Human Life Cycle

The human life cycle involves growth and sexual reproduction. During growth, a type of nuclear division called mitosis ensures that each and every cell has a complete number of chromosomes. Sexual reproduction requires the production of sex cells, which have half the number of chromosomes.A type of nuclear division called meiosis reduces the chromosomal number by one-half. Meiosis occurs in the sex organs, also called the gonads. In males, the testes produce sperms; in females, the ovaries produce cells that become eggs. The sperm and the egg are the sex cells, or gametes. Gametes contain the haploid(n) number of chromosomes; the haploid number of chromosomes in humans is 23.

A new individual comes into existence when a haploid

sperm fertilizes a haploid egg. Each parent contributes one chromosome of each type to a zygote, which then has the **diploid (2n)** number of chromosomes. As the individual develops, mitosis occurs, and each **somatic** (body) **cell** has the diploid number of chromosomes. In humans, the diploid number is 46, and there are 23 pairs of chromosomes.

***The life cycle of humans requires two types of nuclear division: mitosis and meiosis.**

Mitosis 2n 2n

Mitosis is nuclear division that produces two daughter cells,each with the same number and kinds of chromosomes as the parental cell, the cell that divides. Therefore, following mitosis,the parental cell and the daughter cells are genetically identical.

Cell Cycle

The **cell cycle** consists of interphase, mitosis, and cytokinesis

which is division of the cytoplasm and organelles. The cell divides, and then it enters interphase before dividing again. Therefore, **interphase** is the interval of time between cell divisions. The length of time required for the entire cell cycle varies according to the type of cell, but **18–24** hours is typical.

During interphase, DNA replication results in each chromosome having two sister chromatids. The centrioles and other organelles also duplicate.

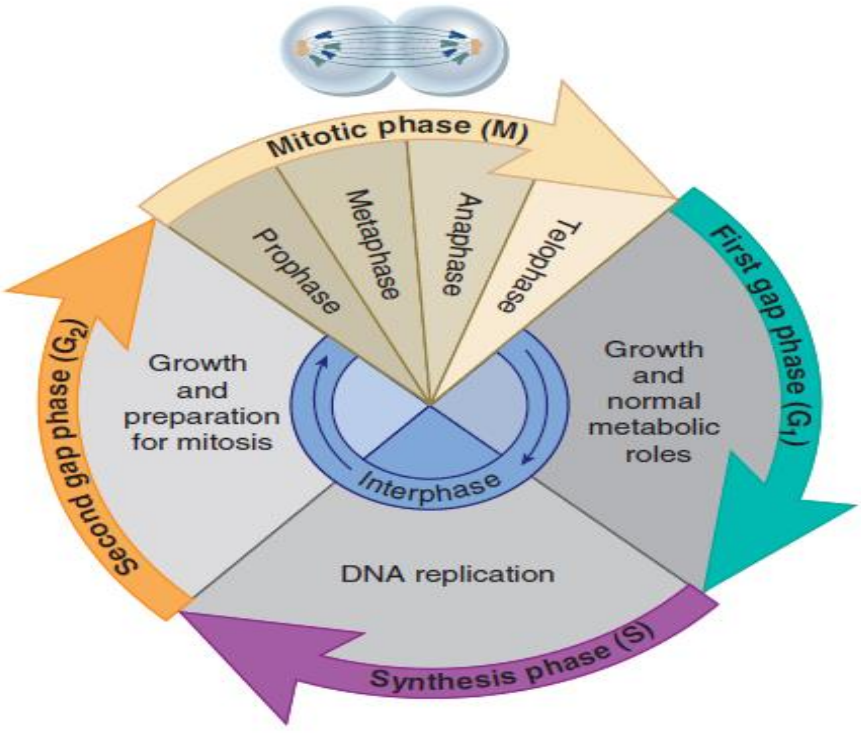


Figure 4.12 The Cell Cycle.

During mitosis, the centromeres divide, the sister chromatids separate, and one of each kind of chromosome goes into each daughter cell. Therefore, each daughter cell gets a complete set of chromosomes and is 2n. (Following separation, each chromatid is called a chromosome.) Since each daughter

cell receives the same number and kinds of chromosomes as the parental cell, each is genetically identical to the other and to the parental cell.

Mitosis occurs in humans when tissues grow or when repair occurs. Following fertilization, the zygote begins to divide mitotically, and mitosis continues during development and the life span of the individual. Also, when a cut heals or a broken bone mends, mitosis has occurred. In the adult, some tissues divide more readily than other tissues. But apparently most tissues contain stem cells, which can continually divide. Stem cells in the red bone marrow divide to produce millions of blood cells every day.

Stages of Mitosis

As an aid in describing the events of mitosis, the process is

divided into four phases: prophase, metaphase, anaphase,

and telophase

Prophase

The events of **prophase** indicate that nuclear division is about to occur. The two pairs of centrioles outside the nucleus begin moving away from each other toward opposite ends of the nucleus. Spindle fibers appear between the separating centriole pairs, **the nuclear envelope begins to fragment, and the nucleolus begins to disappear.**

The chromosomes are now visible. Each is composed of two sister chromatids held together at centromere. Spindle fibers attach to the centromeres as the chromosomes continue to shorten and to thicken. During prophase, chromosomes are randomly placed in the nucleus.

- ***Metaphase***

During **metaphase,** the nuclear envelope is fragmented, and the spindle occupies the region formerly occupied by the nucleus. The chromosomes are now at the equator (center) of the spindle. Metaphase is characterized by a fully formed spindle, and the **chromosomes**, each with two sister chromatids, are aligned at the equator

Anaphase

At the start of anaphase, the sister chromatids separate.

Once separated, the chromatids are called chromosomes. Separation of the sister chromatids ensures that each cell receives a copy of each type of chromosome and thereby has a full complement of genes. During anaphase, the daughter chromosomes move to the poles of the spindle. Anaphase is characterized by the diploid number of chromosomes moving toward each pole.

Telophase

Telophase begins when the chromosomes arrive at the poles. During telophase, the chromosomes become indistinct chromatin again. The spindle disappears as nucleoli appear, and nuclear envelope components reassemble in each cell. Telophase is characterized by the presence of two daughter nuclei.

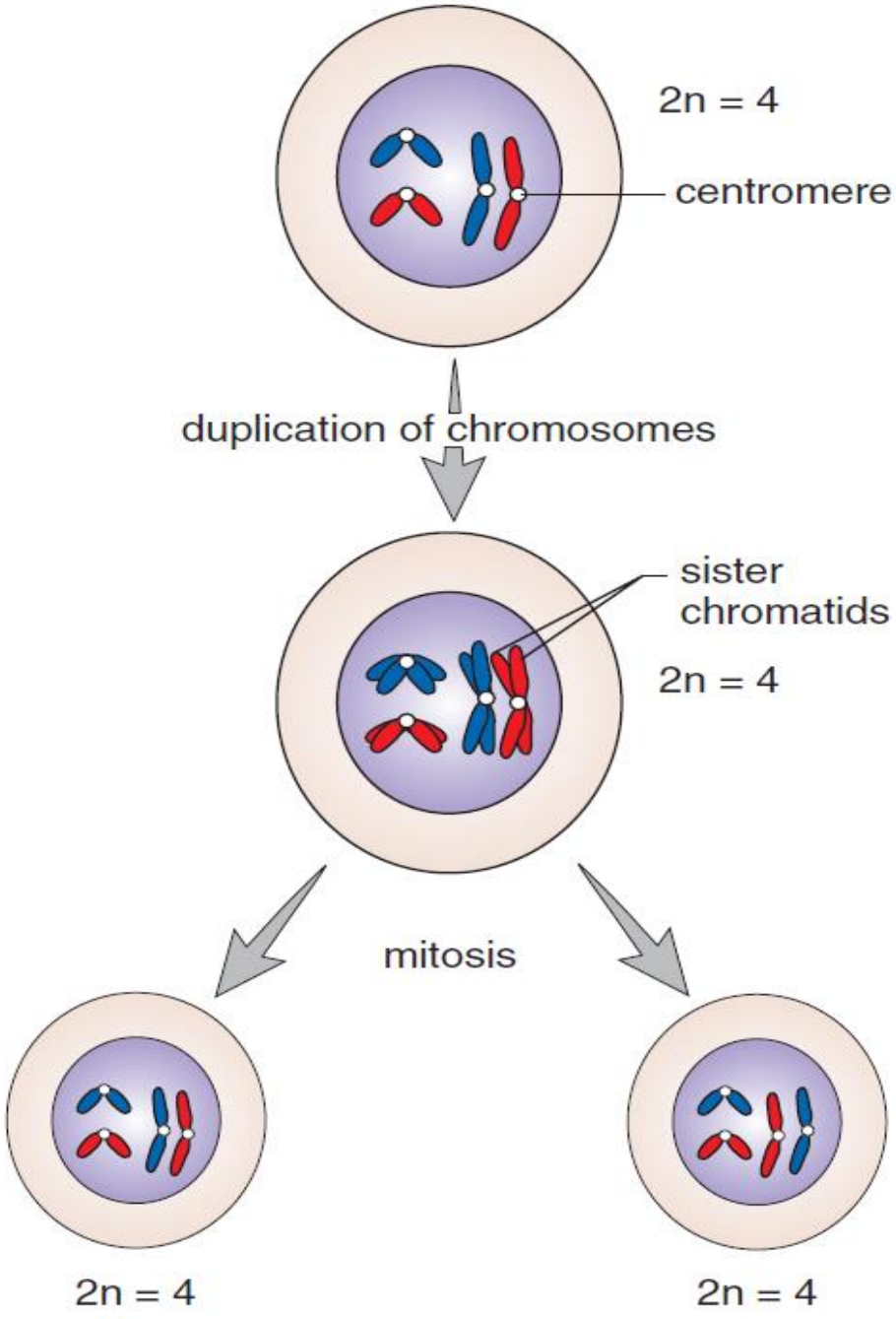


Figure 19.2 Overview of mitosis.
The blue chromosomes were inherited from one parent, and the red chromosomes were inherited from the other parent.

Cytokinesis

Cytokinesis is division of the cytoplasm and organelles. In animal cells, a slight indentation called a **cleavage furrow** passes around the circumference of the cell.

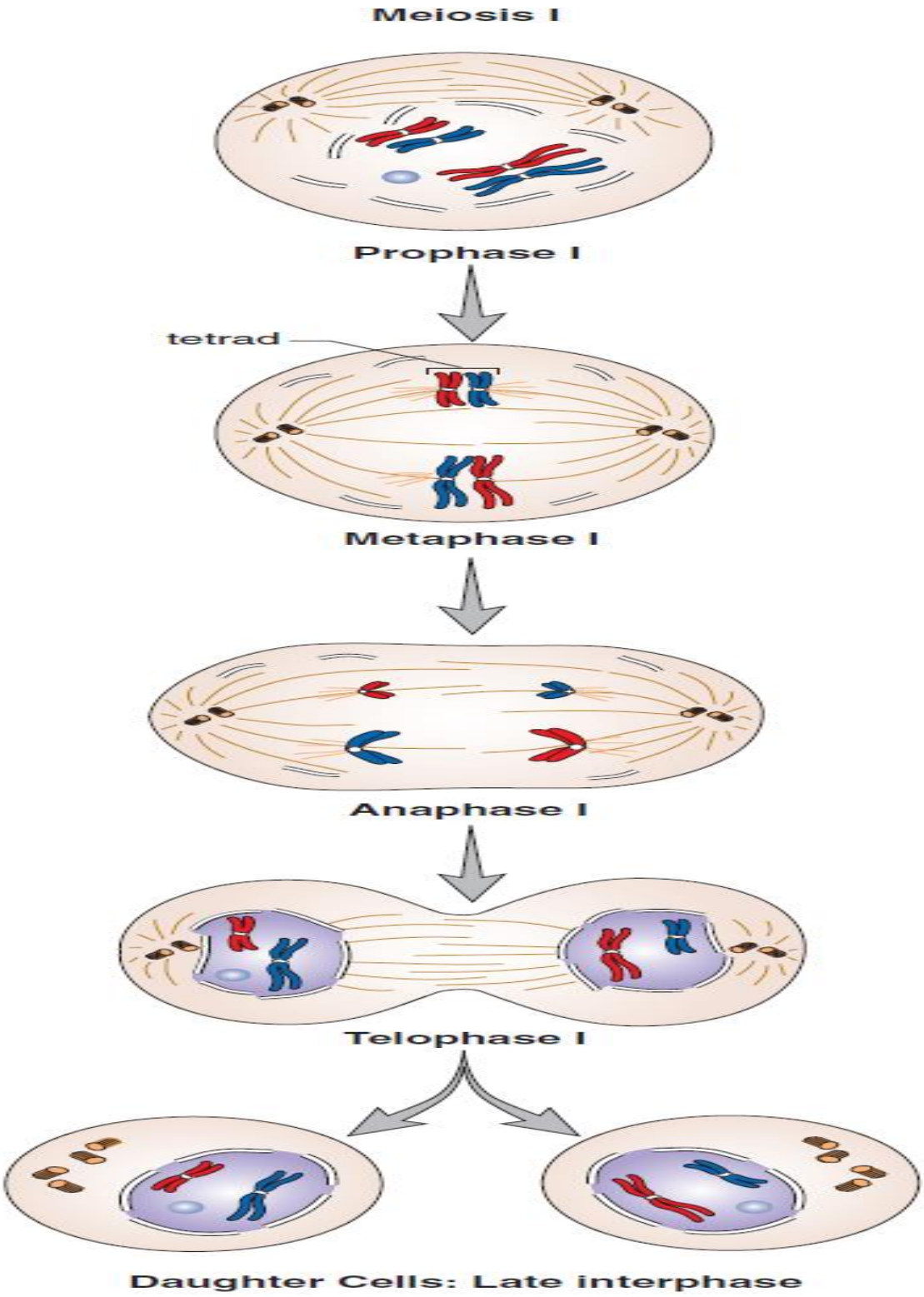
Actin filaments form a contractile ring, and as the ring gets smaller and smaller, the cleavage furrow pinches the cell in half. As a result, each cell becomes enclosed by its own plasma membrane.

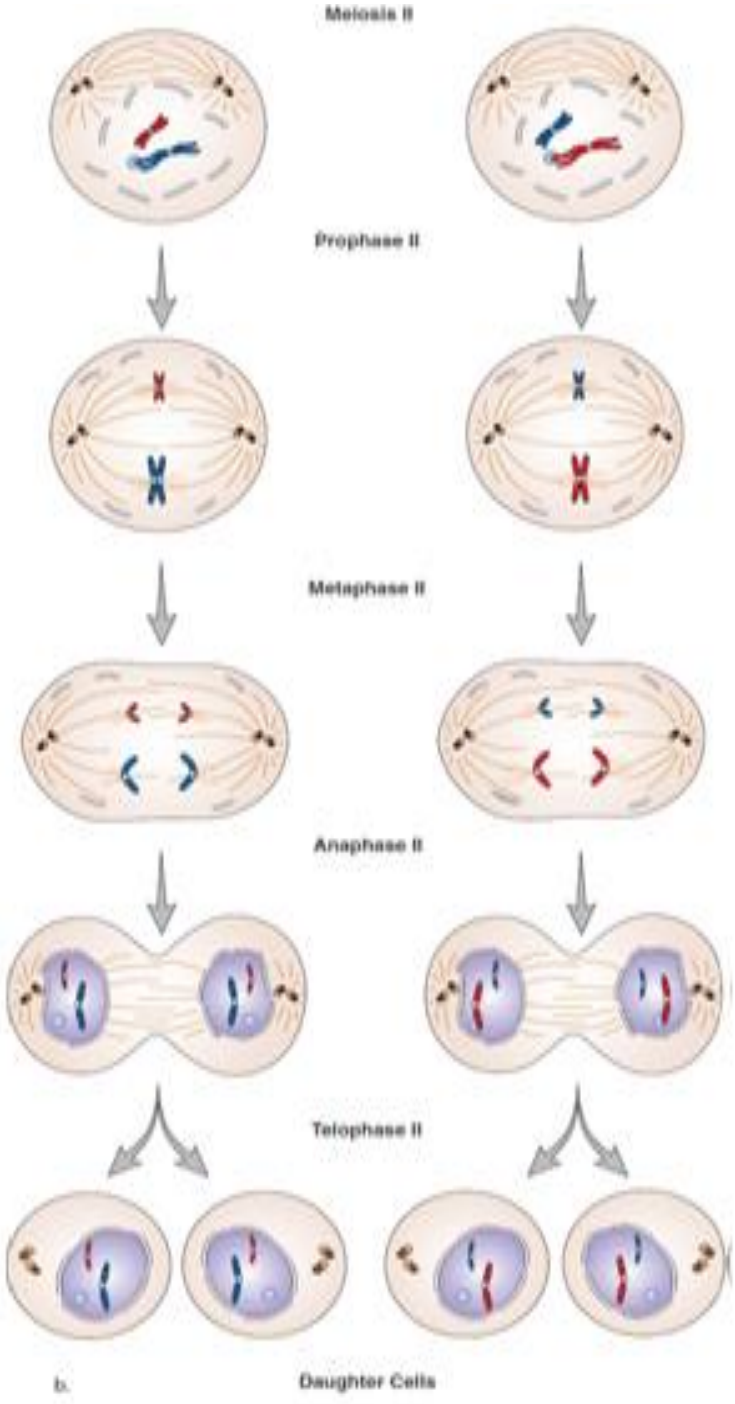
Following mitosis, each daughter cell is 2n. When the sister chromatids separate during anaphase, each newly forming cell receives the same number and kinds of chromosomes as the parental cell.

- **Meiosis: 2n n**

Meiosis, which requires two nuclear divisions, results in four daughter cells, each having one of each kind of chromosome and therefore half the number of chromosomes as the parental cell. The parental cell has the 2n number of chromosomes, while the daughter cells have the n number of chromosomes. Therefore, meiosis is often called reduction division. The daughter cells that result from meiosis go on to become the gametes.

- Following duplication of chromosomes, the parental cell undergoes two divisions:
- **meiosis I** and **meiosis II**. During meiosis I, homologous chromosomes separate, and during meiosis II, chromatids separate. The final daughter cells are haploid. (The blue chromosomes were inherited from one parent, and the red chromosomes were inherited from the other parent.)


Meiosis I
Prophase I
tetrad
Metaphase I
Anaphase I
Telophase I
Daughter Cells: Late interphase


Meiosis II
Prophase II
Metaphase II
Anaphase II
Telophase II
b.
Daughter Cells

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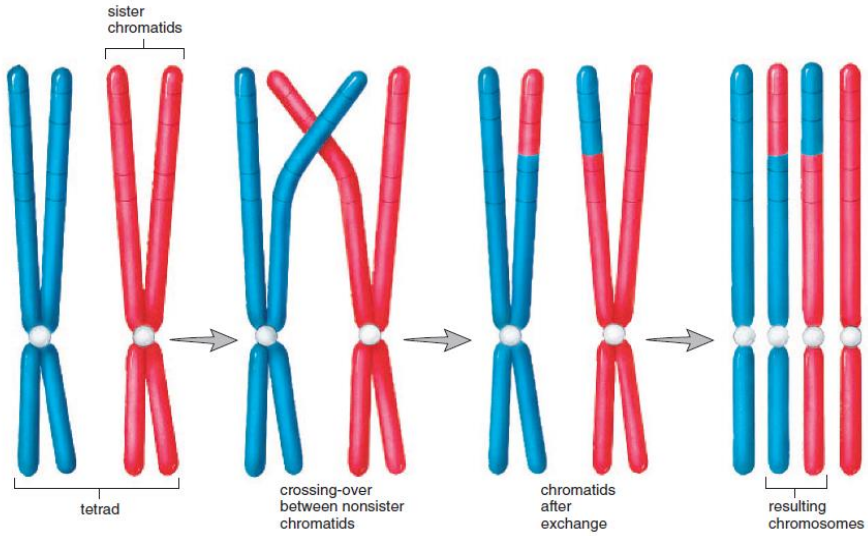
Stage : 1 st
Lab:3

The Importance of Meiosis

Because of meiosis, the chromosomal number stays constant in each generation of humans. In humans, meiosis occurs in the testes and ovaries during the production of the gametes. When a haploid sperm fertilizes a haploid egg, the new individual has the diploid number of chromosomes. There are three ways the new individual is assured a different combination of genes than either parent has:

1. Crossing-over recombines the genes on the sister chromatids of homologous pairs of chromosomes.
2. Following meiosis, gametes have all possible combinations of chromosomes.
3. At fertilization, recombination of chromosomes occurs because the sperm and egg carry varied combinations of chromosomes.



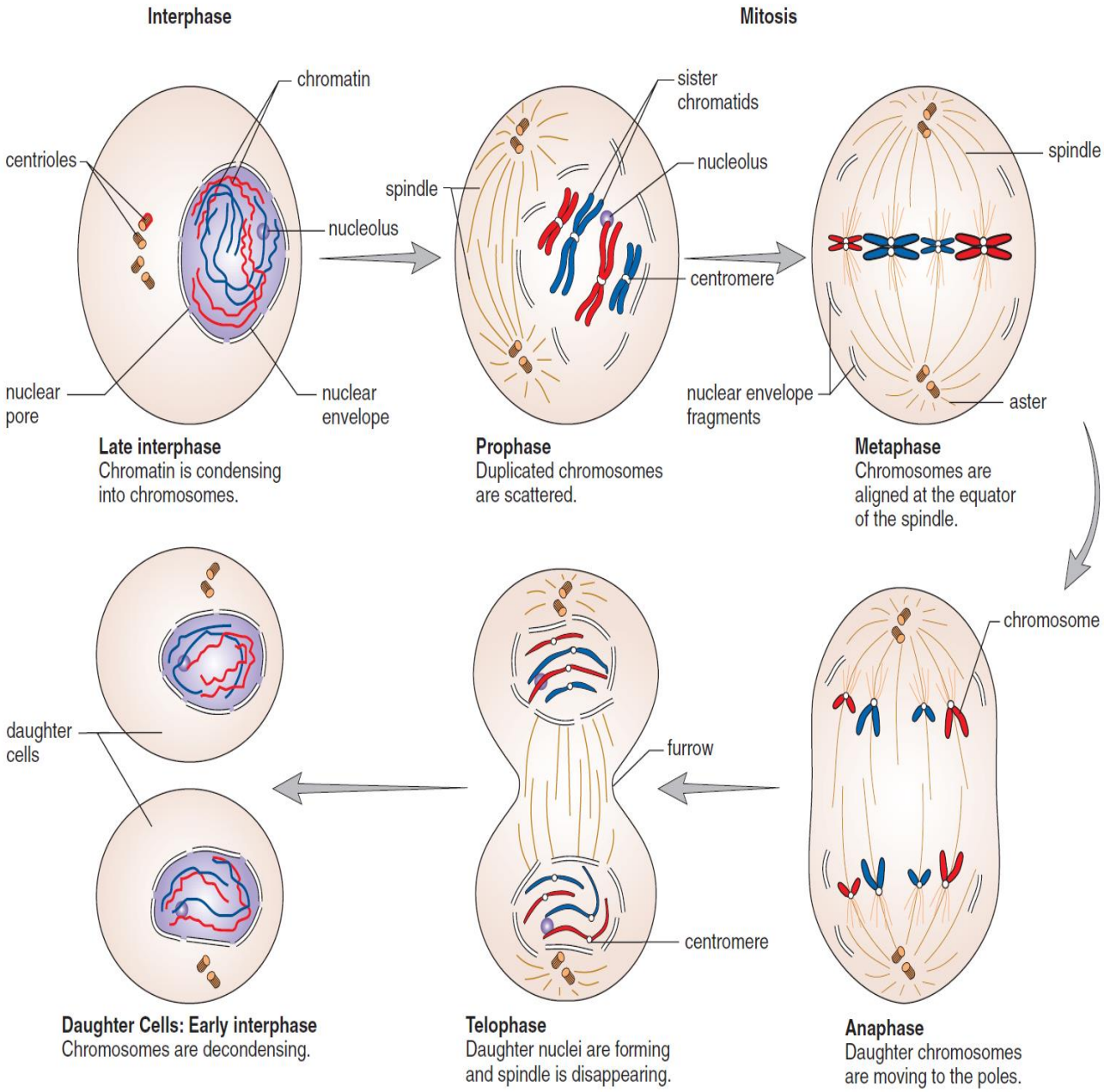


Figure 19.3 **Interphase and mitosis.**
The blue chromosomes were inherited from one parent, and the red chromosomes were inherited from the other parent.