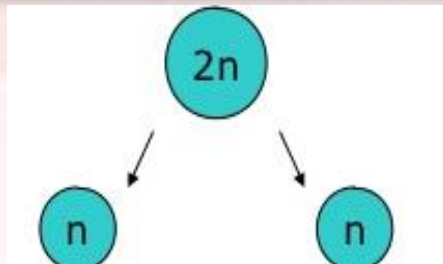
■ **Caption Question Fig. 2** The number of chromosomes is halved during meiosis.

Meiosis

The cell division that formed gametes

Reduce the number of chromosomes

Referred to as a **Reduction division**



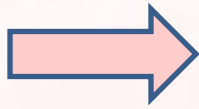
Occurs in the reproductive structures of organisms that reproduce sexually.

involves two consecutive cell divisions called :

meiosis I

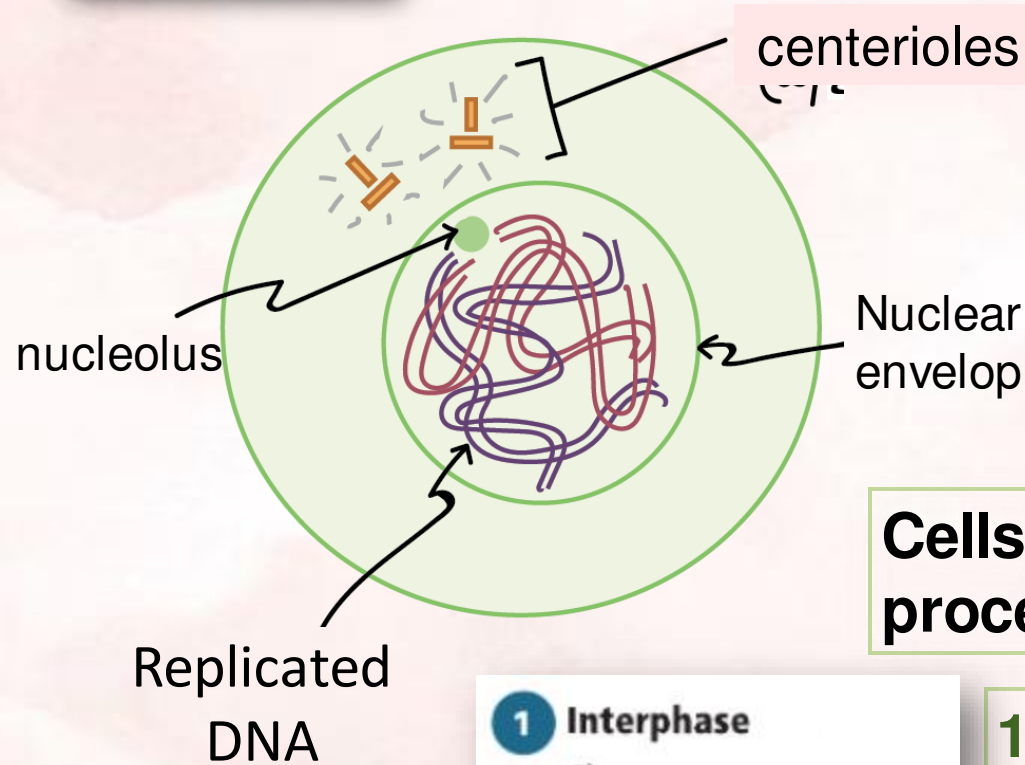
Meiosis II

**Before
Division**



Cell go through Interphase

as part of the cell cycle.



Cells carry out various metabolic processes:

1 Interphase

- Chromosomes replicate.
- Chromatin condenses.

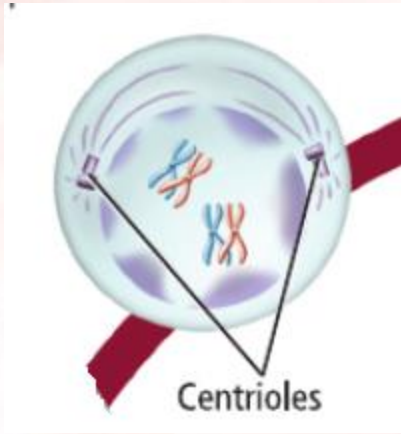


- 1- the replication of DNA
- 2- the synthesis of proteins
- 3- chromatin condense

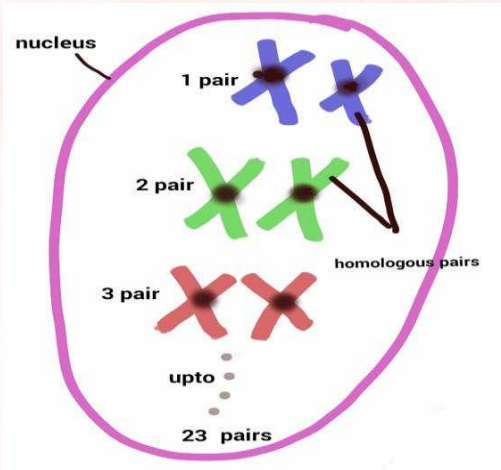
Cell will start

Meiosis I

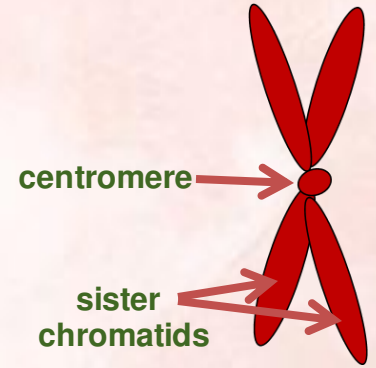
Prophase I



- The nuclear envelope breaks down.
- centrioles move to the cell's opposite poles.
- Spindle fibers form and bind to the sister chromatids at the centromere.

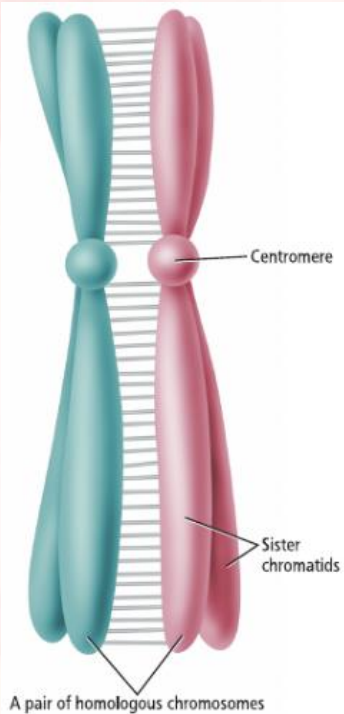


- ✓ The replicated chromosomes become visible.
- ✓ The replicated chromosomes consist of two sister chromatids.
- ✓ Sister chromatids are linked together in the centromere.



Prophase I

As the homologous chromosomes condense



■ **Figure 3** The homologous chromosomes are physically bound together during synapsis in prophase I.



form pairs in a process called **synapsis**.

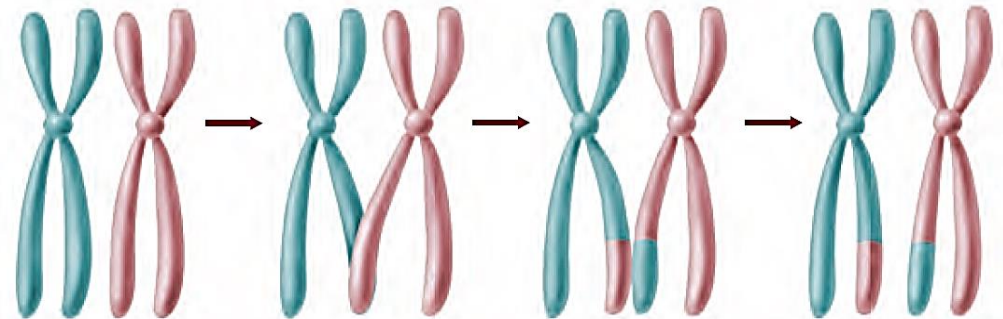


The homologous chromosomes are held tightly together along their lengths



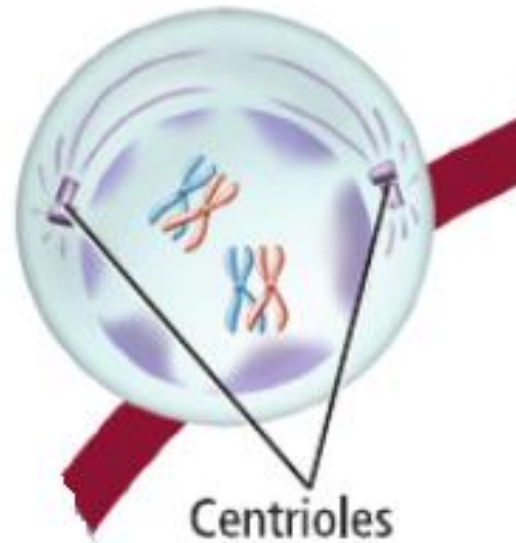
Crossing over occurs during synapsis

Crossing over: is a process during which chromosomal segments are exchanged between a pair of homologous chromosomes



2 Prophase I

- Pairing of homologous chromosomes occurs, each chromosome consists of two chromatids.
- Crossing over produces exchange of genetic information.
- The nuclear envelope breaks down.
- Spindles form.

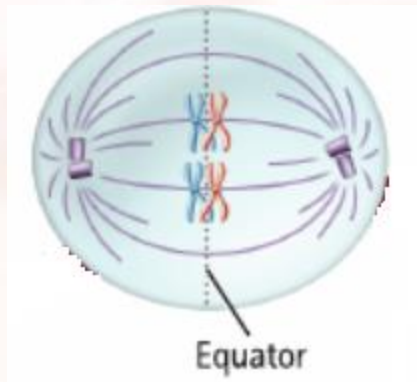
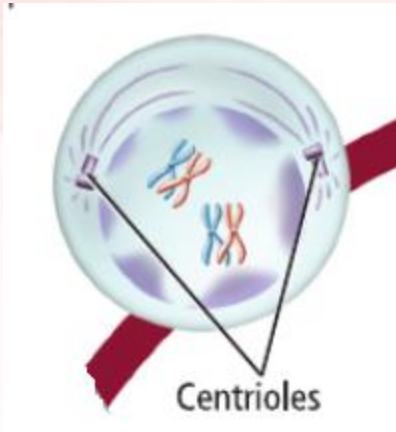


Determine which chromatids exchanged genetic material.

- **Caption Question** Fig. 4 the bottom right segment of the chromosome on the left and the bottom left segment of the chromosome on the right

After prophase I

Cell start **Metaphase I**

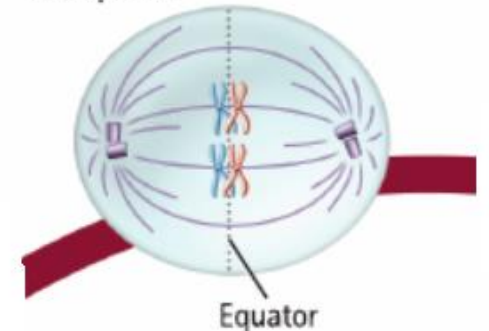


1-the **spindle** fibers **attach to the centromere** of each homologous chromosome.

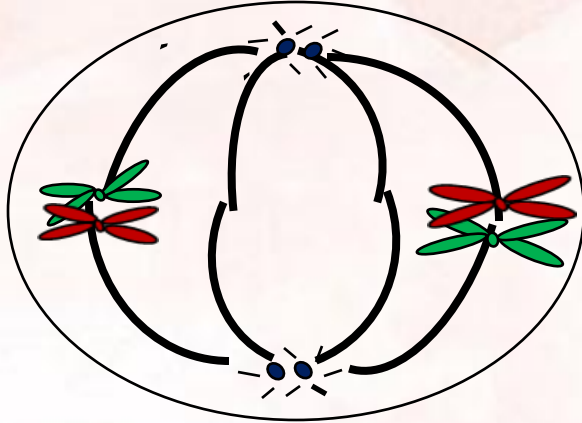
2- the **pairs** of homologous chromosomes **line up at the equator** of the cell.

3 Metaphase I

- Chromosome centromeres attach to spindle fibers.
- Homologous chromosomes line up at the equator.

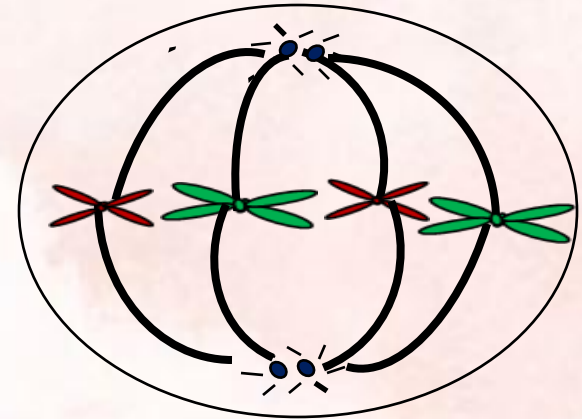


Compare between the Meiosis and Mitosis division in Metaphase I ?



Metaphase I in Meiosis

Pairs of chromosomes



Metaphase in Mitosis

Individual chromosome

After Metaphase I

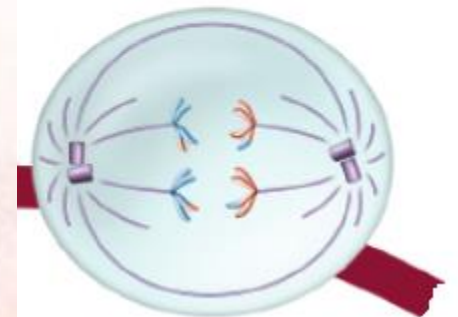
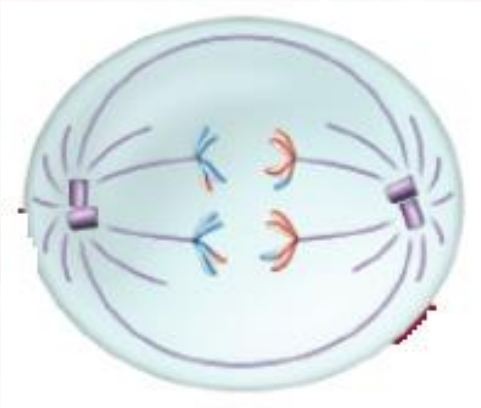
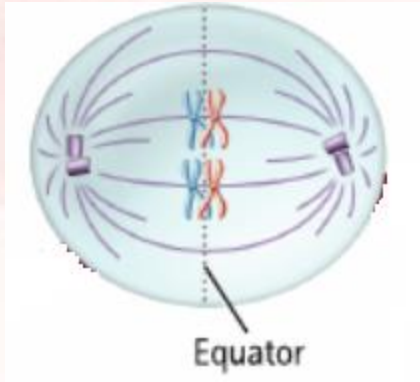
Cell start **Anaphase I**

- the homologous chromosomes separate.
- Each member of the pair is guided by spindle fibers and moves toward opposite poles of the cell.

Causing : reducing of the chromosome number from $2n$ to $1n$

4 Anaphase I

- Homologous chromosomes separate and move to opposite poles of the cell.



Question 4, page 229

4. How many chromosomes would a cell have during metaphase I of meiosis if it has 12 chromosomes during interphase?

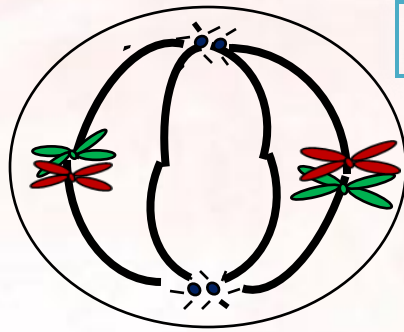
A. 6

B. 12

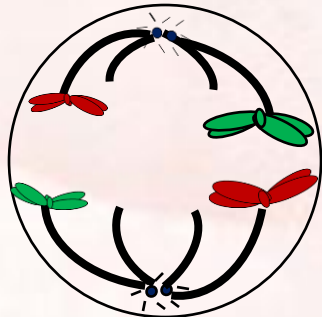
C. 24

D. 36

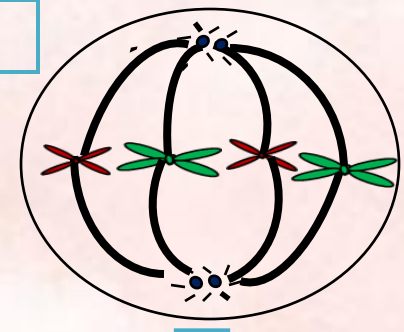
The difference between Meiosis and Mitosis division in Anaphase I ?



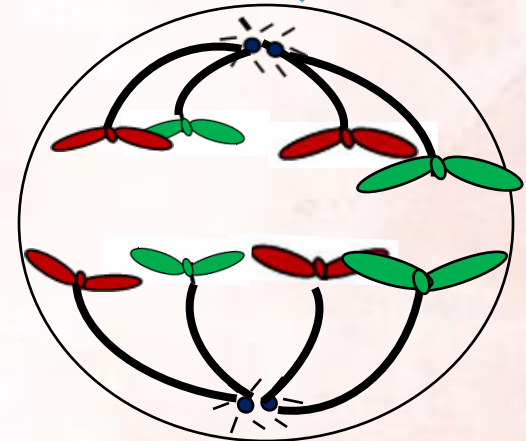
Meiosis



**Homologous chromosome separate,
still sister chromatids.**



Mitosis



**the sister chromatids split during
anaphase.**

After Anaphase I

Cell start **Telophase I**

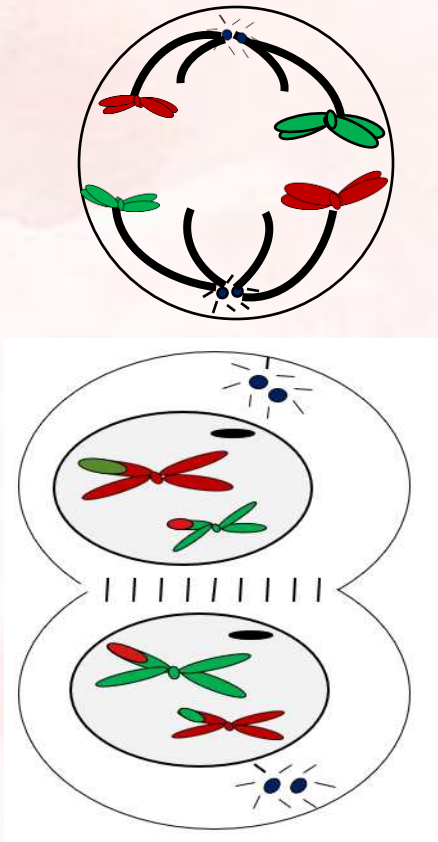
- ❖ homologous chromosomes, reach the cell's opposite poles.
- ❖ Each pole contains only one member of the original pair of homologous chromosomes.

each chromosome still consists of
.....**two sister chromatids**
at the ..**centromere**.

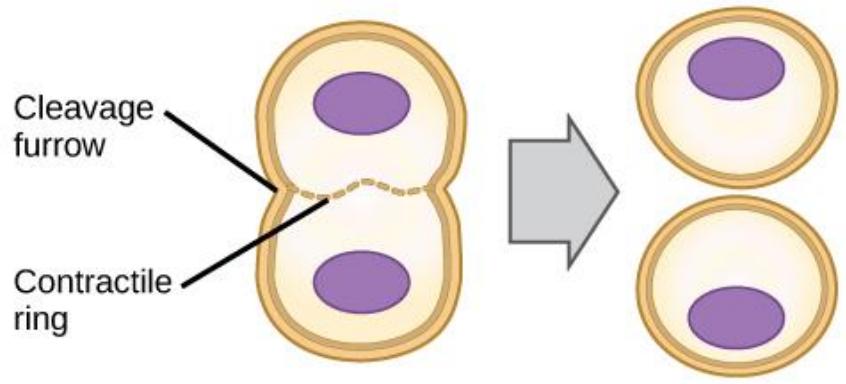
Explain: The sister chromatids might not be identical?

Because crossing over might have occurred during synapsis in prophase I.

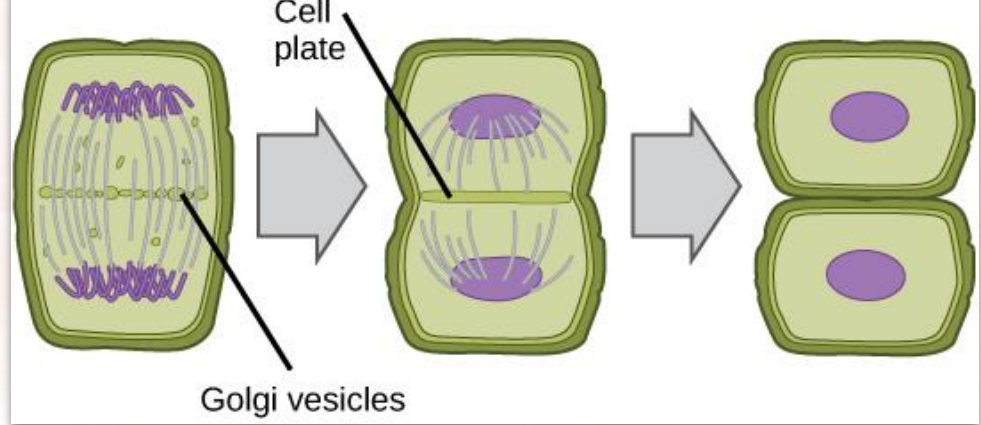
- ❖ cytokinesis usually occurs and the cell divides.
- ❖ the nuclear membrane reappears and Nuclei re-form .
- ❖ the chromosomes uncoil.



Animal cell



Plant cell



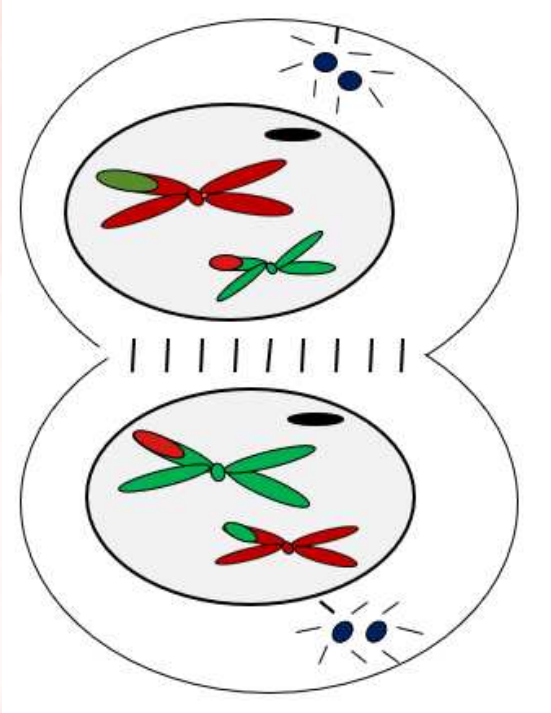
cytokinesis usually occurs:

- forming a furrow by pinching in **animal cells.**
- forming a cell plate in **plant cells.**

**each cell produced from Meiosis I,
will continue the steps of Meiosis II**

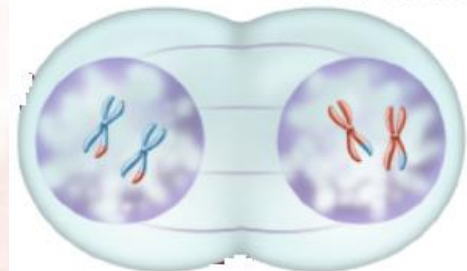
**Do the two new cells pass the phase of DNA
replication (doubled) before entering the
second set of division.**

**The resulting cells may pass
through the interphase but the
DNA is not replicated ... or not.**



5 Telophase I

- The spindles break down.
- Chromosomes uncoil and form two nuclei.
- The cell divides.



Meiosis II

the spindle apparatus forms and the chromosomes condense.

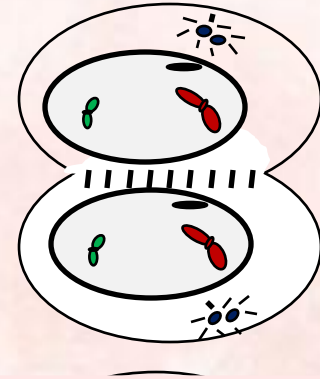
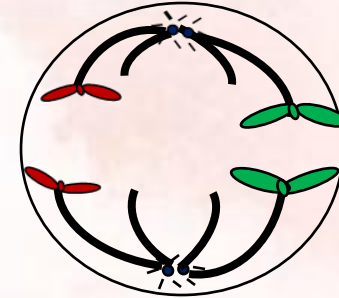
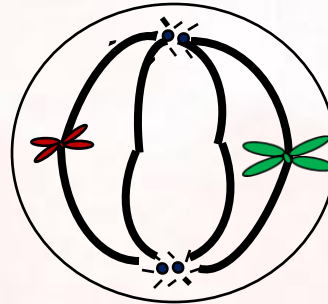
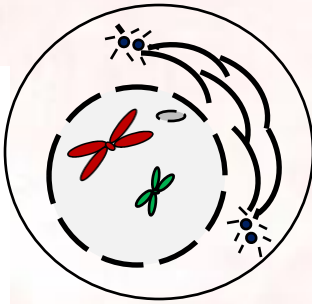
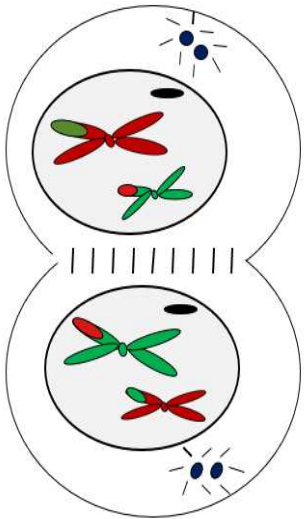
the chromosomes are positioned at the equator by the spindle fibers.

- metaphase of mitosis, a diploid number of chromosomes
- metaphase II of meiosis, however, a haploid number of chromosomes.

the sister chromatids are pulled apart at the centromere by the spindle fibers, and the sister chromatids move toward the opposite poles of the cell.

The chromosomes reach the poles during telophase II and the nuclear membrane and nuclei reform.

- At the end of meiosis II cytokinesis occurs, resulting in four haploid cells.



Prophase II

Metaphase II

Anaphase II

Telophase II

2 Prophase I

- Pairing of homologous chromosomes occurs, each chromosome consists of two chromatids.
- Crossing over produces exchange of genetic information.
- The nuclear envelope breaks down.
- Spindles form.

1 Interphase

- Chromosomes replicate.
- Chromatin condenses.

3 Metaphase I

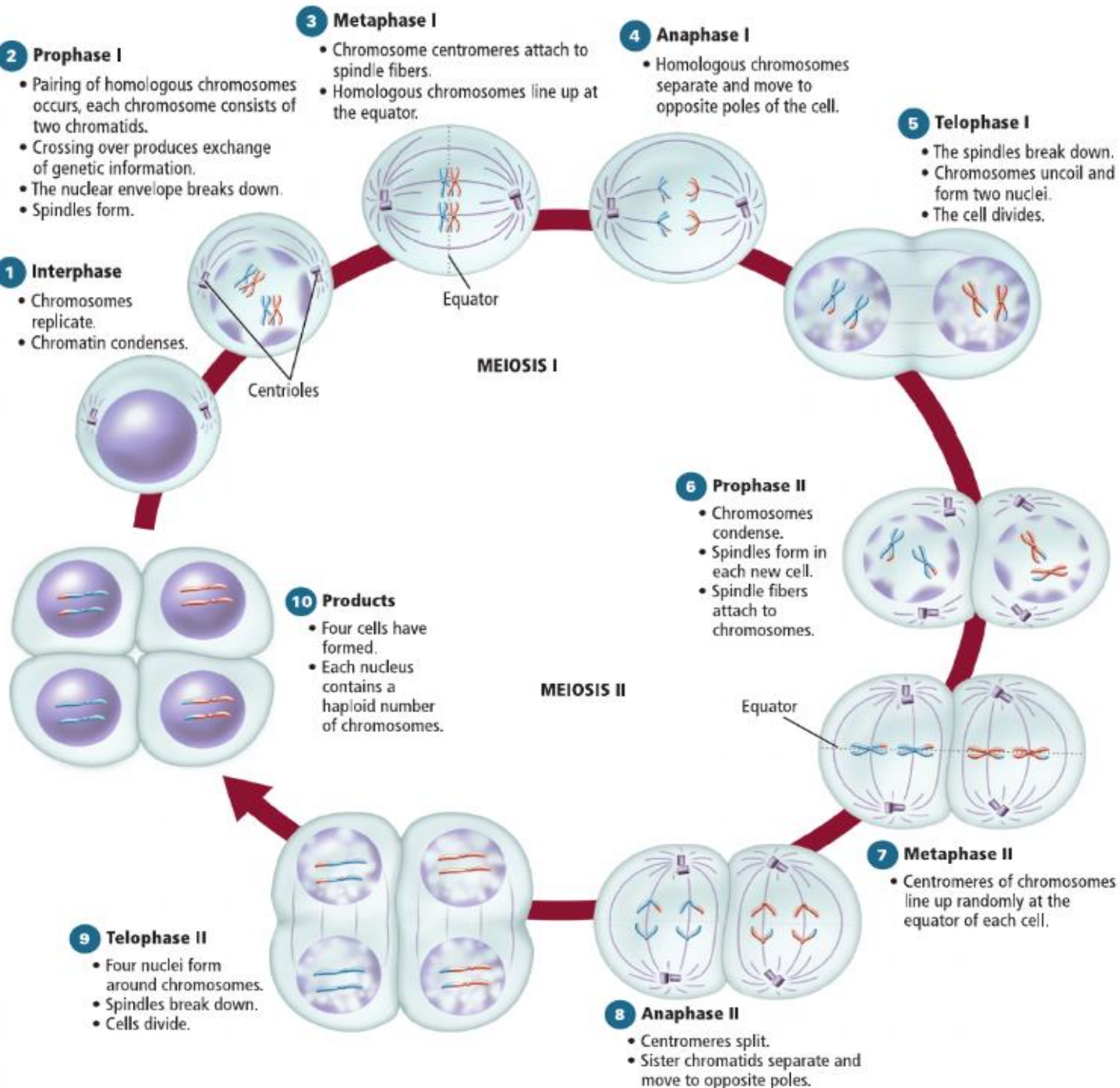
- Chromosome centromeres attach to spindle fibers.
- Homologous chromosomes line up at the equator.

4 Anaphase I

- Homologous chromosomes separate and move to opposite poles of the cell.

5 Telophase I

- The spindles break down.
- Chromosomes uncoil and form two nuclei.
- The cell divides.



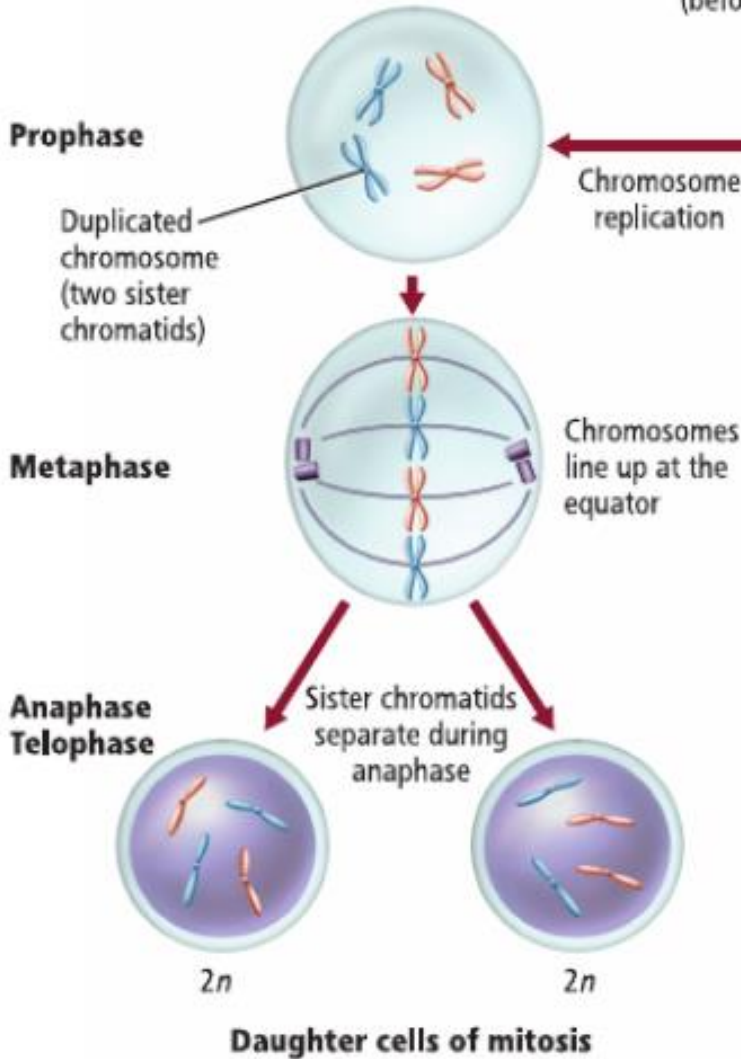


Reading Check Infer Why are the two phases of meiosis important for gamete formation?



Reading Check Answers will vary but should include the necessity of the chromosome number dividing by two in preparation for fertilization.

MITOSIS

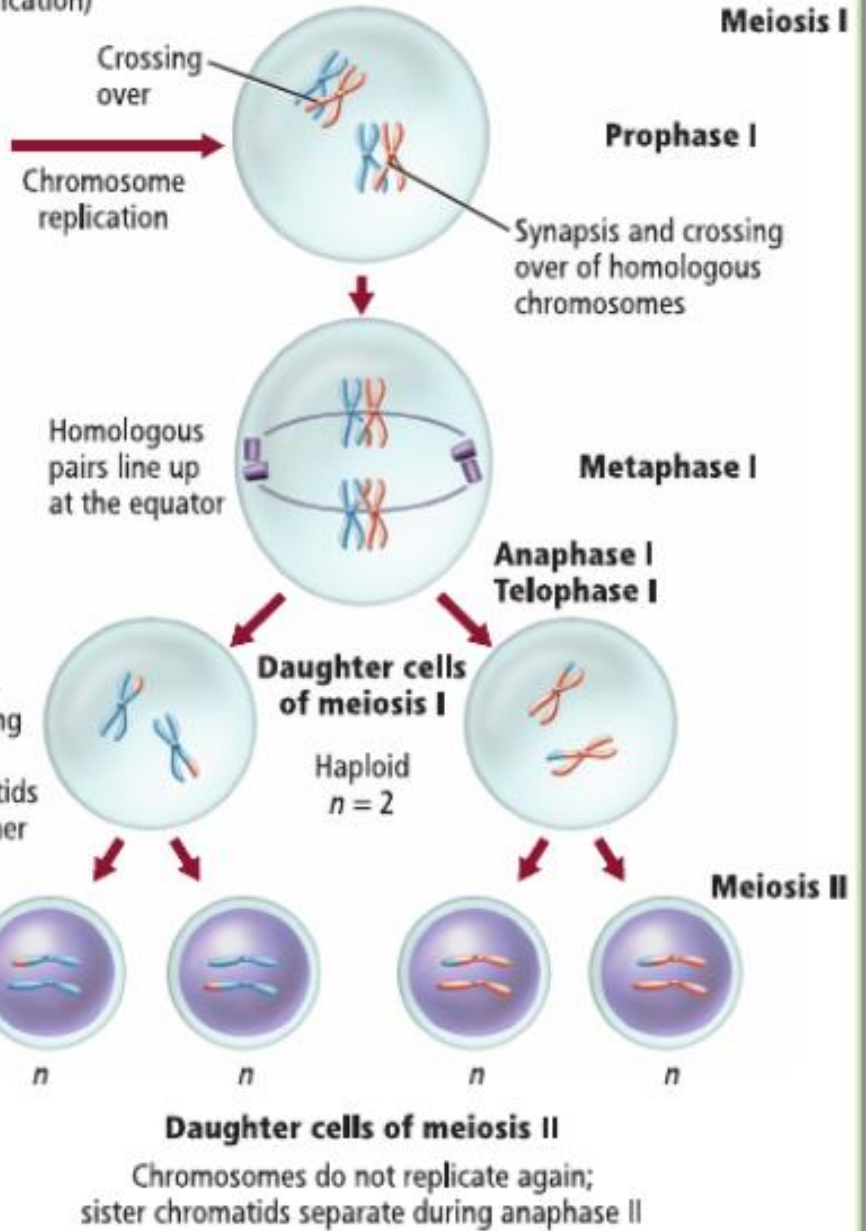


Parent cell
(before chromosome replication)



$2n = 4$

MEIOSIS



Compare between Meiosis & Mitosis?

Meiosis

- ✓ Consist of two sets of divisions
- ✓ Produces four haploid daughter cells (not Identical).

Mitosis

- ✓ Consist of one sets of division phases.
- ✓ Produces two diploid daughter cells (Identical).

Mitosis	Meiosis
<u>One division</u> occurs during mitosis.	<u>Two sets of divisions</u> occur during meiosis: meiosis I and meiosis II.
DNA replication occurs during <u>interphase</u> .	DNA replication occurs once <u>before meiosis I</u> .
Synapsis of homologous chromosomes <u>does not occur</u> .	Synapsis of homologous chromosomes <u>occurs during prophase I</u> .
<u>Two identical cells</u> are formed per cell cycle.	<u>Four haploid cells</u> (n) are formed per cell cycle.
The daughter cells are <u>genetically identical</u> .	The daughter cells are <u>not genetically identical</u> because of crossing over.
Mitosis occurs only in <u>body cells</u> .	Meiosis occurs only in <u>reproductive cells</u> .
Mitosis is involved in <u>growth and repair</u> .	Meiosis is involved in the <u>production of gametes and providing genetic variation</u> in organisms.

Why Meiosis is **important** ?

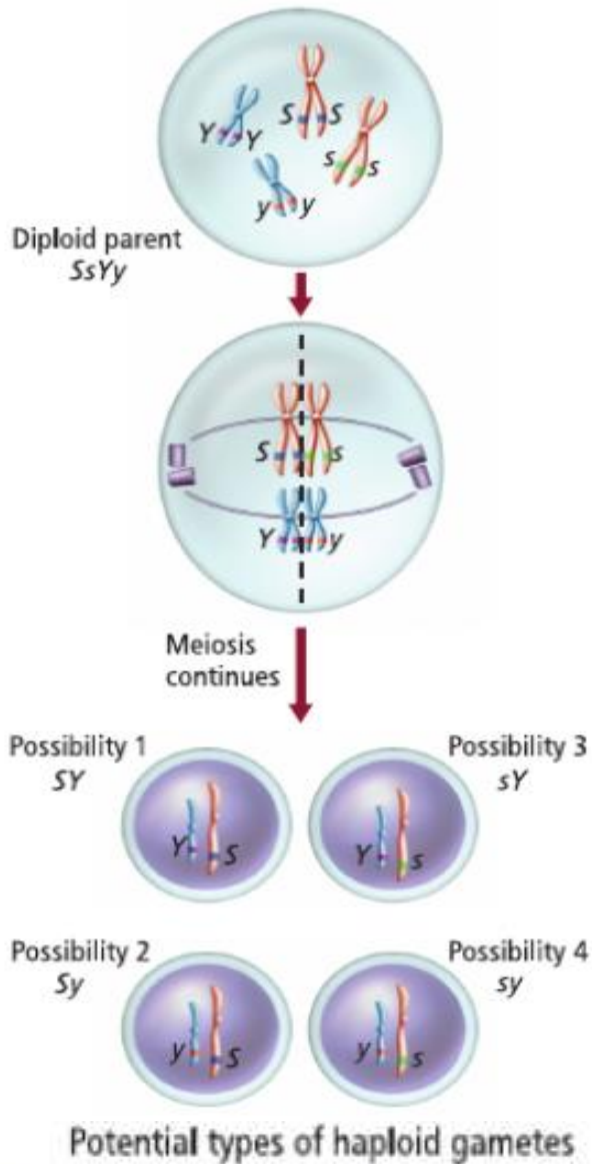
Because it results in genetic variation.

How Meiosis provides variation?

1- By **crossing over**.

2- During the **random distribution** of chromosomes during metaphase I.

3- During **fertilization**, when gametes randomly combine.



■ **Figure 6** The order in which the homologous pairs line up explains how a variety of sex cells can be produced.

How Meiosis provides variation?

during

Metaphase I

Anaphase

Chromosomes line up at the equator randomly



that results in gametes with different combinations of chromosomes

4 gametes, with 4 different combinations of chromosomes can result.

Sexual reproduction

v.

Asexual reproduction

Example of organisms:

- ✓ Human
- ✓ Advanced animals

Characteristics of organisms:

Organism inherits all chromosomes from both parents

Example of organisms:

- ✓ Bacteria

Characteristics of organisms:

- Organism inherits all chromosomes from single parent.
- New individual is genetically identical to its parent.

Example of organisms:

- ✓ Most Protists
- ✓ Most plants
- ✓ More simple animals

Explain: why do some species reproduce sexually while others reproduce asexually?

1- The rate of accumulation of beneficial mutations is faster.

2- The beneficial genes multiply faster over time than they do when reproduction is asexual.

Section 1 Assessment

1. Through reduction division, each gamete contains half the numbers of chromosomes.
2. Metaphase I: homologous pairs line up; Metaphase of mitosis: individual chromosomes of two sister chromatids line up.
3. Homologous chromosomes are physically bound together during synapsis in prophase I.
4. Diagrams should demonstrate understanding of how chromosomes line up in meiosis I and II. Diagrams should show four chromosomes in each of the two daughter cells at the end of meiosis I and two chromosomes in each of the four daughter cells at the end of meiosis II.
5. During meiosis, the independent assortment of the pairs of chromosomes and crossing over provide a large amount of genetic variation. Mitosis produces identical cells.
6. Diagrams should reflect similarities and differences.
7. Answers will vary but should be narrative in nature and describe the processes involved in meiosis and the possible outcomes of the process.

Section 1

Vocabulary Review

1. diploid
2. meiosis
3. crossing over

Understand Main Ideas

4. B
5. D
6. D
7. C

Constructed Response

8. Gametes are the result of meiosis. During fertilization, gametes unite to restore the chromosome number of body cells.
9. Accept any logical hypotheses. It may be related to the firm square or rectangular shape of plant cells, naturally creating poles in the cell.

Think Critically

10. During metaphase I, the different chromosomes will not be able to find their homologous pair, so mules cannot normally make sex cells.

11. Students' answers may vary, but might include that sperm production does not occur through a typical meiosis with halving of the number of chromosomes.

