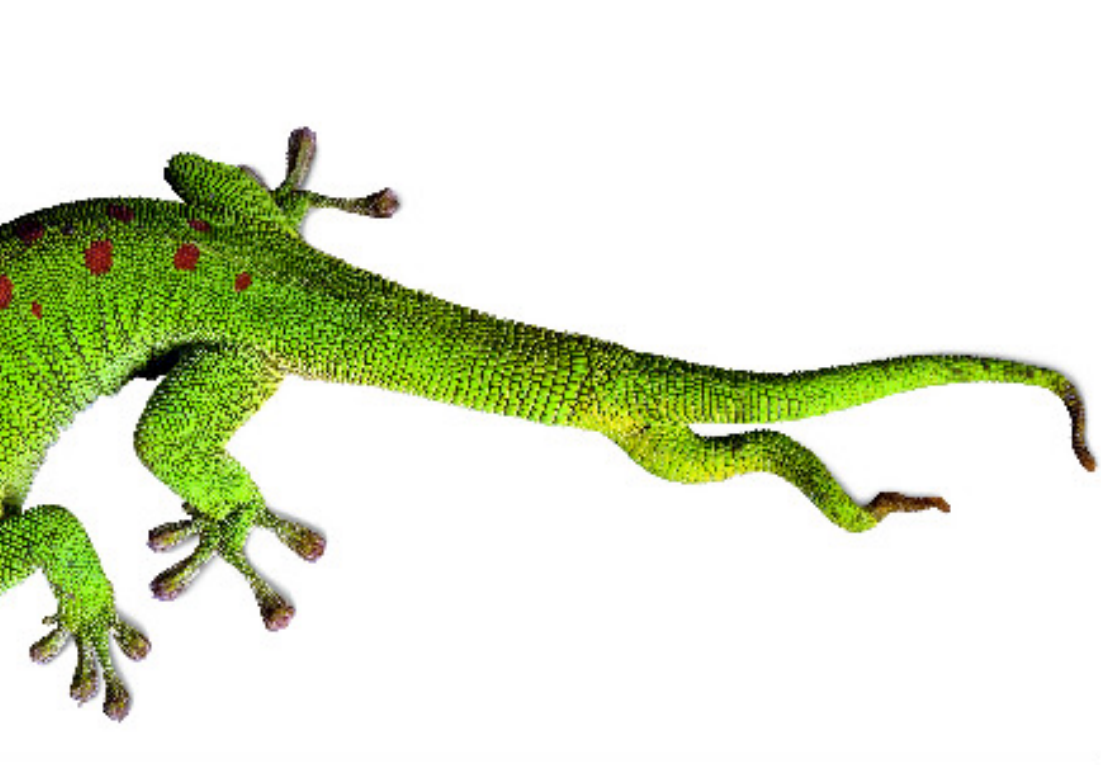
Lab 5: Mitosis and Meiosis



Mitosis vs. Meiosis

- Mitosis and meiosis are the processes of cellular reproduction for different types of cells
- Somatic cells = body cells
  - Skin, brain, muscle cells, etc.
  - Diploid (two copies of chromosomes)
  - Only undergo MITOSIS
- Germ cells = gamete cell
  - Either egg or sperm
  - Haploid (only one copy of chromosomes)
  - Only undergo MEIOSIS

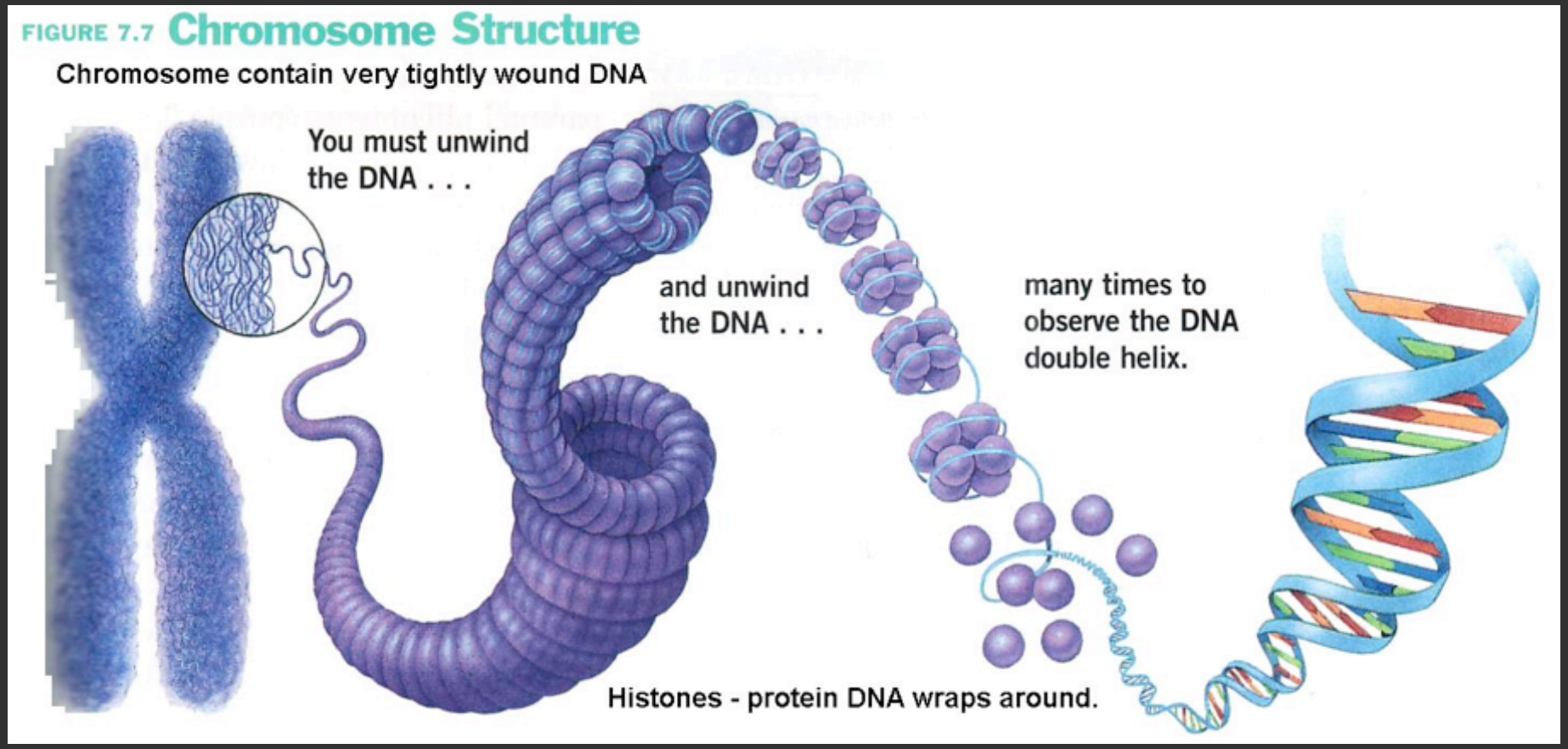
Levels of DNA organization

What does DNA look like?
Depends on which stage!

Just like the yarn, DNA sometimes needs to be coiled.

Because unraveled, all the DNA in a single human cell would be about 2 meters long!

Levels of DNA organization

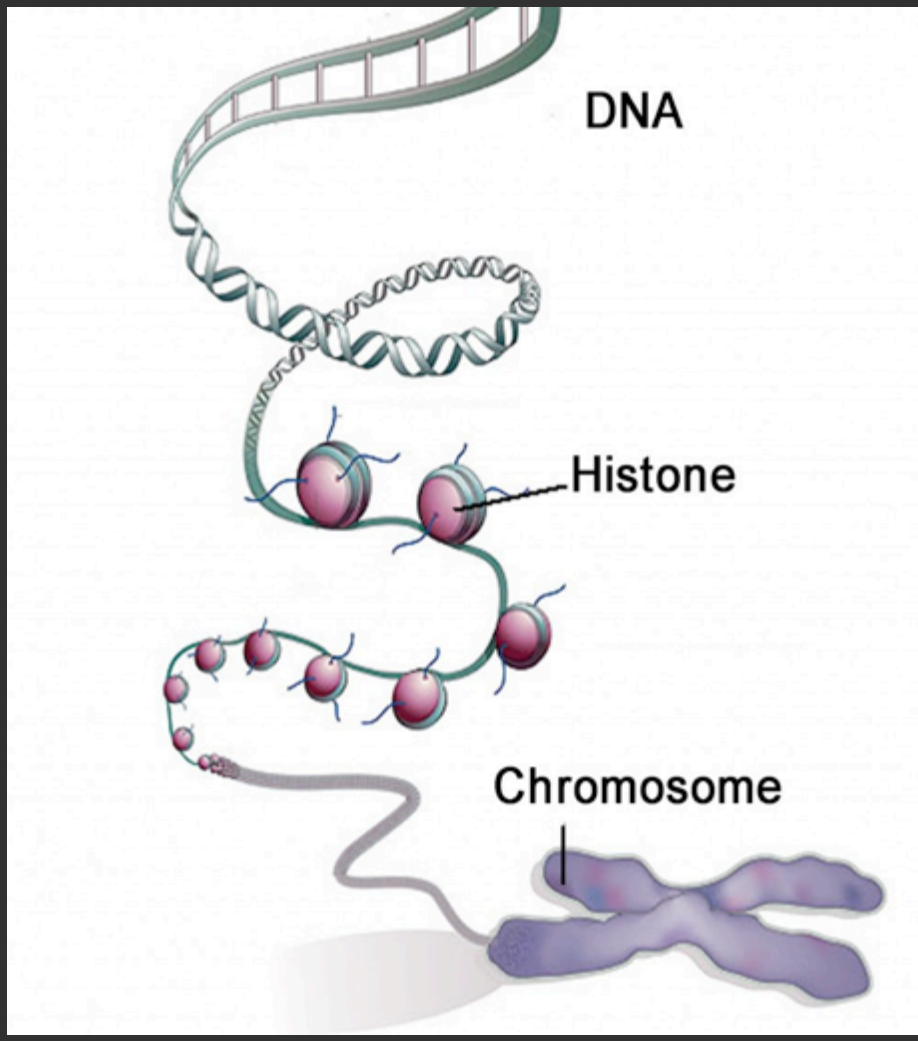


Levels of DNA organization

Most of the time DNA is in the form of **chromatin,** or thin coiled "threads" of DNA wrapped around **histones** (proteins).

- DNA + Histones = Nucleosome

During mitosis and meiosis, DNA is seen in the form of a **chromosome.**



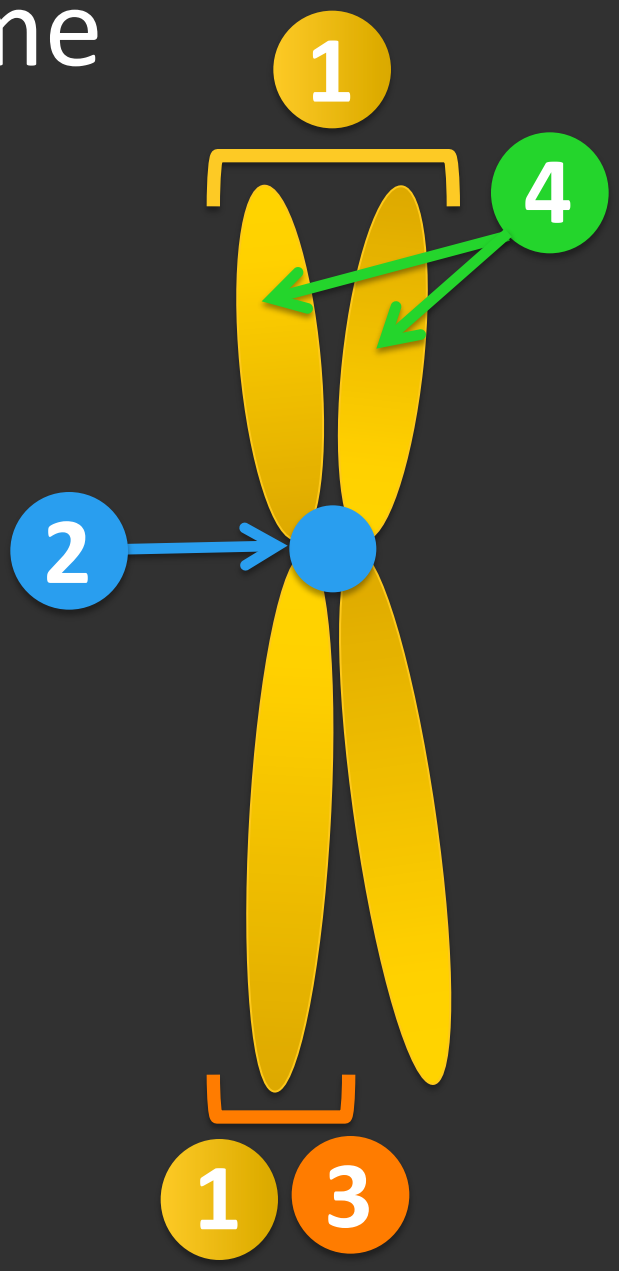
The chromosome

1 **Chromosome:** most condensed form of DNA; seen during mitosis

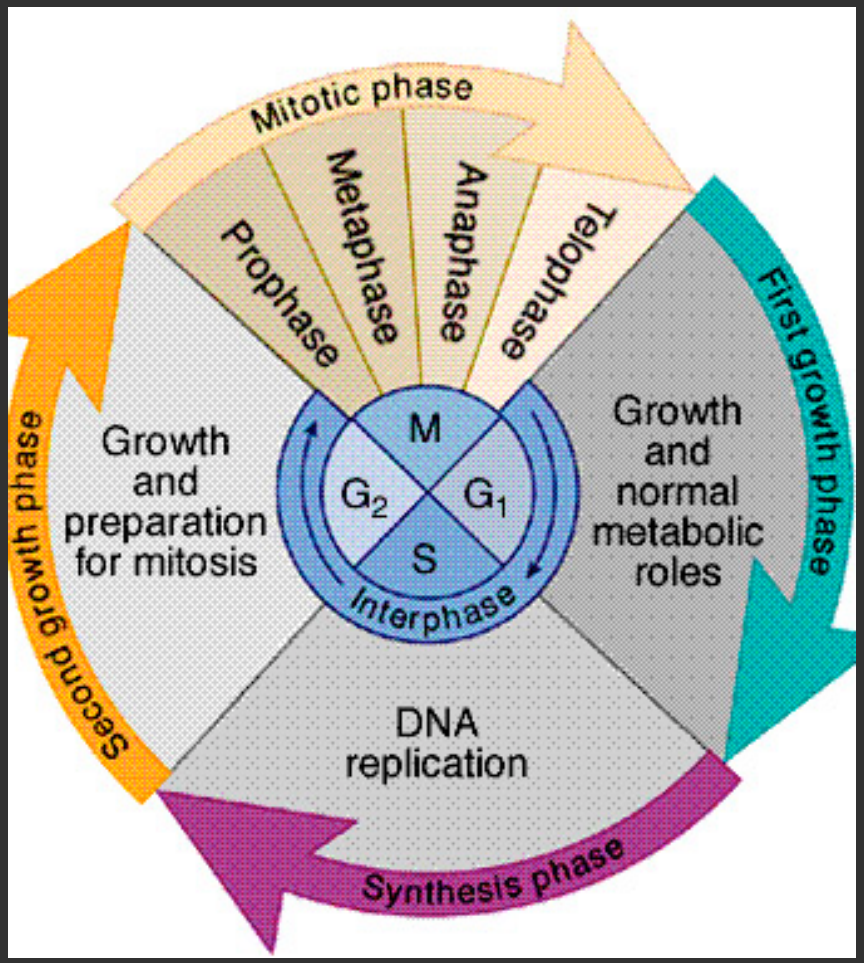
2 **Centromere:** a constricted region of the chromosome; holds the chromatids together and is where spindle fibers attach.

3 **Chromatid:** one half of a duplicated chromosome

4 Sister chromatids: Identical halves



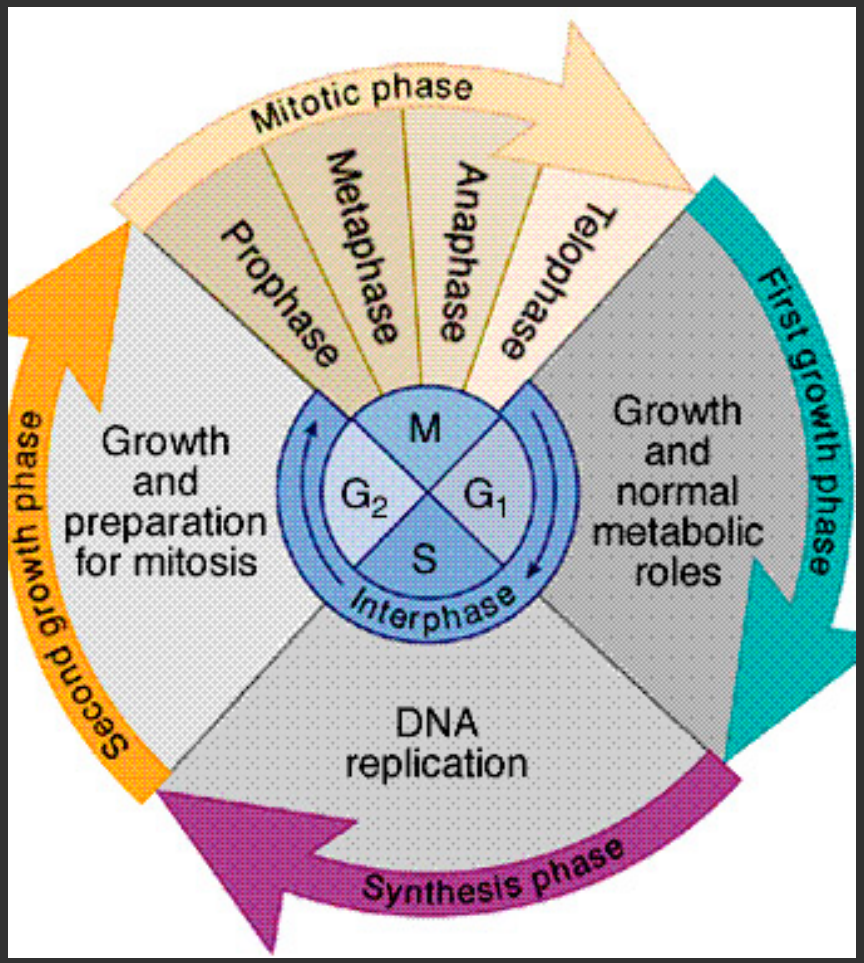
The cell cycle



3 stages of Interphase:

- **G_1** (growth): Organelle duplication
- **S** (synthesis): DNA duplication
- **G_2**: Further preparation for cell division, incl. protein synthesis

The cell cycle



4 phases of Mitosis:

- Prophase
- Metaphase
- Anaphase
- Telophase

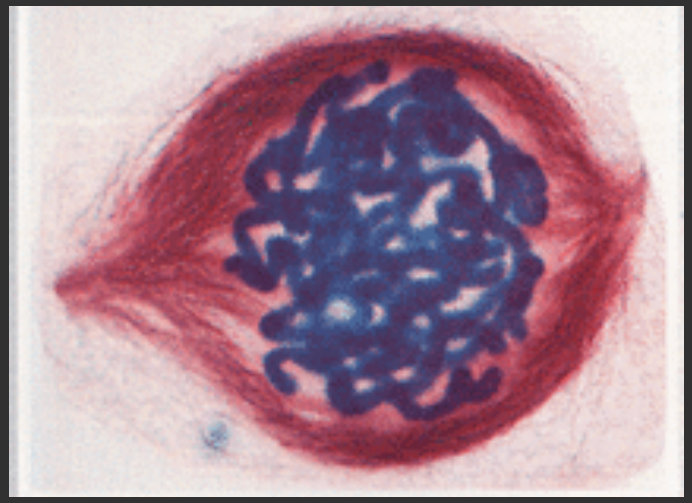
Additional process:

- Cytokinesis – process starts during mitosis; divides the cytoplasm

Mitosis: Prophase

Within the nucleus:

- Duplicated chromosomes begin to condense into two sister chromatids

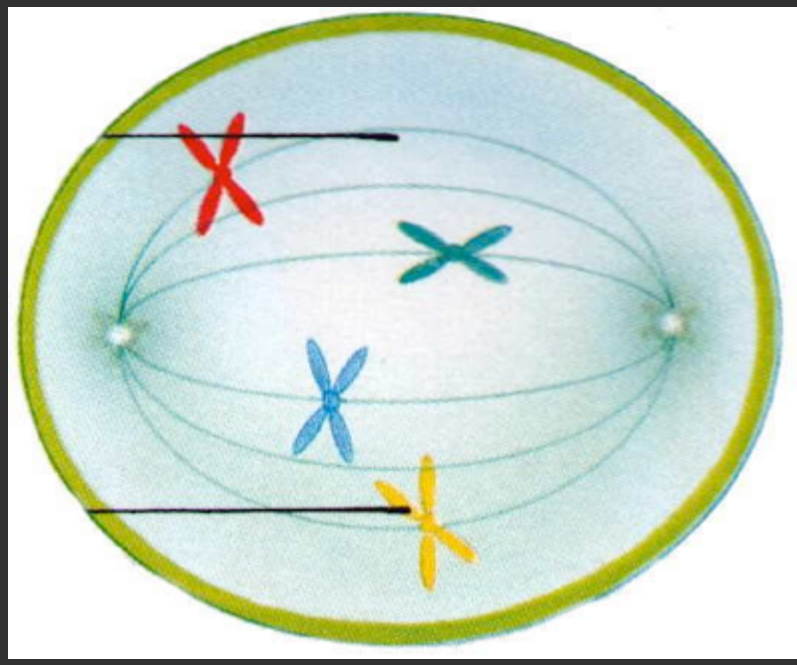


Outside the nucleus:

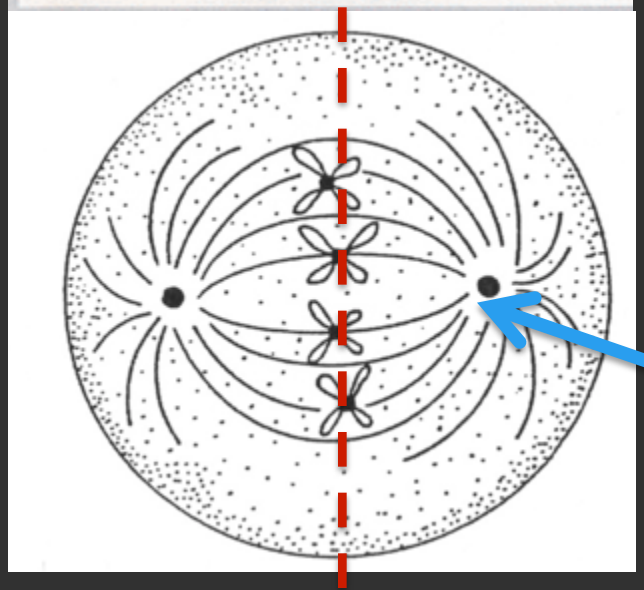
- Centro<u>somes</u> start migrating to opposite ends
- Spindles fibers start forming

Mitosis: Prophase (continued)

- Nuclear envelope dissolves and nucleolus disappears
- Spindle fibers start to attach to proteins found at chromosome centromeres



Mitosis: Metaphase

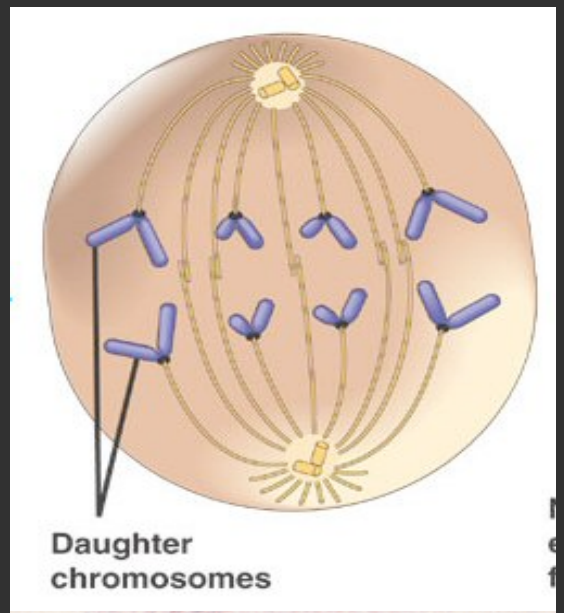


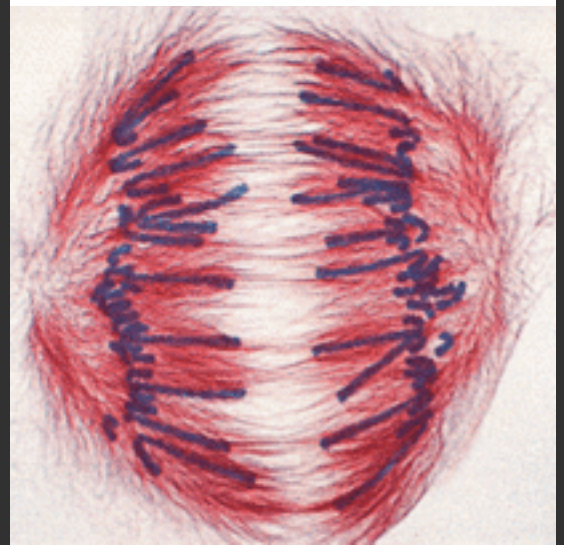
- Chromosomes align at the equator or metaphase plate of the cell
  - a point midway between the spindle poles

Spindle pole formed by centrosomes

Mitosis: Anaphase

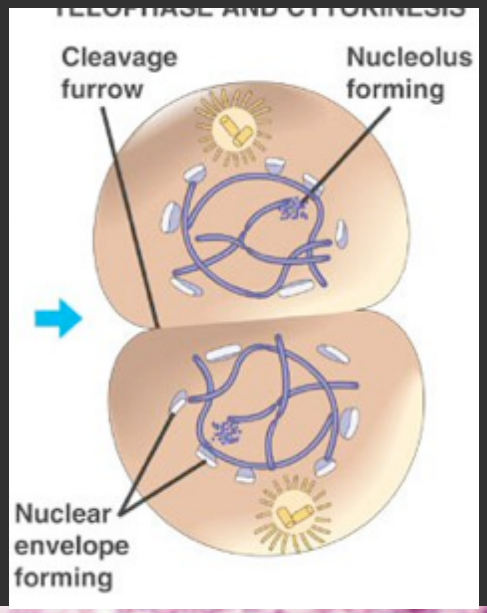
- Sister chromatids separate to become sister chromosomes
- Spindle poles move even farther apart
- Spindle fibers begin to disassemble

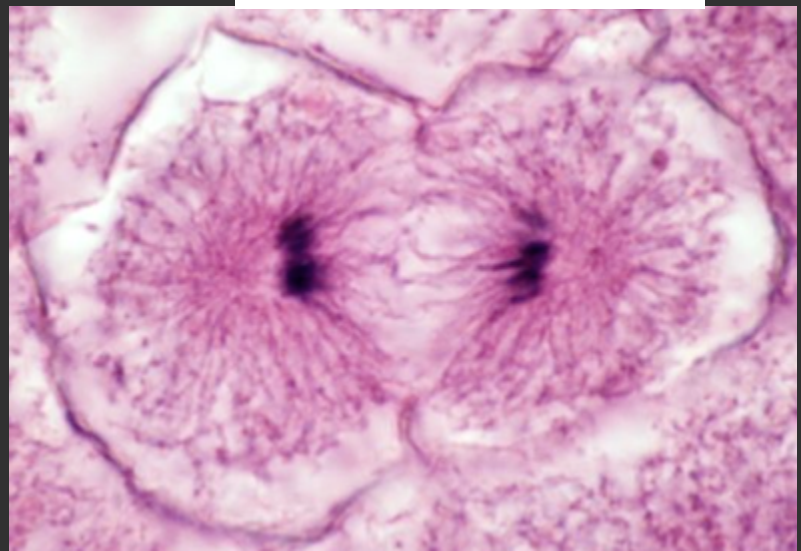




Mitosis: Telophase

- New nuclear envelopes form around each set of daughter chromosomes
- Spindles disappear, some spindle fibers still visible between nuclei
- Division of cytoplasm begins (cytokinesis)

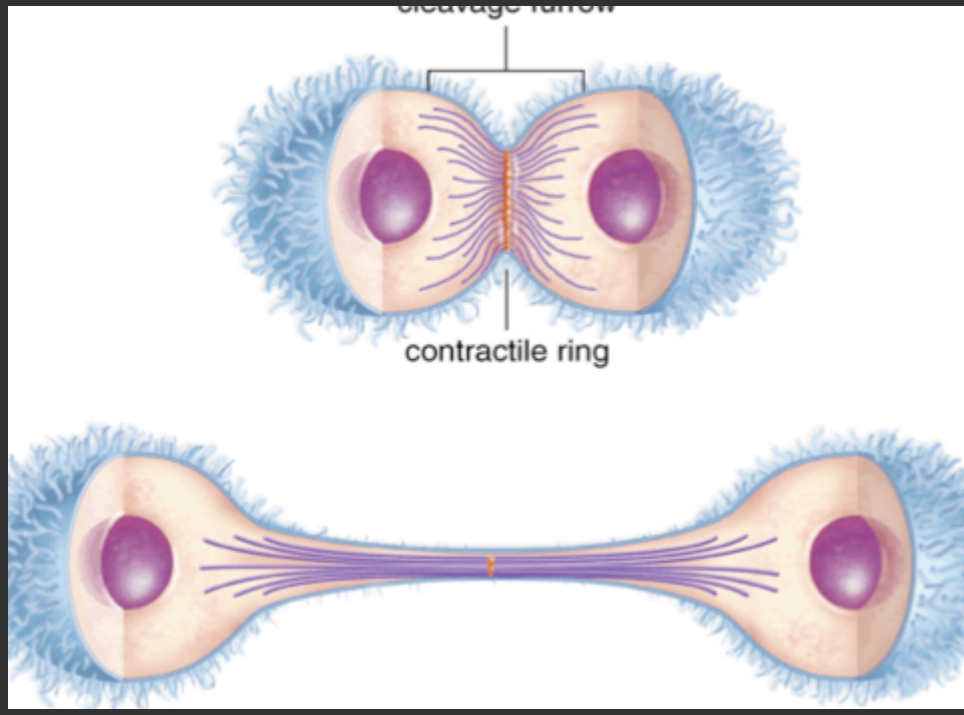




Cytokinesis (animals)

Process dividing cytoplasm into two daughter cells.

- Contractile ring: a band of actin filaments contracting between new nuclei
- Cleavage furrow: indentation of the plasma membrane created by the contractile ring

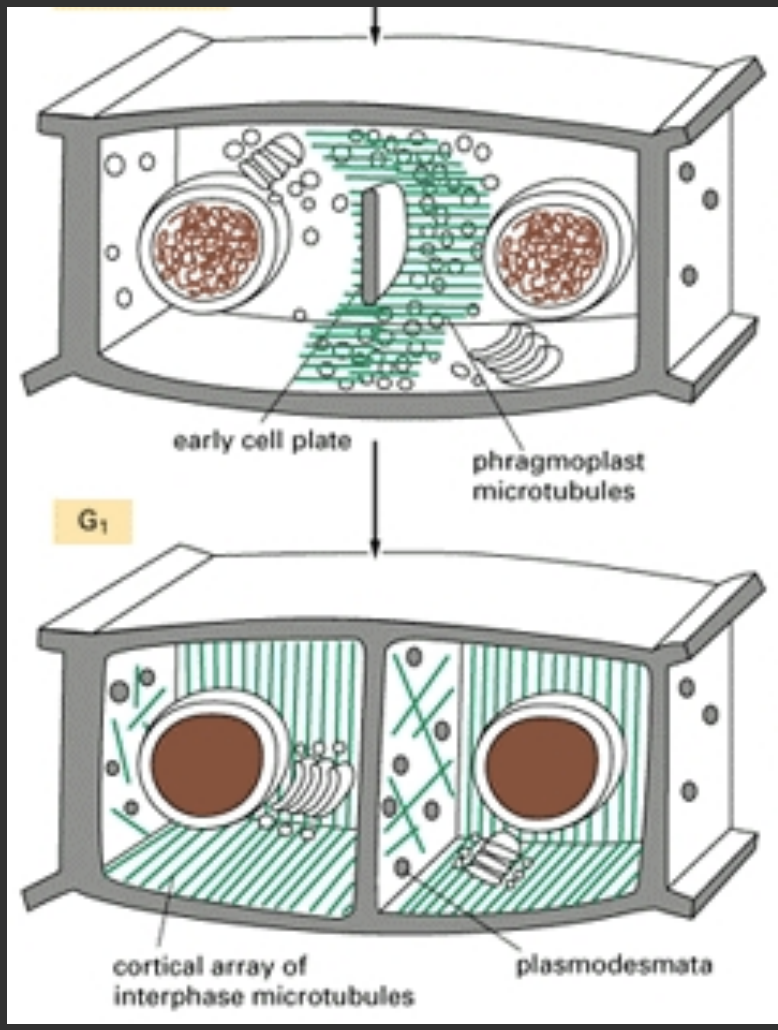


Cytokinesis (plants)

Rigid cell wall prevents cleavage furrow from forming.

Instead, a cell plate is formed from vesicles produced by Golgi apparatus.

Vesicle membranes form the new plasma membrane and release molecules that will make a new cell wall.



Mitosis Results

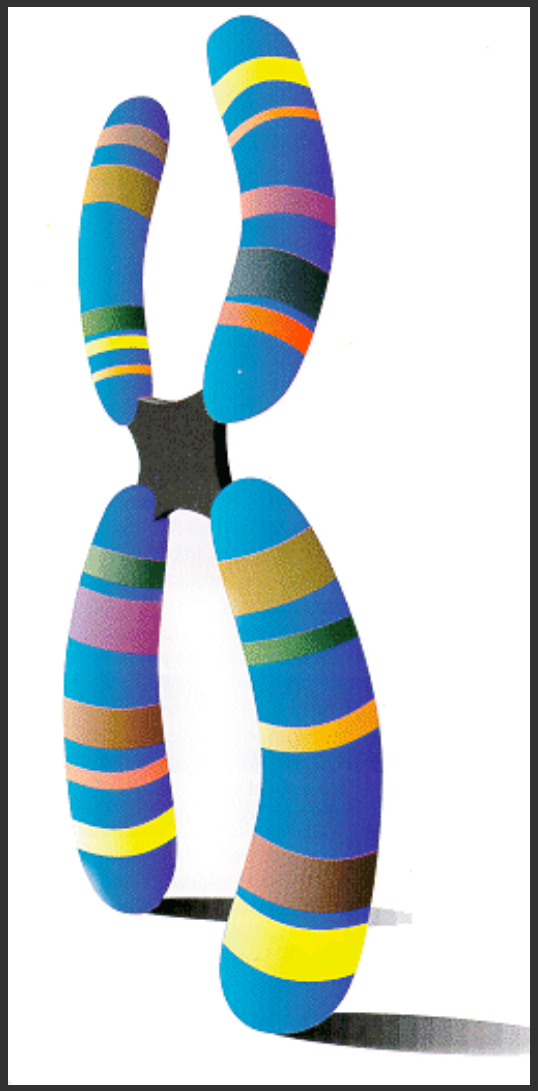
At the end of mitosis:

- Two daughter cells from one parental
- Every daughter cell has the same # of chromosomes as the parental cells

Homologous chromosomes

Homologous chromosomes are chromosomes of the same length and genes sequence.

Don't confuse homologs with sister chromatids. Homologous chromosomes are not identical!



Meiosis: similar but different

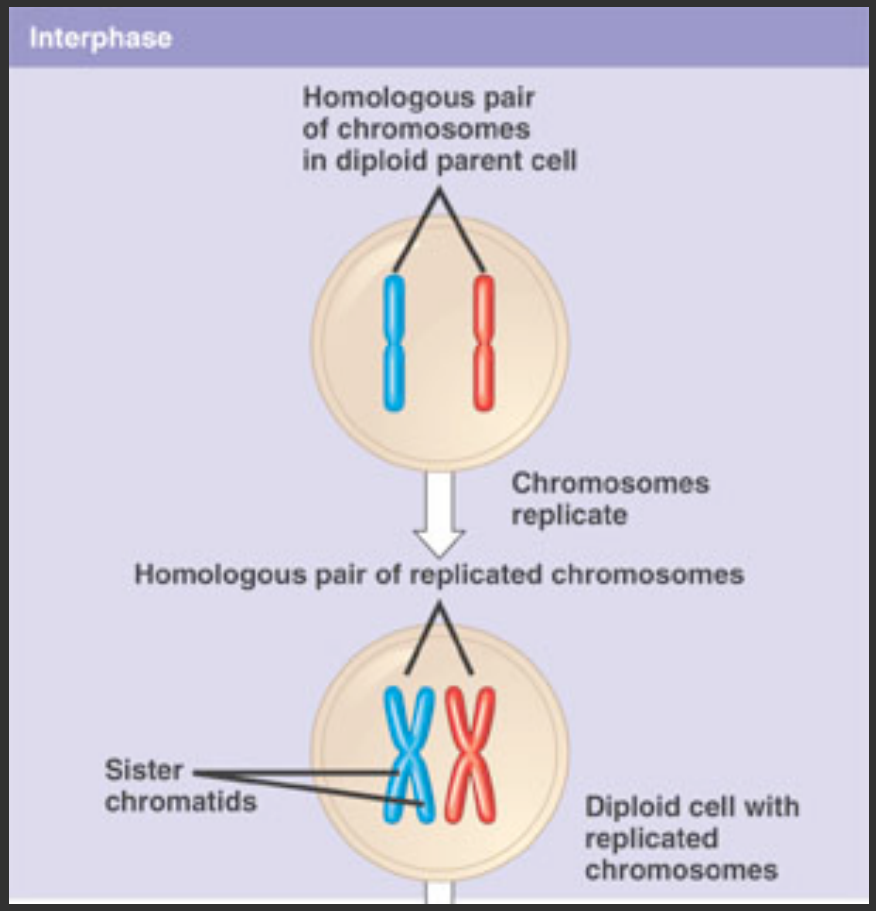
Meiosis has all the same phases as mitosis but it performs them twice.

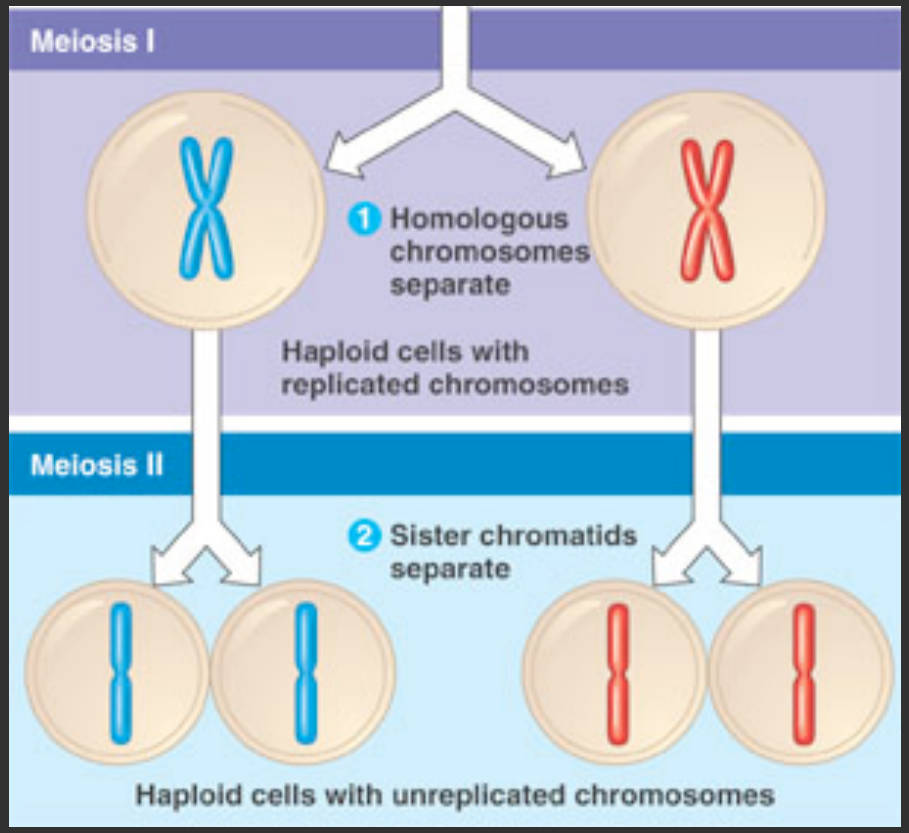
Another major difference are the chromosomes meiosis begins with – tetrads in Meiosis I and dyads in Meiosis II.

Tetrads – two homologous chromosomes, four chromatids total; “tetra” = 4

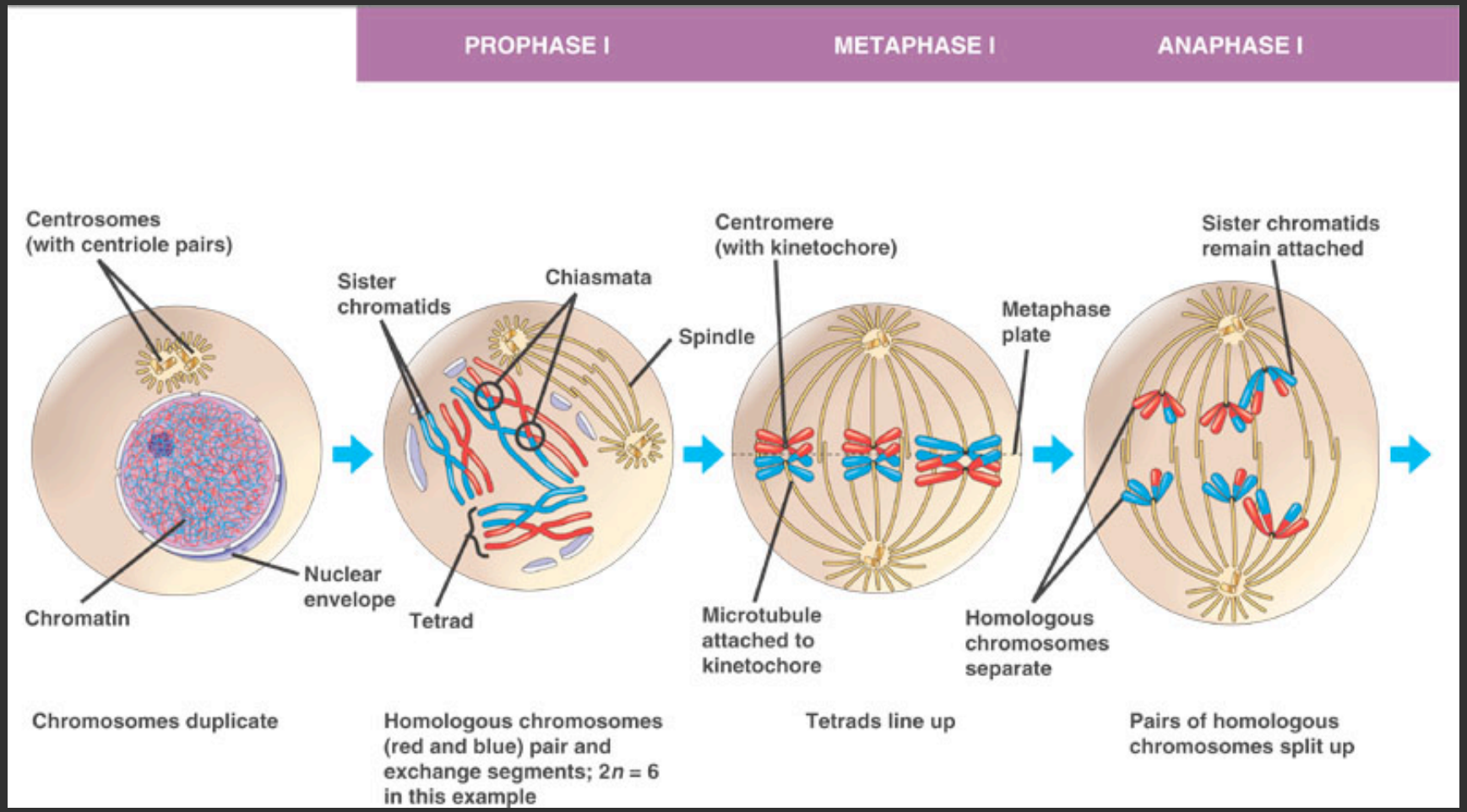
Dyads – Two sister chromatids; “dy” or “di” = 2

Meiosis overview

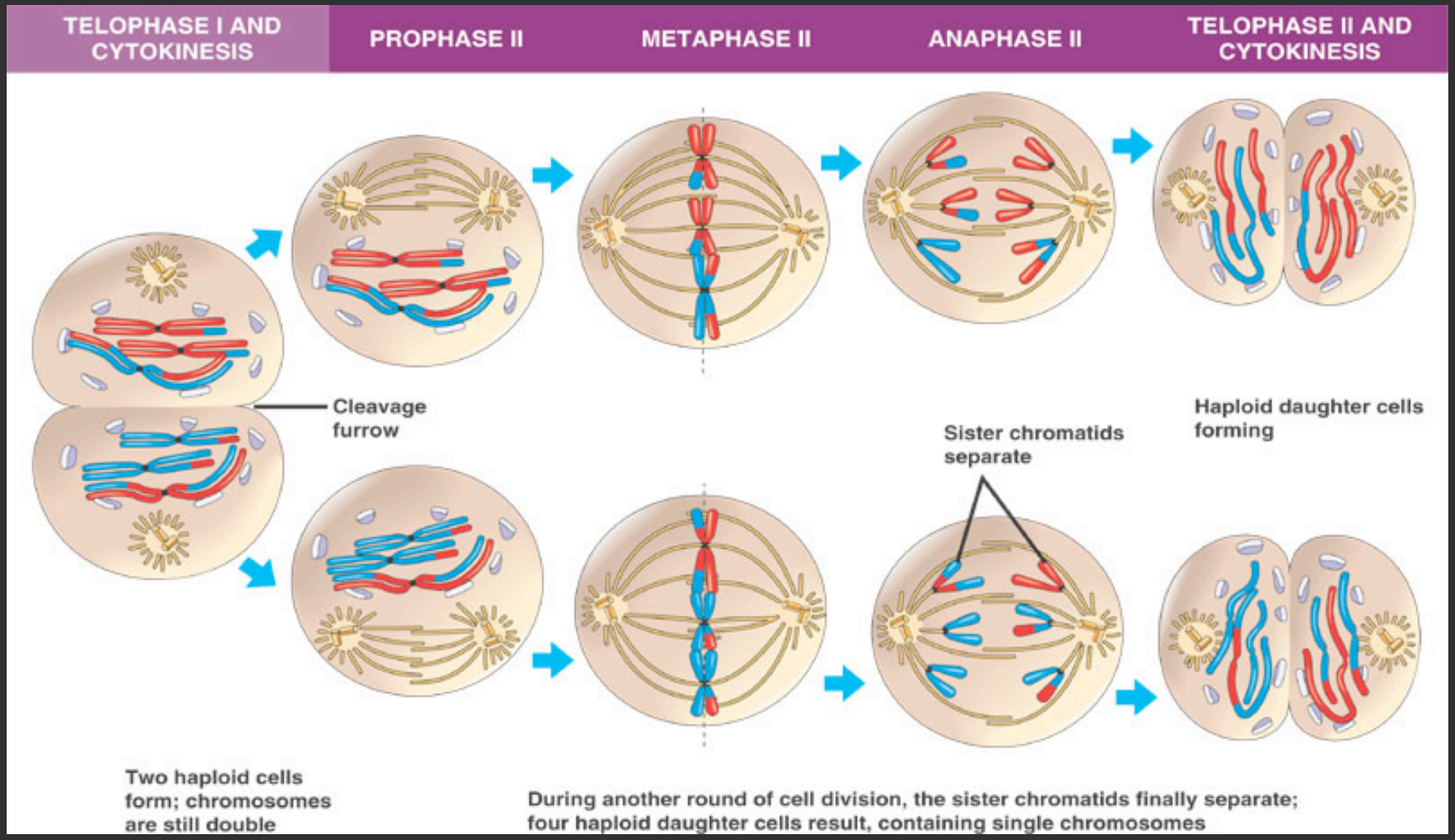




Meiosis I: Homologous chromosomes separate



Meiosis II: Sister chromatids separate



Meiotic Stages

MEIOSIS I

- Prophase I
- Metaphase I
- Anaphase I
- Telophase I
  - Cytokinesis

→ INTERKINESIS

No DNA duplication!

→

MEIOSIS II

- Prophase II
- Metaphase II
- Anaphase II
- Telophase II
  - Cytokinesis

Mitosis vs. Meiosis:

MITOSIS

- One nuclear division
- Start with duplicated chromosomes
- Begin and end process as diploid cells (2n → 2n)
- Produces two daughter cells

MEIOSIS

- Two nuclear divisions
- Start out with tetrads (two homologous copies of duplicated chromosomes)
- Begin as diploid, but end haploid cells (2n → 1n)
- Produces four daughter cells

Meiosis: generating genetic variation

Do you have a brother or sister? If you have the same parents – why aren't you twins?

Meiosis, that's why!

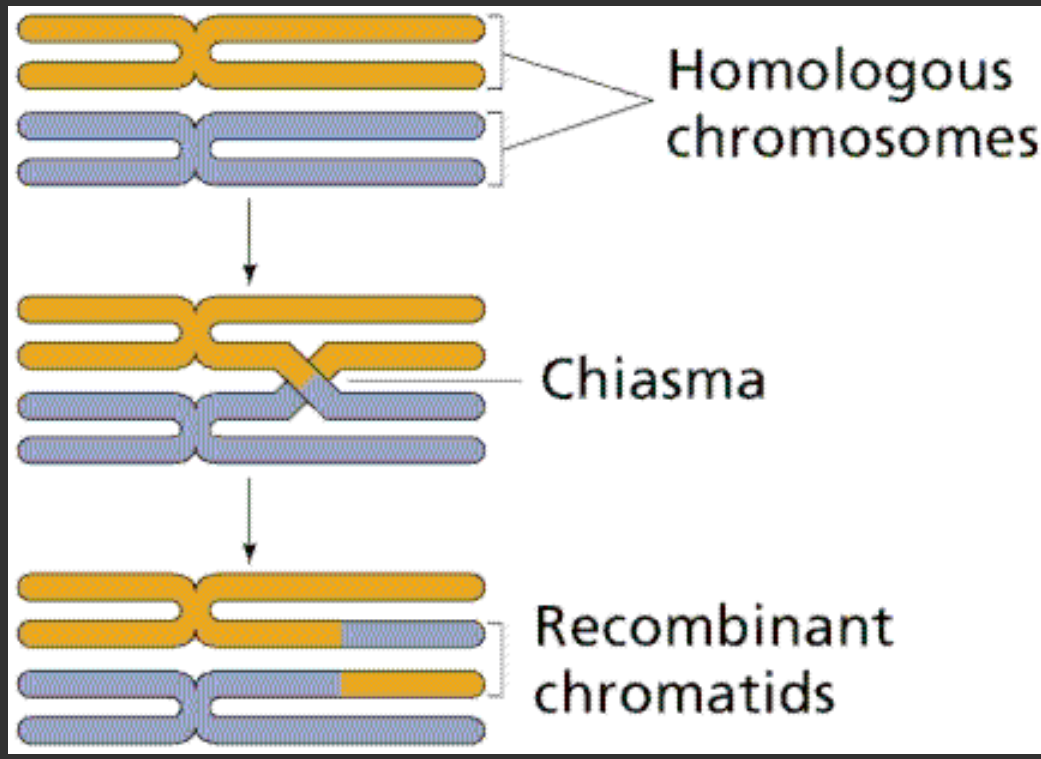
Meiosis generates genetic variation in two ways:

- Crossing over
- Independent assortment

Crossing Over

When homologous chromosomes are lined up side-by-side (synapsis), they can exchange genetic information, like alleles.

This event happens during Prophase I.



Independent assortment

Is the random assortment of alleles and chromosomes during gamete production (meiosis)

- Alleles – different "versions" of a gene
  - For example, if there was a single gene for eye color, there would be certain alleles for brown eyes and other alleles for blue eyes.

Today's Objectives

- View prepared slides and be able to identify the phases of mitosis.

- Simulate the phases of meiosis using beads and magnets.
  - Understand how crossing over and independent assortment can affect the gametes you "create"