Human Life Cycle

The human life cycle involves growth and sexual reproduction. During growth,

1- a type of nuclear division called mitosis ensures that each and every cell has a complete number of chromosomes.

2- Sexual reproduction requires the production of sex cells, which have half the number of chromosomes.

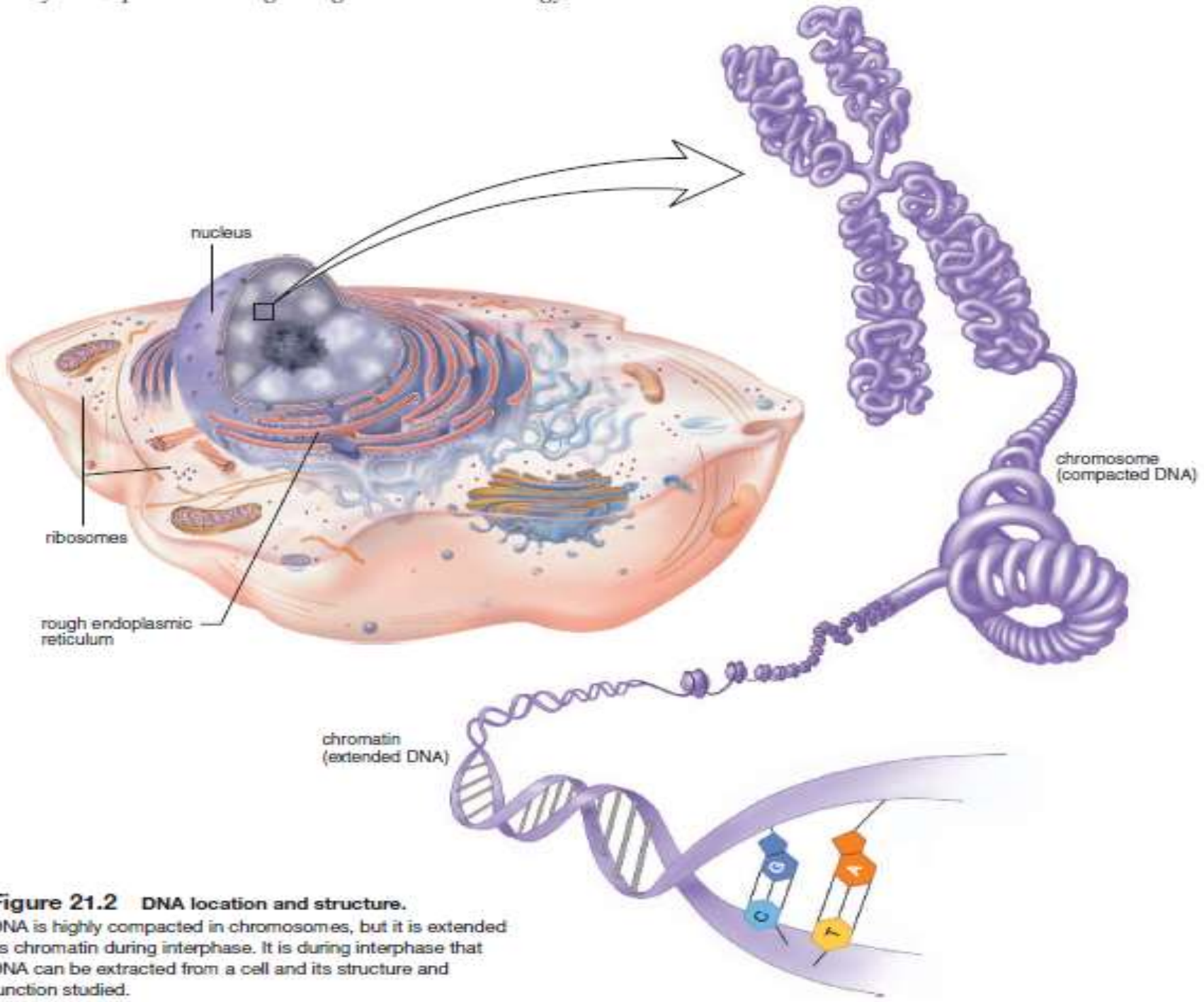
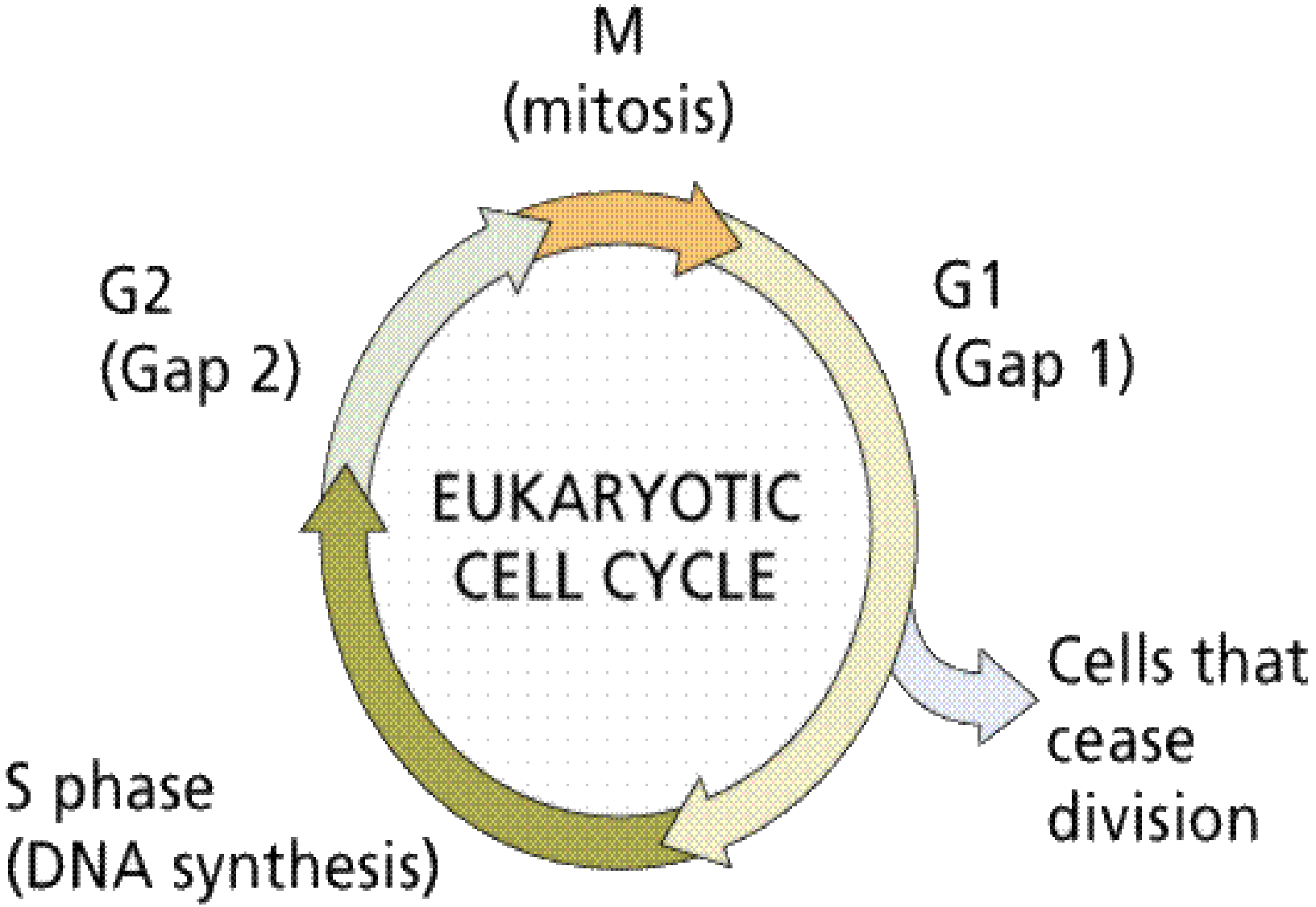


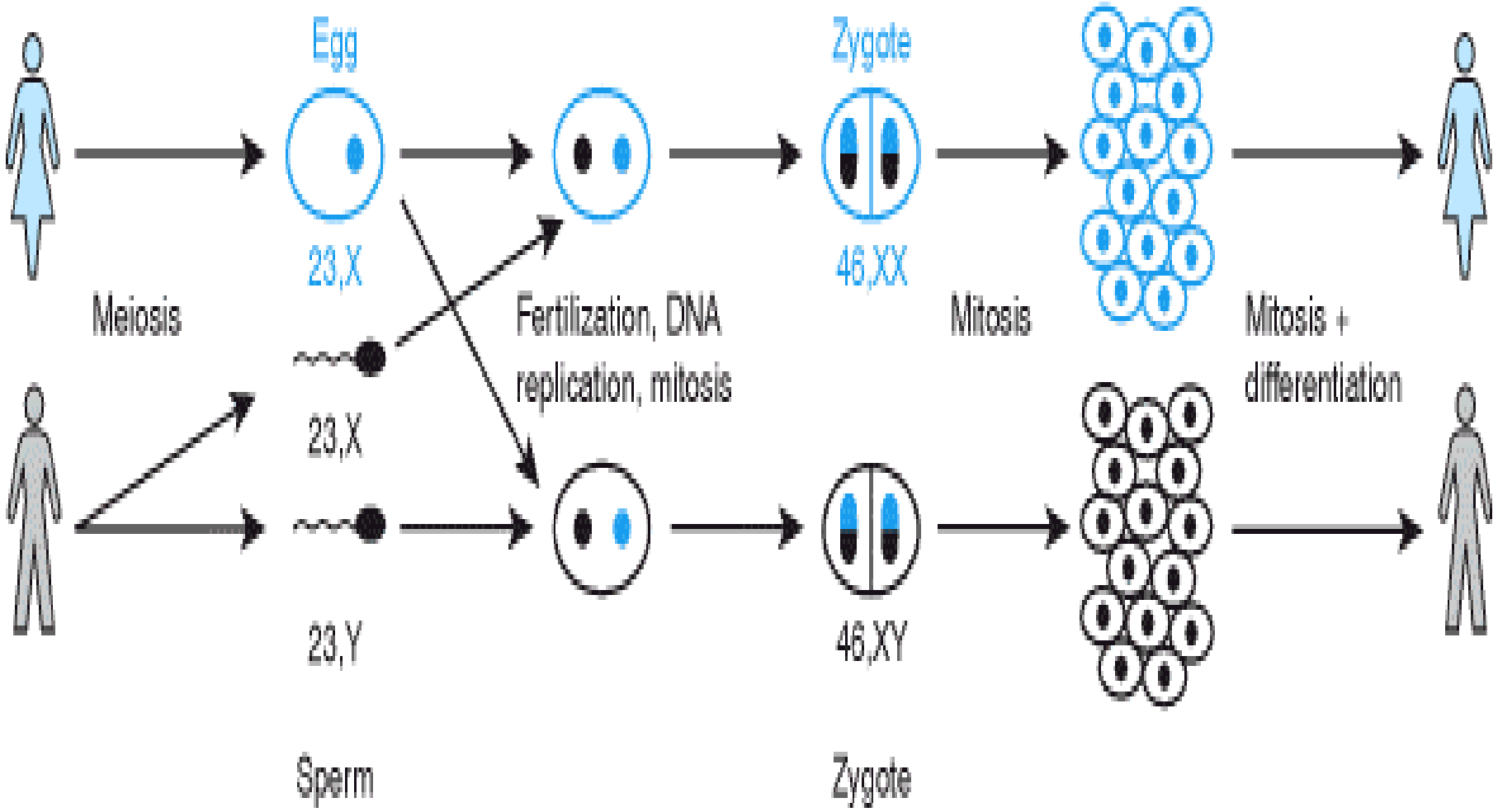
Figure 21.2 **DNA location and structure.**
DNA is highly compacted in chromosomes, but it is extended as chromatin during interphase. It is during interphase that DNA can be extracted from a cell and its structure and function studied.

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.**


M
(mitosis)
G2
(Gap 2)
G1
(Gap 1)
EUKARYOTIC
CELL CYCLE
Cells that
cease
division
S phase
(DNA synthesis)


Egg
Zygote
23,X
46,XX
Meiosis
Fertilization, DNA
replication, mitosis
Mitosis
Mitosis +
differentiation
23,X
23,Y
46,XY
Sperm
Zygote

Mitosis 2n → 2n

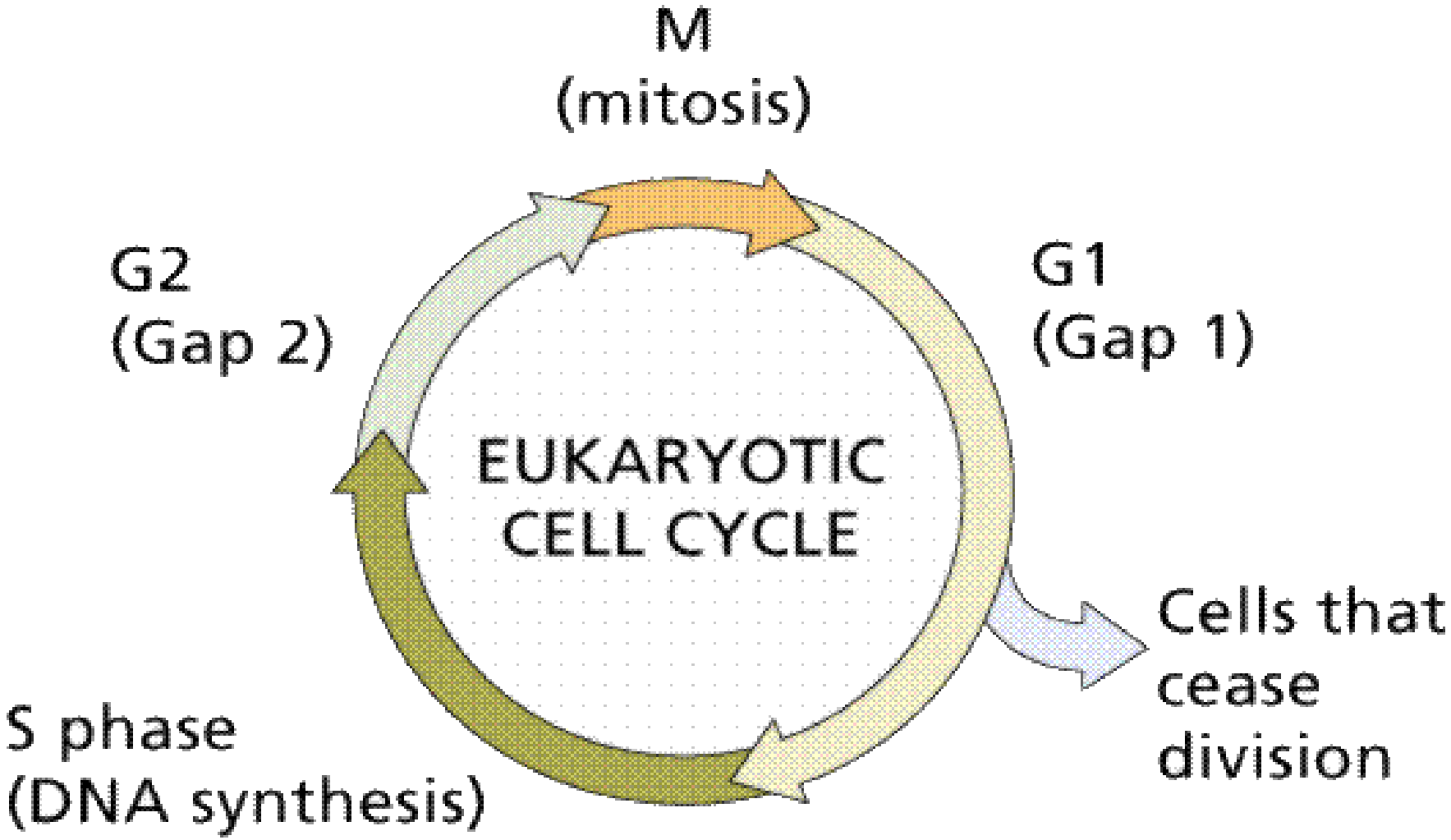
Mitosis is nuclear division that produces two daughter cells, each with the same number and kinds of chromosomes as the parental cell, the cell that divides. Therefore, following mitosis, the parental cell and the daughter cells are genetically identical.

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,

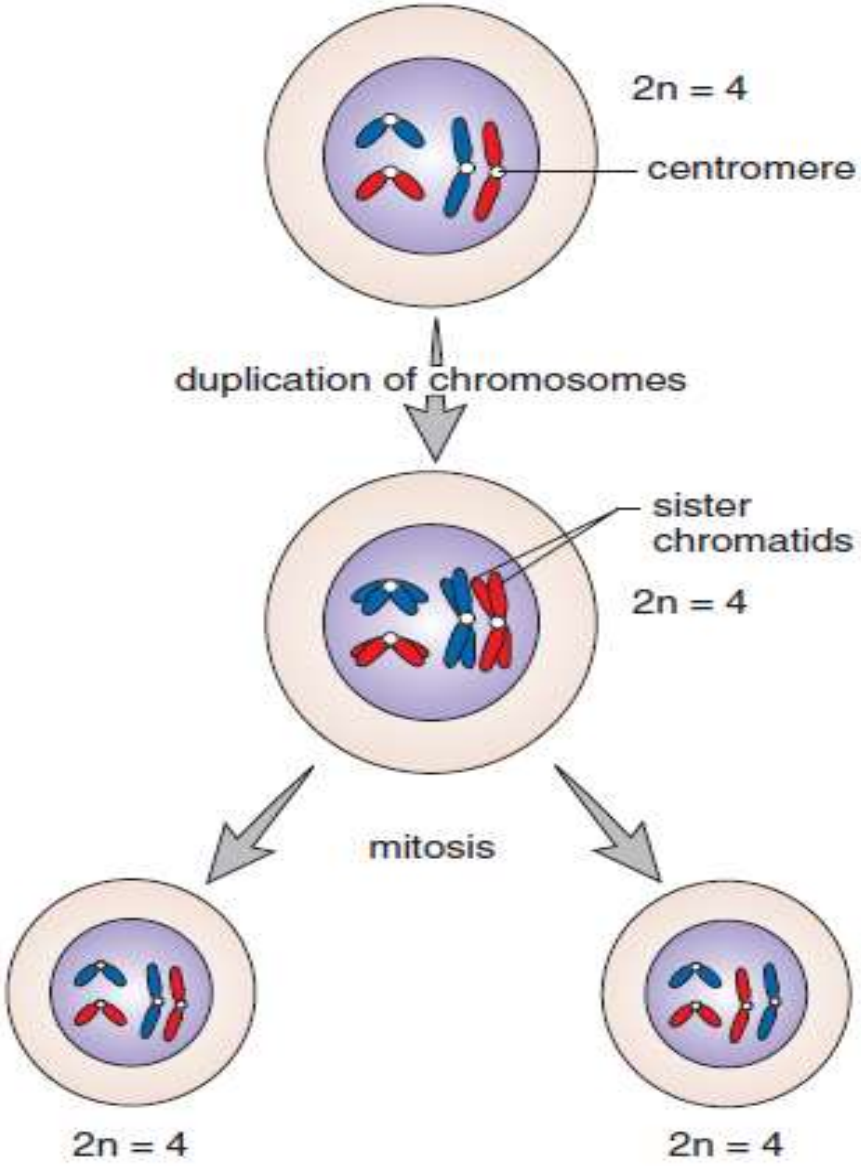
interphase is the interval of time between cell divisions.

The length of time required for the entire cell cycle varies according to the type of cell, but **18–24** hours is typical.


M
(mitosis)
G2
(Gap 2)
G1
(Gap 1)
EUKARYOTIC
CELL CYCLE
Cells that
cease
division
S phase
(DNA synthesis)

The cell cycle includes interphase, mitosis, and cytokinesis.

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


2n = 4
centromere
duplication of chromosomes
sister
chromatids
2n = 4
mitosis
2n = 4
2n = 4

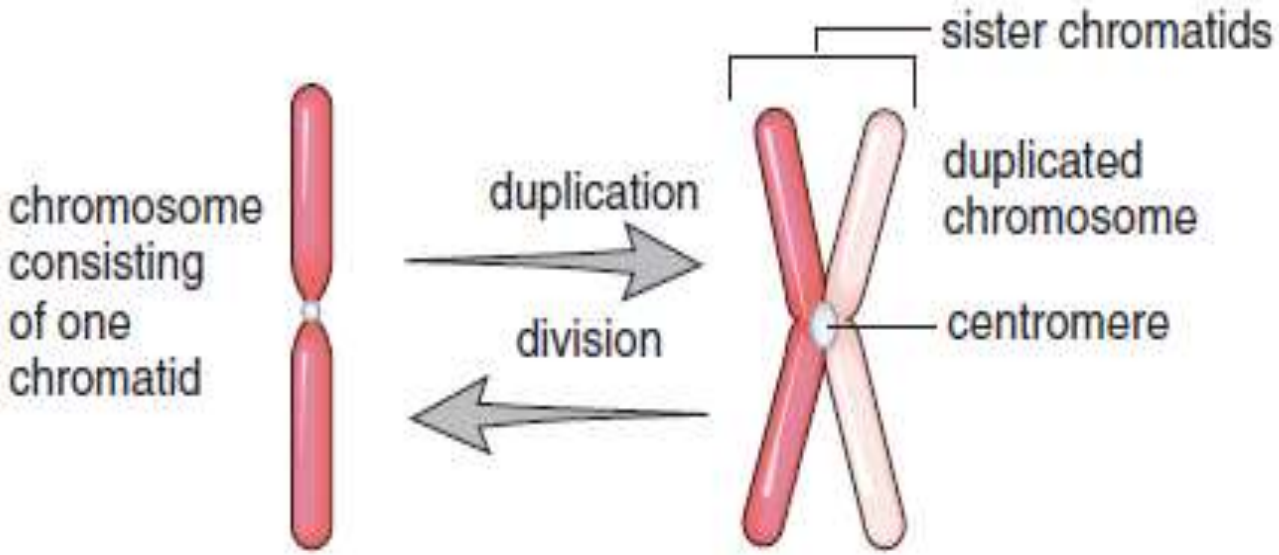
During mitosis, the centromeres divide, the sister chromatids separate, and one of each kind of chromosome goes into each daughter cell.

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 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.

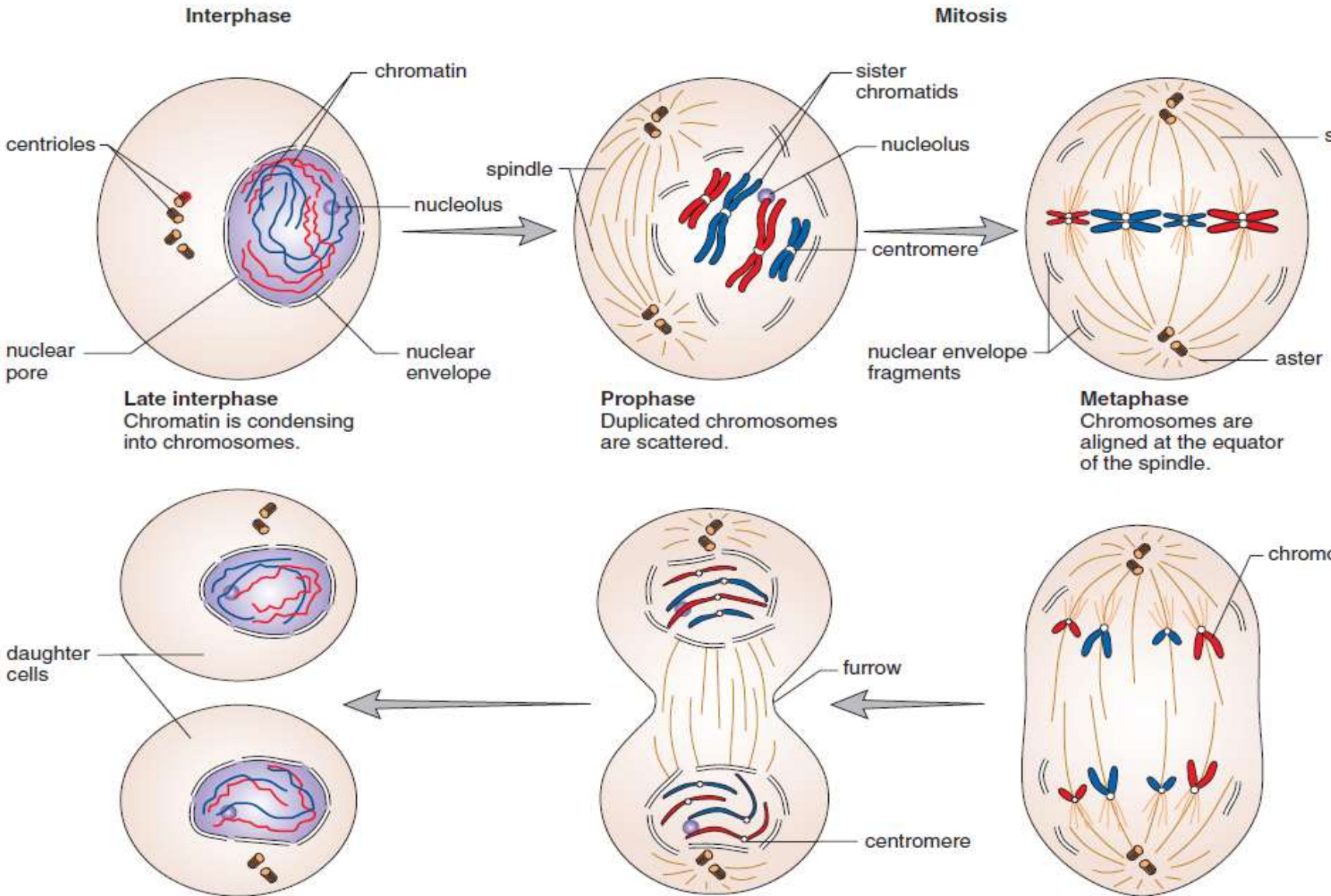

sister chromatids
chromosome consisting of one chromatid
duplication
division
duplicated chromosome
centromere

Stages of Mitosis

the process of mitosis 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.**


Interphase
Mitosis
chromatin
centrioles
nucleolus
nuclear pore
nuclear envelope
Late interphase
Chromatin is condensing into chromosomes.
sister chromatids
spindle
nucleolus
centromere
Prophase
Duplicated chromosomes are scattered.
nuclear envelope fragments
aster
Metaphase
Chromosomes are aligned at the equator of the spindle.
daughter cells
furrow
centromere

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 •

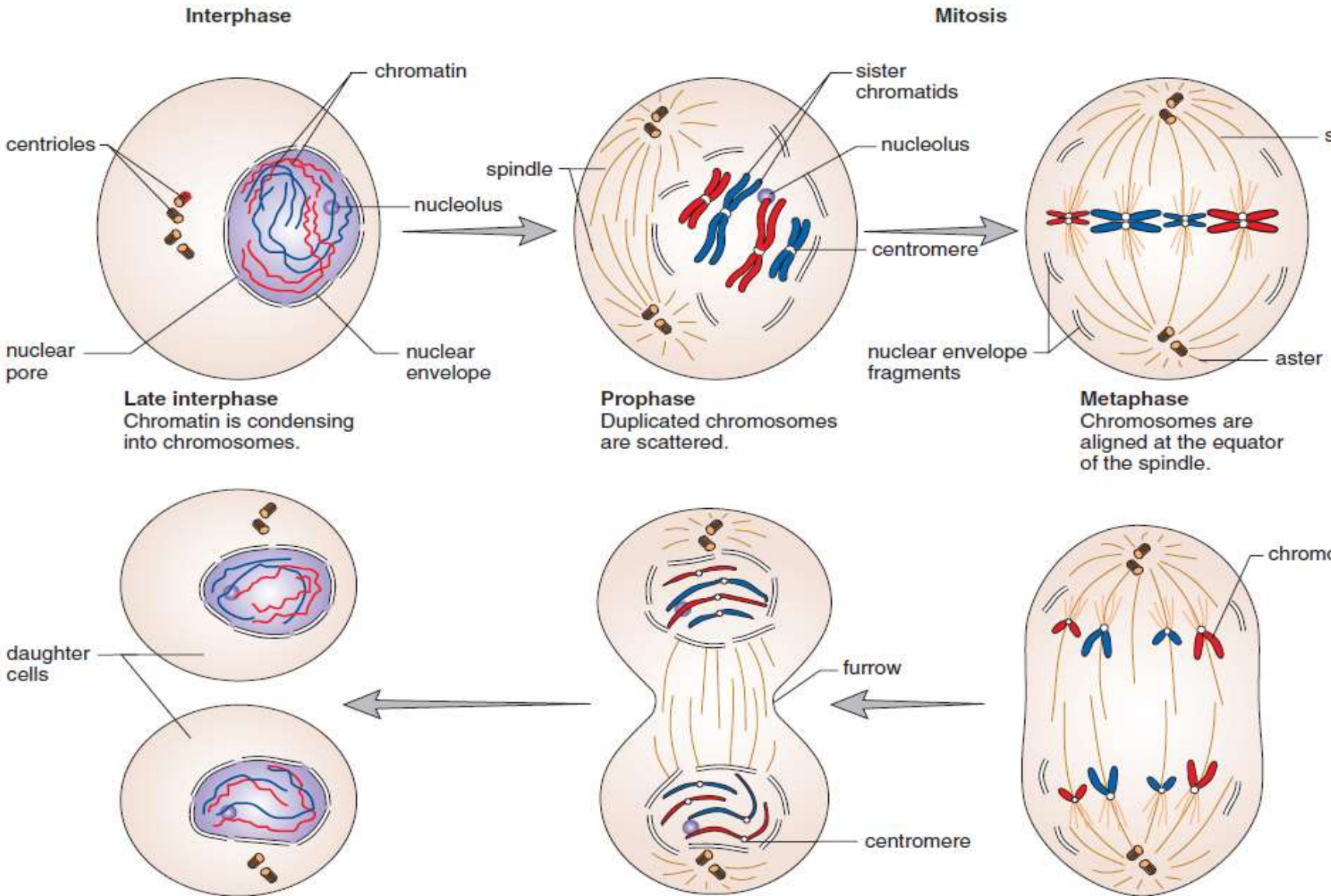
During **metaphase,** the nuclear envelope is fragmented, and the spindle occupies the region formerly occupied by the nucleus. The chromosomes are now at the equator (center) of the spindle. Metaphase is characterized by a fully formed spindle, and the **chromosomes**, each with two sister chromatids,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


Interphase
Mitosis
chromatin
centrioles
nucleolus
nuclear pore
nuclear envelope
Late interphase
Chromatin is condensing into chromosomes.
sister chromatids
spindle
nucleolus
centromere
Prophase
Duplicated chromosomes are scattered.
nuclear envelope fragments
aster
Metaphase
Chromosomes are aligned at the equator of the spindle.
daughter cells
furrow
centromere

- **Meiosis: 2n → n**

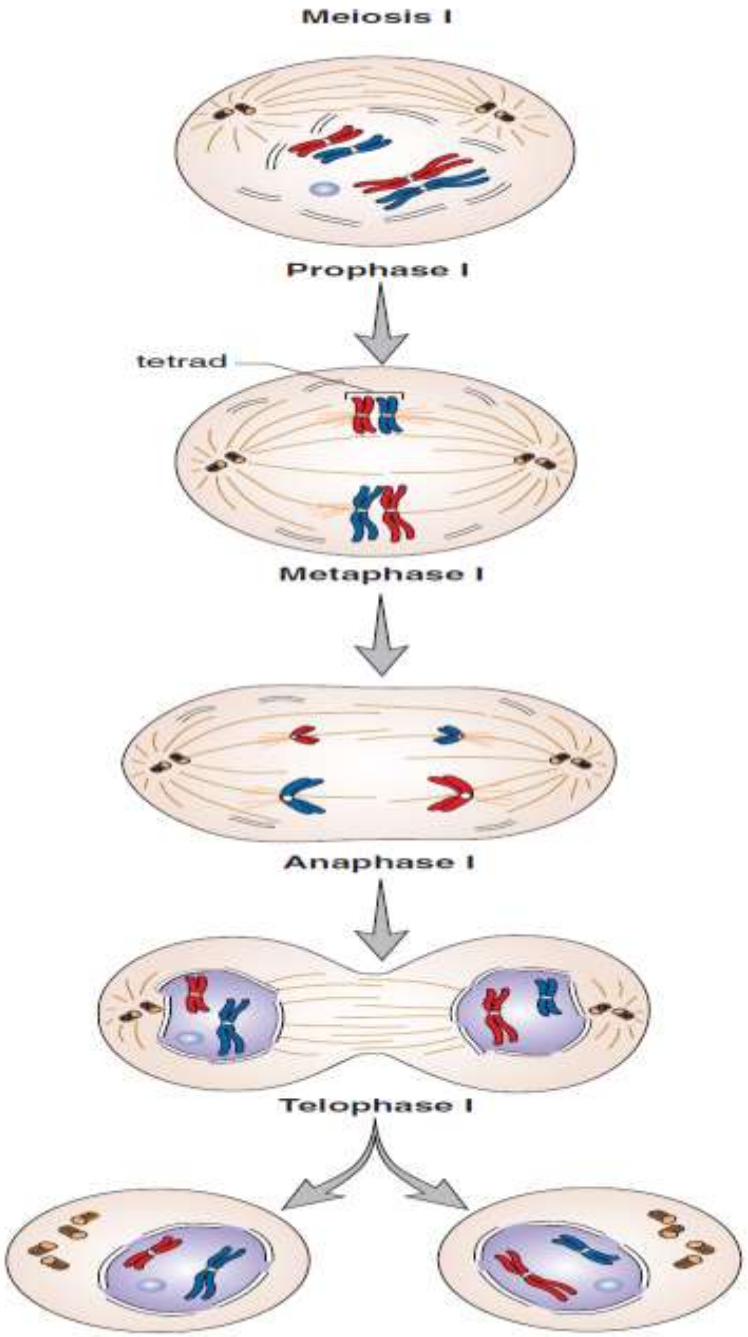
Meiosis, which requires two nuclear divisions, results in four daughter cells, each having one of each kind of chromosome and therefore half the number of chromosomes as the parental cell. The parental cell has the 2n number of chromosomes, while the daughter cells have the 1n number of chromosomes. 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.)

Stages of Meiosis

The same four stages of mitosis—prophase, metaphase, anaphase, and telophas—occur during both meiosis I and meiosis II.

- **The First Division**
- The stages of meiosis I are diagrammed in Figure 19.7*a*. During
- prophase I,the spindle appears while the nuclear envelope fragments and the nucleolus disappears.
- The homologous chromosomes, each having two sister chromatids ,undergo synapsis, forming tetrads. Crossing-over occurs now,
- In metaphase I, tetrads line up at the equator of the spindle.
- During anaphase I, homologous chromosomes of each pair separate and move to opposite poles of the spindle.
- During telophase I, nucleoli appear, and nuclear envelopes form as the spindle disappears.
- **During cytokinesis**, the plasma membrane furrows to give two cells. Each daughter cell contains only one chromosome from each homologous pair.
- The chromosomes are dyads, and each has two sister chromatids. No replication of DNA occurs during a period of time called interkinesis .


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

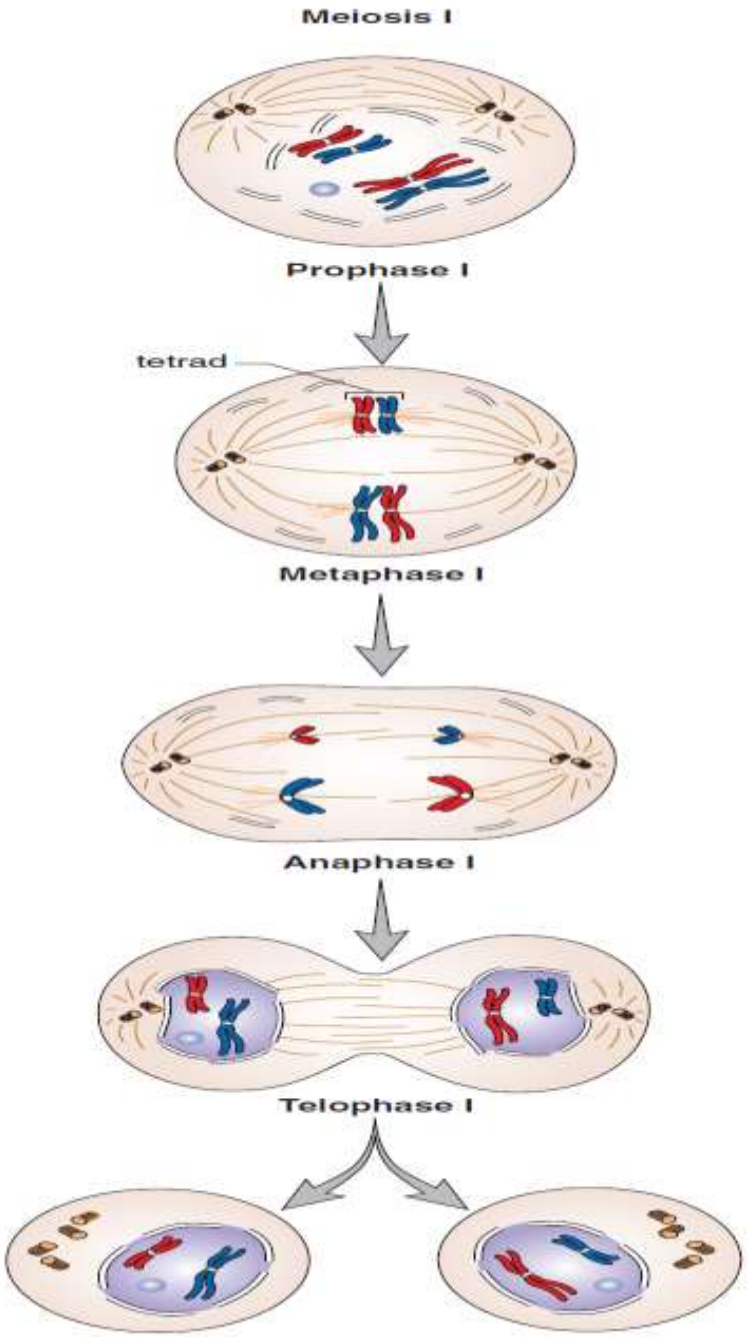
The Second Division

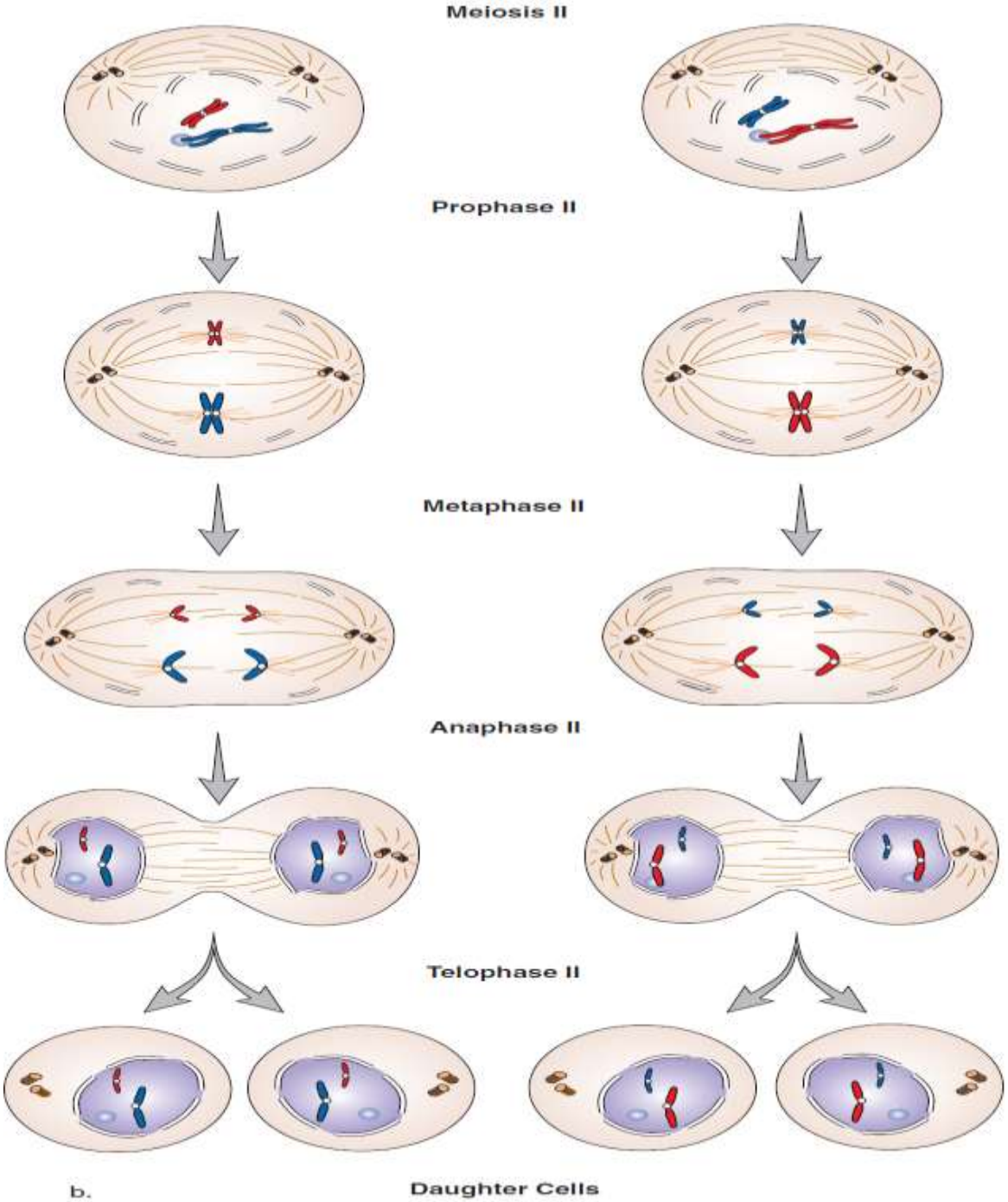
The stages of meiosis II are diagrammed in Figure 19.7*b*. A the beginning of prophase II, a spindle appears while the nuclear envelope disassembles and the nucleolus disappears. Dyads (one dyad from each pair of homologous chromosomes) are present, and each attaches to the spindle independently . During metaphase II, the dyads are lined up at the equator. At the start of anaphase II, the centromeres split. The sister chromatids of each dyad separate and move toward the poles. chromosomes. In telophase II, the spindle disappears as nuclear envelopes form.

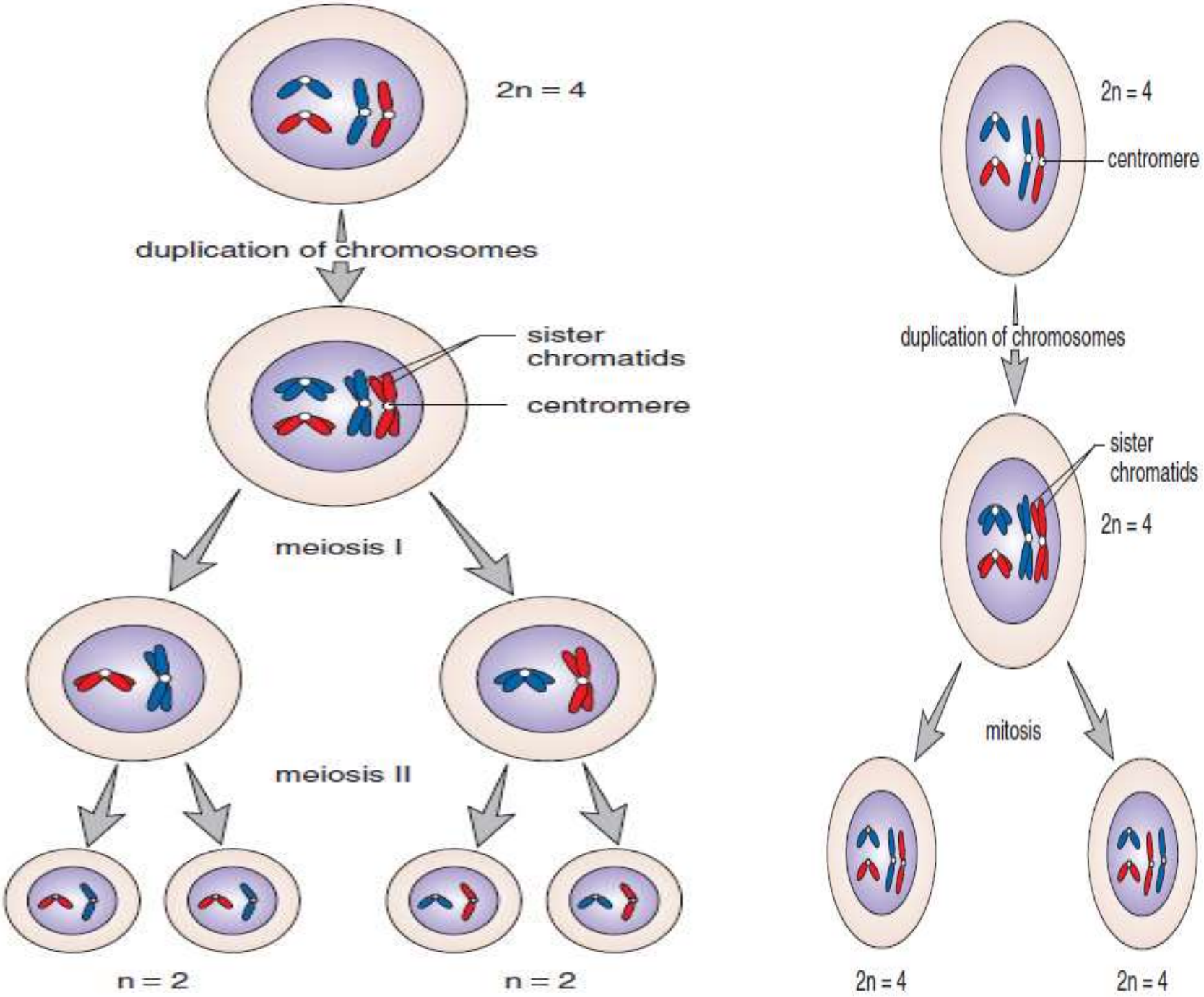
During cytokinesis, the plasma membrane furrows to give two complete cells, each of which has the haploid, or n, number of

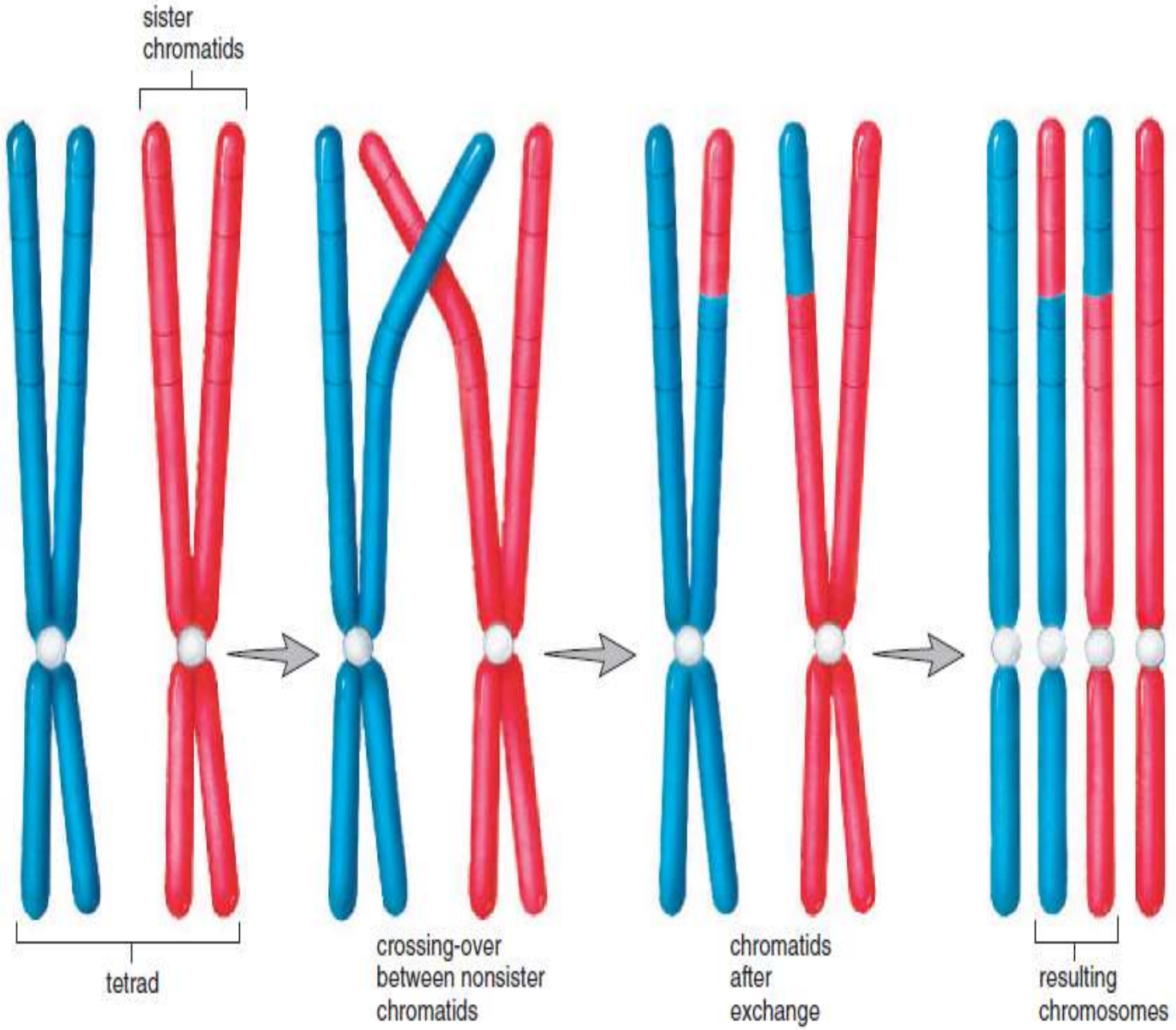
Summary

- Since each cell from meiosis I undergoes meiosis II, there are four daughter cells altogether.
- Meiosis involves two cell divisions.
- During **meiosis I,** tetrads form and crossing-over occurs.
- Homologous chromosomes separate, and each daughter cell receives one of each kind of chromosome.
- **During meiosis II**, the sister chromatids separate, and there are four daughter cells, each with the haploid number of chromosomes


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


2n = 4
duplication of chromosomes
sister chromatids
centromere
meiosis I
meiosis II
n = 2
n = 2
2n = 4
centromere
duplication of chromosomes
sister chromatids
2n = 4
mitosis
2n = 4
2n = 4


sister
chromatids
tetrad
crossing-over
between nonsister
chromatids
chromatids
after
exchange
resulting
chromosomes

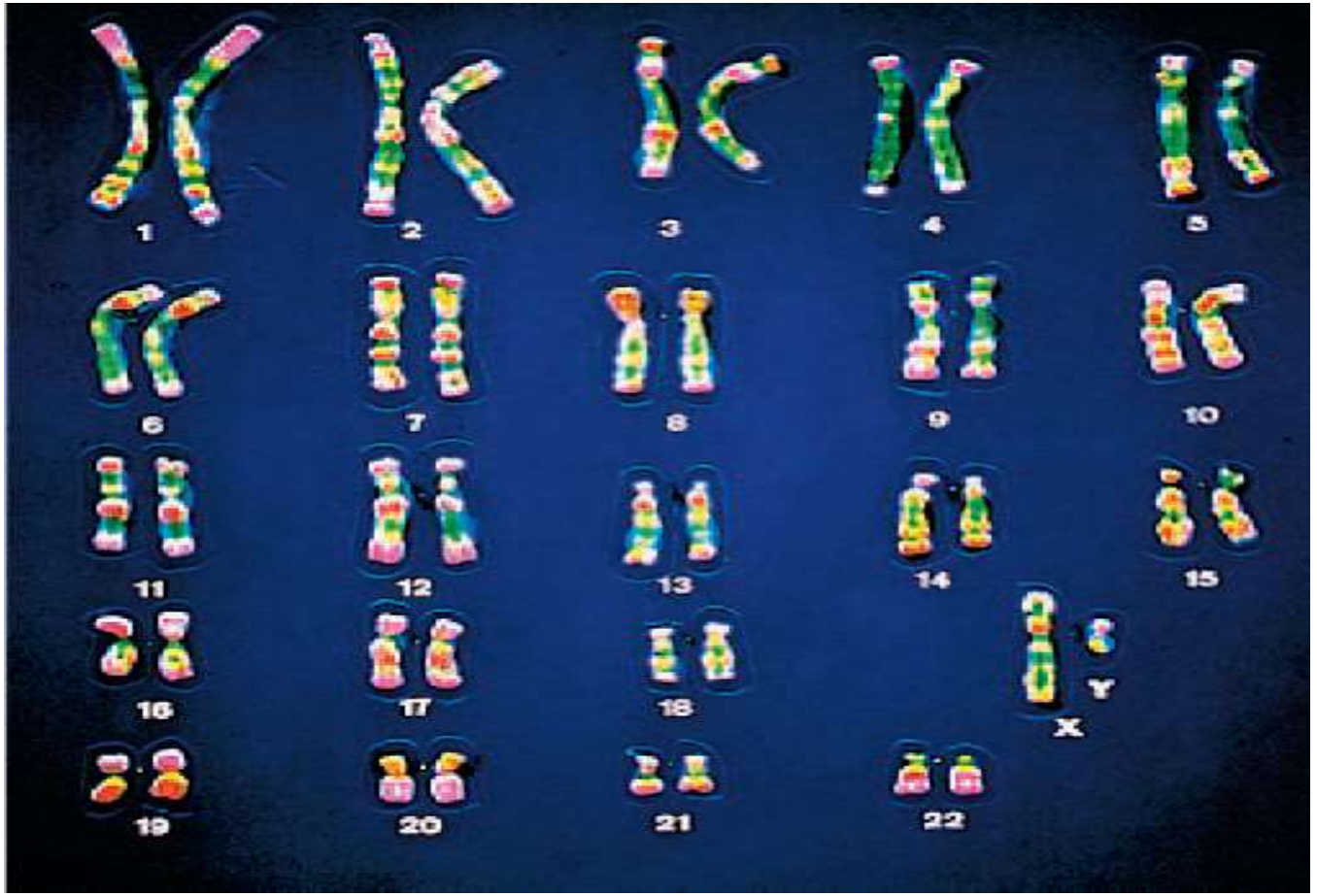
The Importance of Meiosis

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.



Karyotype: Chromosomes are paired by size, centromere location, and banding patterns. This is a normal karyotype.

The Reproductive System
In human is separated to male & female

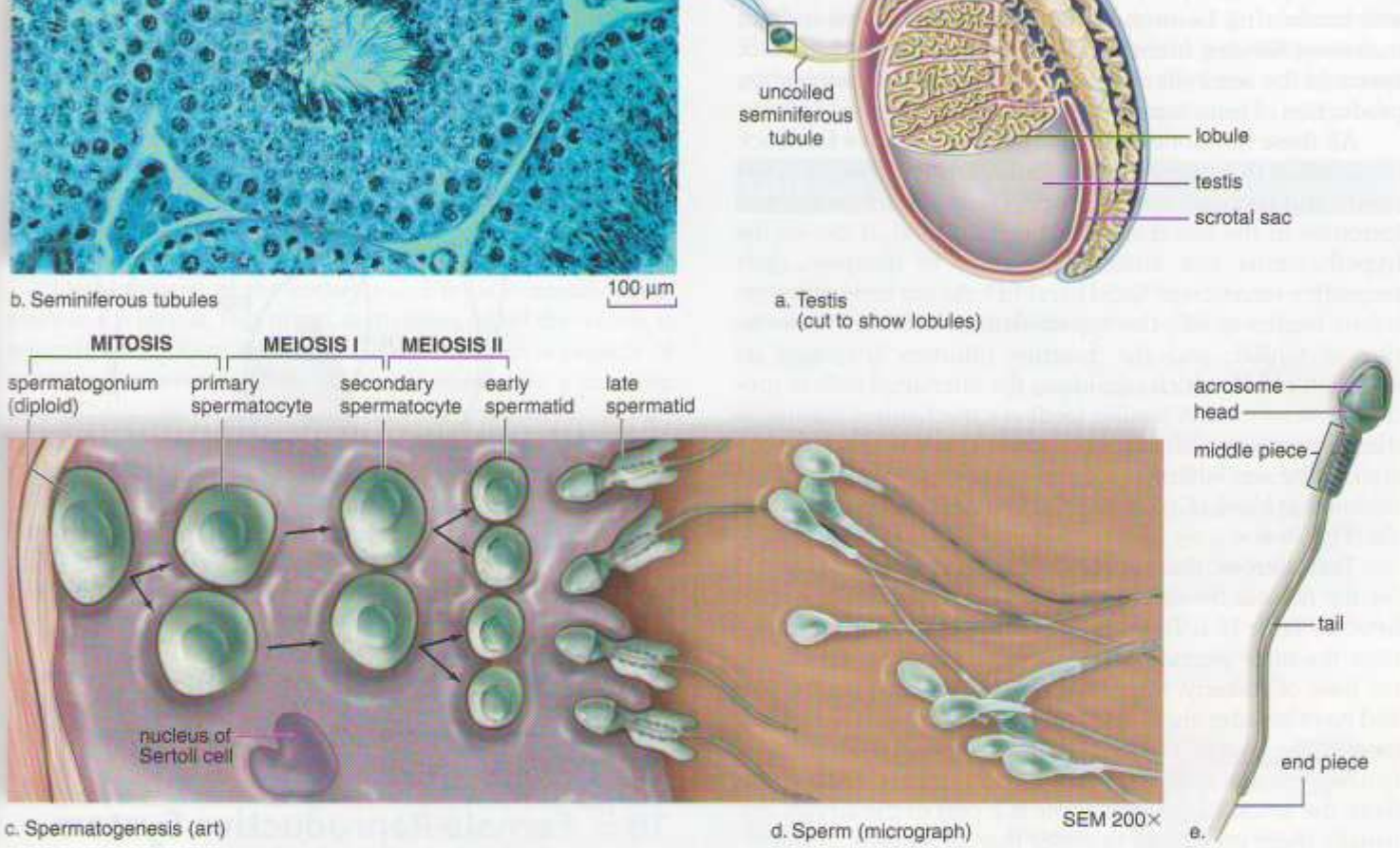
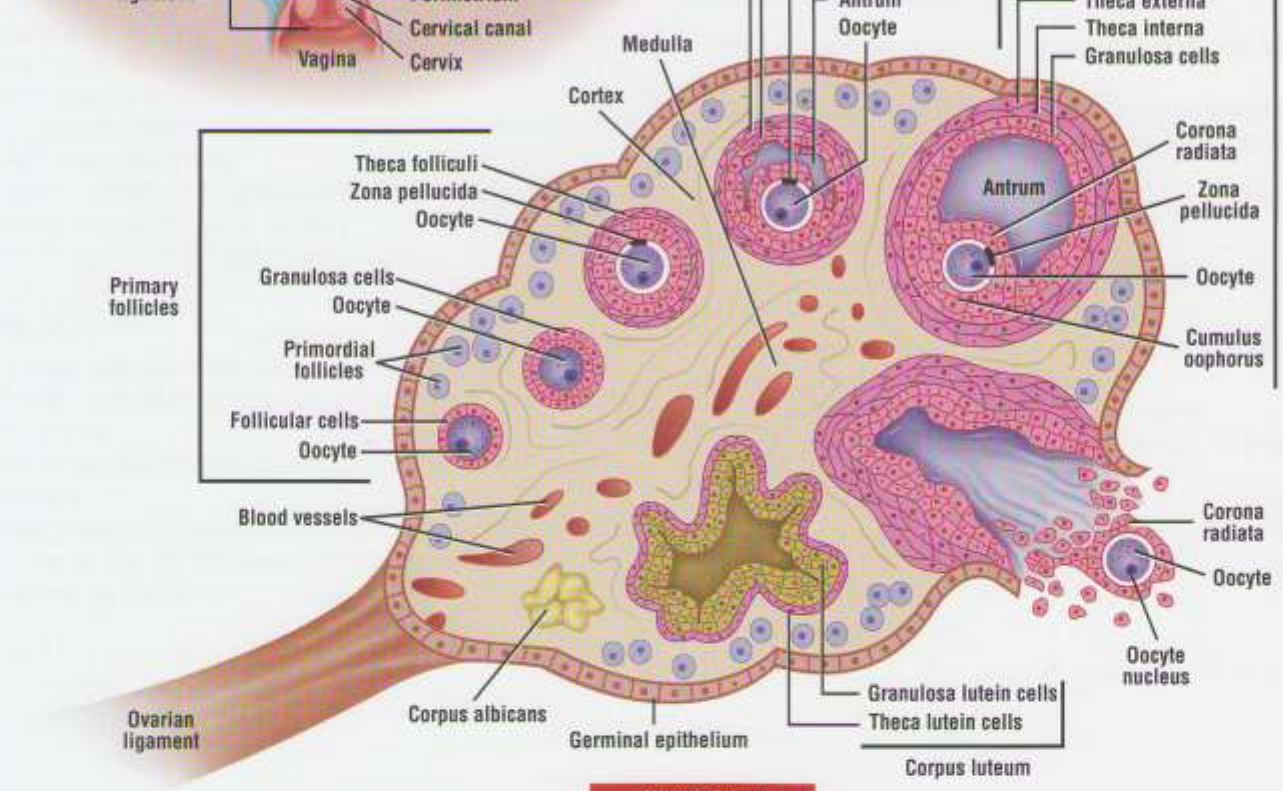


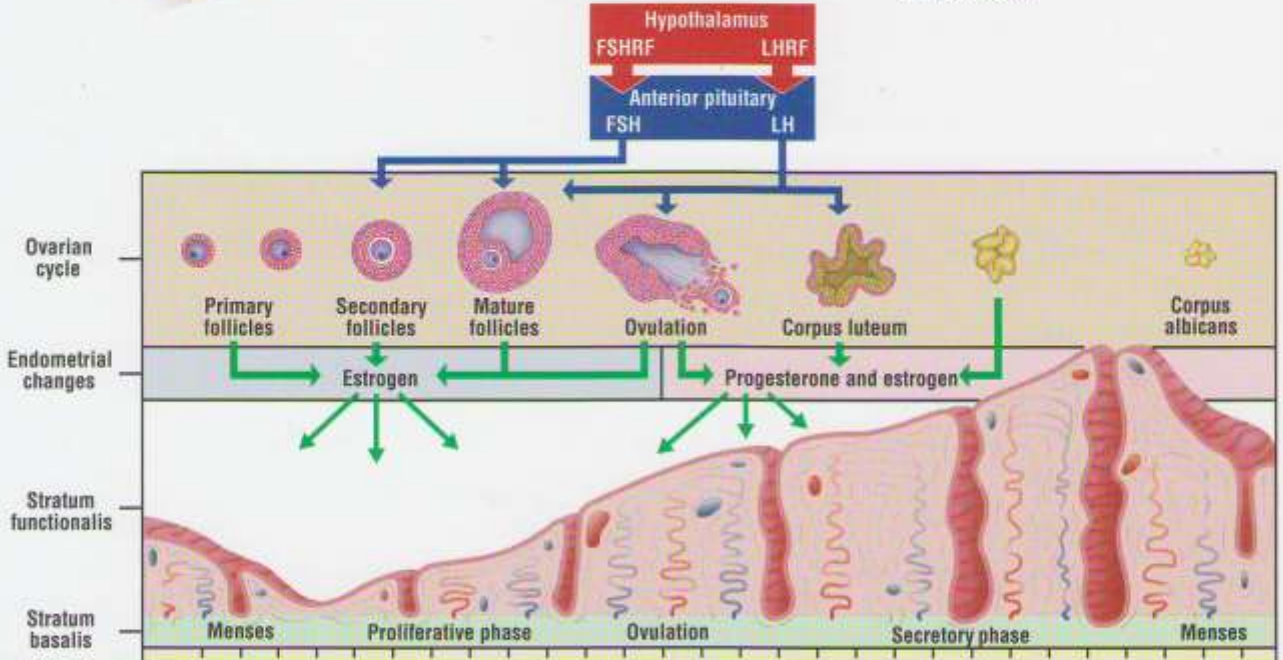
Figure 16.4 **Testis and sperm.**

a. The lobules of a testis contain seminiferous tubules. **b.** Electron micrograph of a cross section of the seminiferous tubules, where spermatogenesis occurs. Note the location of interstitial cells in clumps among the seminiferous tubules. **c.** Diagrammatic representation of spermatogenesis, which occurs in wall of tubules. **d.** Micrograph of sperm. **e.** A sperm has a head, a middle piece, and a tail. The nucleus is in the head, which is capped by the enzyme-containing acrosome.

three tightly coiled **seminiferous tubules** (Fig. 16.4*a*). A microscopic cross section of a seminiferous tubule reveals that

Mature **sperm,** or spermatozoa, have three distinct parts: a head, a middle piece, and a tail (Fig. 16.4*d*). Mitochondria in the middle piece provide energy for the movement of the tail.


Cervical canal
Vagina
Cervix
Medulla
Cortex
Oocyte
Theca externa
Theca interna
Granulosa cells
Corona radiata
Antrum
Zona pellucida
Oocyte
Cumulus oophorus
Theca folliculi
Zona pellucida
Oocyte
Primary follicles
Granulosa cells
Oocyte
Primordial follicles
Follicular cells
Oocyte
Blood vessels
Corona radiata
Oocyte
Oocyte nucleus
Granulosa lutein cells
Theca lutein cells
Corpus luteum
Corpus albicans
Germinal epithelium
Ovarian ligament


Hypothalamus
FSHRF
LHRF
Anterior pituitary
FSH
LH
Ovarian cycle
Primary follicles
Secondary follicles
Mature follicles
Ovulation
Corpus luteum
Corpus albicans
Endometrial changes
Estrogen
Progesterone and estrogen
Stratum functionalis
Stratum basalis
Menses
Proliferative phase
Ovulation
Secretory phase
Menses

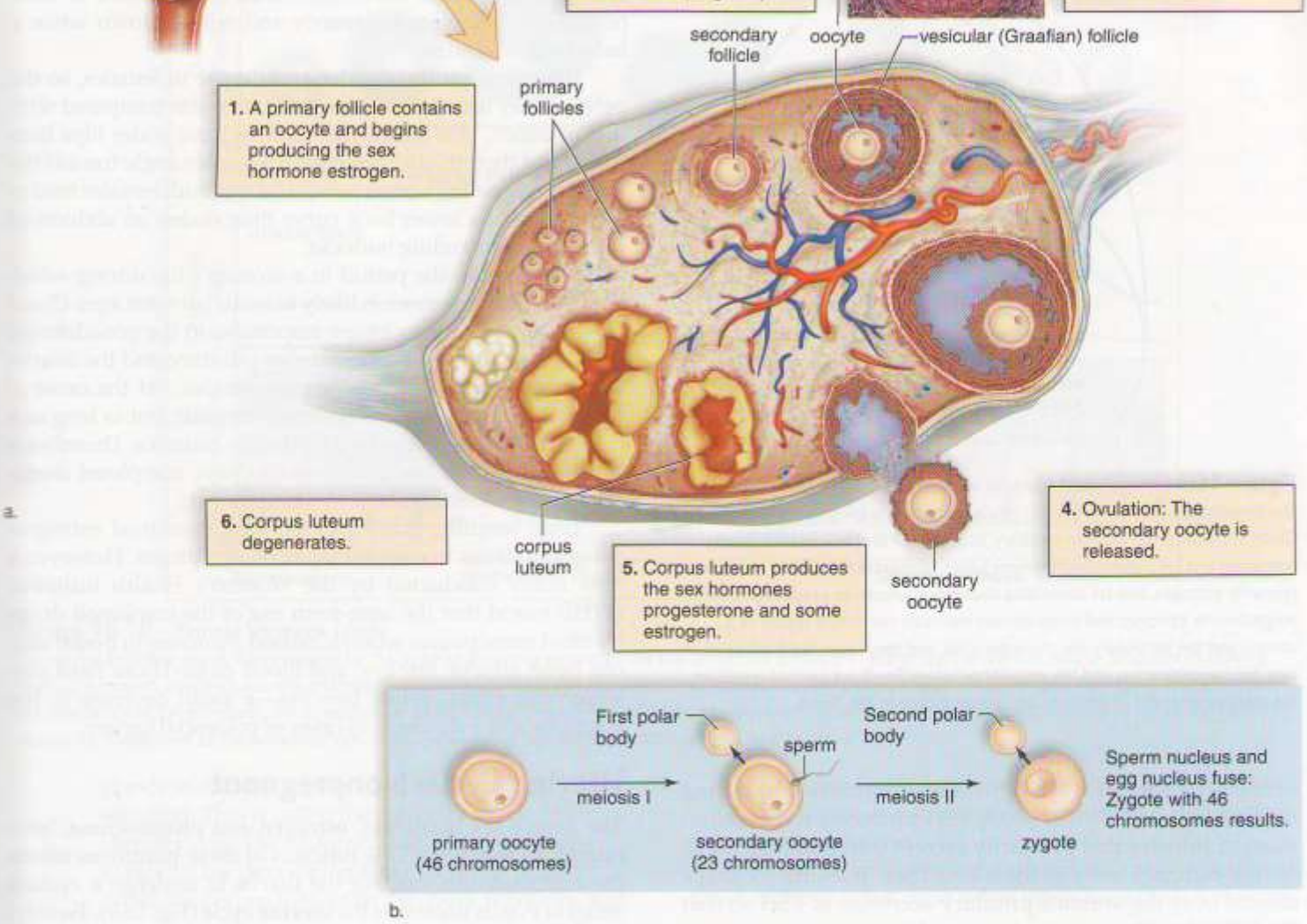


Figure 16.8 **Ovarian cycle.**

a. A single follicle actually goes through all stages (1–6) in one place within the ovary. As the follicle matures, layers of follicle cells surround a secondary oocyte. Eventually, the mature follicle ruptures, and the secondary oocyte is released. The follicle then becomes the corpus luteum, which eventually disintegrates. b. During oogenesis, the chromosome number is reduced from 46 to 23. Fertilization restores the full number of chromosomes.

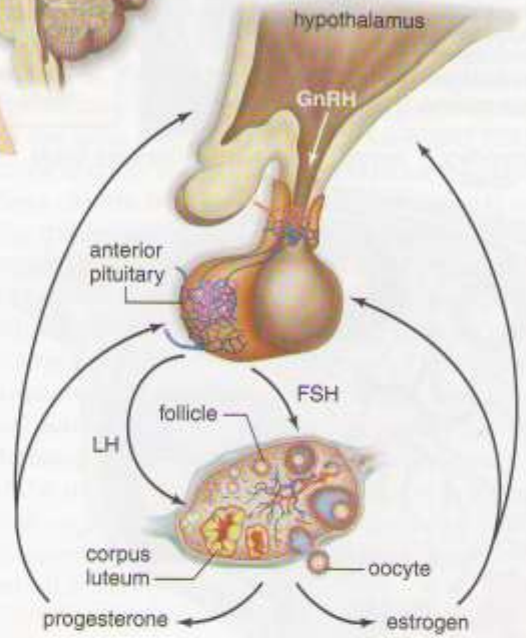


Figure 16.9 **Hormonal control of ovaries.**
The hypothalamus produces GnRH (gonadotropin-releasing hormone). GnRH stimulates the anterior pituitary to produce FSH (follicle-stimulating hormone) and LH (luteinizing hormone). FSH stimulates the follicle to produce primarily estrogen, and LH stimulates the corpus luteum to produce primarily progesterone. Estrogen and progesterone maintain the sexual organs (e.g., uterus) and the secondary sex characteristics, and they exert feedback control over the hypothalamus and the anterior pituitary. Feedback control regulates the relative amounts of estrogen and progesterone in the blood.

THANK YOU

Will MEET IN NEW LECTURE