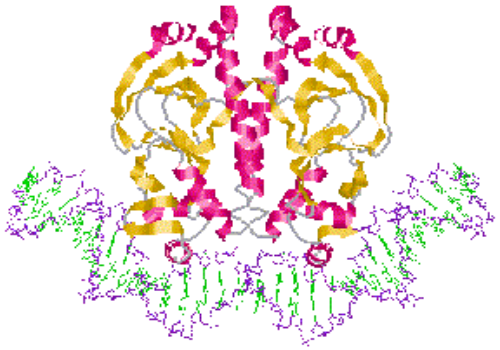
Mitosis and Meiosis and their comparison



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Outline of course

- Genetic continuity between generations of cells and between generations of sexually reproducing organisms is maintained through the processes of mitosis and meiosis, respectively.
- Diploid eukaryotic cells contain their genetic information in pairs of homologous chromosomes, with one member of each pair being derived from the maternal parent and one from the paternal parent.
- Mitosis provides a mechanism by which chromosomes, having been duplicated, are distributed into progeny cells during cell reproduction.

Outline of course

- Mitosis converts a diploid cell into two diploid daughter cells.
- The process of meiosis distributes one member of each homologous pair of chromosomes into each gamete or spore, thus reducing the diploid chromosome number to the haploid chromosome number.
- Meiosis generates genetic variability by distributing various combinations of maternal and paternal members of each homologous pair of chromosomes into gametes or spores.
- During the stages of mitosis and meiosis, the genetic material is condensed into discrete structures called chromosomes.

Cell Structure Is Closely Tied to Genetic Function

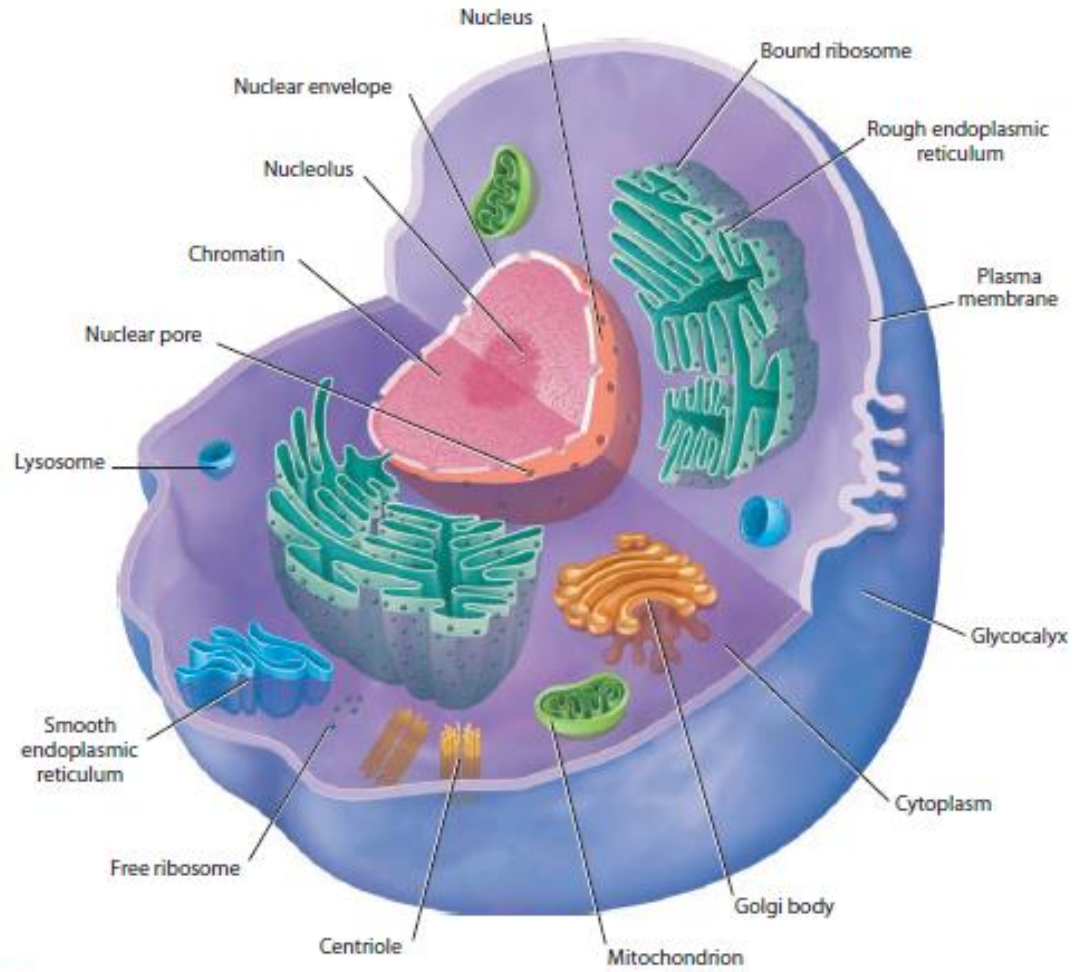


FIGURE 2.1 A generalized animal cell. The cellular components discussed in the text are emphasized here.

Chromosomes Exist in Homologous Pairs in Diploid Organisms

Centromere location	Designation	Metaphase shape	Anaphase shape
Middle	Metacentric	Sister chromatids, Centromere	Migration
Between middle and end	Submetacentric	p arm, q arm	
Close to end	Acrocentric		
At end	Telocentric		

FIGURE 2.3 Centromere locations and the chromosome designations that are based on them. Note that the shape of the chromosome during anaphase is determined by the position of the centromere during metaphase.

Chromosomes Exist in Homologous Pairs in Diploid Organisms

TABLE 2.1 The Haploid Number of Chromosomes for a Variety of Organisms

Common Name	Scientific Name	Haploid Number
Black bread mold	*Aspergillus nidulans*	8
Broad bean	*Vicia faba*	6
Chimpanzee	*Pan troglodytes*	24
Corn	*Zea mays*	10
Cotton	*Gossypium hirsutum*	26
Dog	*Canis familiaris*	39
Fruit fly	*Drosophila melanogaster*	4
Garden pea	*Pisum sativum*	7
House mouse	*Mus musculus*	20
Human	*Homo sapiens*	23
Jimson weed	*Datura stramonium*	12
Pink bread mold	*Neurospora crassa*	7
Roundworm	*Caenorhabditis elegans*	6
Wheat	*Triticum aestivum*	21
Yeast	*Saccharomyces cerevisiae*	16
Zebrafish	*Danio rerio*	25

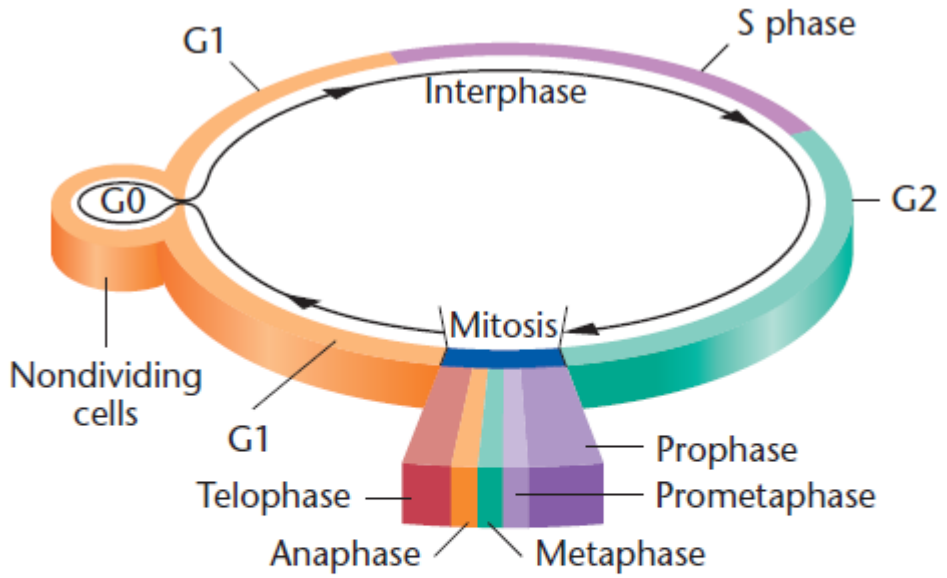


FIGURE 2.5 The stages comprising an arbitrary cell cycle. Following mitosis, cells enter the G1 stage of interphase, initiating a new cycle. Cells may become nondividing (G0) or continue through G1, where they become committed to begin DNA synthesis (S) and complete the cycle (G2 and mitosis). Following mitosis, two daughter cells are produced, and the cycle begins anew for both of them.

Mitosis Partitions Chromosomes into Dividing Cells

Interphase			Mitosis
G1	S	G2	M
5	7	3	1

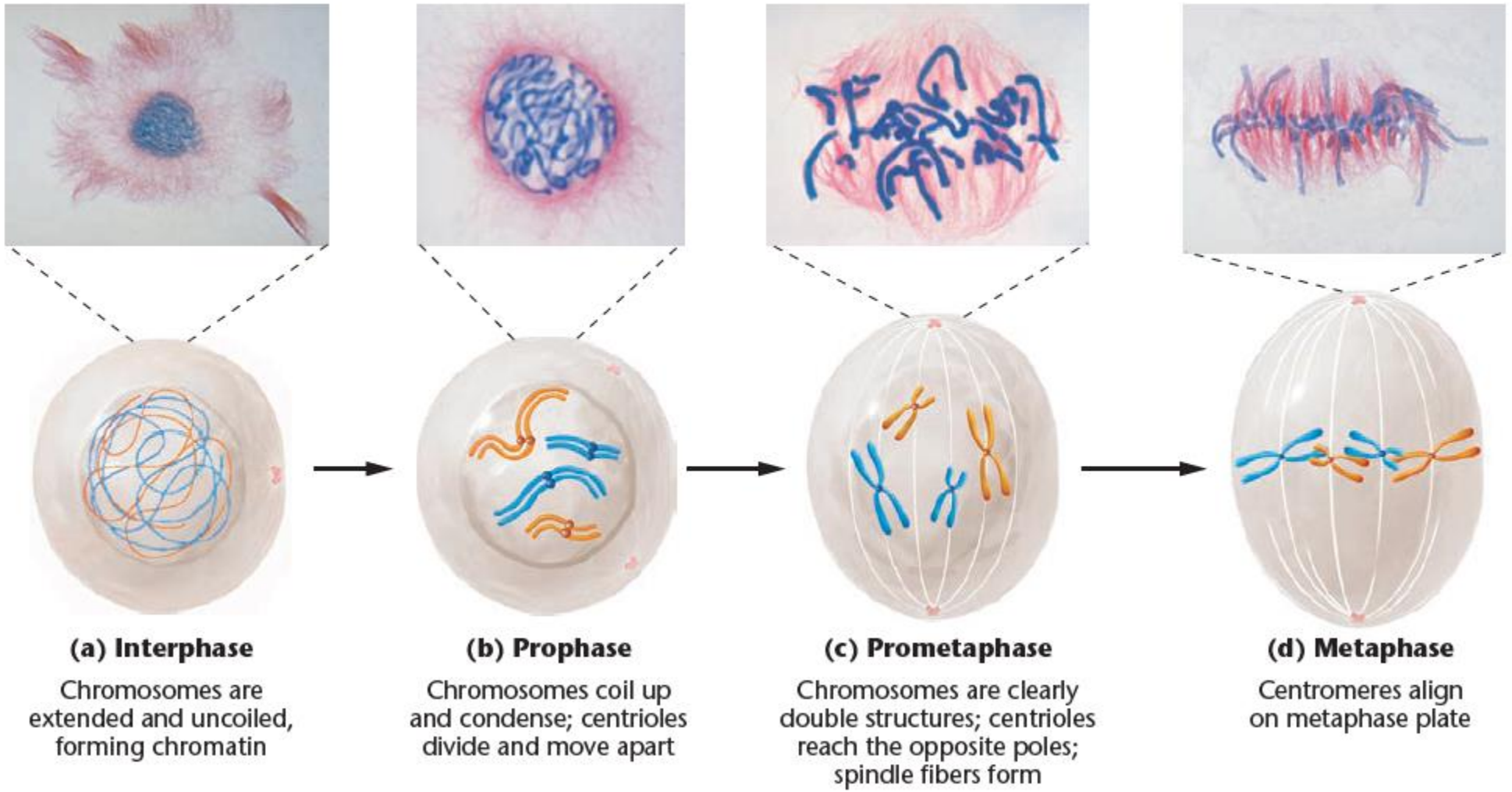
Hours

Pro	Met	Ana	Tel
36	3	3	18

Minutes

FIGURE 2.6 The time spent in each interval of one complete cell cycle of a human cell in culture. Times vary according to cell types and conditions.

Mitosis Partitions Chromosomes into Dividing Cells



(a) Interphase

Chromosomes are extended and uncoiled, forming chromatin

(b) Prophase

Chromosomes coil up and condense; centrioles divide and move apart

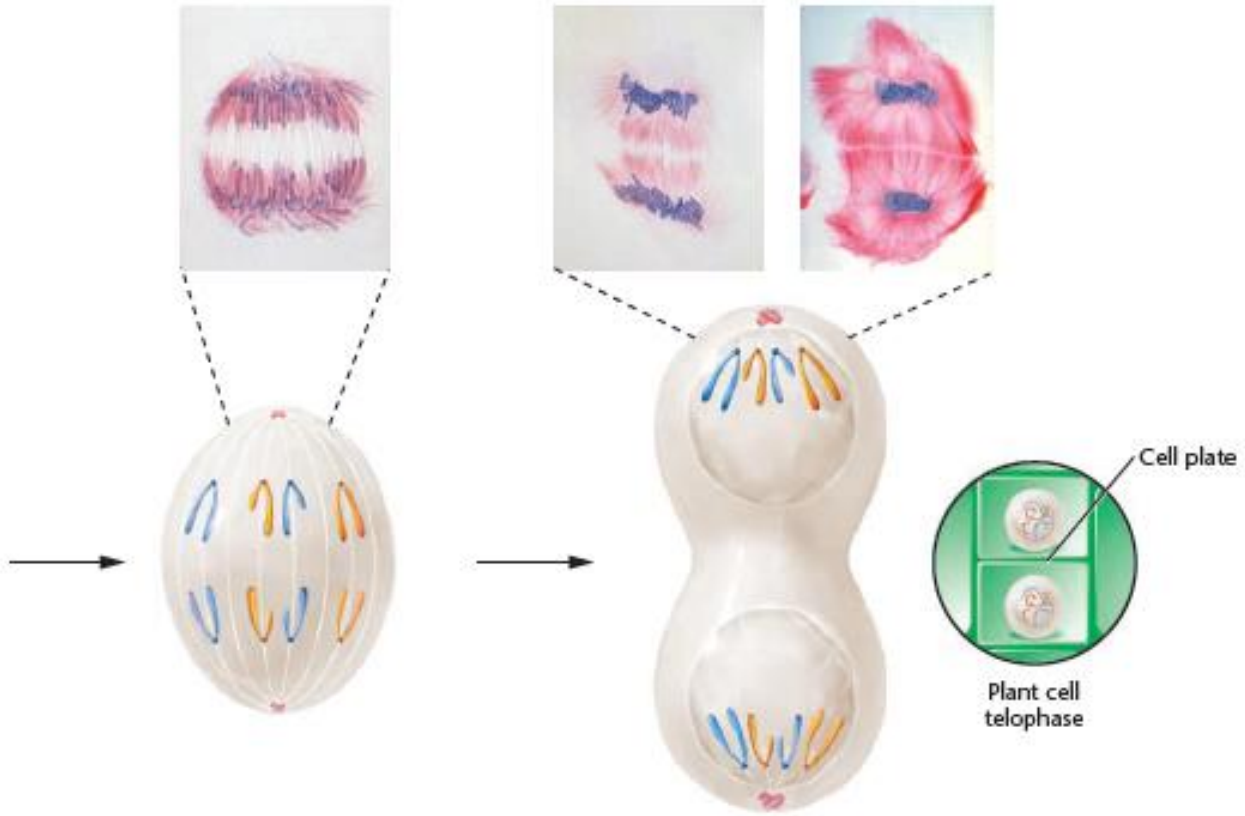
(c) Prometaphase

Chromosomes are clearly double structures; centrioles reach the opposite poles; spindle fibers form

(d) Metaphase

Centromeres align on metaphase plate

Mitosis Partitions Chromosomes into Dividing Cells



(e) Anaphase

Centromeres split and daughter chromosomes migrate to opposite poles

(f) Telophase

Daughter chromosomes arrive at the poles; cytokinesis commences

FIGURE 2.7 Drawings depicting mitosis in an animal cell with a diploid number of 4. The events occurring in each stage are described in the text. Of the two homologous pairs of chromosomes, one pair consists of longer, metacentric members and the other of shorter, submetacentric members. The maternal chromosome and the paternal chromosome of each pair are shown in different colors. To the right of (f), a drawing of late telophase in a plant cell shows the formation of the cell plate and lack of centrioles. The cells shown in the light micrographs came from the flower of *Haemanthus*, a plant that has a diploid number of 8.

Meiosis Creates Haploid Gametes and Spores and Enhances Genetic Variation in Species

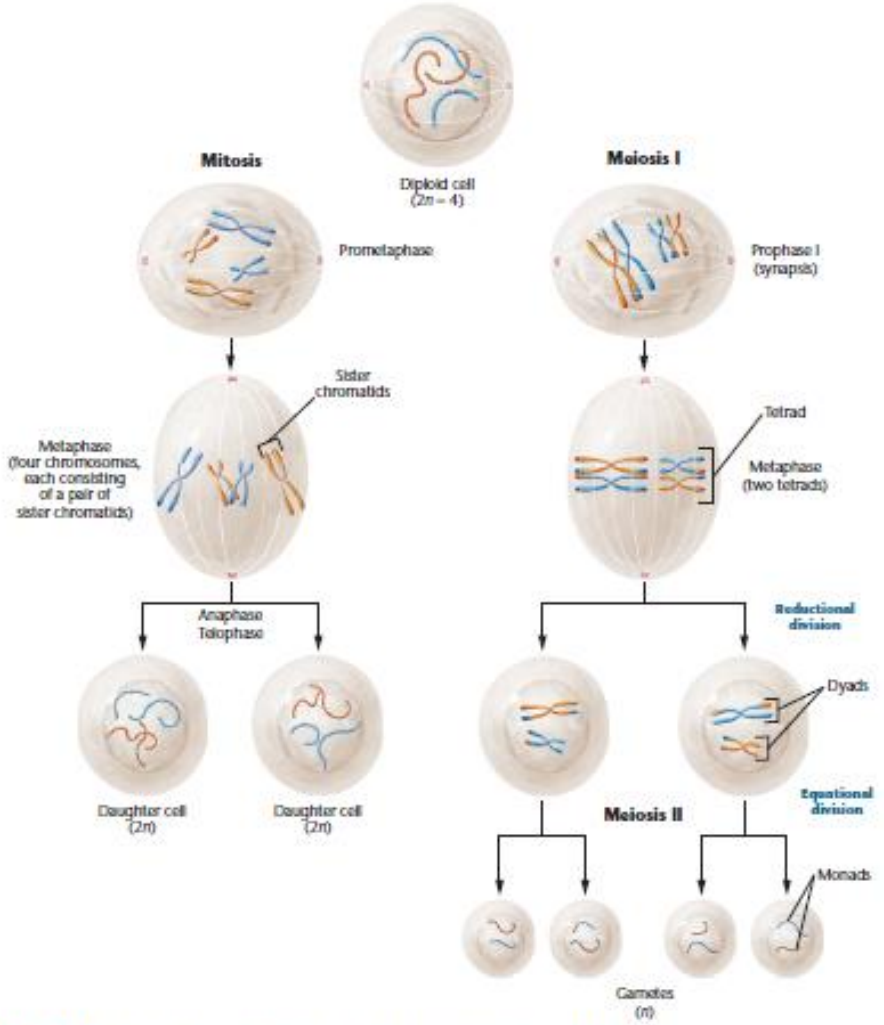


FIGURE 2.3 Overview of the major events and outcomes of mitosis and meiosis. As in Figure 2.2, two pairs of homologous chromosomes are followed.

Meiosis Creates Haploid Gametes and Spores and Enhances Genetic Variation in Species

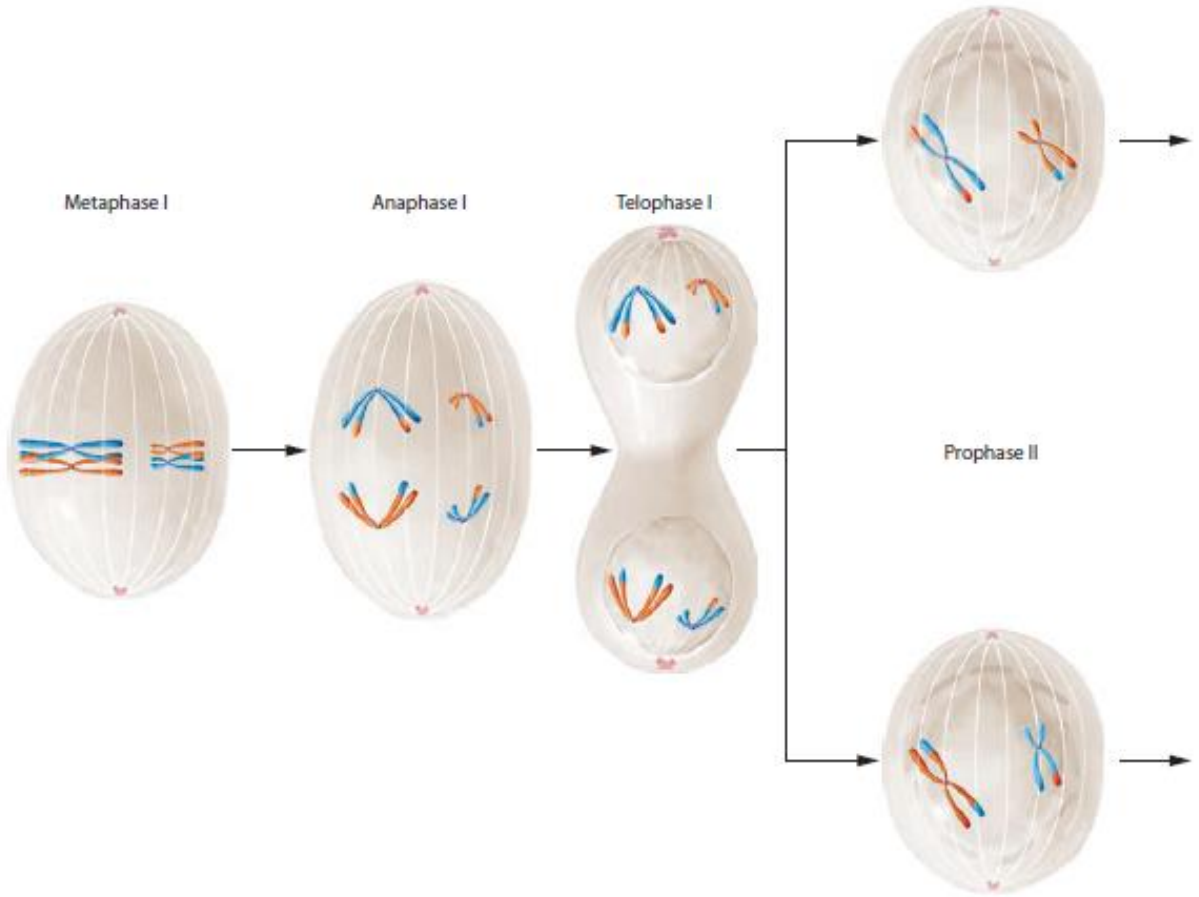


FIGURE 2.11 The major events in meiosis in an animal cell with a diploid number of 4, beginning with metaphase I. Note that the combination of chromosomes in the cells produced following telophase II is dependent on the random alignment of each tetrad and dyad on the equatorial plate during metaphase I and metaphase II. Several other combinations, which are not shown, can also be formed. The events depicted here are described in the text.

Meiosis Creates Haploid Gametes and Spores and Enhances Genetic Variation in Species

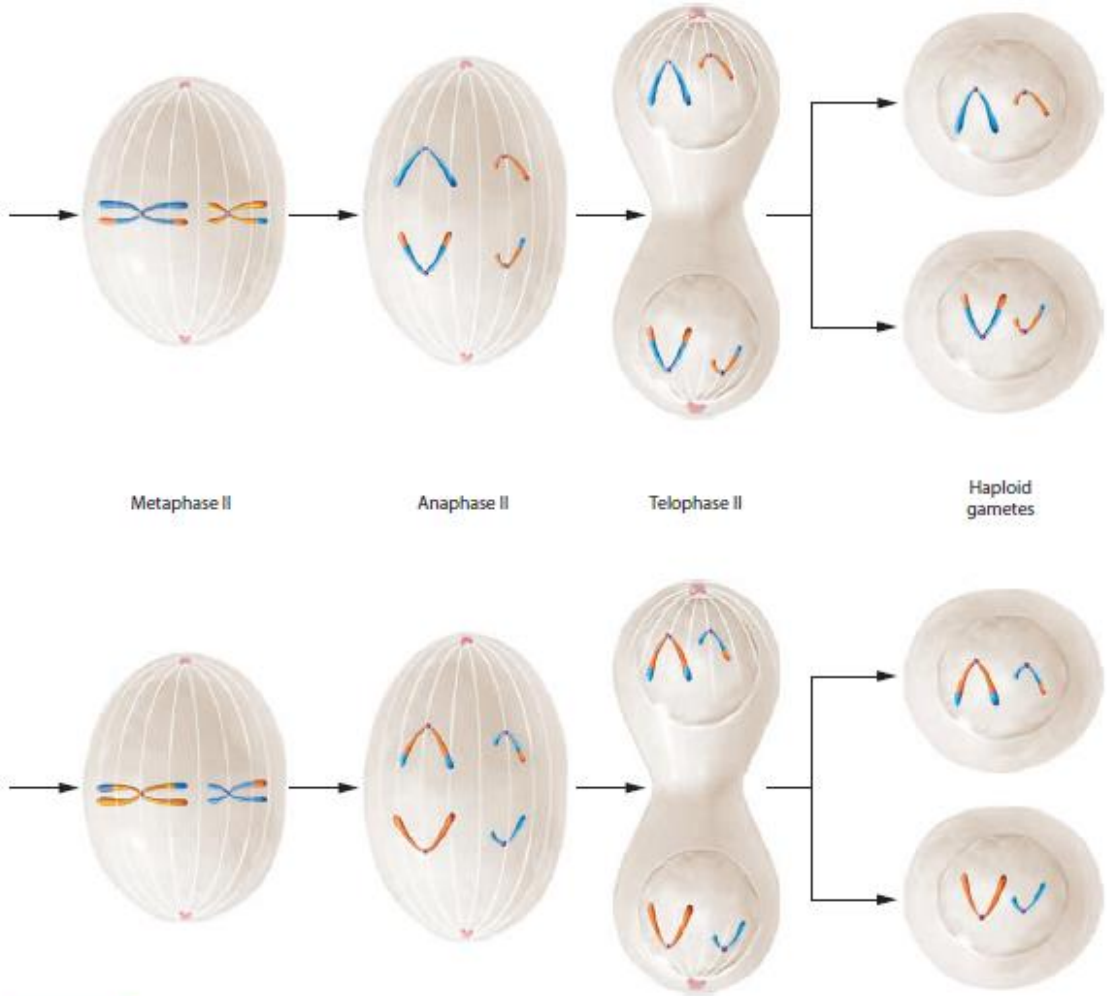


FIGURE 2.11 *(Continued)*

Meiosis Creates Haploid Gametes and Spores and Enhances Genetic Variation in Species

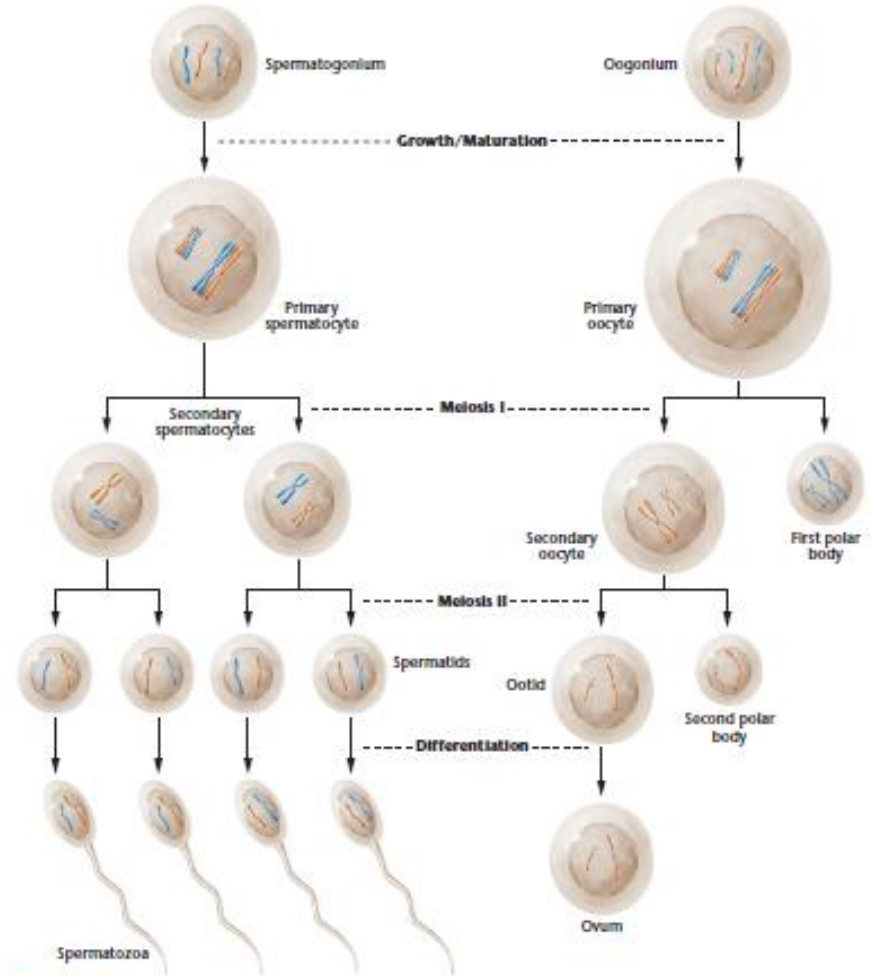


FIGURE 2.12 Spermatogenesis and oogenesis in animal cells.

Meiosis Is Critical to Sexual Reproduction in All Diploid Organisms

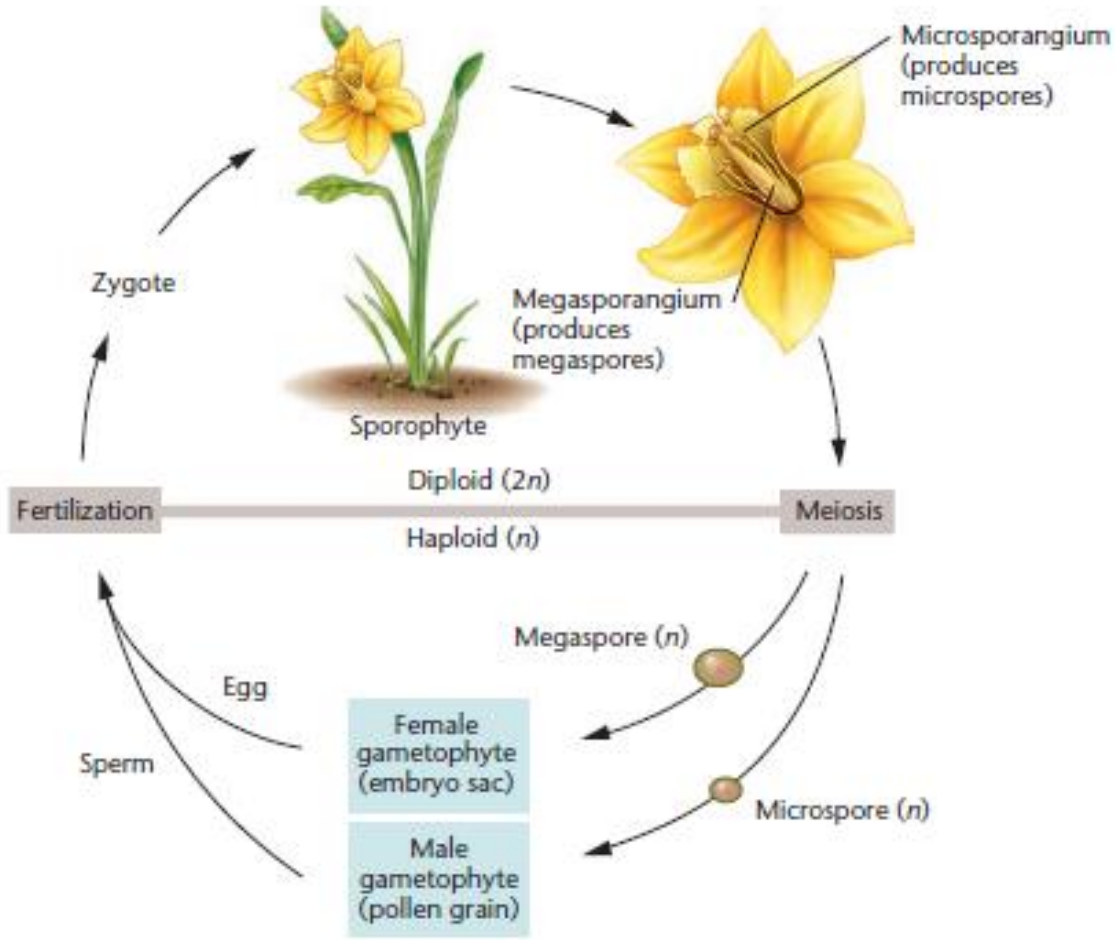


FIGURE 2.13 Alternation of generations between the diploid sporophyte ($2n$) and the haploid gametophyte (n) in a multicellular plant. The processes of meiosis and fertilization bridge the two phases of the life cycle. In angiosperms (flowering plants), like the one shown here, the sporophyte stage is the predominant phase.

Electron Microscopy Has Revealed the Physical Structure of Mitotic and Meiotic Chromosomes

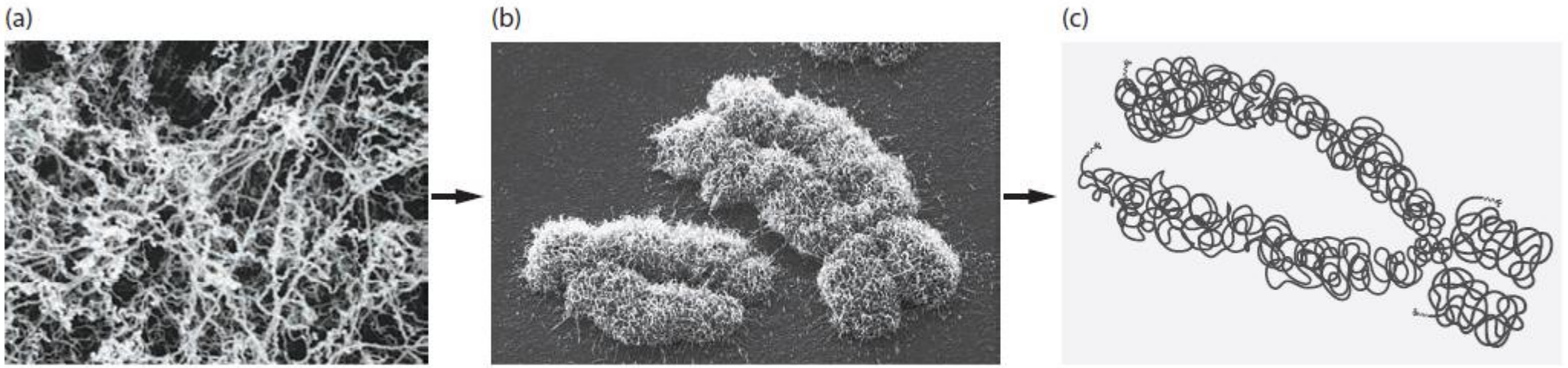


FIGURE 2.14 Comparison of (a) the chromatin fibers characteristic of the interphase nucleus with (b) metaphase chromosomes that are derived from chromatin during mitosis. Part (c) diagrams a mitotic chromosome, showing how chromatin is condensed to produce it. Part (a) is a transmission electron micrograph and part (b) is a scanning electron micrograph.