The Cell Cycle

Chapter 10

Why Do Cells Divide?

Unicellular

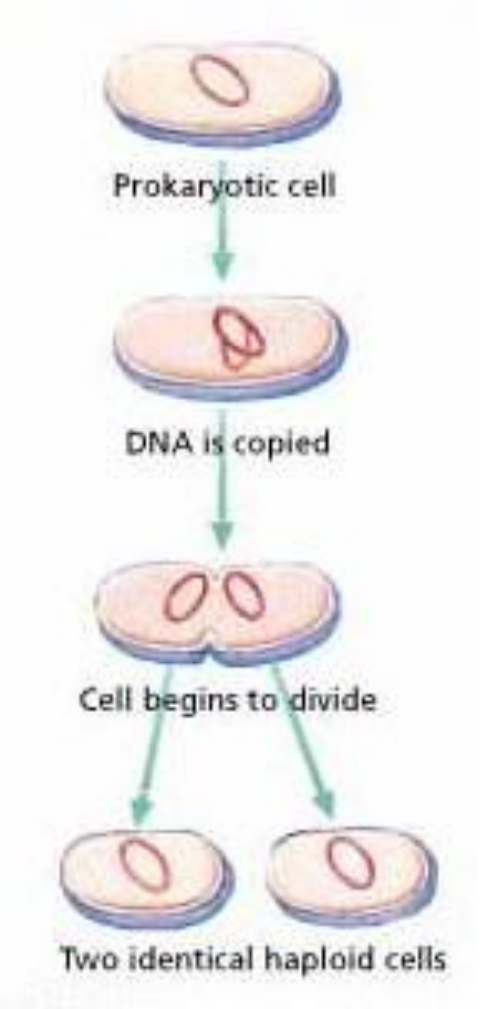
1. Reproduction

Multicellular

1. Grow
2. Repair
3. Development/reproduction

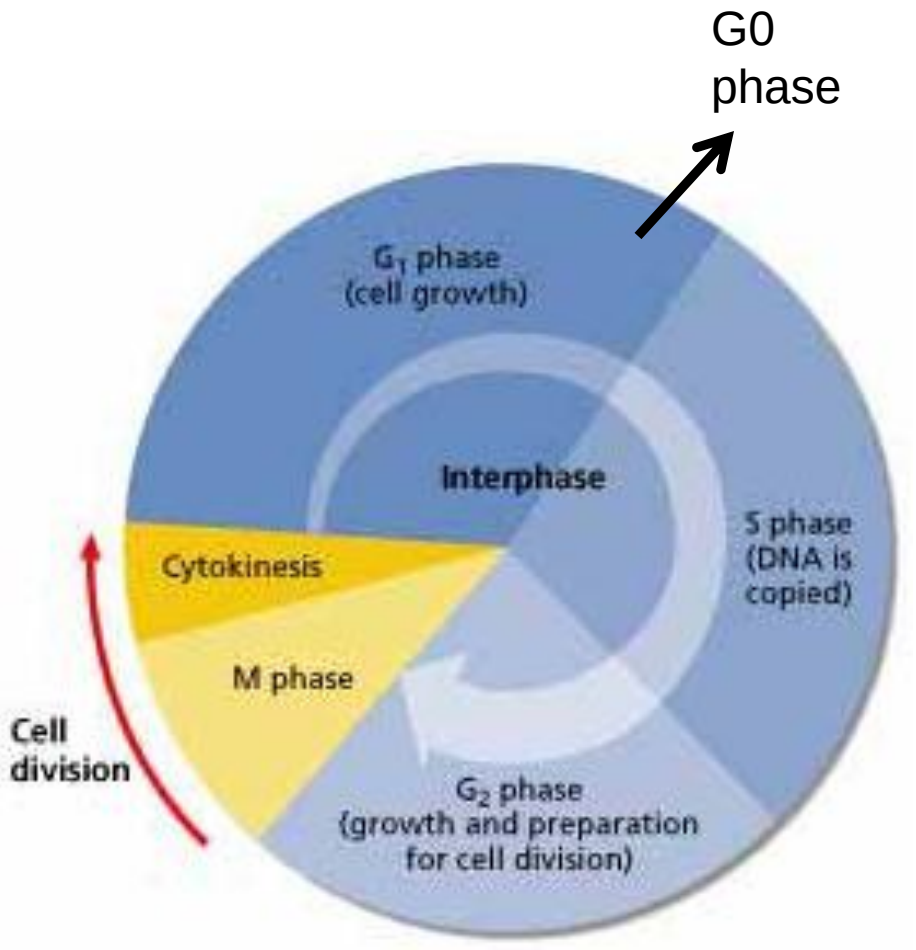
Types of Division

- Prokaryotic cells
  - Binary fission = asexual reproduction
- Eukaryotic cells
  - The cell cycle: Mitosis



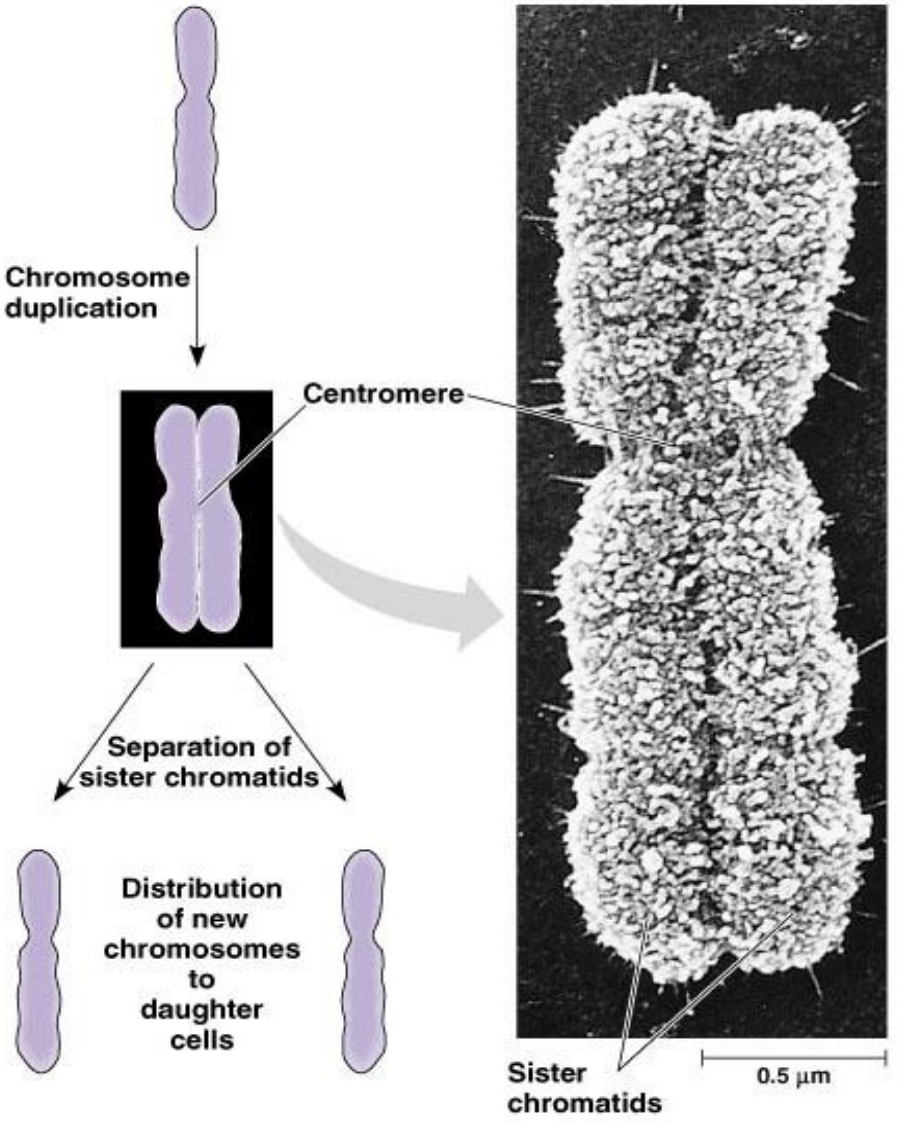
Cell Cycle

- Cell cycle – life of a cell from the time it is formed until its own division into two daughter cells
  - Passes identical genetic material to cellular offspring



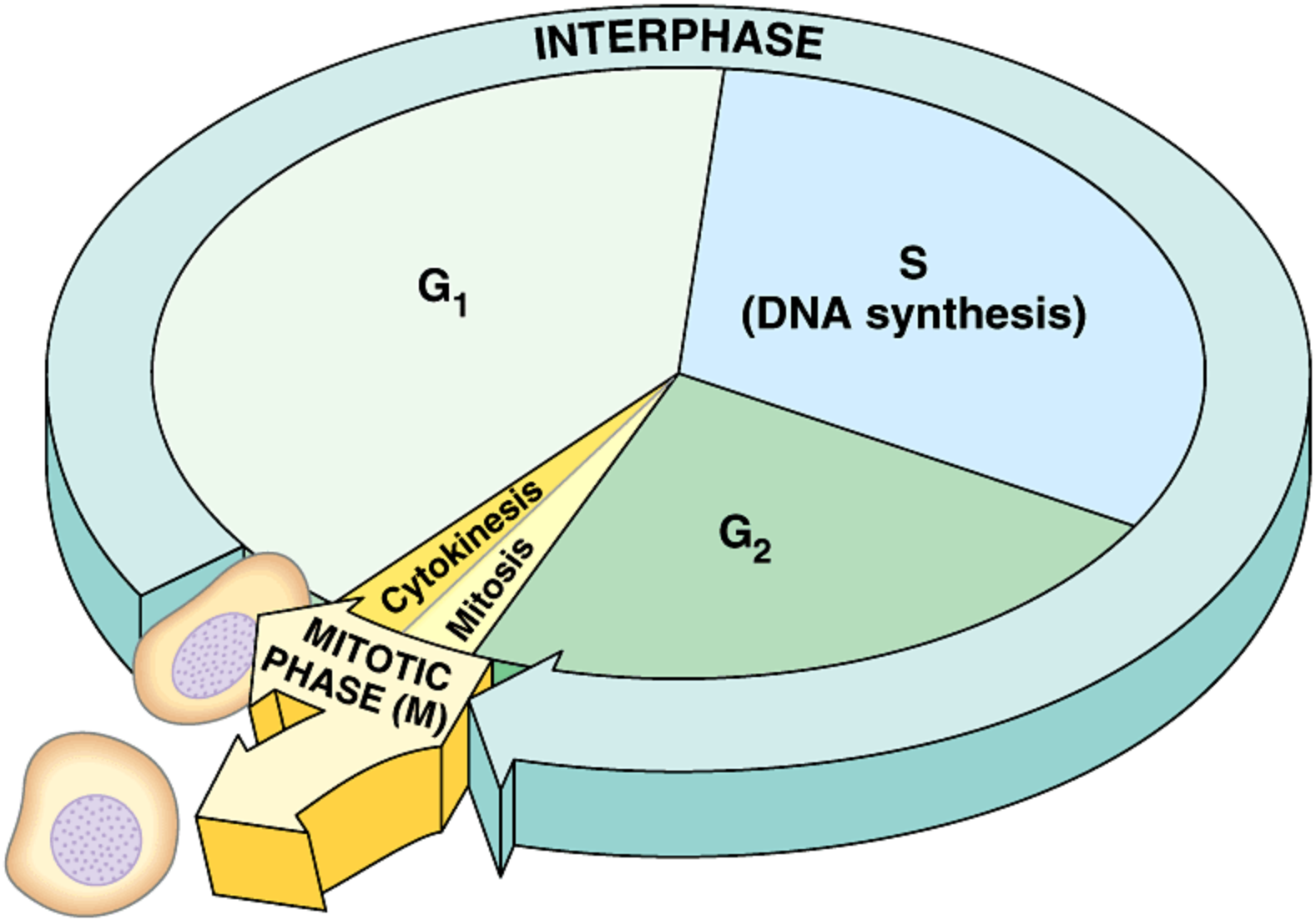
Chromosome Structure

- Non-dividing cells' chromosomes are in the form of **CHROMATIN**
- Following DNA duplication chromosomes coil & condense
- Duplicated chromosomes have 2 halves = **SISTER CHROMATIDS**
- Chromatids connected by **CENTROMERE**



Phases of the cell cycle

- Interphase (90% of cell's life)
  1. G_1 Phase
  2. S Phase
  3. G_2 Phase
- M phase – mitotic phase (10% of cell's life)
  1. Prophase
  2. Metaphase
  3. Anaphase
  4. Telophase
- Cytokinesis



Interphase

Divided into 3 subphases:

1. G_1 phase = cell growth
2. S phase = DNA replication
3. G_2 phase = prepares to divide

MITOSIS

- **MITOSIS** = division of the nucleus

- **CYTOKINESIS** = division of the cytoplasm
  - Mitosis **MAINTAINS** the chromosome number
    - If a cell begins with 46 chromosomes, the new cell will have 46 chromosomes.

M phase – Mitosis - **Prophase**

- Copied DNA forms chromosomes
- Nuclear membrane breaks down
- Spindle fibers begin to form and centrioles start to move

M phase – Mitosis – **Metaphase**

- Chromosomes line up in the middle of the cell
- Centrioles move to opposite sites of the cell
- Spindle fibers attach to chromosomes at the centromeres

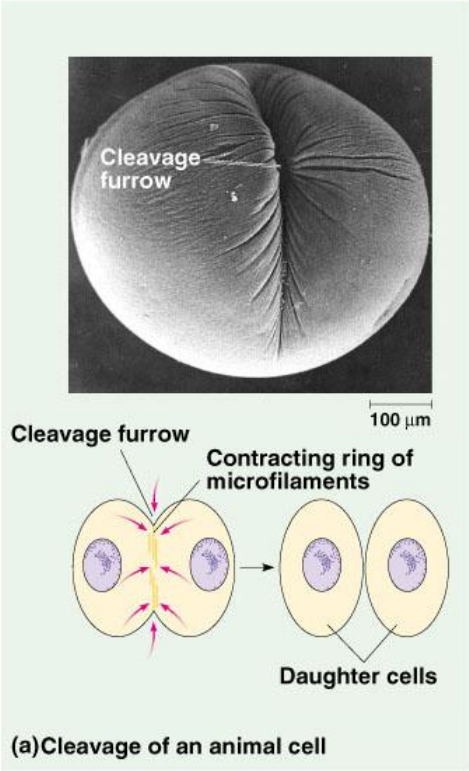
M phase – Mitosis – **Anaphase**

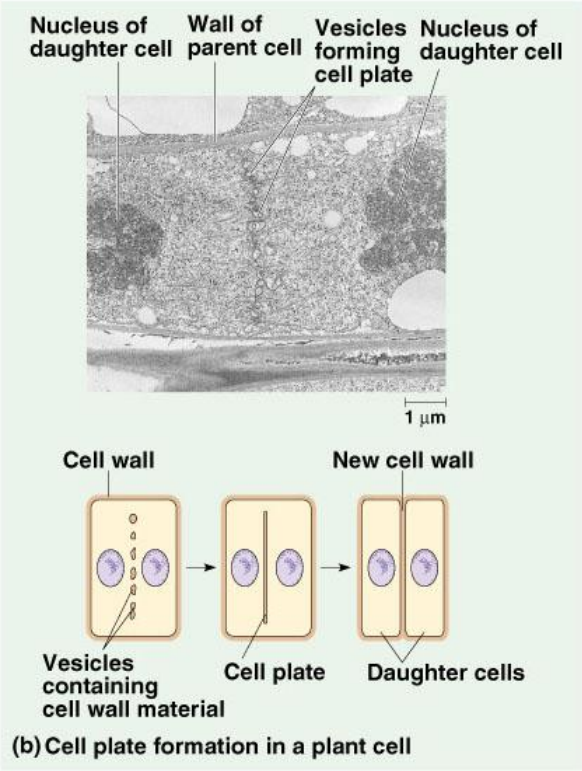
- Chromatids split and move to opposite sides of the cell
- Spindle fibers shorten

M phase – Mitosis – **Telophase**

- Nuclear membrane starts to form again
- Chromosomes start to relax
- Spindle fibers break down

- Animal cells – cell membrane pinches in to form a cleavage furrow
- Plant cells – forms a cell plate which eventually creates the cell wall





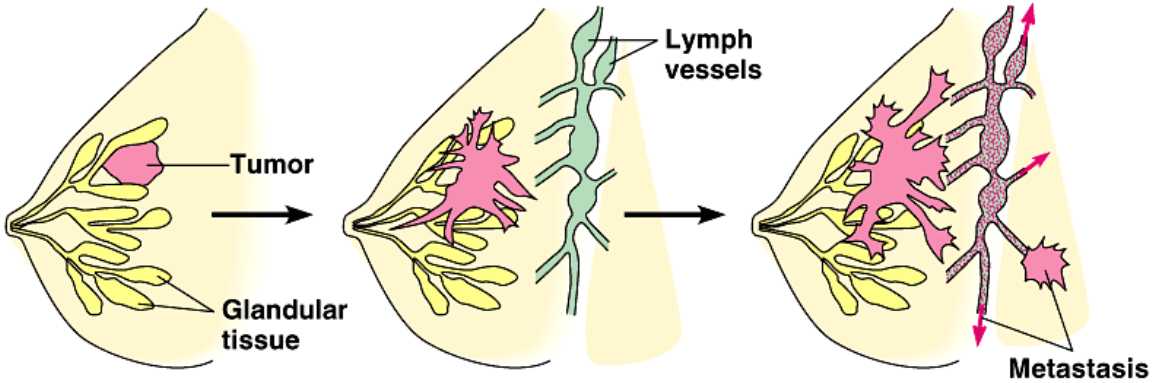
M phase – Mitosis – **Cytokinesis**

- Division of the cytoplasm and creation of 2 daughter cells

- **End Results:**
  - **2 daughter cells that are identical to the parent cell**
  - **Diploid to diploid**

Cancer

- Cancer = uncontrollable cell division
- Mutated DNA in the cell causes the normal disruption of the cell's activities
- Cancer cells can spread to other parts of your body if they break free



Cancer

- Tumors can be benign (noncancerous) or malignant (cancerous)

- Metastasis – spreading cancer cells to other parts of the body

Types of Reproduction

- Sexual
  - Two parents used to create an offspring
  - 2 haploid gametes creates a zygote
  - Advantage: creates genetic variation and diversity
  - Disadvantage: energy use to find a mate

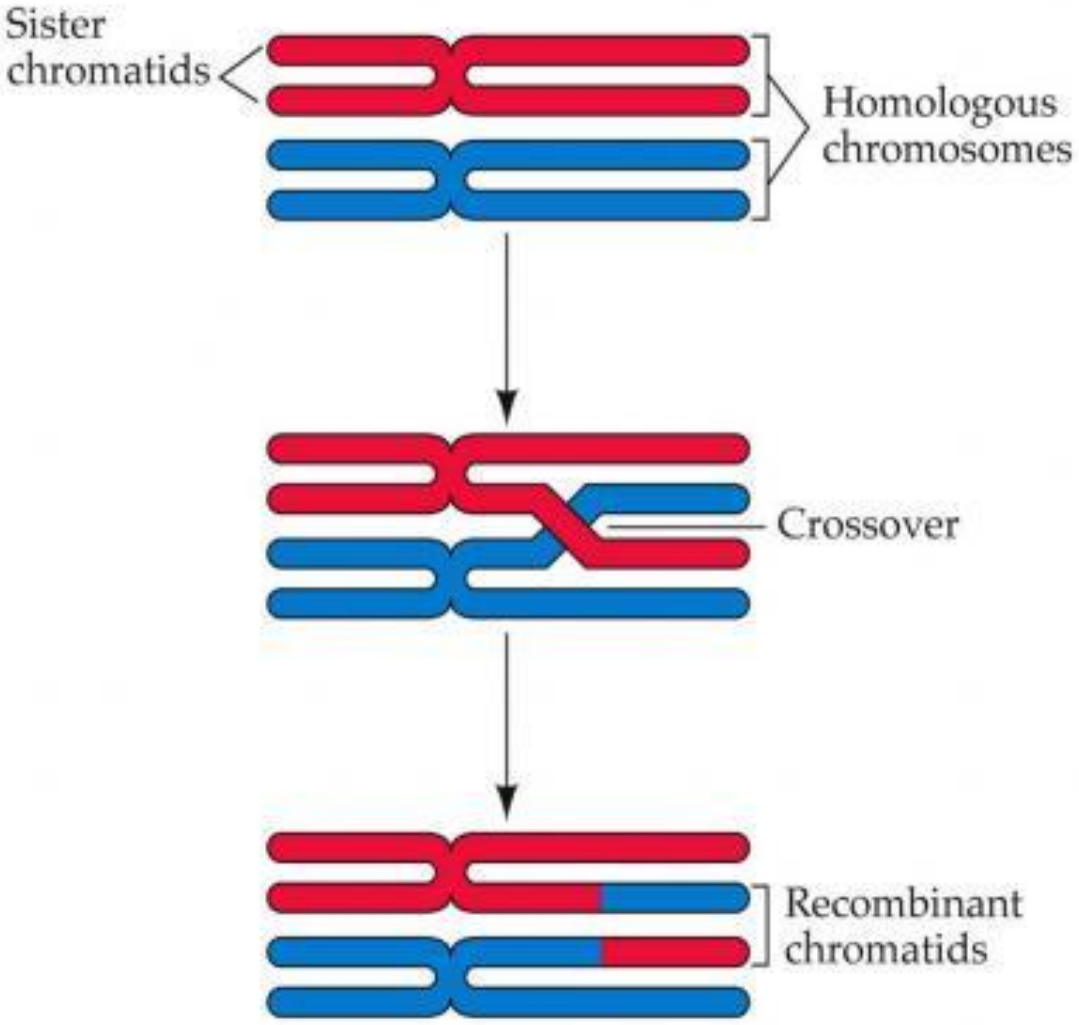
- Asexual
  - One parents creates an offspring
  - Advantage: rapid reproduction, don't have to find a mate
  - Disadvantage: doesn't create genetic variation

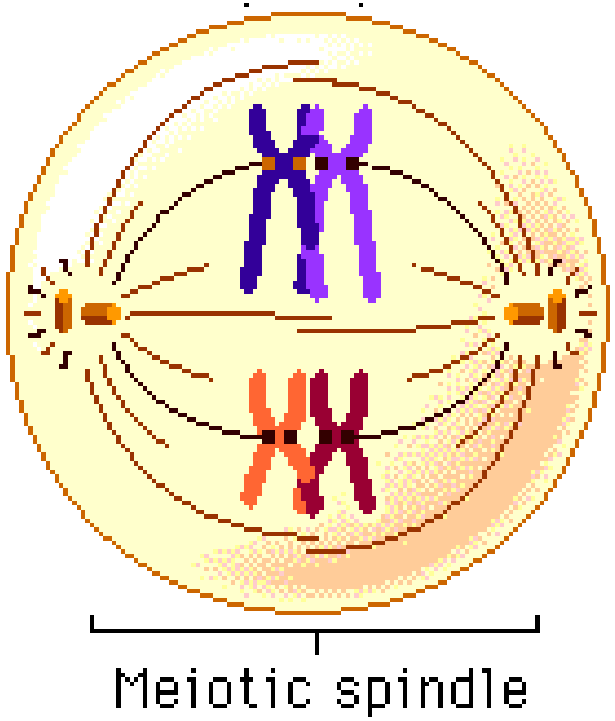
Meiosis

- Purpose: create sex cells (gametes) which have half the DNA (haploid)
- Interphase still occurs before cell division
  - S phase = copies the DNA
- 2 cell divisions, 1 DNA replication
- Nuclear membrane, spindle fibers, and centrioles are still performing the same functions as in Mitosis

Meiosis I

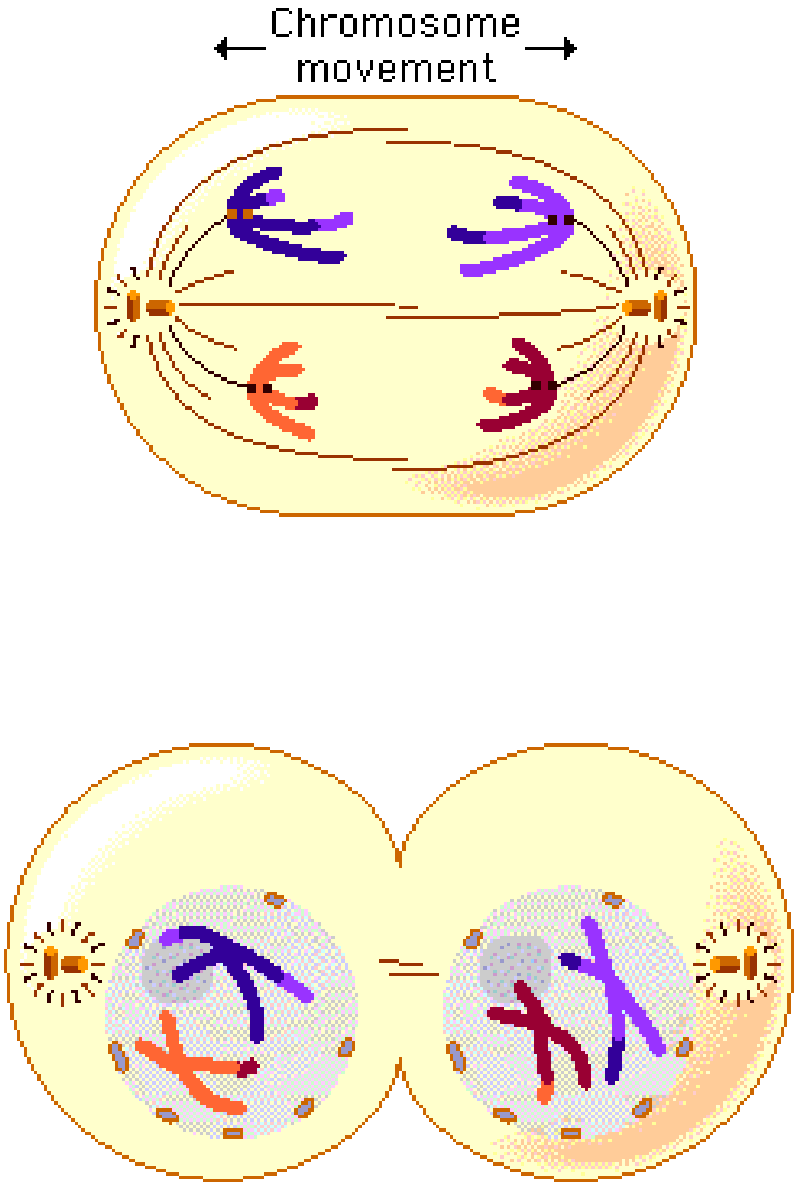
- Prophase I
  - Copied DNA condenses into chromosomes
  - Homologous chromosomes pair up and form a tetrad (4 chromatids together)
  - Crossing over (switching of DNA) occurs between the chromatids of homologous chromosomes
- Metaphase I
  - Homologous chromosomes move to the middle of the cell

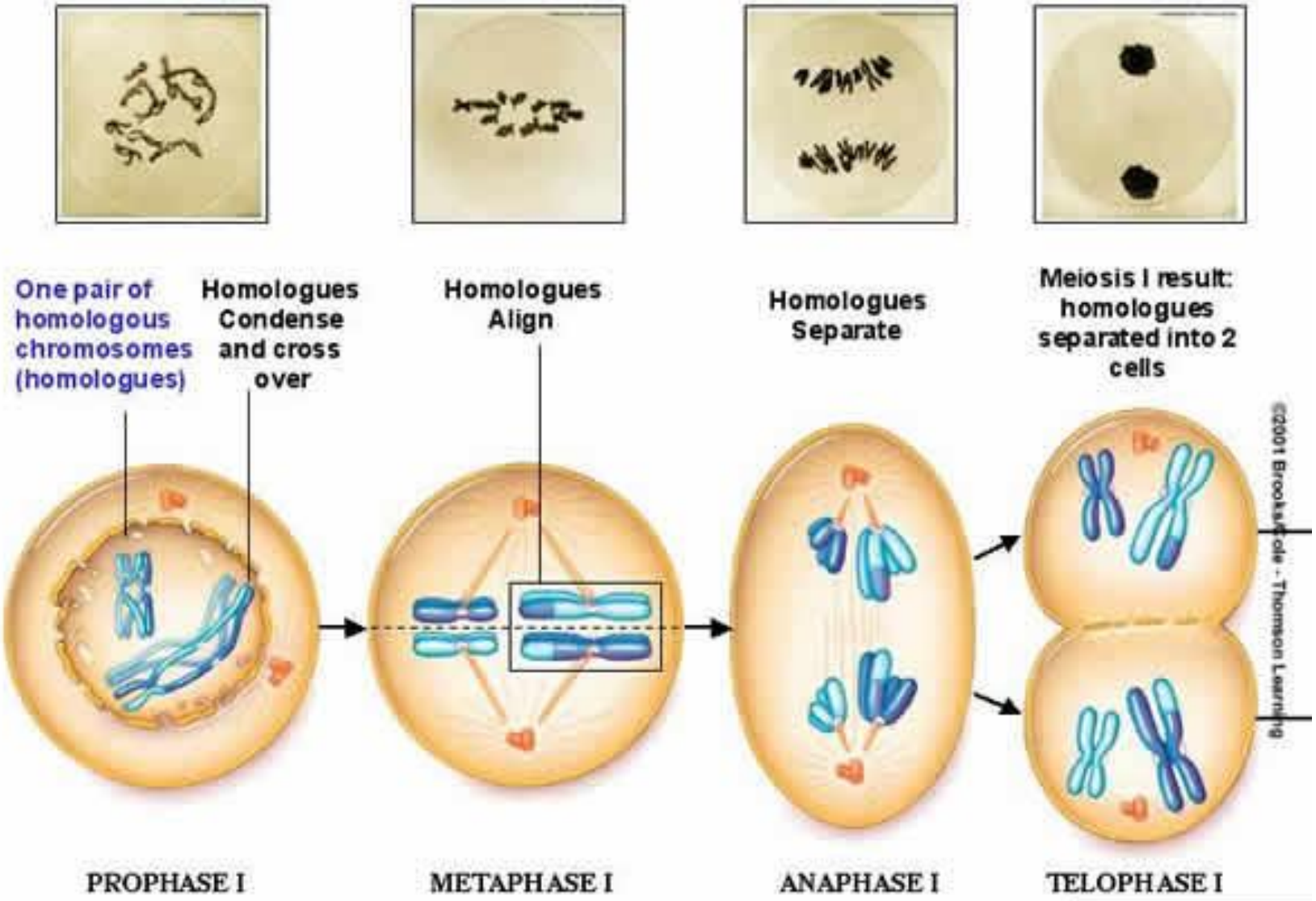

Sister chromatids
Homologous chromosomes
Crossover
Recombinant chromatids


Meiotic spindle

Meiosis I

- Anaphase I
  - Homologous chromosomes split and move to opposite sides of the cell
- Telophase I
  - Chromosomes relax and nuclear membrane starts to come back
- Cytokinesis
  - Cytoplasm divides and 2 cells are formed


Chromosome
movement



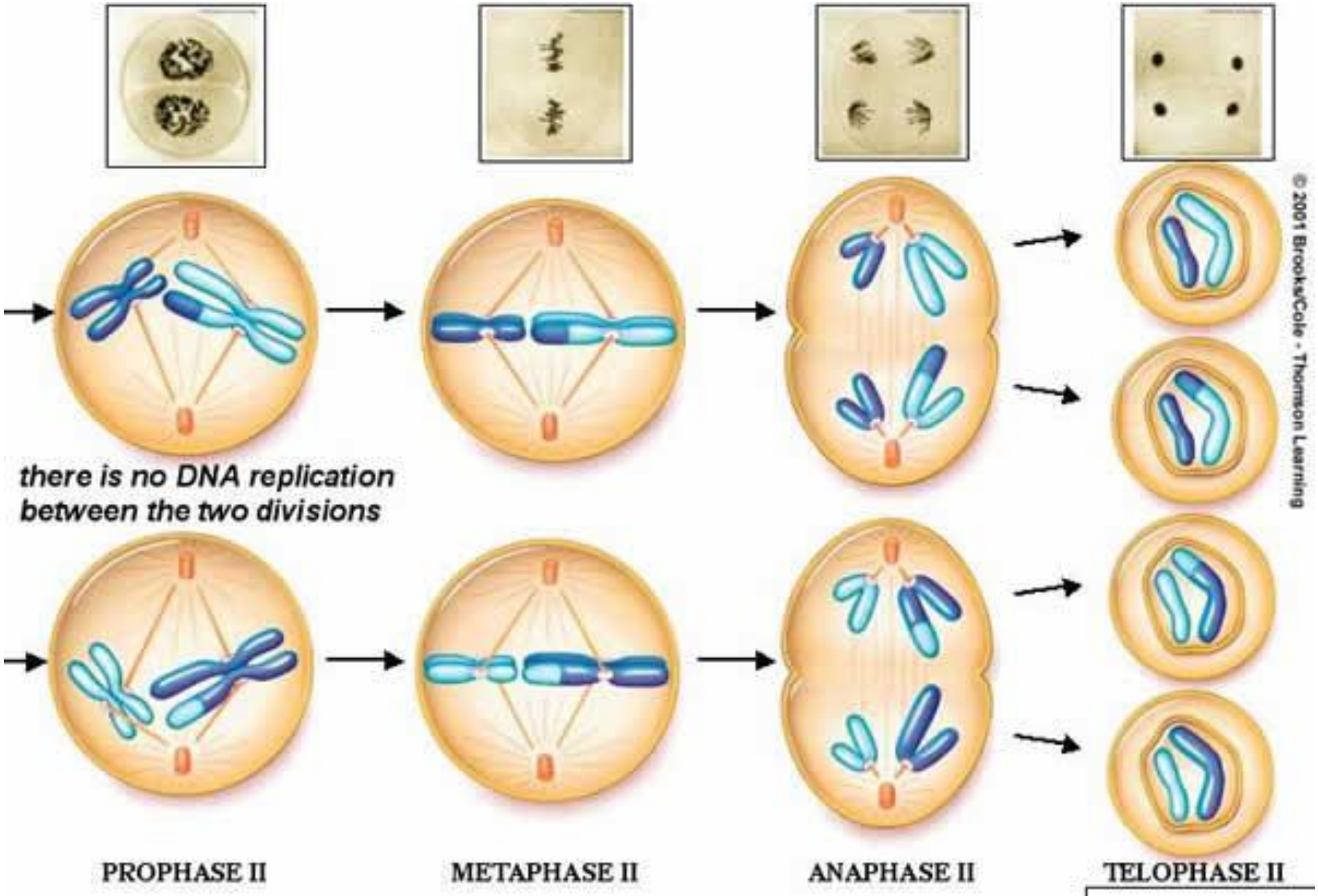
MEIOSIS I: Separate the Homologues

Meiosis II

- 2 cells go through the phases at the same time
- Prophase II
  - Chromosomes form again
- Metaphase II
  - Chromosomes move to the middle of the cell
- Anaphase II
  - Chromosomes split and chromatids move to opposite sides of the cell

Meiosis II

- Telophase II
  - Chromosomes relax and nuclear membrane starts to form again
- Cytokinesis
  - Cytoplasm divides and 4 cells are formed



MEIOSIS II: Separate the Sister Chromatids (by mitosis)

End Results

- 1 cell → 4 cells
- Not identical to parents
- Diploid → Haploid
- Crossing over occurs

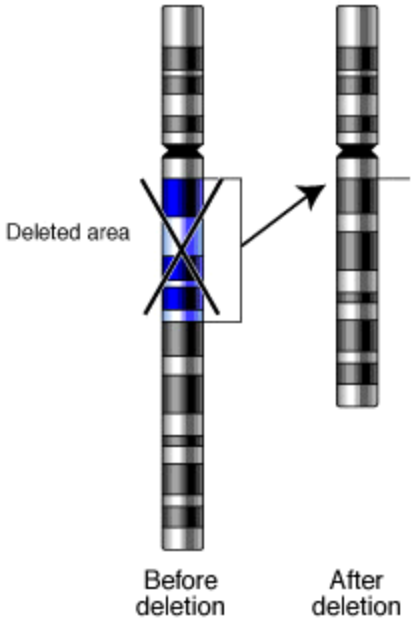
Types of Mutations: Point

- Point = Change in a single DNA nucleotide

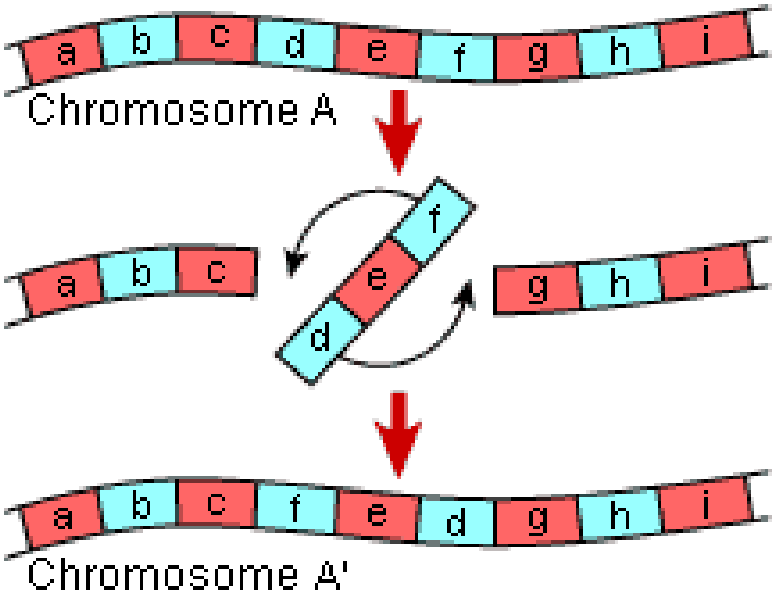
- Substitution
  - Change one nucleotide for another
  - Ex: Sickle cell anemia
- Frameshift: Addition or Deletion
  - Add or remove one nucleotide that changes the "reading frame" for the amino acids

Type of Mutations: Chromosome

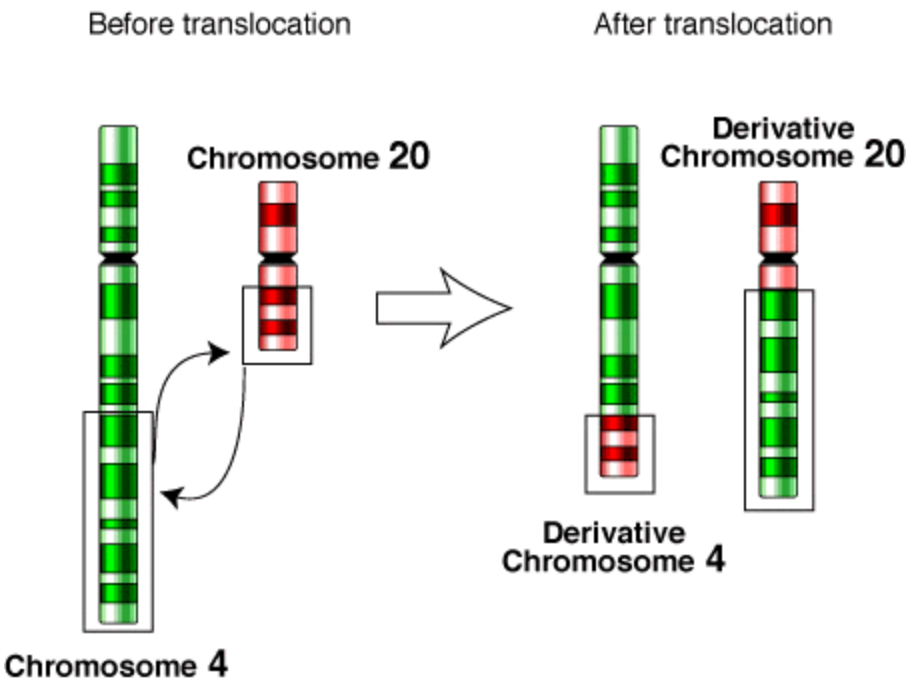
- Deletion = loss of a large segment of DNA

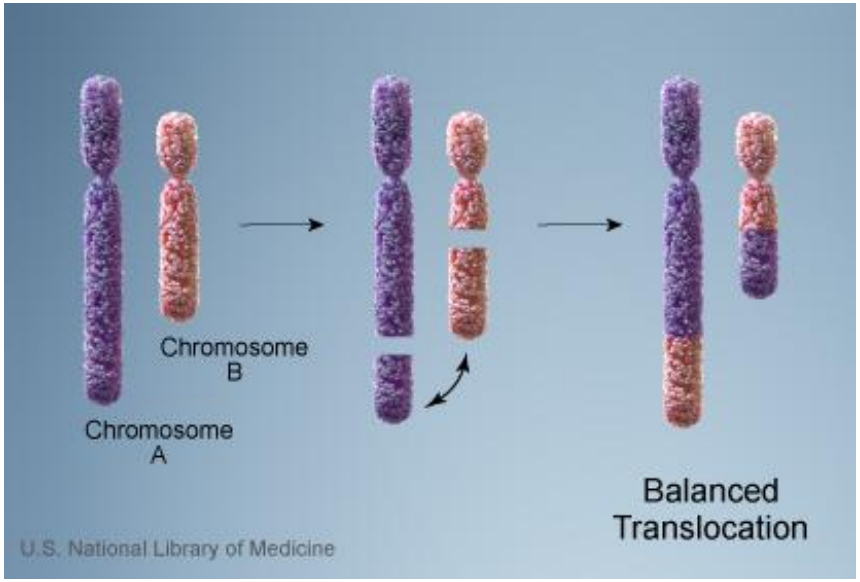


– Inversion = when a piece of DNA breaks off and reattaches in reverse order on the same chromosome



– Translocation = when a piece of DNA breaks off and attaches to a nonhomologous chromosome





– Nondisjunction = when a chromosome fails to separate in Meiosis resulting in an extra piece of DNA in the offspring