Meiosis Cell division

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Biology

First Semester

Week 6

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Outline

- Meiosis cell division
- Number of division
- Meiosis I stages
- Meiosis II stages
- Crossing over
- Results of Meiosis division

Objectives

- Understanding the importance of Meiosis
- Explaining why we have two Meiosis
- Making difference between Meiosis I and Meiosis II
- Making difference between Mitosis and Meiosis Cell division
- Explaining the stages of Meiosis I and II

Meiosis

- **Meiosis** is **a type of cell division that reduces the number of chromosomes in the parent cell by half and produces four gamete cells**.
- This process is required to produce **egg** and sperm cells for sexual reproduction

✓ Occurs in the testes in males (Spermatogenesis)

✓ Occurs in the ovaries in females (Oogenesis)

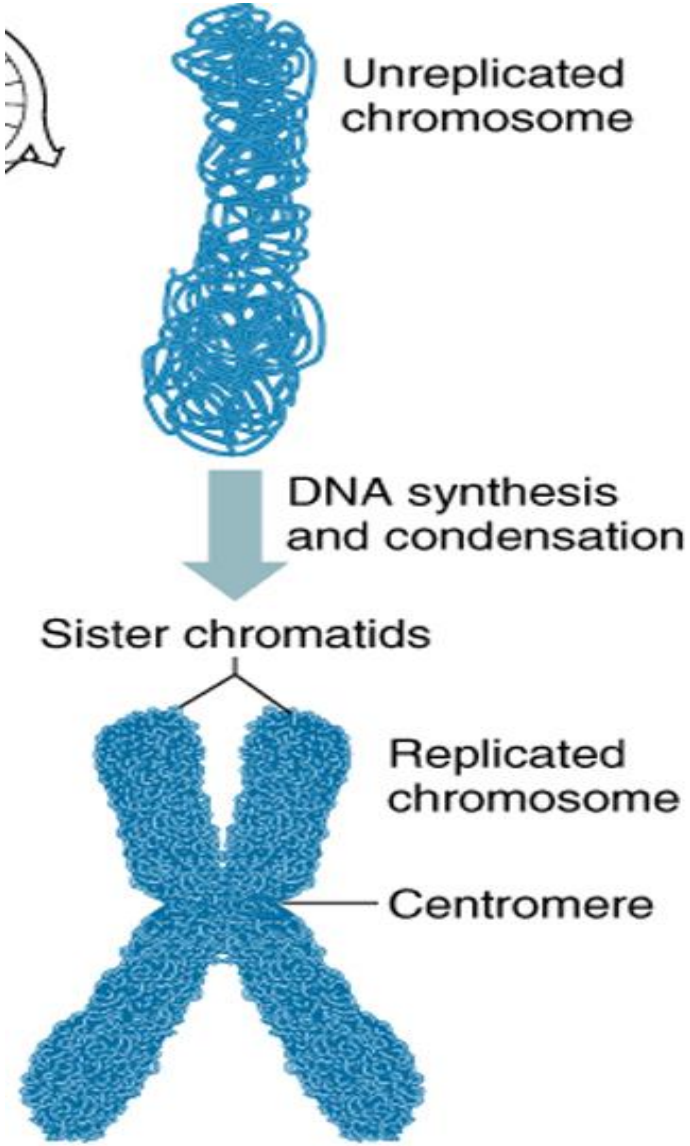
- Gametes are the only types of human cells produced by **meiosis**, rather than mitosis
- Meiosis results in one set of chromosomes in each gamete
- **Fertilization** and **meiosis** alternate in sexual life cycles to maintain chromosome number

The Stages of Meiosis

- After chromosomes duplicate, two divisions follow
  - **Meiosis I** (reductional division): homologs pair up and separate, resulting in two haploid daughter cells with replicated chromosomes.
  - **Meiosis II** (equational division) sister chromatids separate. The result is four haploid daughter cells with un-replicated chromosomes

Interphase

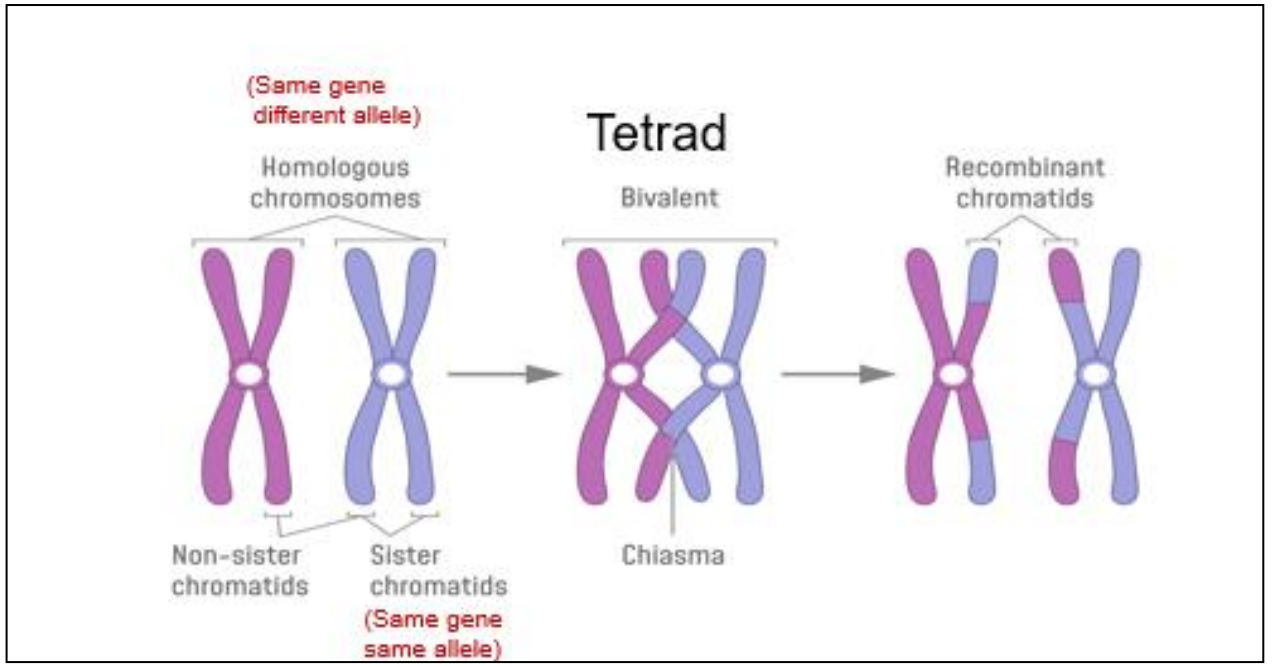
- Meiosis I is preceded by interphase, when the chromosomes are duplicated to form sister chromatids.
- The sister chromatids are genetically identical and joined at the centromere.
    - Replicated copies are called sister chromatids
    - Held together at centromere



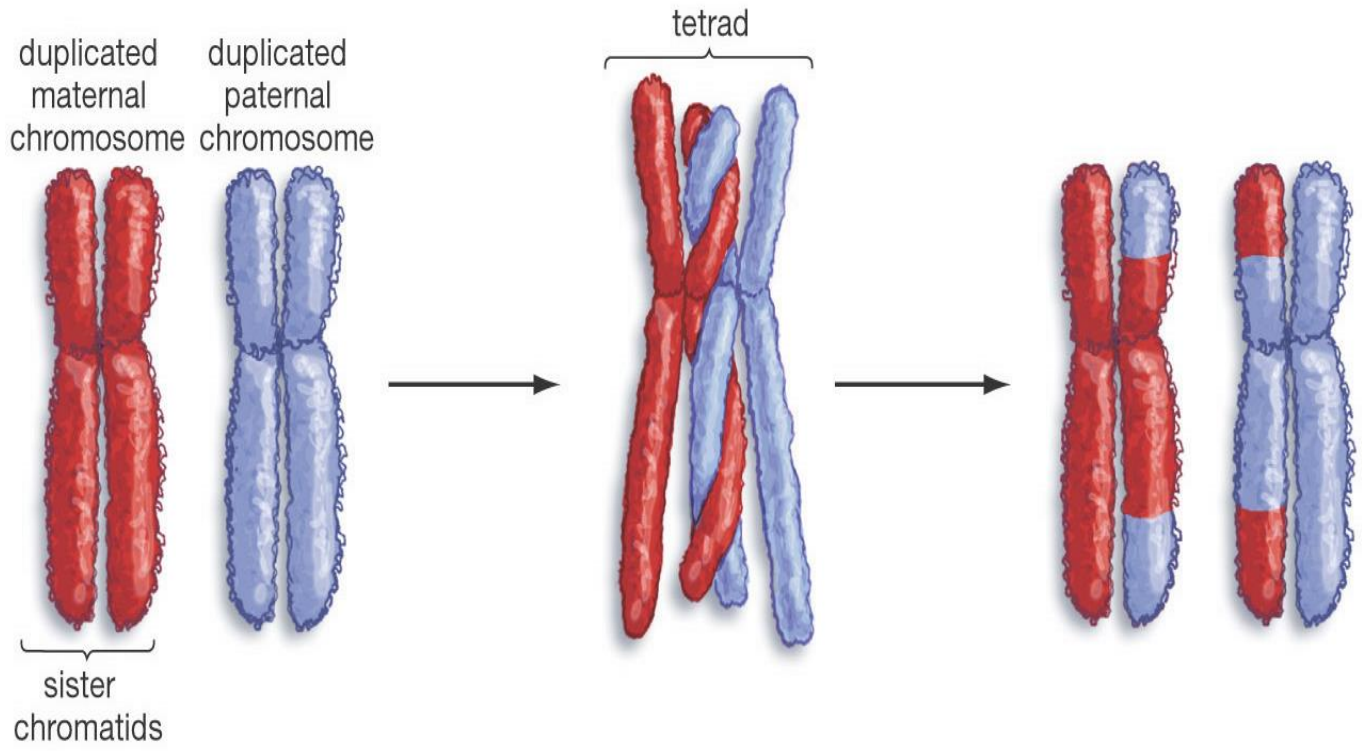
- **Meiosis 1 reductional division Separates homologous chromosomes**
- Division in meiosis I occurs in four phases
  - Prophase I
  - Metaphase I
  - Anaphase I
  - Telophase I and cytokinesis

Prophase I

- Chromosomes begin to condense
- In **synapsis**, homologous chromosomes loosely pair up, aligned gene by gene Each pair of chromosomes forms a **tetrad(bivalent),** a group of four chromatids
- Each tetrad usually has one or more **chiasmata**, X-shaped regions where crossing over occurred
- In **crossing over**, non-sister chromatids exchange DNA segments

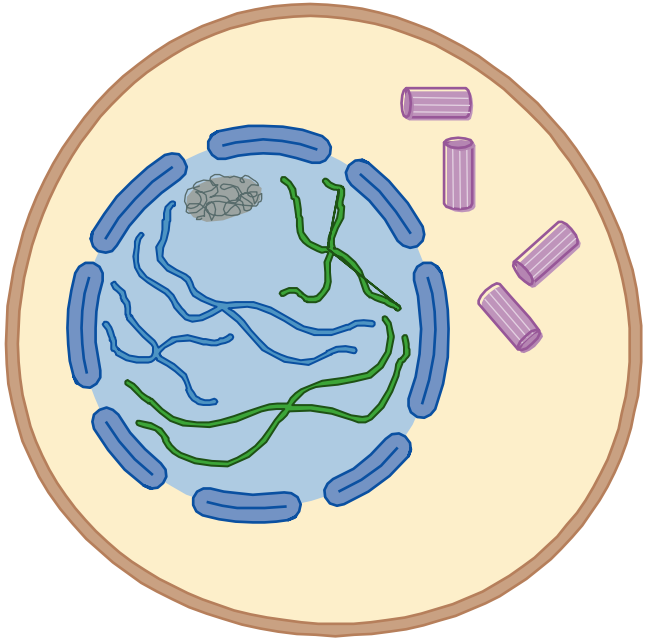


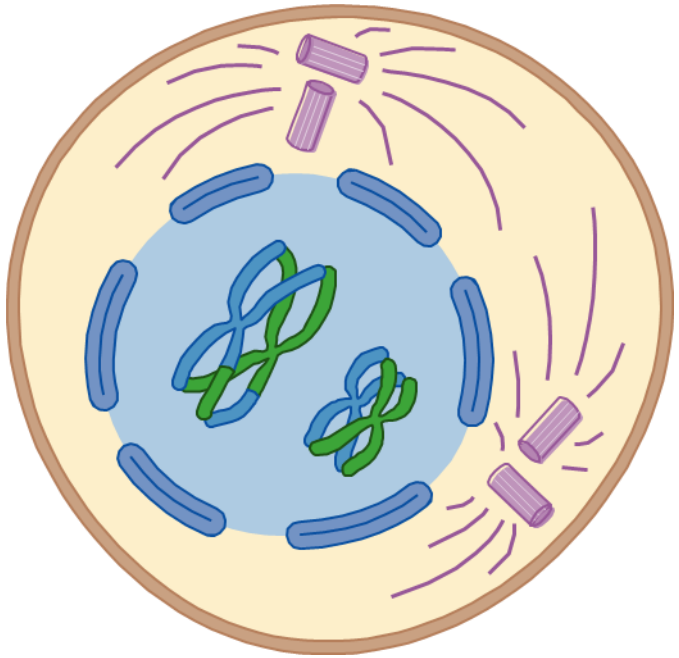
Crossing-Over



Crossing-over multiplies the already huge number of different gamete types produced by independent assortment

Prophase I





Early prophase

✓Homologs pair.

✓Crossing over occurs.

Late prophase

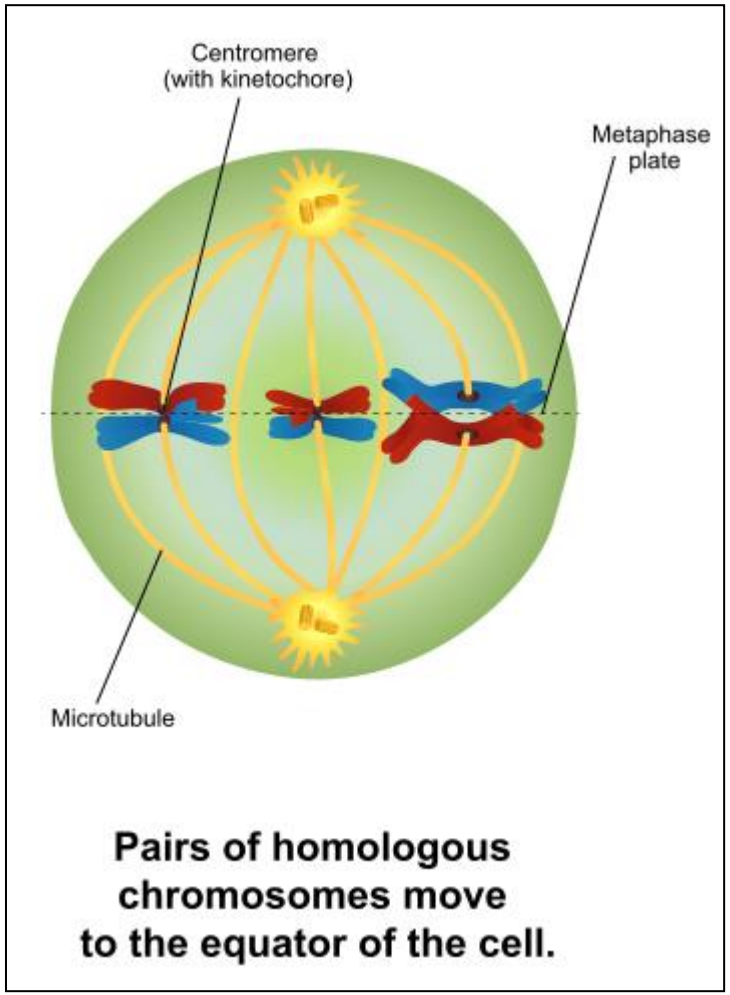
✓Chromosomes condense.

✓Spindle forms.

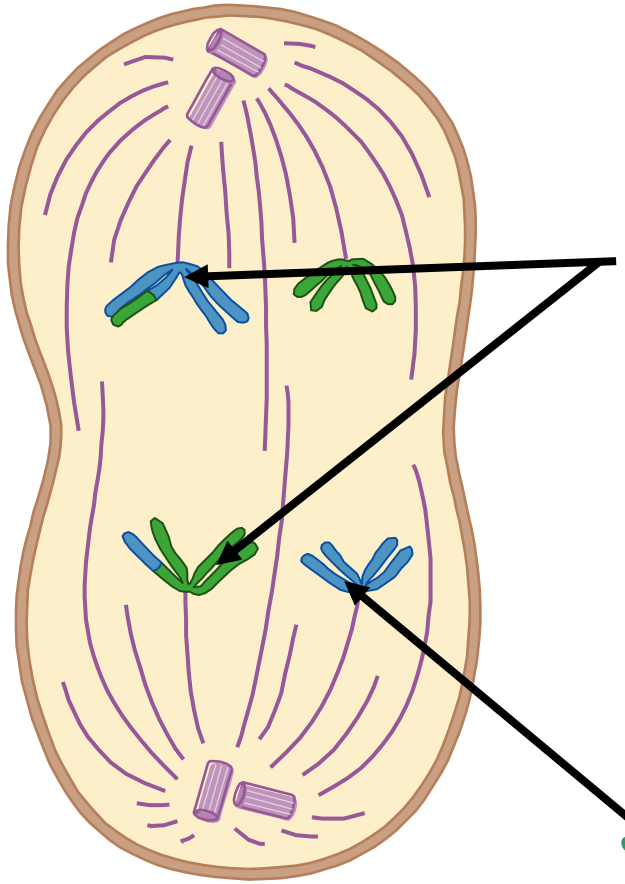
✓Nuclear envelope fragments.

Metaphase I

- In metaphase I, tetrads line up at the metaphase plate, with one chromosome facing each pole
- Both chromatids of one homolog are attached to kinetochore microtubules from one pole; those of the other homolog are attached to microtubules from the opposite pole



Anaphase I



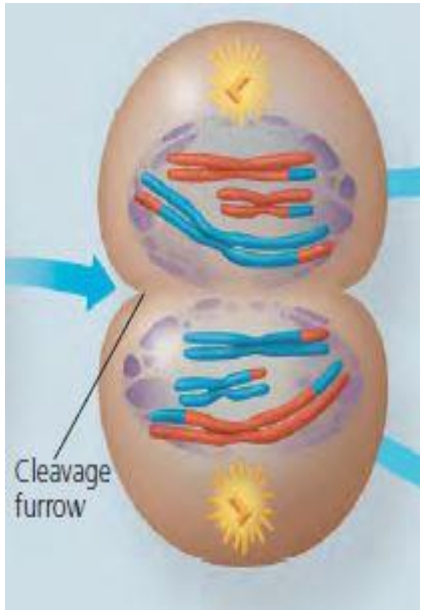
Homologs separate and move to opposite poles guided by the spindle apparatus..

Sister chromatids remain attached at their centromeres.

Telophase I and Cytokinesis

- In the beginning of telophase, I, each half of the cell has a haploid set of chromosomes; each chromosome still consists of two sister chromatids
- Cytokinesis usually occurs simultaneously, forming two haploid daughter cells
- In animal cells, a cleavage furrow forms; in plant cells, a cell plate forms

Telophase I



Nuclear envelopes reassemble.

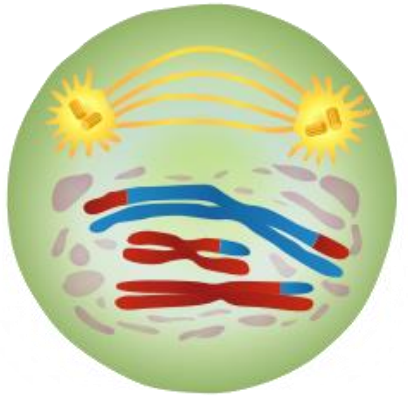
Spindle disappears.

Cytokinesis divides cell into two.

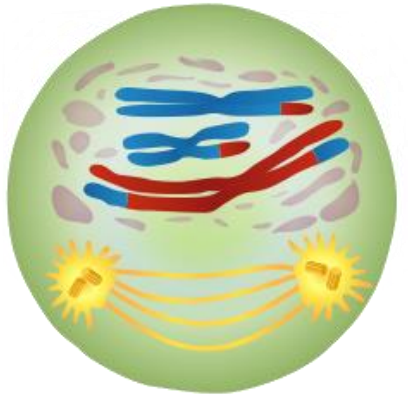
No chromosome duplication occurs between meiosis I and meiosis II

Meiosis II Separates sister chromatids

Only one homolog of each chromosome is present in the cell.



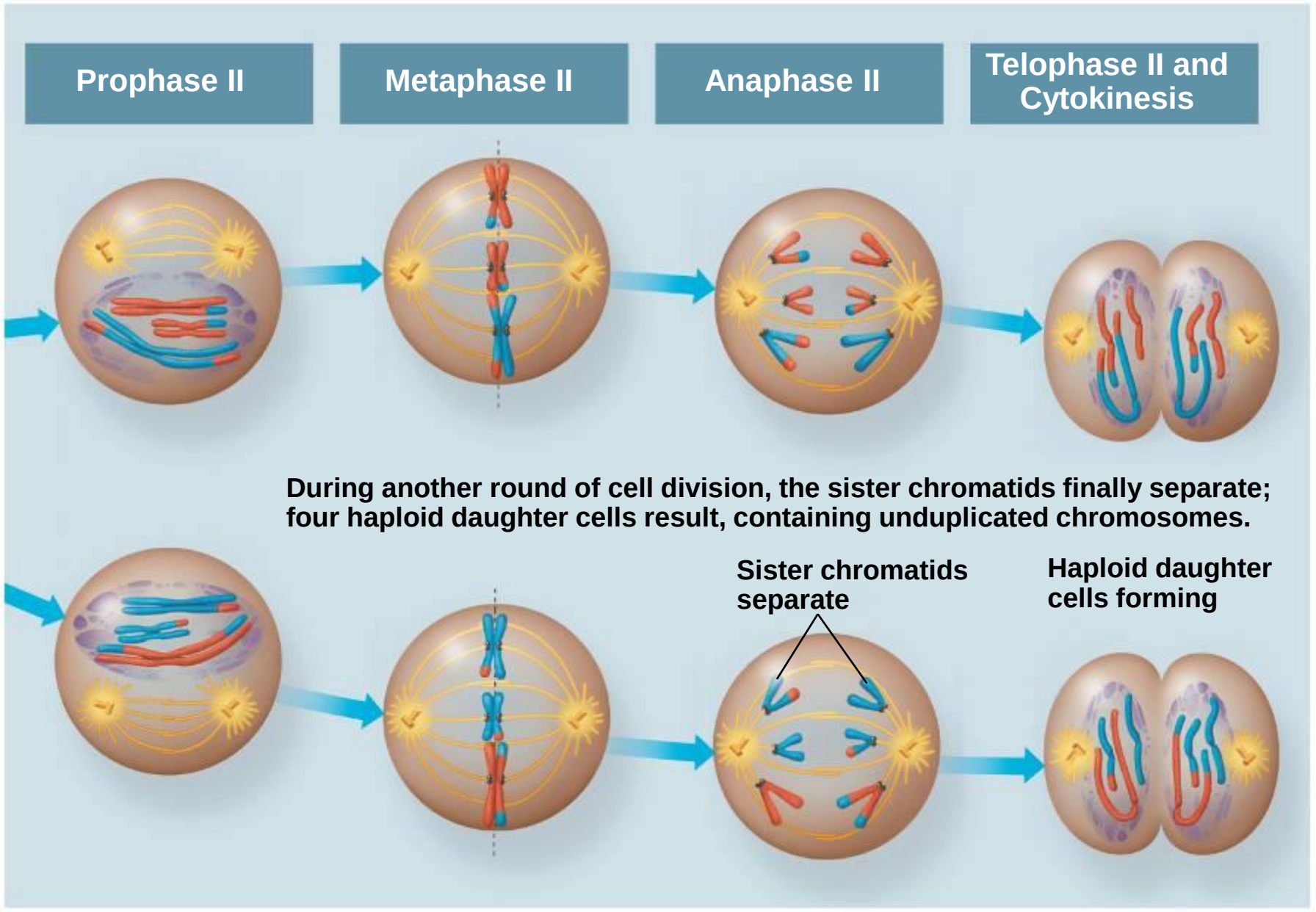
Sister chromatids carry identical genetic information.



Division in meiosis II

- Division in meiosis II also occurs in four phases
  - Prophase II
  - Metaphase II
  - Anaphase II
  - Telophase II and cytokinesis
- Meiosis II is very similar to mitosis

Figure 13.8b



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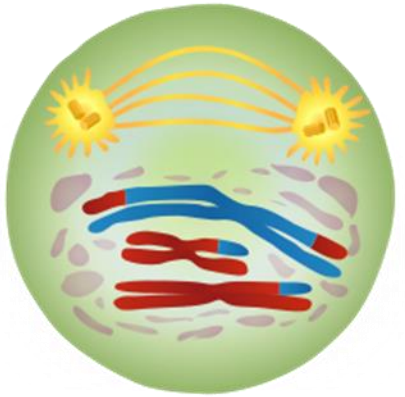
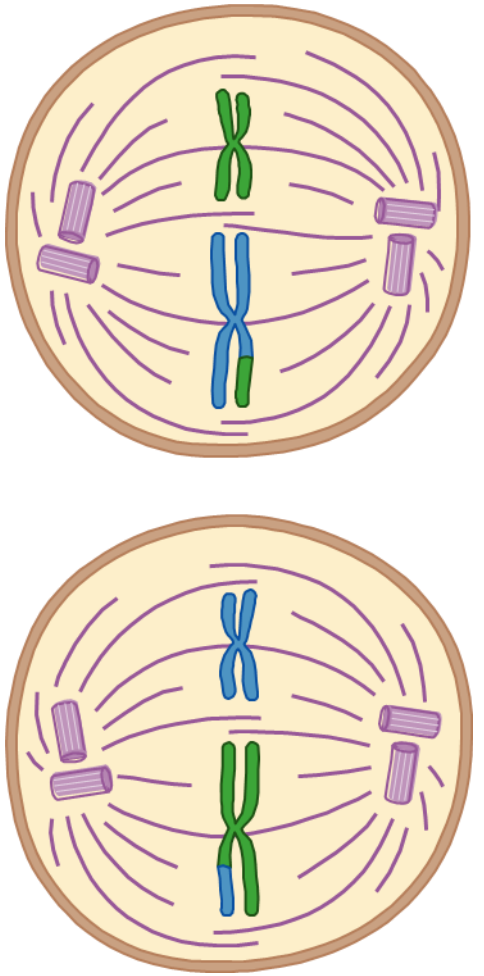
Prophase II

- In prophase II, a spindle apparatus forms
- In late prophase II, chromosomes (each still composed of two chromatids) move toward the metaphase plate
- **Nuclear envelope fragments.**



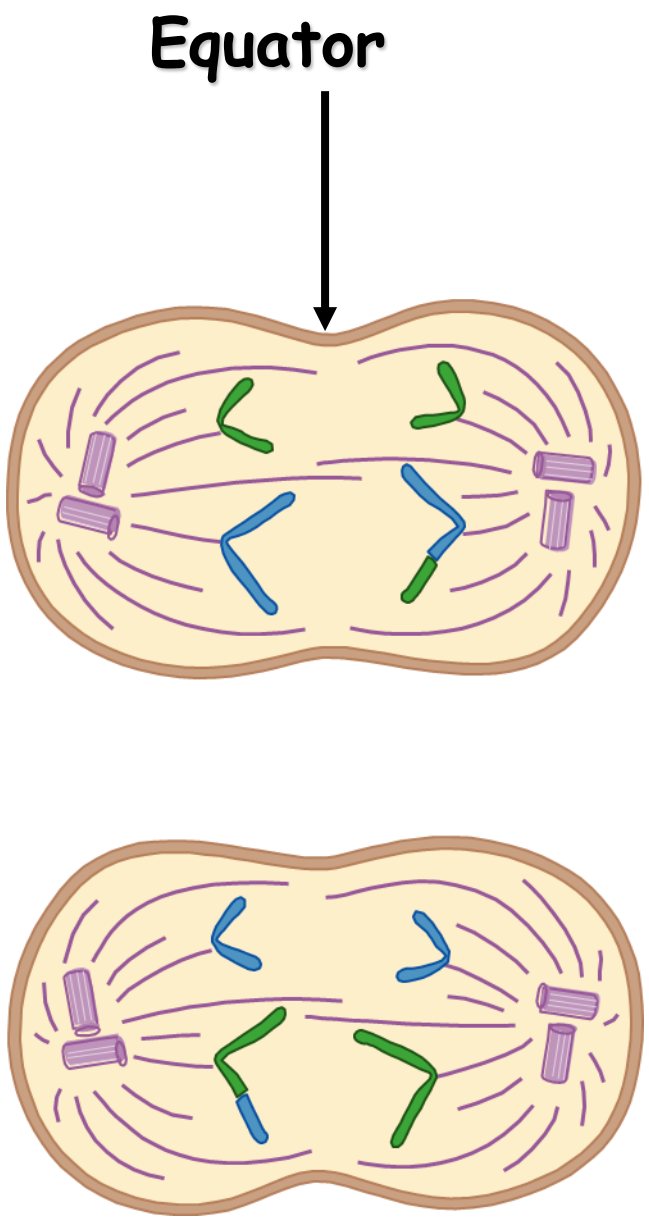
Metaphase II

- In metaphase II, the sister chromatids are arranged at the metaphase plate
- Because of crossing over in meiosis I, the two sister chromatids of each chromosome are no longer genetically identical
- The kinetochores of sister chromatids attach to microtubules extending from opposite poles



Anaphase II

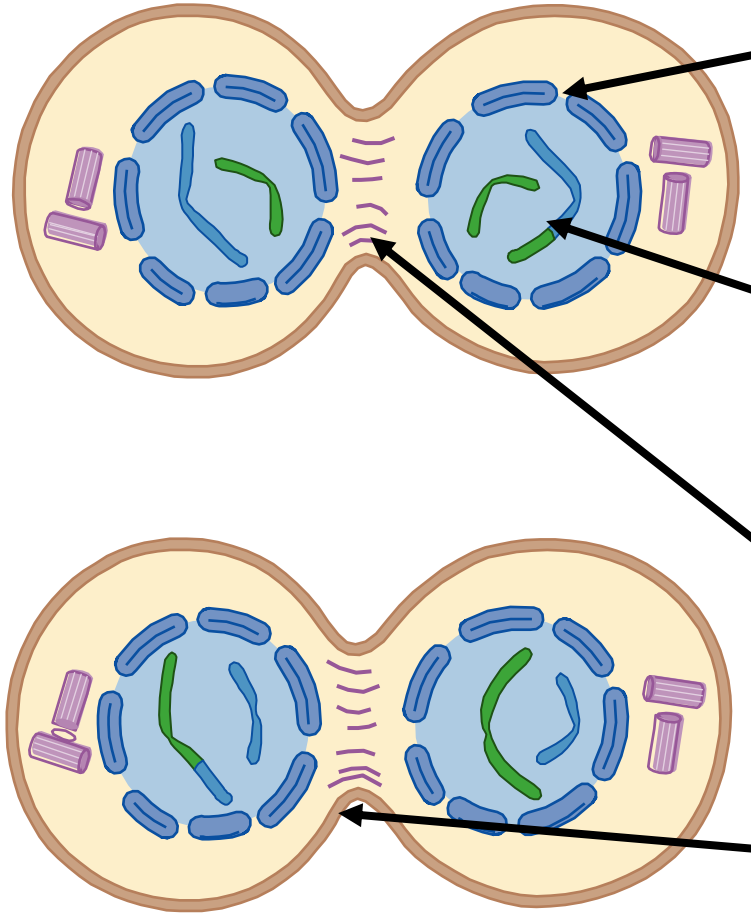
- In anaphase II, the sister chromatids separate
- The sister chromatids of each chromosome now move as two newly individual chromosomes toward opposite poles



Telophase II and Cytokinesis

- In telophase II, the chromosomes arrive at opposite poles
- Nuclei form, and the chromosomes begin decondensing
- Cytokinesis separates the cytoplasm
- At the end of meiosis, there are four daughter cells, each with a **haploid set** of replicated chromosomes
- Each daughter cell is **genetically distinct** from the others and from the parent cell

Telophase II



Nuclear envelope assembles.

Chromosomes decondense.

Spindle disappears.

Cytokinesis divides cell into two.

Figure 13.8a

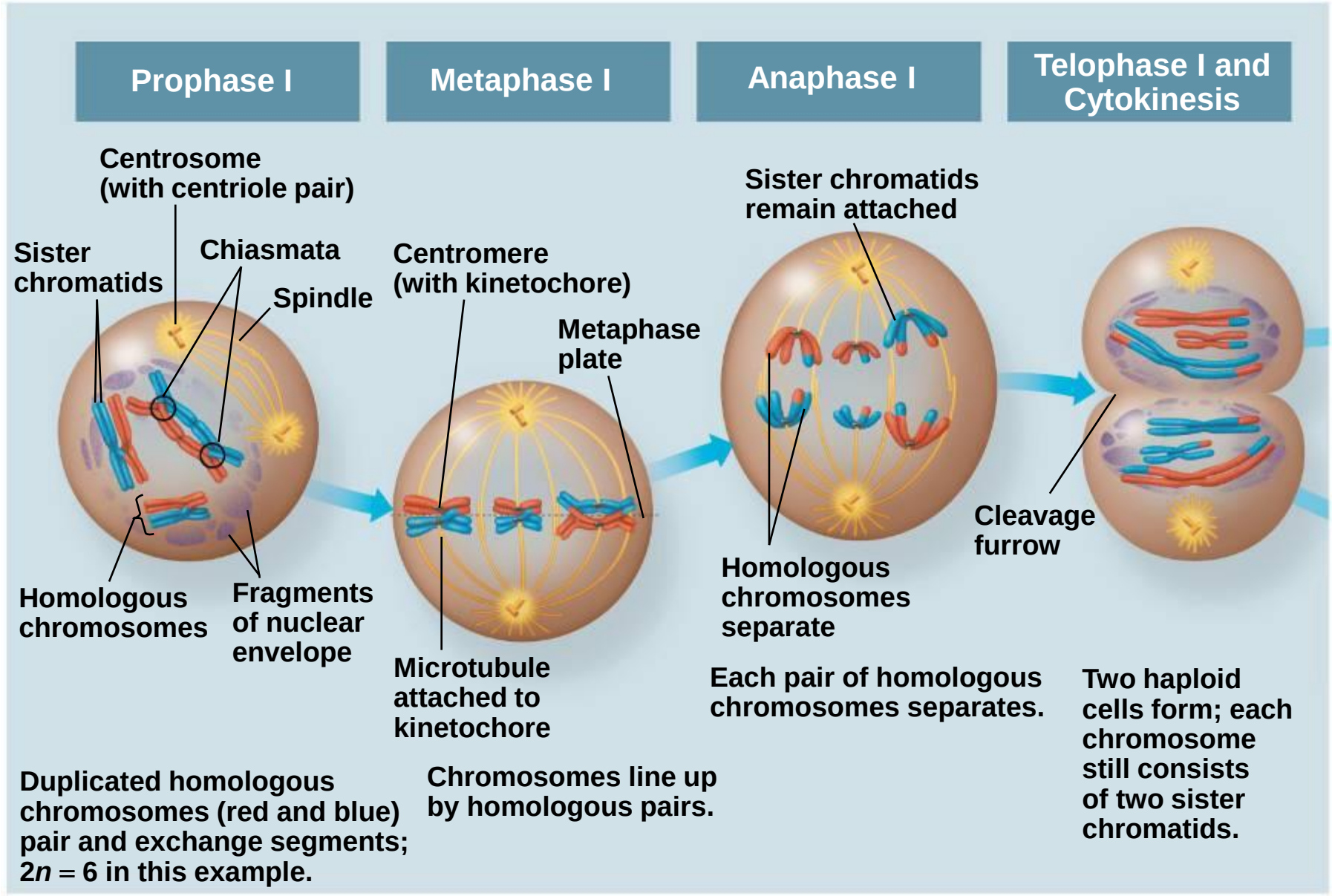


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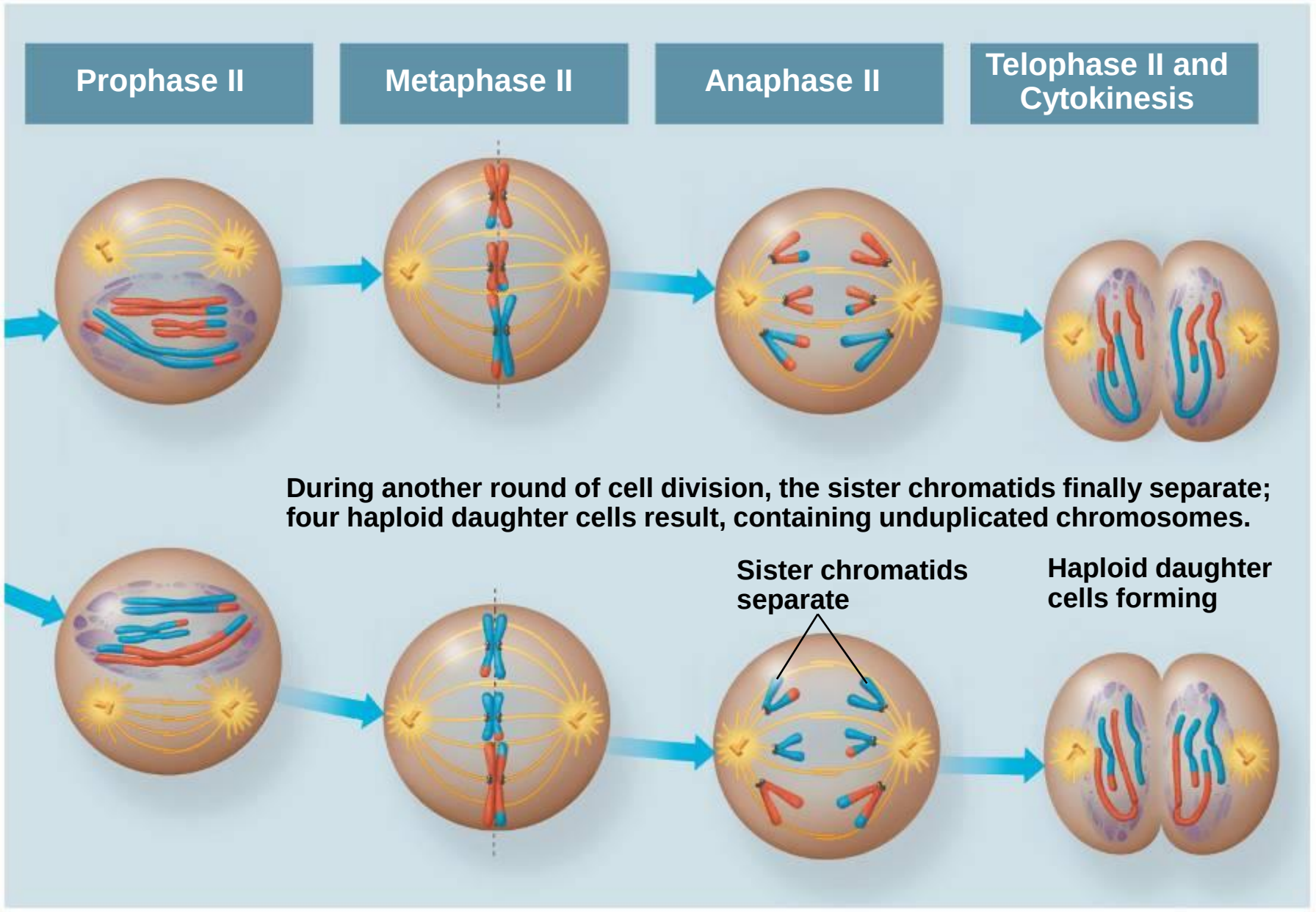
Figure 13.8b



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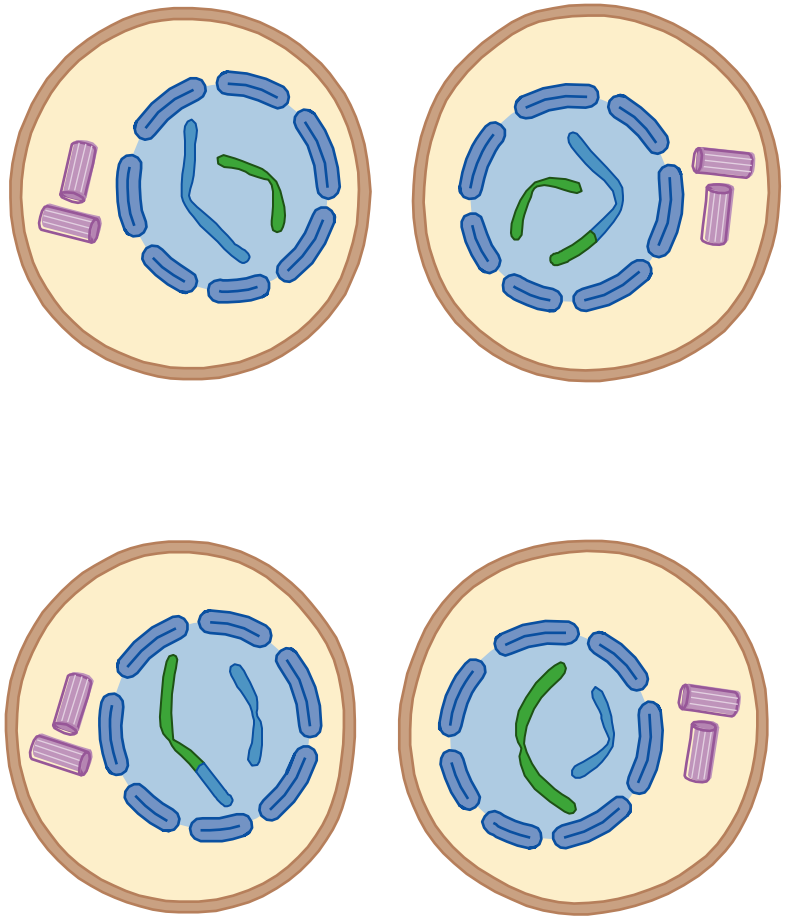
Results of Meiosis



The meiotic division of one parent cell produces four daughter cells, each with a haploid set of (unduplicated) chromosomes.

The four daughter cells are genetically distinct(different) from one another and from the parent cell.

Gametes (egg & sperm) form

Four haploid cells with one copy of each chromosome

One allele of each gene

References

- Urry, L. A., Cain, M. L. 1., Wasserman, S. A., Minorsky, P. V., Reece, J. B., & Campbell, N. A. (2017). Campbell biology. Eleventh edition. New York, NY, Pearson Education, Inc.
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