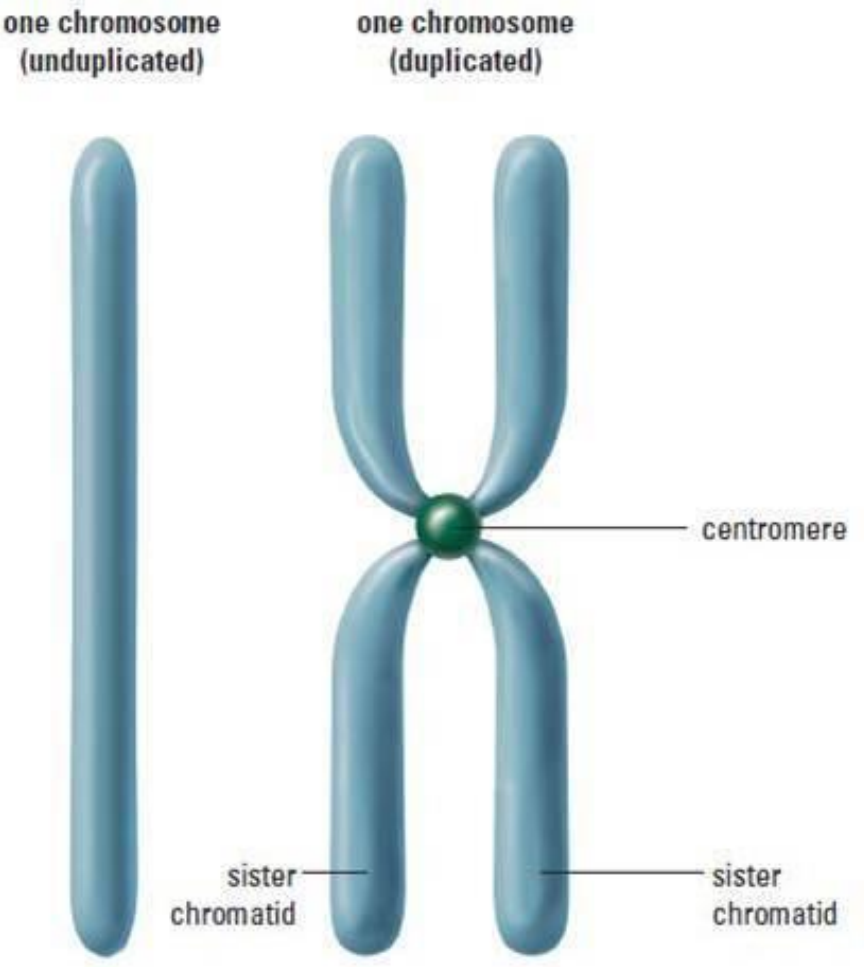
# Mitosis vs Meiosis

# Definitions

- **Sister chromatids**

  - One of two copies of chromosome connected at centromere after replication

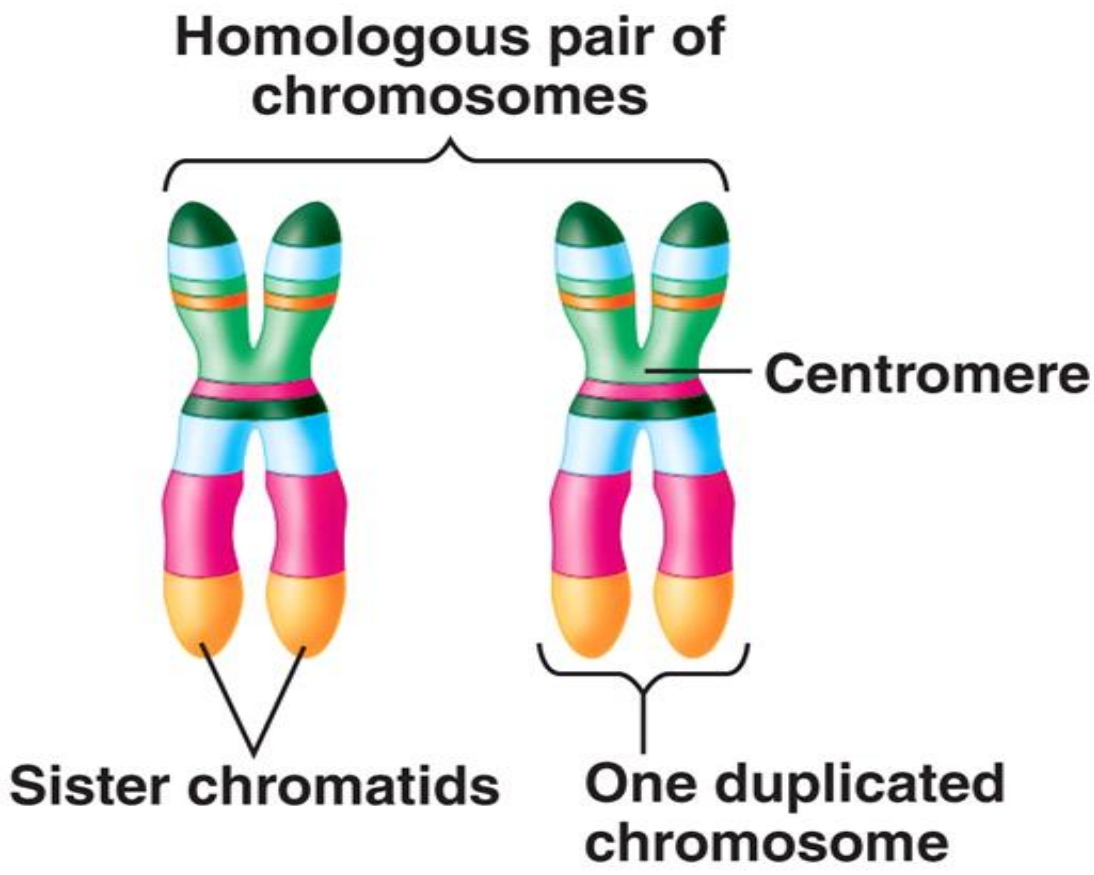



- **Centromere**

  - Attachment point of sister chromatids
  - Attachment point for spindle fibers

# Definitions

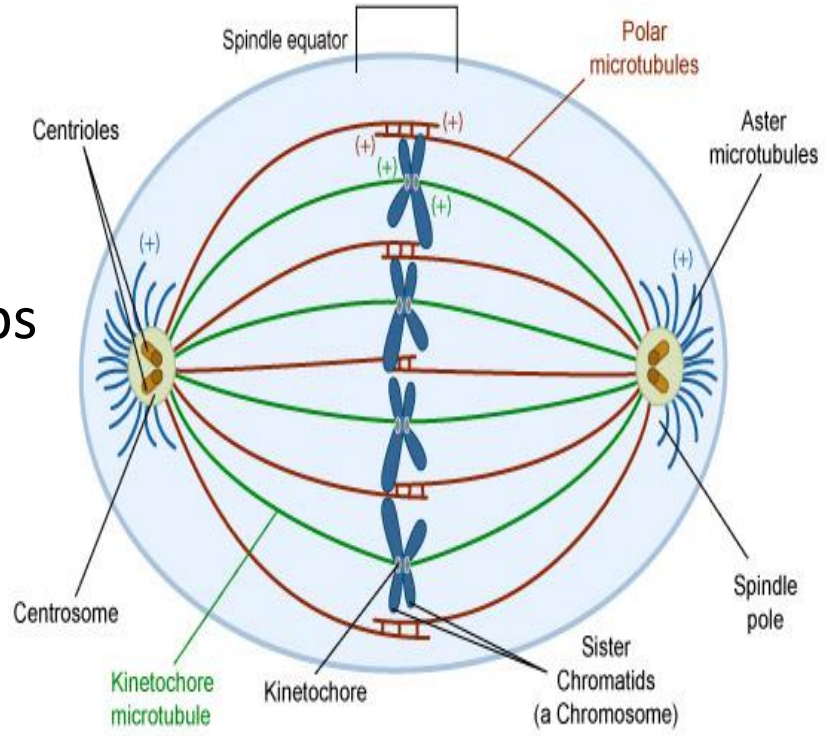
- **Homologous pair of chromosomes**
  - Matched pair of chromosomes
  - One from each of two different parents
  - Slightly different
  - Contain the same array of genes
  - 23 pairs of chromosomes in humans



# Definitions

- **Spindle fibers**
  - Made up of microtubules
  - Form at opposite ends or poles of cell
  - Connect to proteins of centromere and centrosome
  - Push and pull the chromosomes toward cell center

- **Centrosome**
  - Structure from which the spindle apparatus develops
  - Made up of the centriole surrounded by proteins

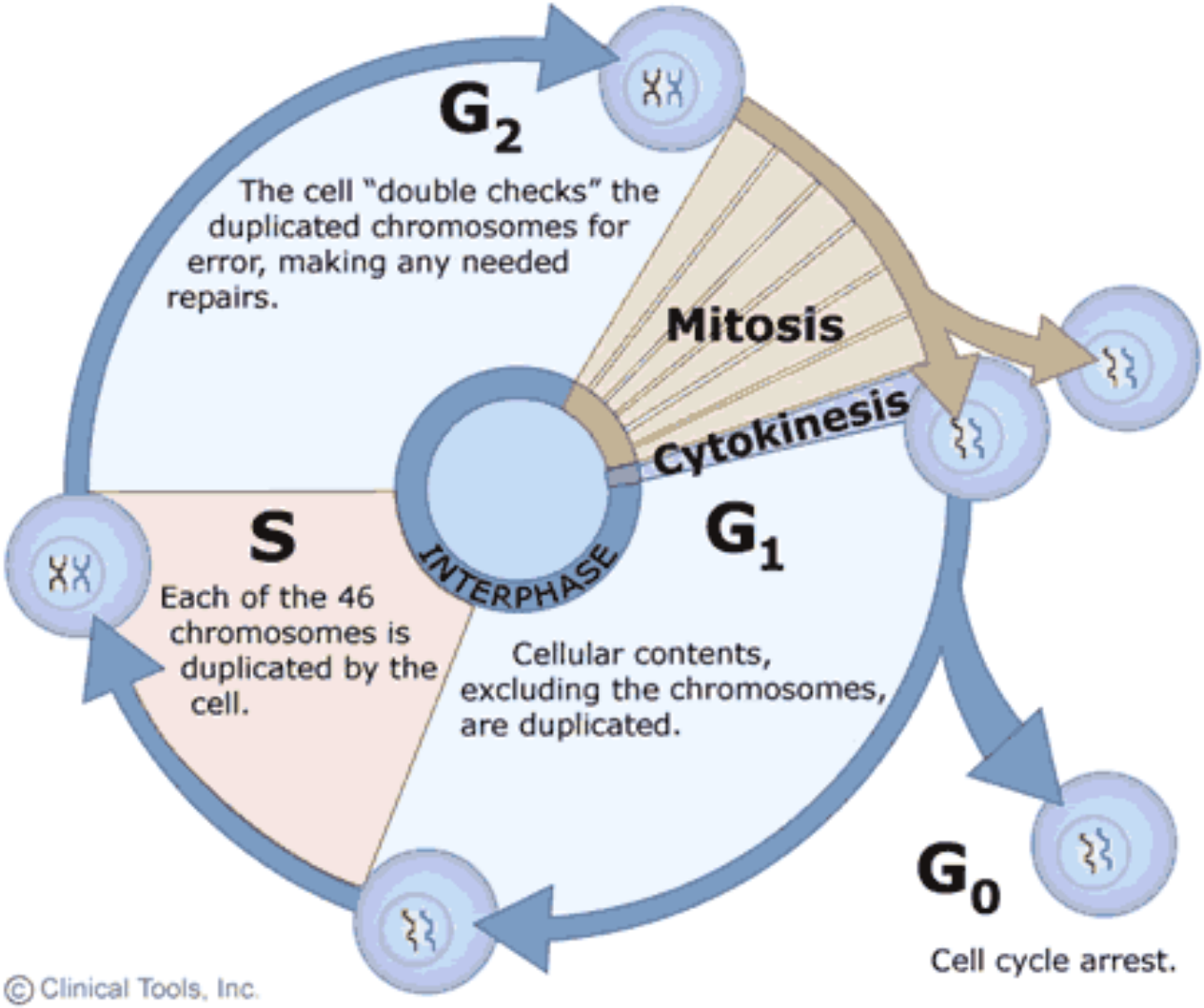


# Definitions

- **Haploid** - Having only one set of chromosomes
- **Diploid** - Having two sets of chromosomes
- **Gametes**
  - Reproductive haploid cells, also called germ cells
  - Cells which unite during fertilization to form a zygote
    - Human female gametes are called eggs
    - Human male gametes are called sperm

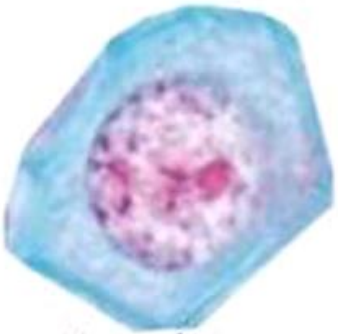
# Cell Cycle

- Interphase
- Mitosis
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
- Cytokinesis

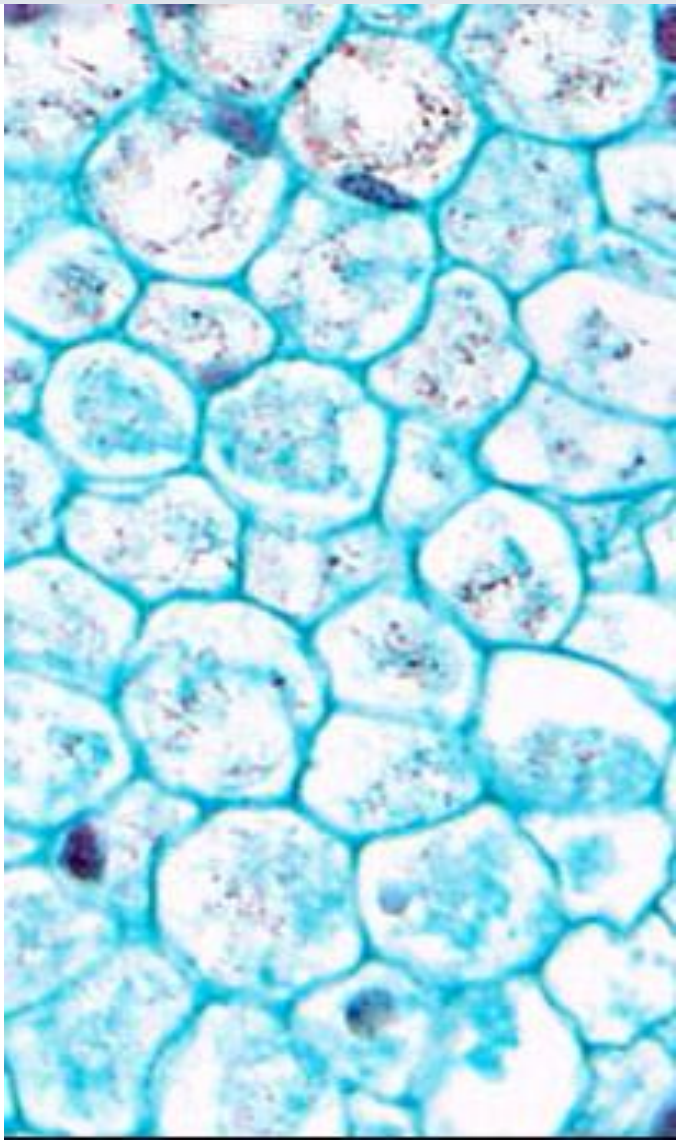


# Interphase

- Cell's normal process of living
- Cell spends about 90% of its time in interphase

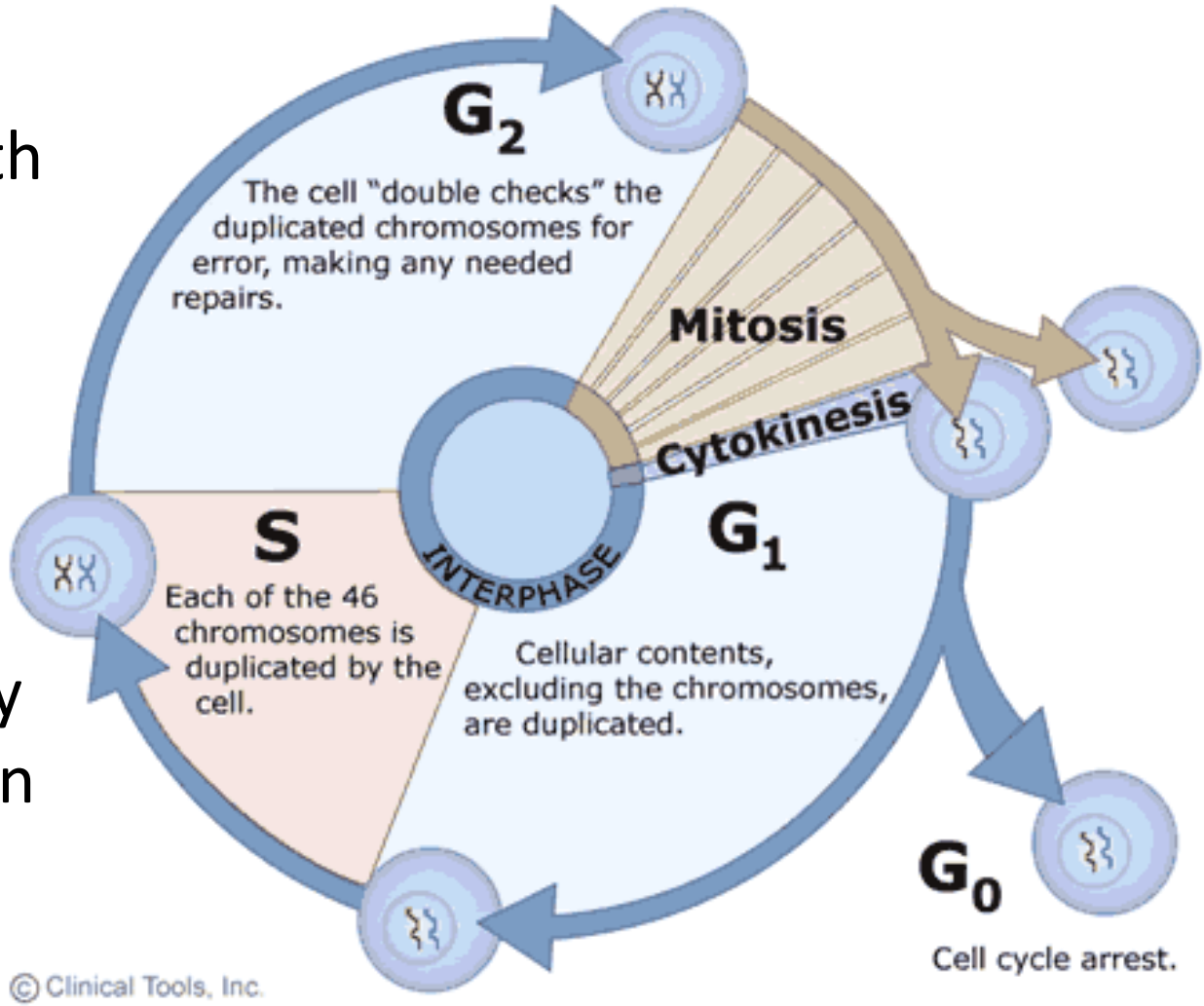


Interphase



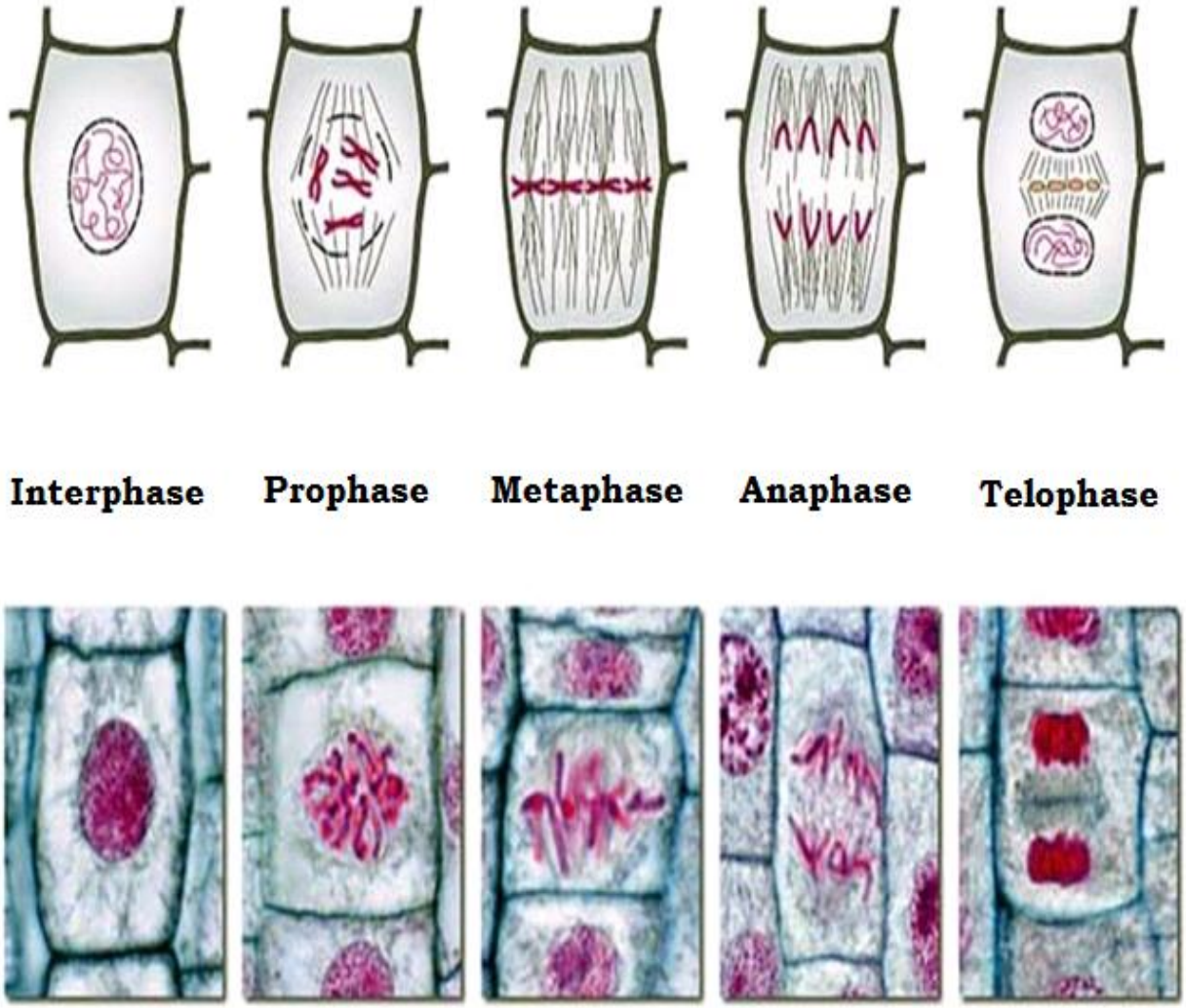
# Interphase

- G1(Gap 1)
  - Cellular growth
- S (Synthesis)
  - DNA is replicated
- G2 (Gap 2)
  - Cell gets ready for cell division to take place



# Mitosis

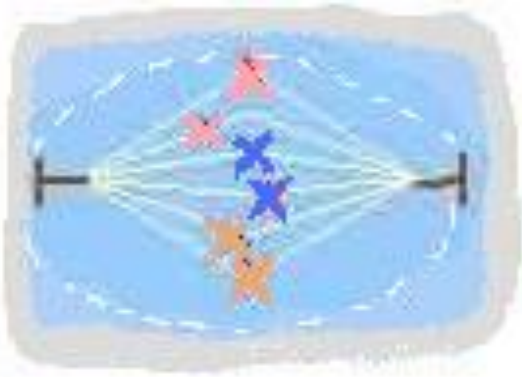
- Cell division
  - Process of making new cells
- Parent cell divides into two genetically identical diploid cells



# Prophase

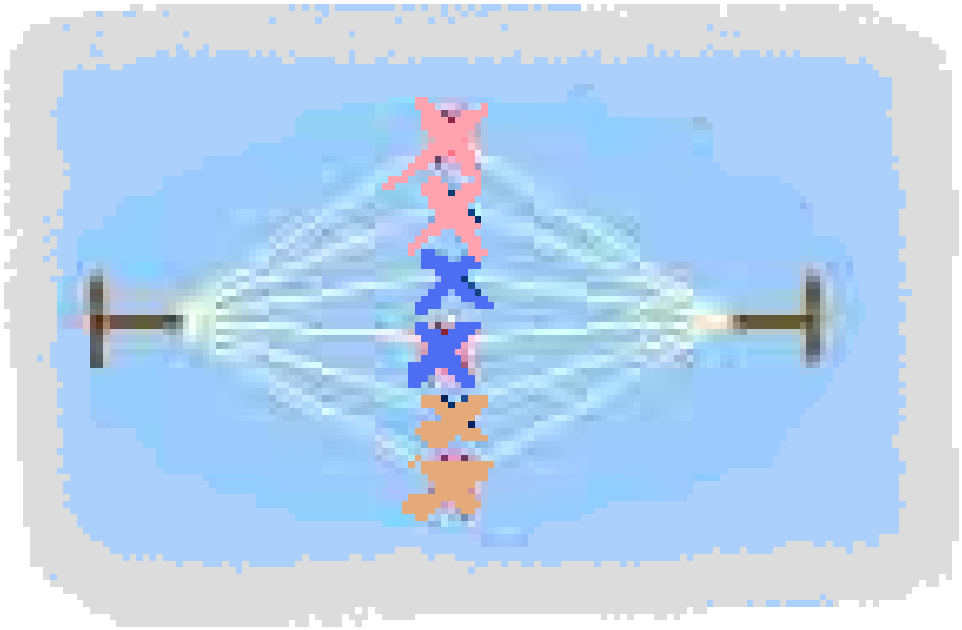
- Early prophase
  - Chromosomes condense to become visible
  - Each chromosome is in the form of a pair of sister chromatids joined at a centromere
  - Chromosomes begin to migrate toward the cell center

- Late prophase
  - Nuclear envelope breaks up
  - Spindle fibers
    - Form in the cytoplasm at opposite poles
    - Connect to the centromere of chromosomes



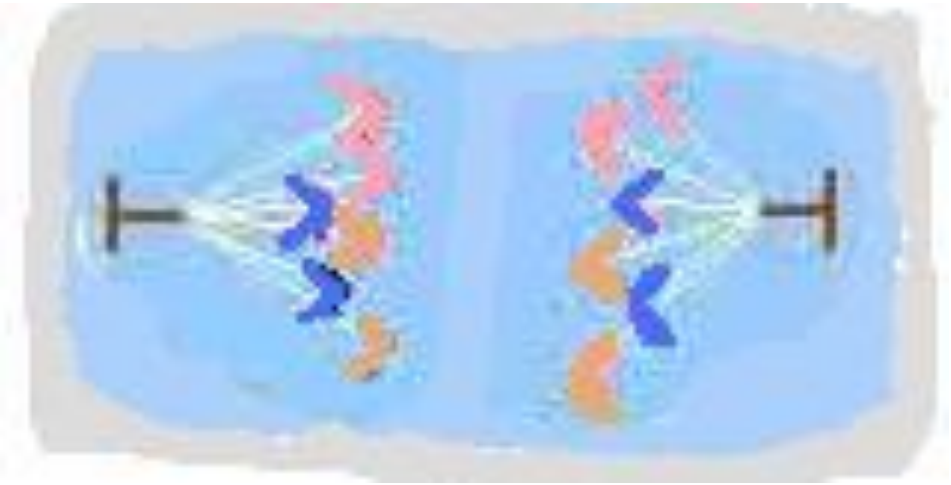
# Metaphase

- Spindle fully develops
- Chromosomes align at the cell center
- Nuclear membrane disappears completely



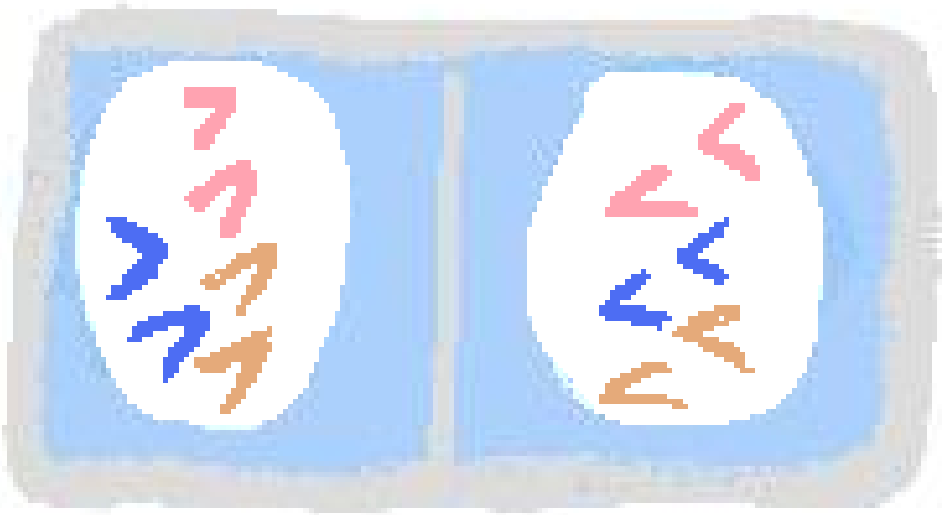
# Anaphase

- Paired chromosomes separate into daughter chromosomes
- Daughter chromosomes move to opposite poles
- Spindle fibers lengthen and elongate cell
- Each pole contains complete set of chromosomes when phase ends



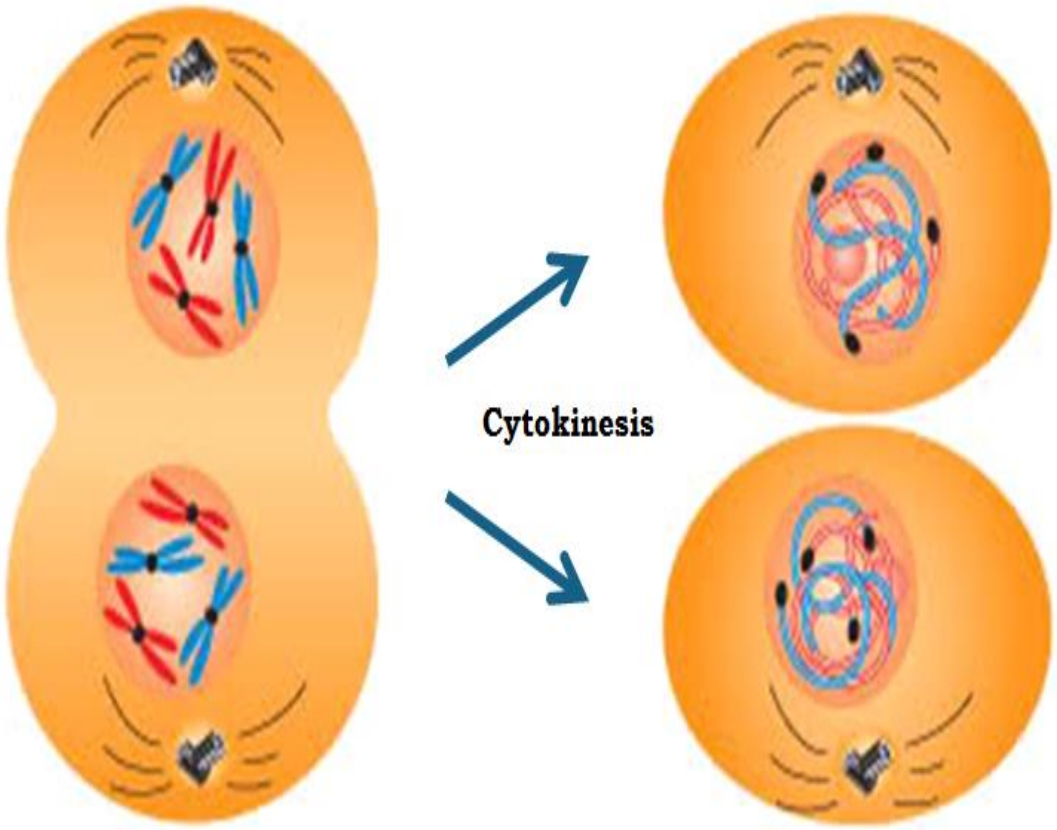
# Telophase

- Two distinct  nuclei form at poles
  - Nuclear envelopes formed
  - Contain chromosomes
- Chromosomes uncoil
  - Chromosomes no longer visible



# Cytokinesis

- Cytoplasm divides to produce two cells
  - Occurs after mitosis and meiosis

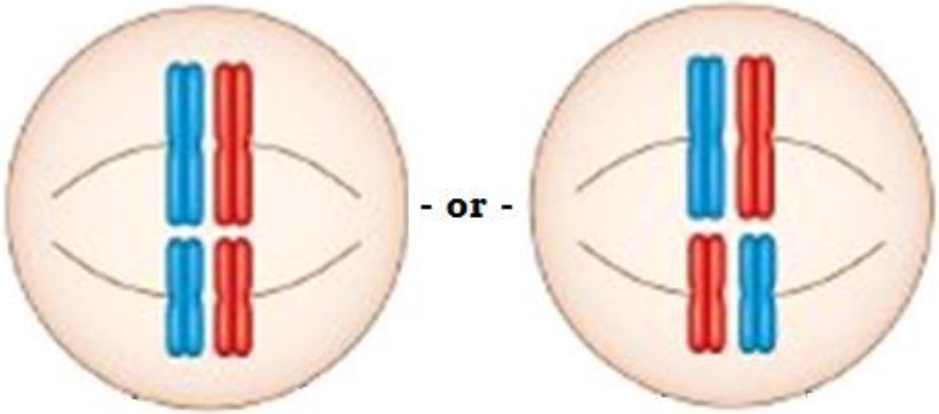


# Meiosis

- Cell division in sex cells
- Two part process leading to making of gametes
- Results in four genetically unique haploid daughter cells
- First: Meiosis I
  - Separates homologous chromosomes
  - Cells reduced from diploid to haploid
- Second: Meiosis II
  - Separates sister chromatids

# Recombination

- Rearrangement of genes to produce genetic variation in gametes
- Two types
  - Crossing over
  - Independent assortment

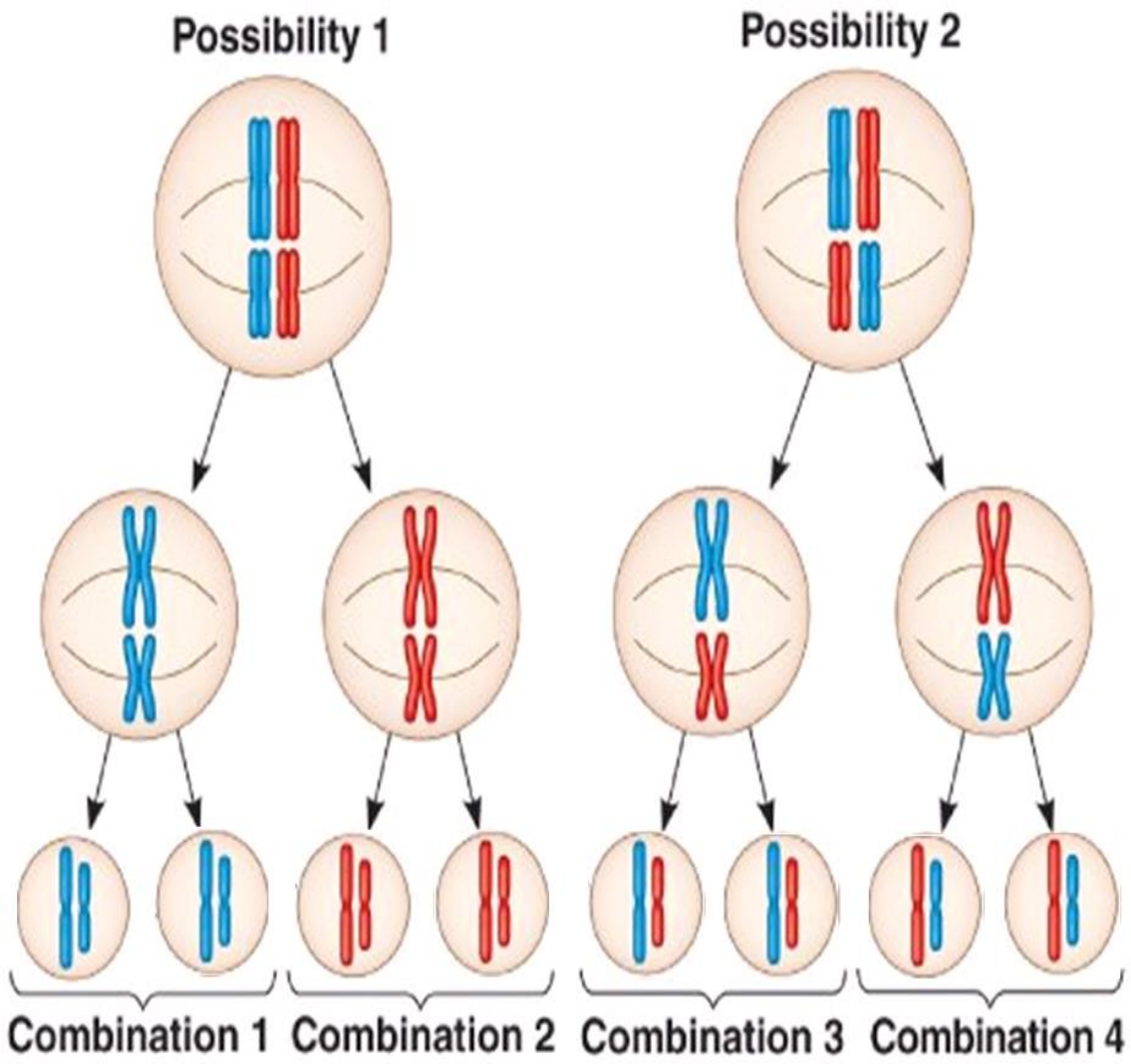


# Crossing Over

- Exchange of genetic material between homologous non-sister chromatids

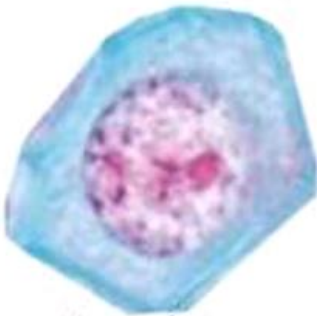
# Independent Assortment

- Chromosomes line up different ways at the beginning of meiosis
  - Makes different arrangements of maternal and paternal chromosomes

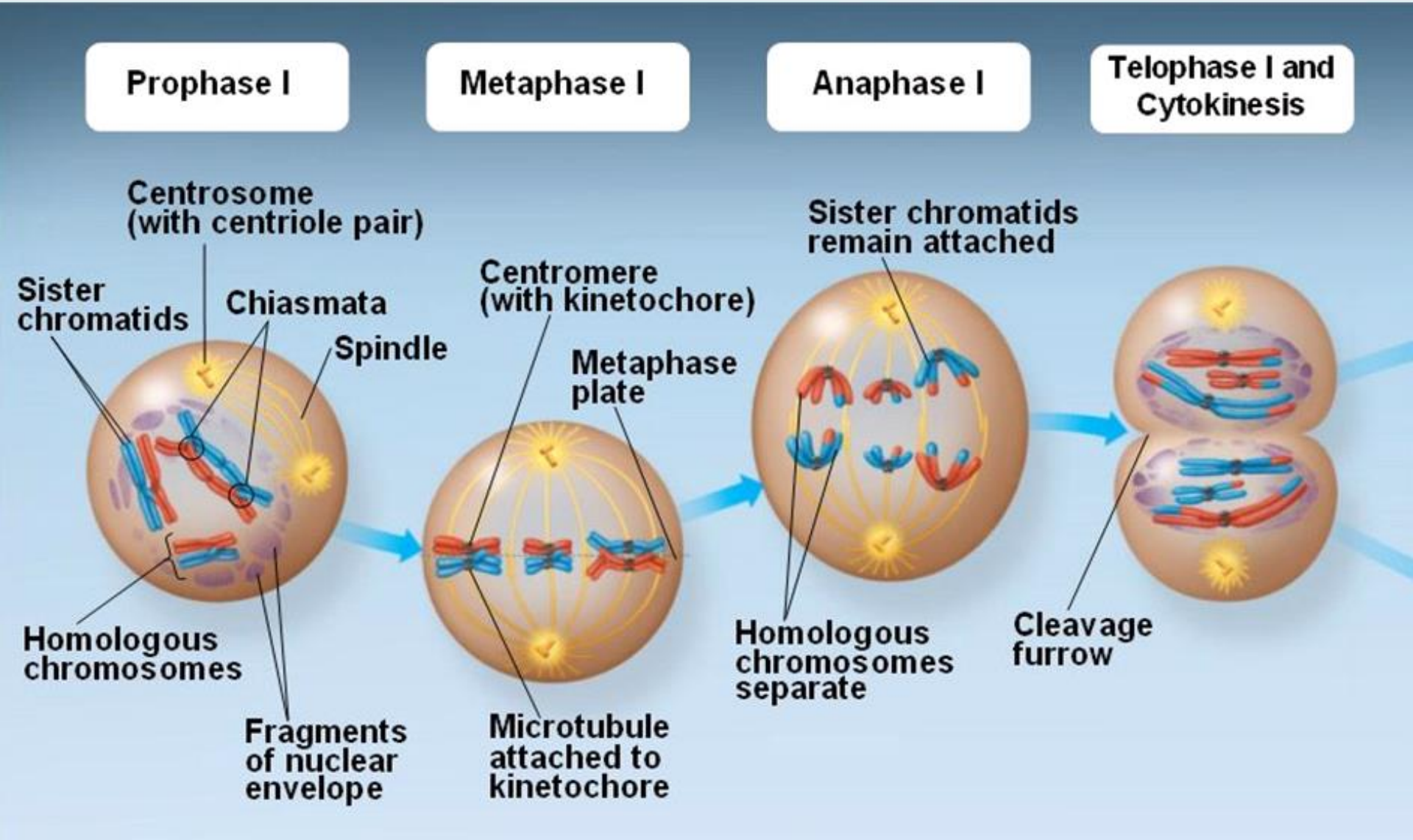


# Cell during Interphase

- Chromosomes from mom
  - Red
- Chromosomes from dad
  - Blue
- Metaphase plate
  - Imaginary line dividing cell in half
- During S phase of interphase
  - Each chromosome is duplicated
  - Sister chromatids added to each chromosome

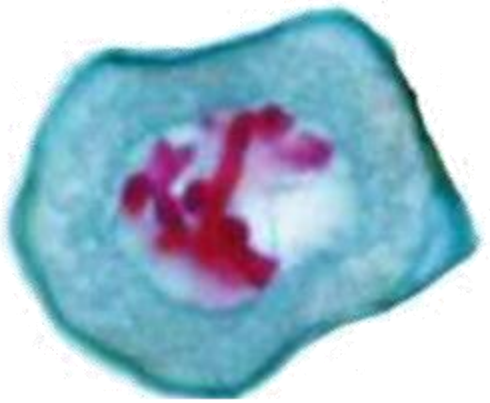

Interphase

# Meiosis I


Prophase I
Metaphase I
Anaphase I
Telophase I and Cytokinesis
Centrosome (with centriole pair)
Sister chromatids
Chiasmata
Spindle
Homologous chromosomes
Fragments of nuclear envelope
Centromere (with kinetochore)
Metaphase plate
Microtubule attached to kinetochore
Sister chromatids remain attached
Homologous chromosomes separate
Cleavage furrow

# Prophase I

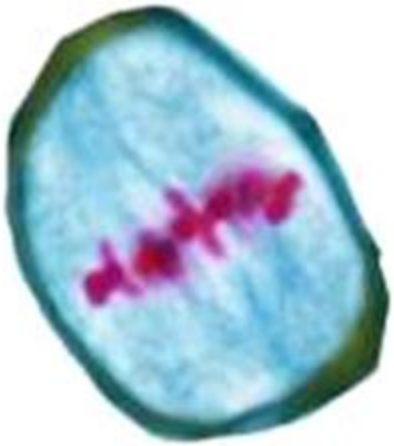
- Chromosomes begin to condense, become visible
- Homologous chromosomes pair up
  - Crossing over occurs between non-sister chromatids
  - Spindle fibers begin to form



Prophase I

# Metaphase I

- Paired homologous chromosomes line up on metaphase plate



Metaphase I

# Anaphase I

- Homologous pairs separate and move toward opposite poles

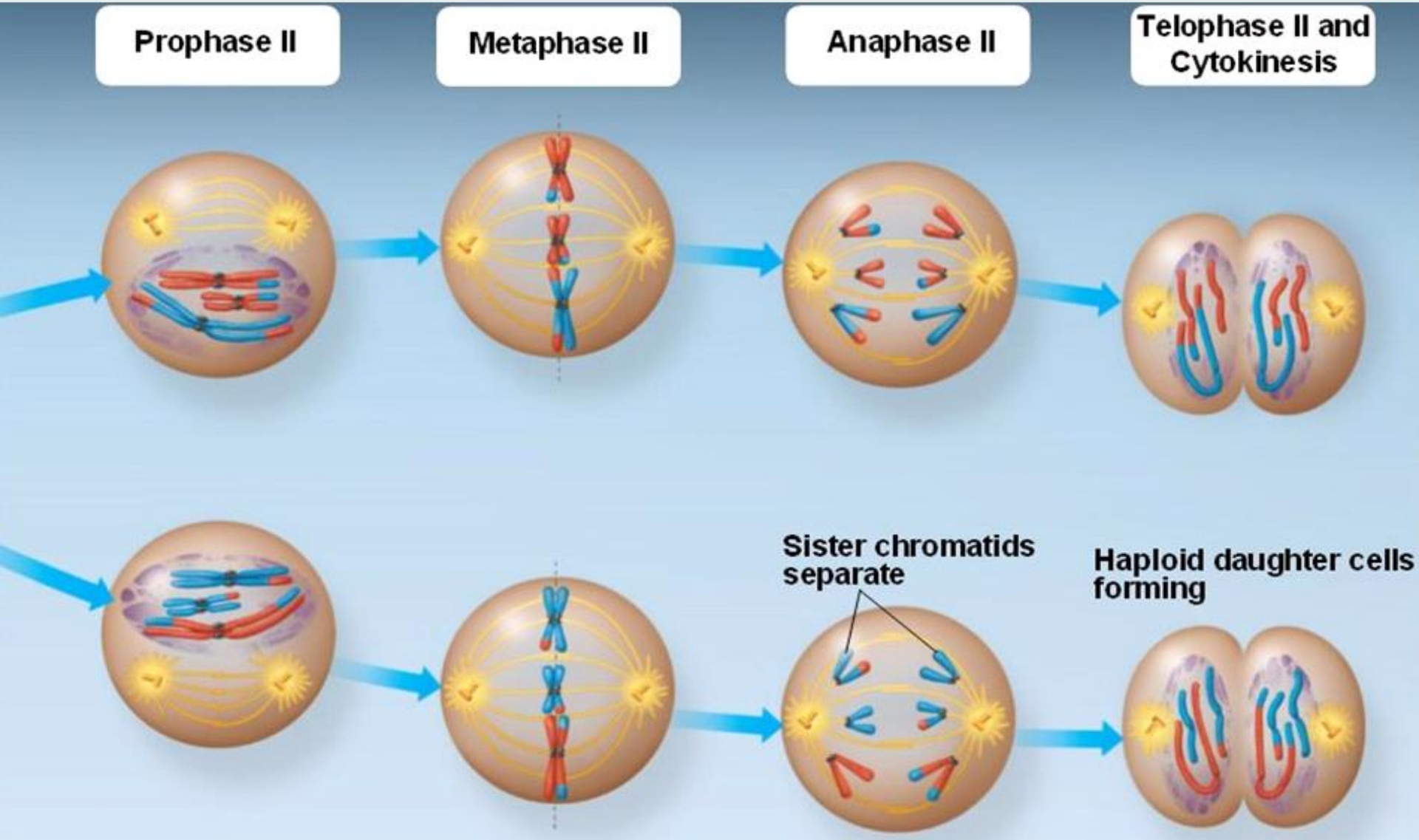
Anaphase I

# Telophase I

- Chromosomes arrive at the spindle poles
  - Followed by cytokinesis

Telophase I

# Meiosis II


Prophase II
Metaphase II
Anaphase II
Telophase II and Cytokinesis
Sister chromatids separate
Haploid daughter cells forming

# Prophase II

- Chromosomes become visible again
- Spindle reforms

Prophase II

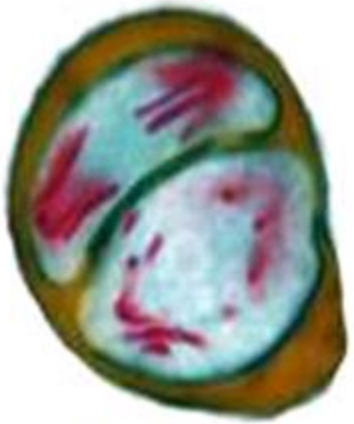
# Metaphase II

- Individual chromosomes line up on the metaphase plate

Metaphase II

# Anaphase II

- Sister chromatids separate and move toward the spindle poles
  - Results in two new chromosomes
    - Each chromosome with only one chromatid



Anaphase II

# Telophase II

- Chromosomes arrive at spindle pole
- Spindle breaks down
- Nuclear envelope re-forms
  - Followed by cytokinesis

Telophase II

# End Result of Meiosis

- Four genetically unique daughter cells
  - Further processing necessary to produce gametes

Four Daughter Cells