

Cell Division and Inheritance

تقسیم سلولی
و
وراثت

CELL DIVISION

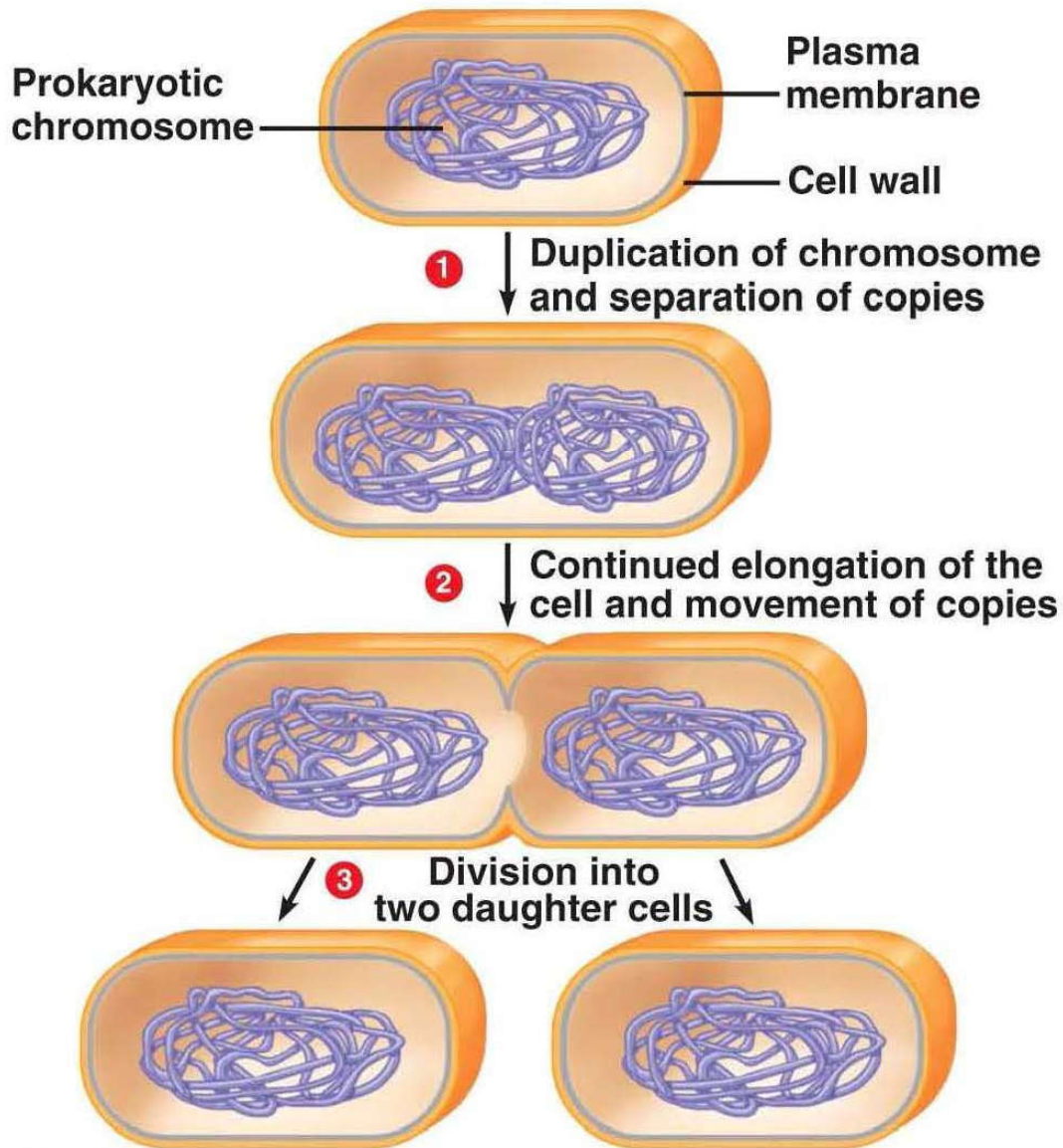
- ◉ Continuing life relies on reproduction
 - Individual organism—replacing dead or damaged cells
 - Species—making more of same species
- ◉ Reproduction
 - Cells divide, grow, divide again

CELL DIVISION

- ◉ **Mitosis—division of body (somatic) cells by multicelled organisms**
 - Increasing number of cells during growth
 - Replaces cells that are worn-out, dead, or damaged
 - **Asexual** reproduction by some plants, animals, fungi, single-celled protists
 - In undifferentiated somatic cells (skin, liver, bone marrow, blood vessels), not in differentiated cells (nerve and Muscle cells, adult stem cells)
- ◉ **Meiosis—formation of sex (germ) cells (sperm, eggs) and spores**
 - Basis for **sexual** reproduction
 - Creates gametes
- ◉ **Prokaryotic (Binary) fission**

BINARY FISSION

- ◉ Prokaryotes have no nucleus or organelles.
- ◉ As chromosome duplicates, copies move to opposite sides of cell.
- ◉ After duplication and cell growth, membrane grows inward, dividing the cell.
- ◉ Daughter cells same genes as parent cell
 - Effectively are clones of the parent cell



CHROMOSOMES

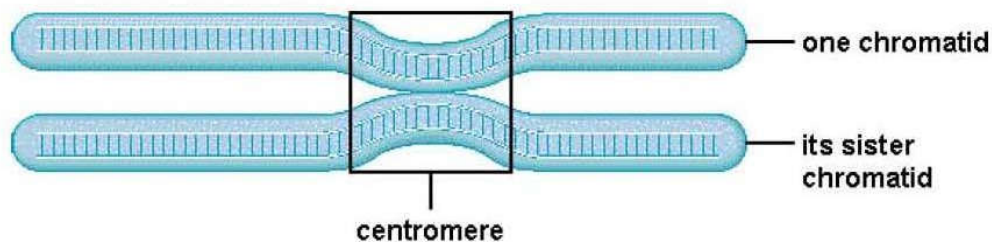
- Basis for genetic code
- Different number of chromosomes in each species
- Copied before cell division
 - Sister chromatids

one chromosome (unduplicated)



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one chromosome (duplicated)



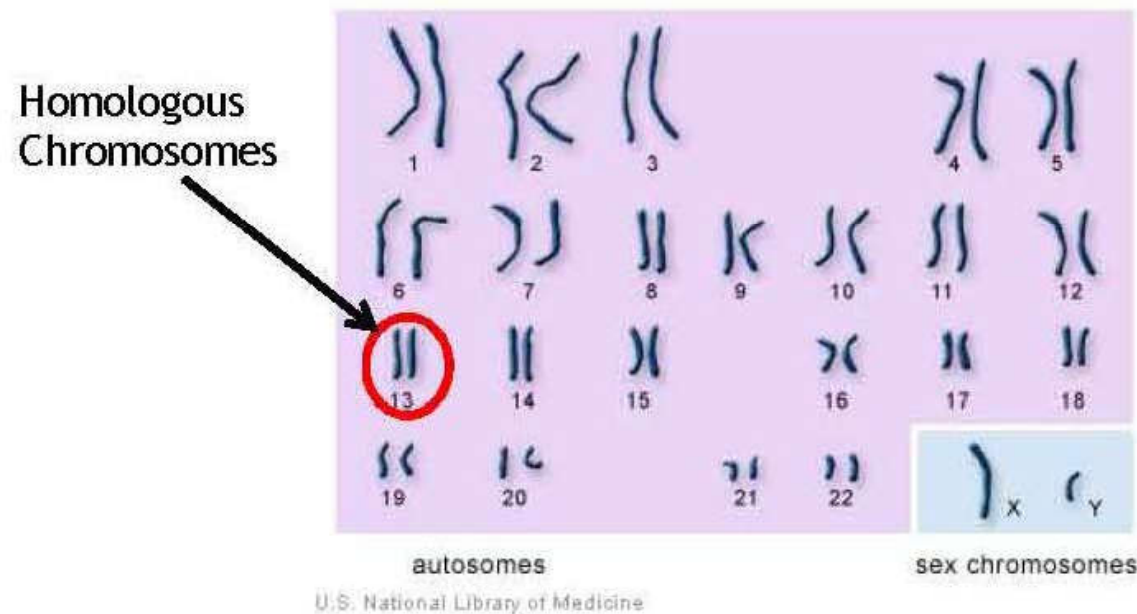
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CHROMOSOMES

- ⦿ Chromosome number—sum total of chromosomes
- ⦿ Diploid number—number of chromosomes when including pairs, “ $2n$ ”
 - One set from each parent\
 - Somatic cells
- ⦿ Homologous chromosomes—each chromosome in a matched pair
 - Only one set of each sex chromosome
- ⦿ Haploid number—half of the normal chromosome number, “ n ”
 - Gametes

CHROMOSOMES

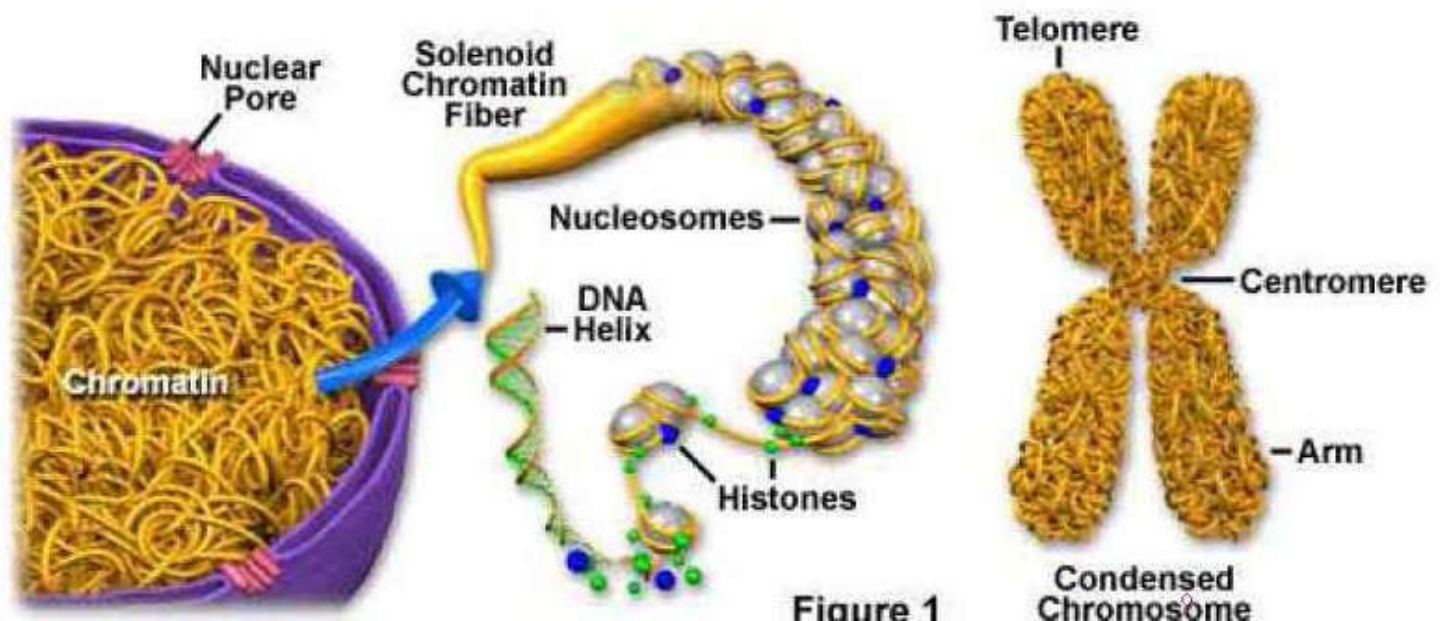
- ◉ Diploid number = 46 in humans (“2n”)
- ◉ Haploid number = 23 in humans (“n”)



CHROMOSOMES

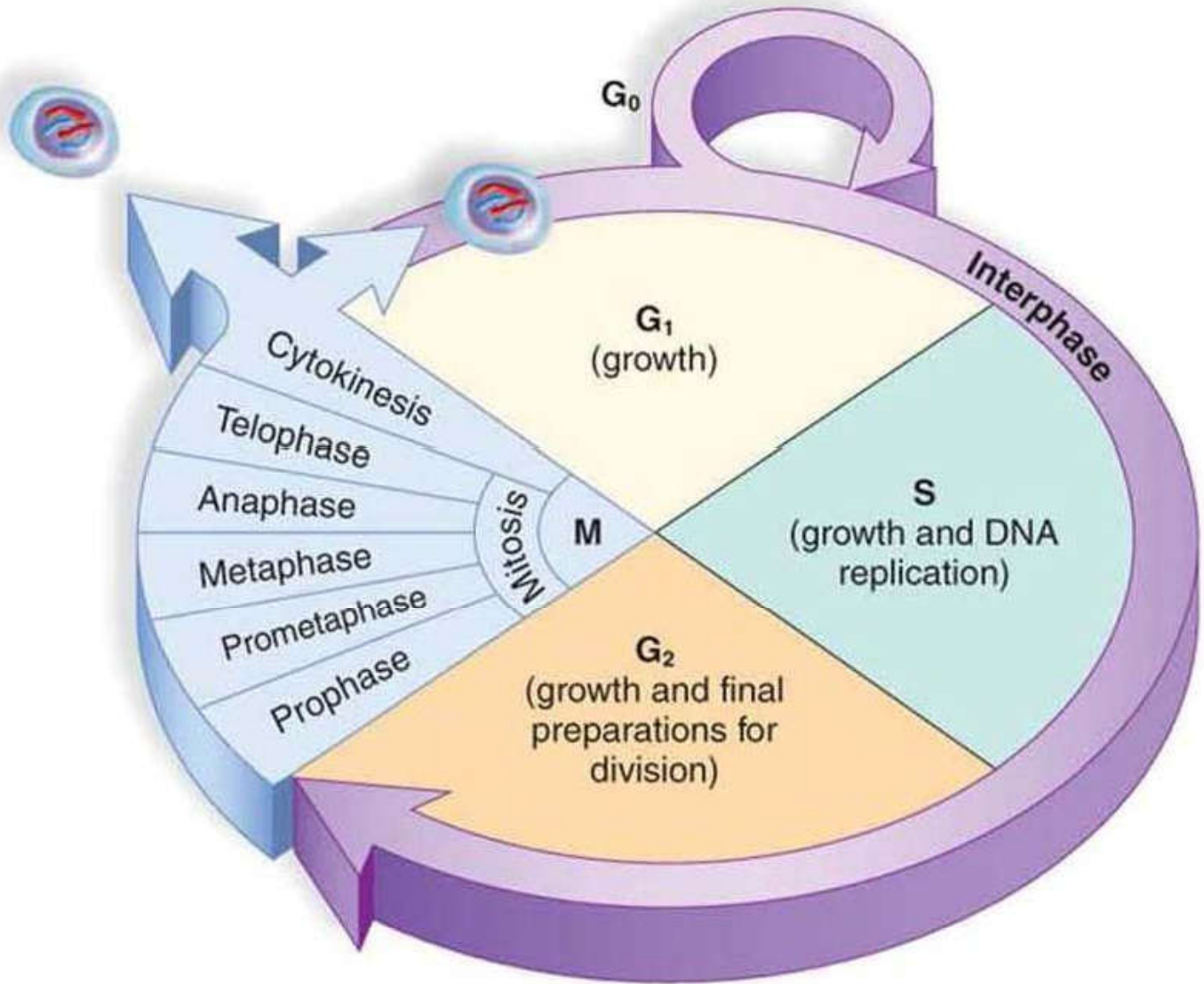
- ◉ DNA helix wraps around histones, forms nucleosome
- ◉ Multiple levels of coiling into chromatin
- ◉ Condensed into chromosome

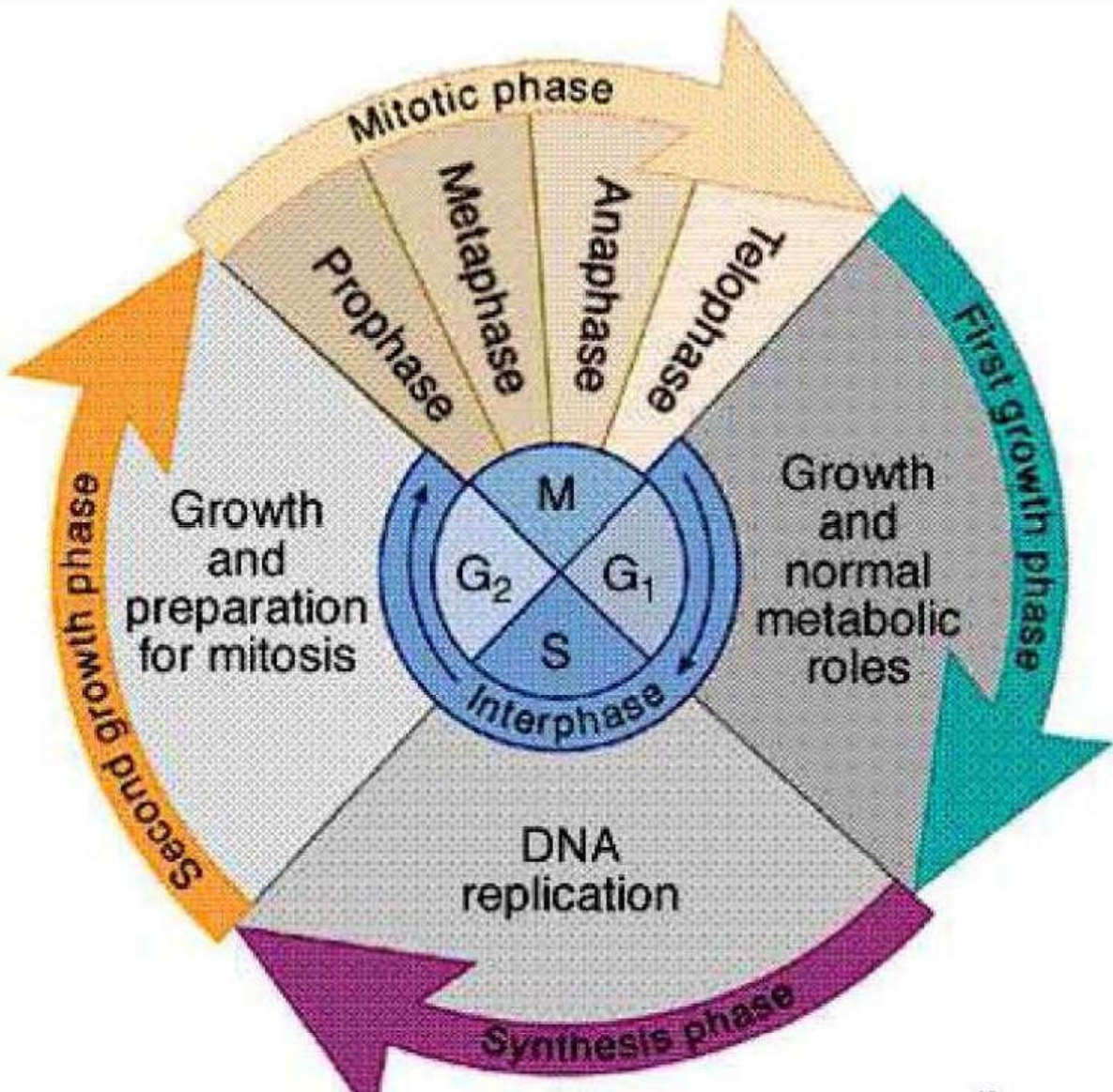
Chromatin and Condensed Chromosome Structure



CELL CYCLE

- ◉ **Interphase—normal growth and function**
 - G1—initial growth & normal roles
 - S—DNA replication
 - G2—preparation to divide
 - ◉ **Mitosis (about 10% of cell's cycle)**
 - Prophase
 - Metaphase
 - Anaphase
 - Telophase
-
- **Mitosis** - nuclear division in the cell cycle
 - **Cytokinesis** - division of the cytoplasm





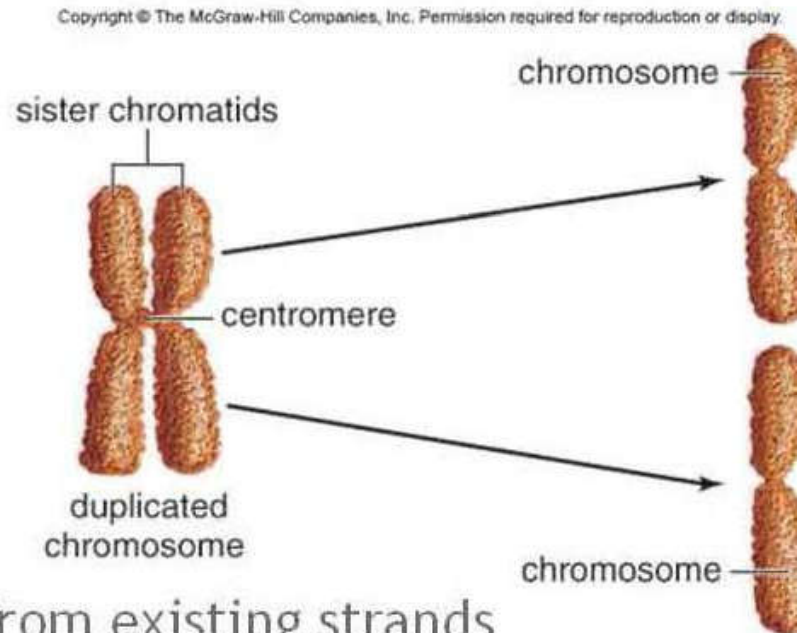
EUKARYOTIC CHROMOSOMES ARE VISIBLE DURING CELL DIVISION

When a eukaryotic cell is not undergoing division, the DNA within a chromosome is a mass of thin threads called **chromatin**

- Before nuclear division chromatin condenses,
- 2 identical chromatids are **sister chromatids**

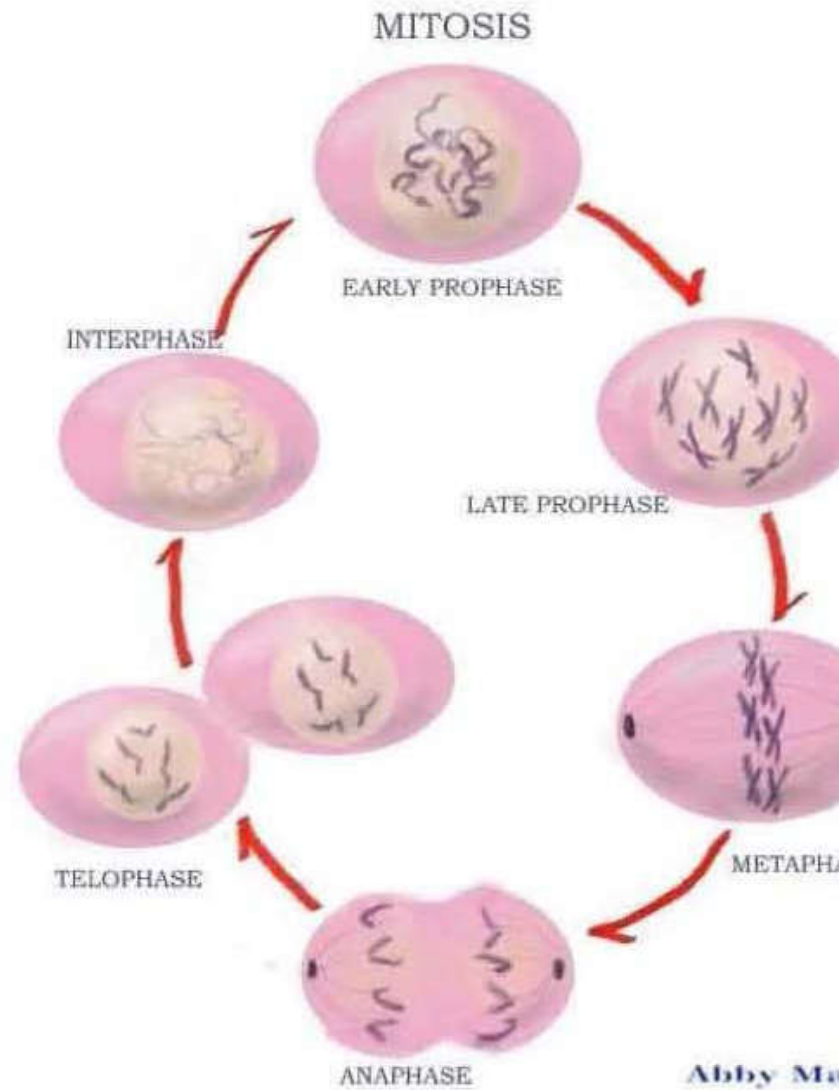
INTERPHASE

- ⊙ **G1**
 - Most of life for many cells
 - Normal functions
- ⊙ **S**
 - New strands of DNA created from existing strands
 - Chromosome doubles into connected sister chromatids
- ⊙ **G2**
 - Microtubules and other structures made for cell division
 - Organelles duplicated



MITOSIS

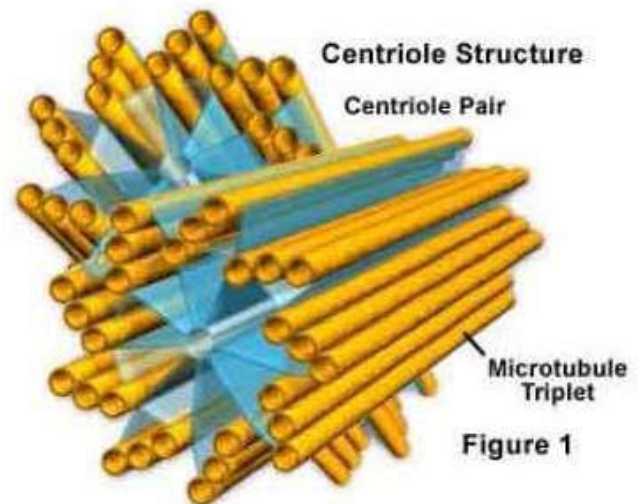
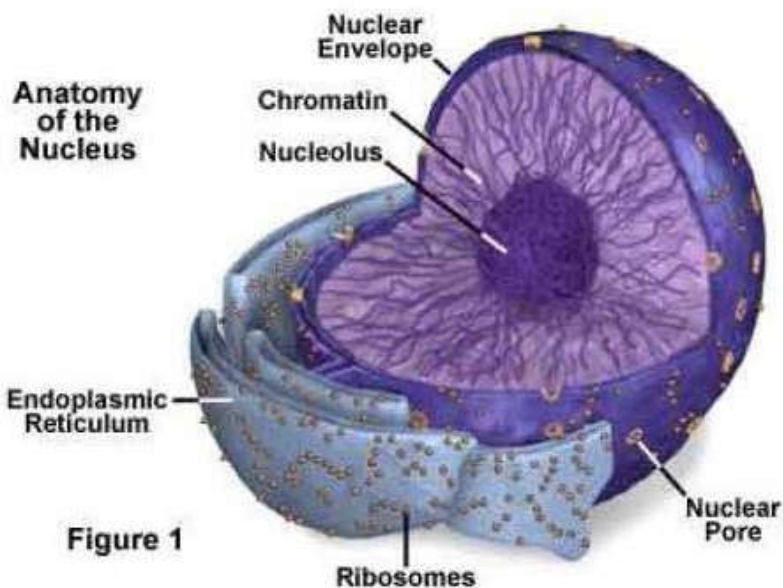
- During interphase, chromosomes double
- Cell divides once
- Chromatid divides once
- Leaves $2n$ in each daughter cell



MITOSIS

Prophase

- Chromosomes become visible
- Centrioles form spindle fibers
- Nuclear membrane starts to break down
- Centromeres modified into kinetochores
 - Site of spindle attachment



MITOSIS

⦿ Metaphase

- Centrioles moved to opposite ends of the cell (“poles”)
- Chromosomes lined up in middle of cell
- Spindle fibers attached to centromeres

⦿ Anaphase

- Sister chromatids pulled towards each pole and separate
- Cell elongates in direction of poles

MITOSIS

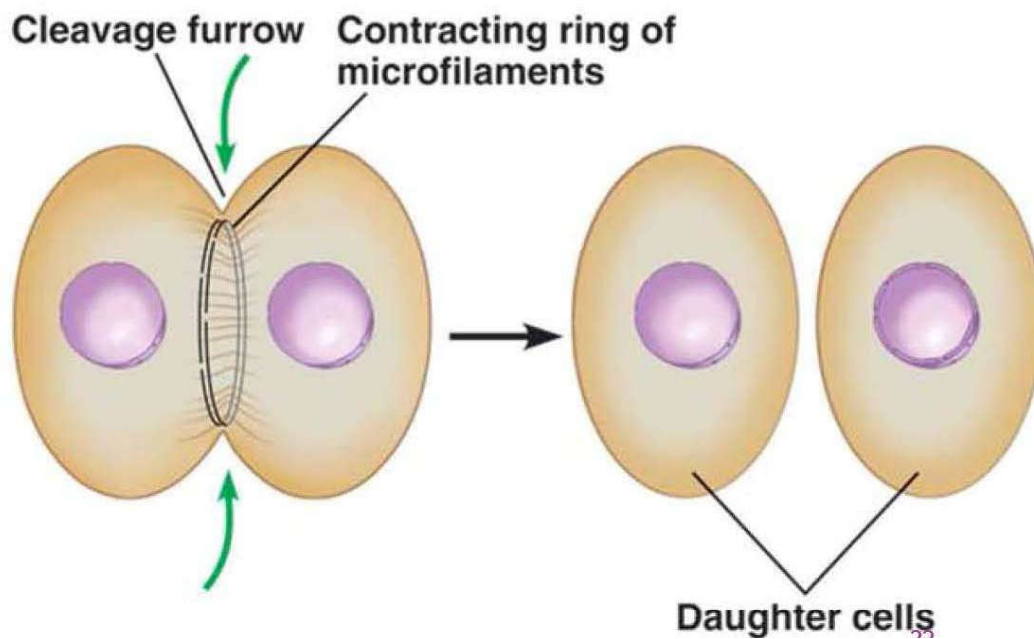
◉ Telophase

- Cell divides in middle, forms cleavage furrow
- Cytokinesis—complete cell division
- Nuclear membrane re-forms around each set of chromosomes

CYTOPLASMIC DIVISION

◉ Animal cells

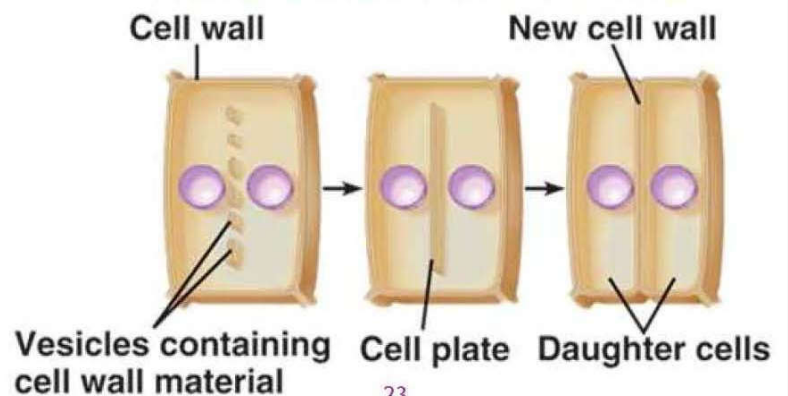
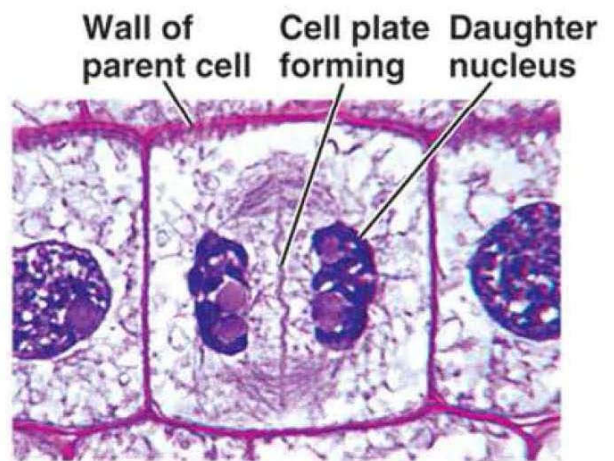
- Contractile ring mechanism—actin filaments at equator contract



CYTOPLASMIC DIVISION (CYTOKINESIS)

○ Plant cells

- Vesicles cluster at equator
- Vesicle membranes fuse
- New cell membranes form along fused vesicles
 - Cell Plate
- Cellulose deposited between membranes, will form new cell walls



SEXUAL REPRODUCTION

- ◉ Meiosis → Gamete formation → Fertilization
- ◉ Diploid → Haploid → Fertilization → Diploid

MEIOSIS

- ◉ Almost identical to mitosis
- ◉ Chromosomes mix
- ◉ Cells and chromosomes divide *TWICE* before process ends
- ◉ Ends with 4 daughter cells, each haploid
- ◉ Pro-, Meta-, Ana-, Telophase I
- ◉ Pro-, Meta-, Ana-, Telophase II

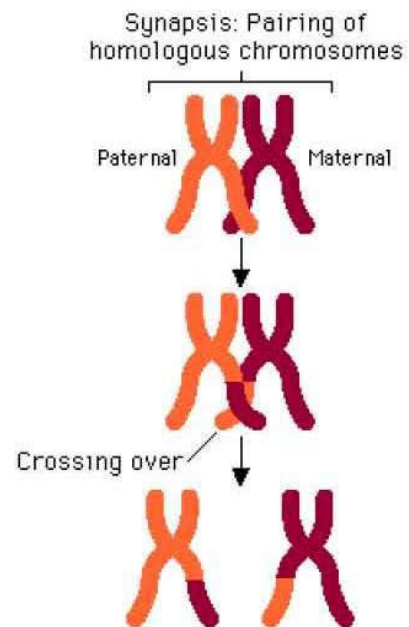
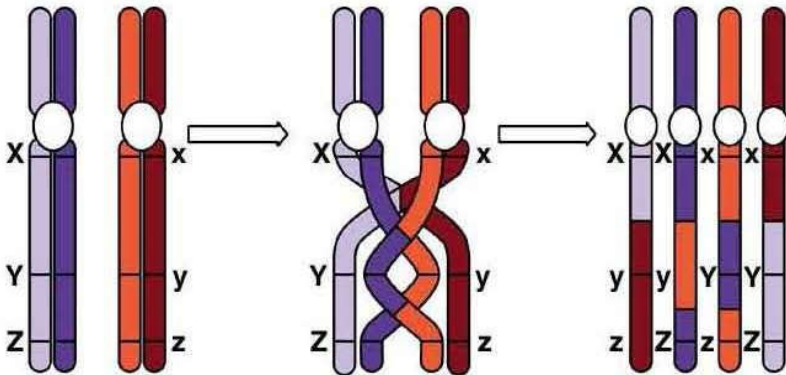
MEIOSIS

Prophase 1

- Homologous chromosomes pair up (Synapsis)
- Usually swap segments (crossing over)
- Otherwise normal prophase

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Crossing over during meiosis



MEIOSIS

⦿ Metaphase 1

- Spindle fibers attach to centromere of each type of chromosome
- Otherwise normal metaphase

⦿ Anaphase 1

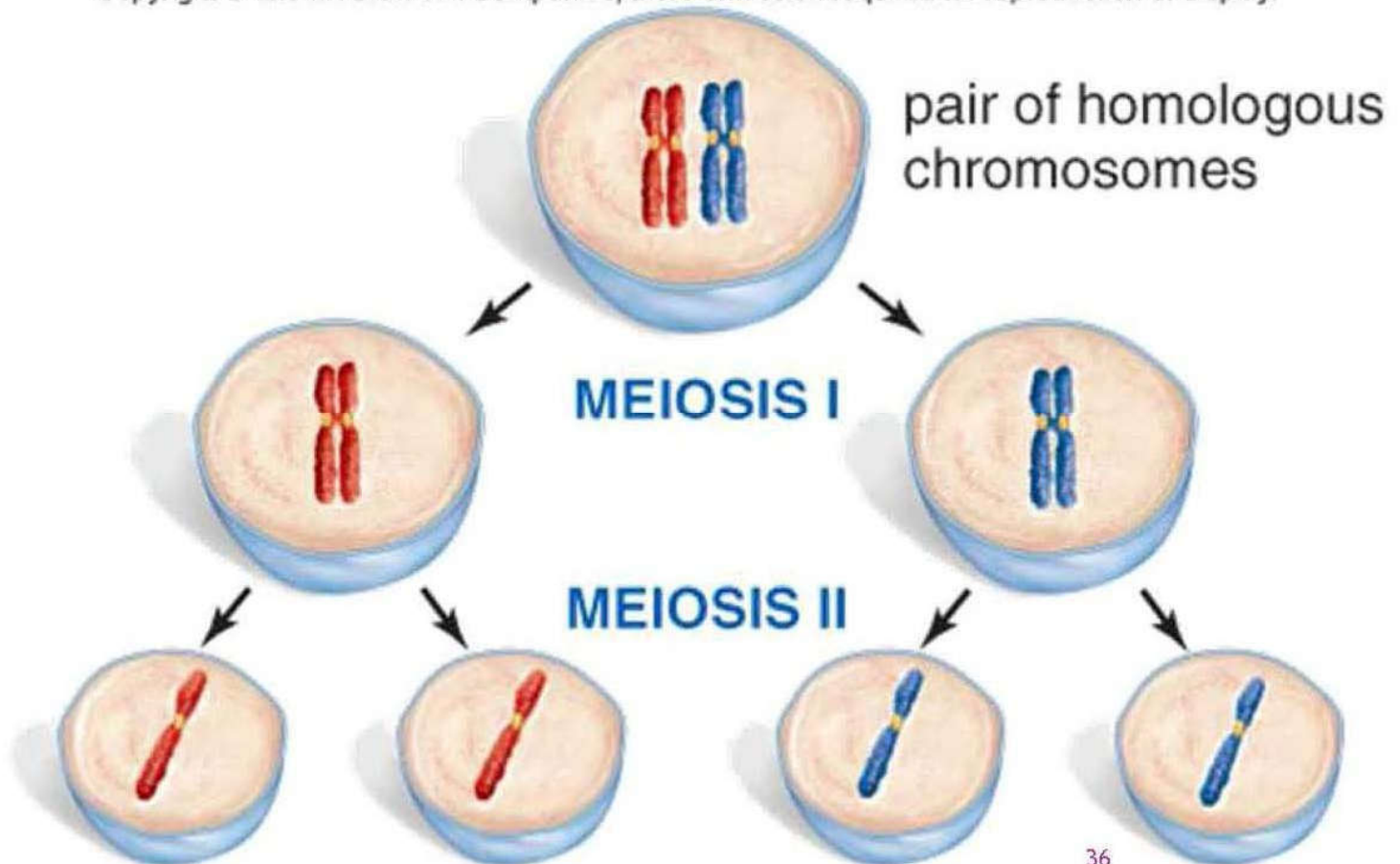
- Homologous chromosomes separated to each pole of cell
- Otherwise normal anaphase

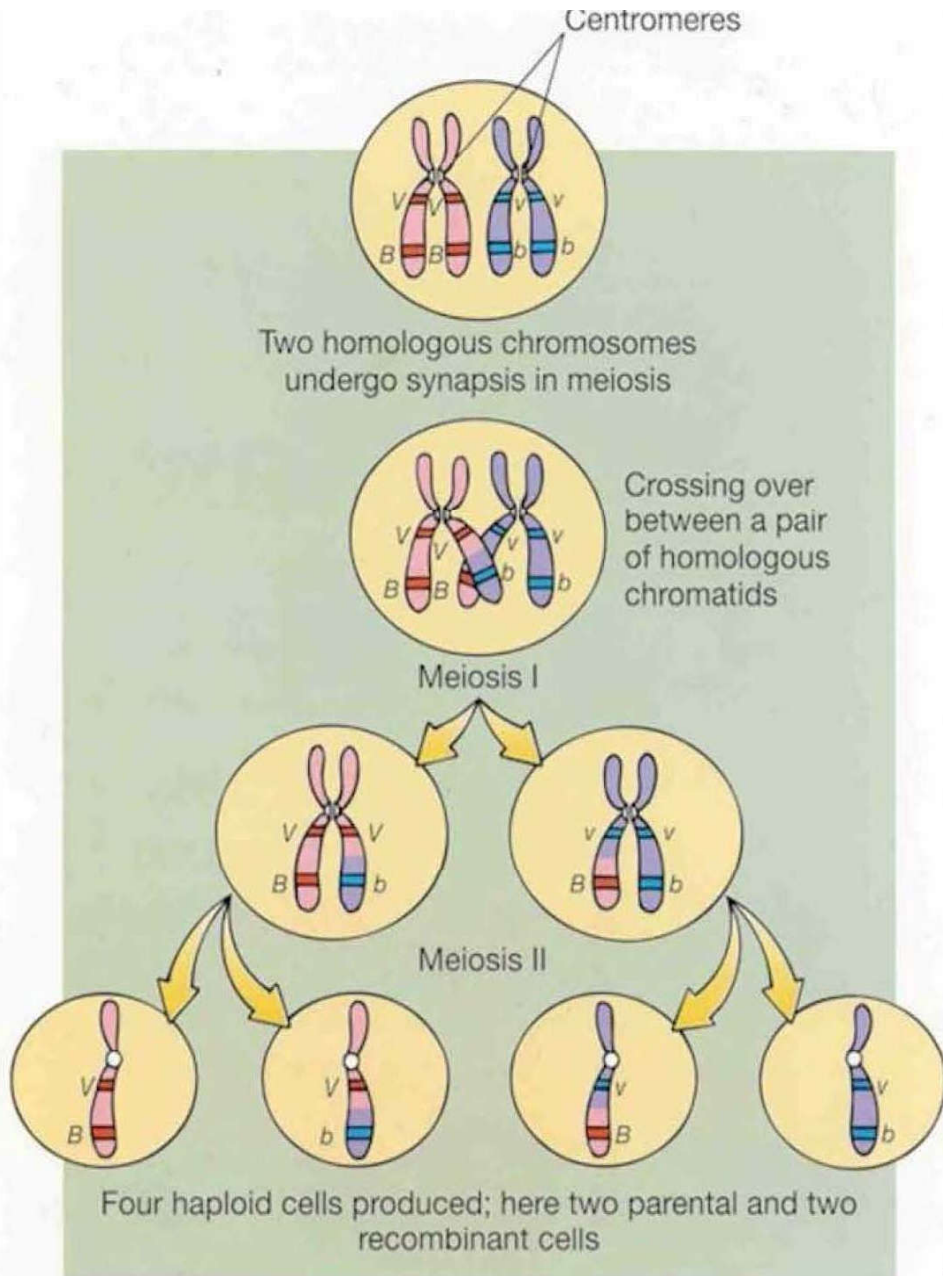
⦿ Telophase 1

- Cytokinesis (normal telophase)
- Does *NOT* go to Interphase

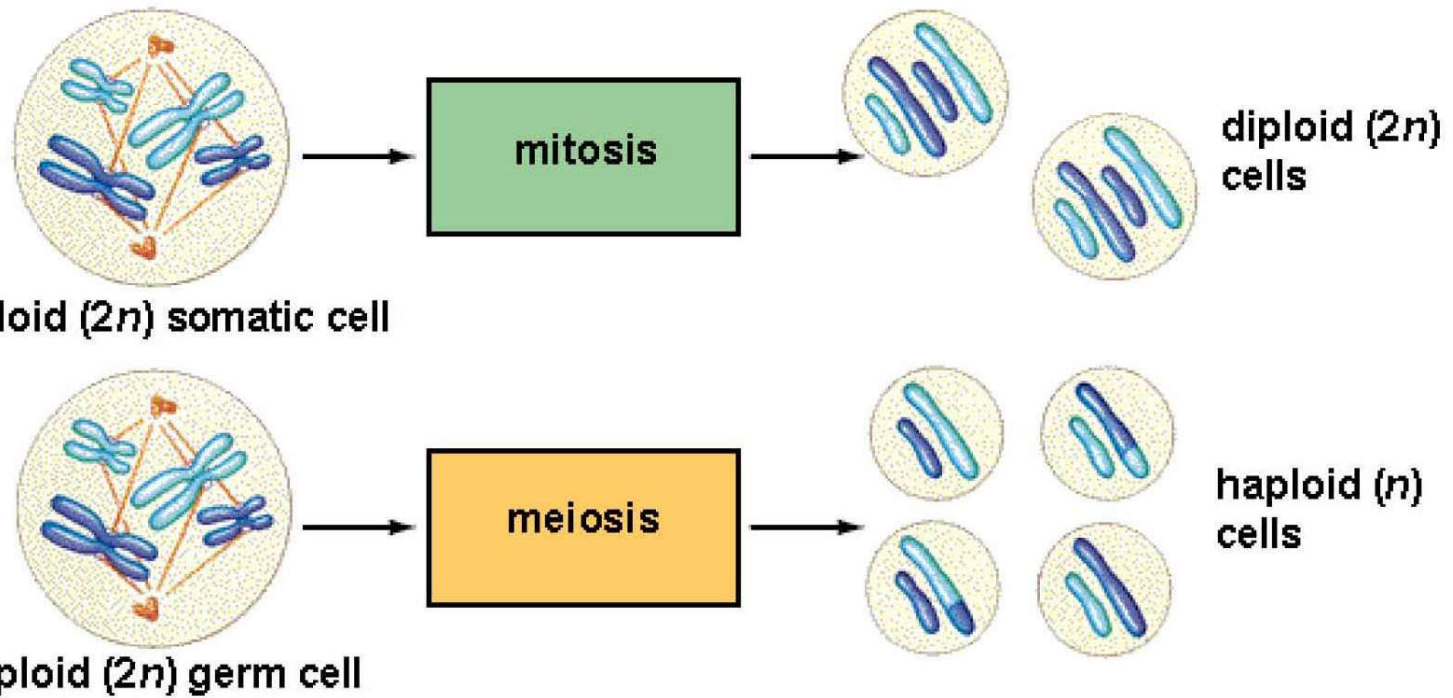
No replication of DNA occurs during **interkinesis** (the period between meiosis I and II)

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MITOSIS VS. MEIOSIS



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