Cell division: MITOSIS

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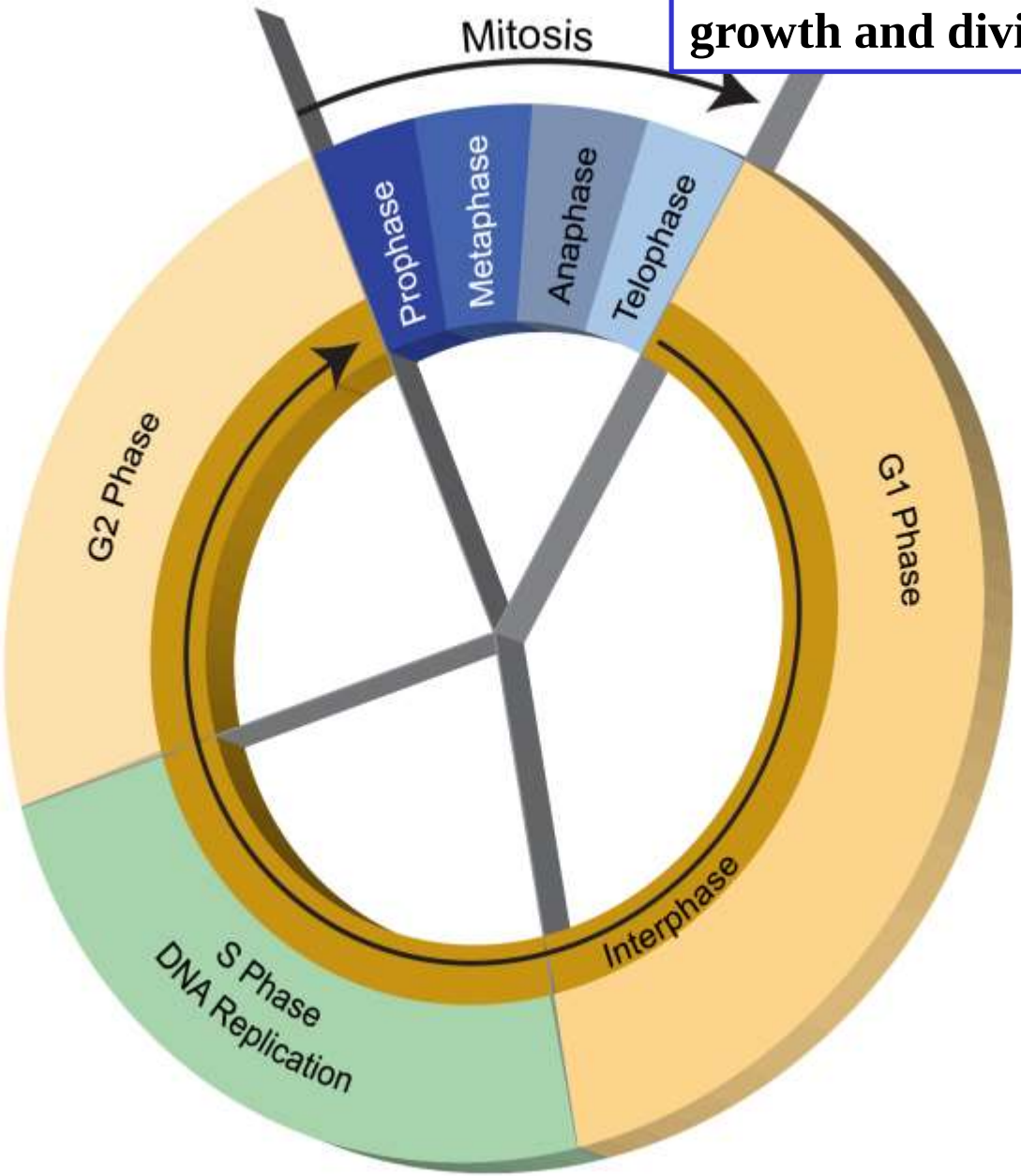
3 Types of Cell Division

Type of Cell Division	Type of Cells it occurs in	Function
Binary Fission	Prokaryotes	Asexual Reproduction
Mitosis	Eukaryotes	Asexual Reproduction Growth of Individual Repair/Maintenance of Tissues
Meiosis	Eukaryotes	Sexual Reproduction

The cell cycle is a sequence of cell growth and division.



The Cell Cycle

- The cell cycle is the period from the beginning of one division to the beginning of the next.

- **The cell cycle consists of 2 major phases:**
  - **Interphase** (cell growth and copying of chromosomes in preparation for cell division

✓ G_1 - primary growth phase

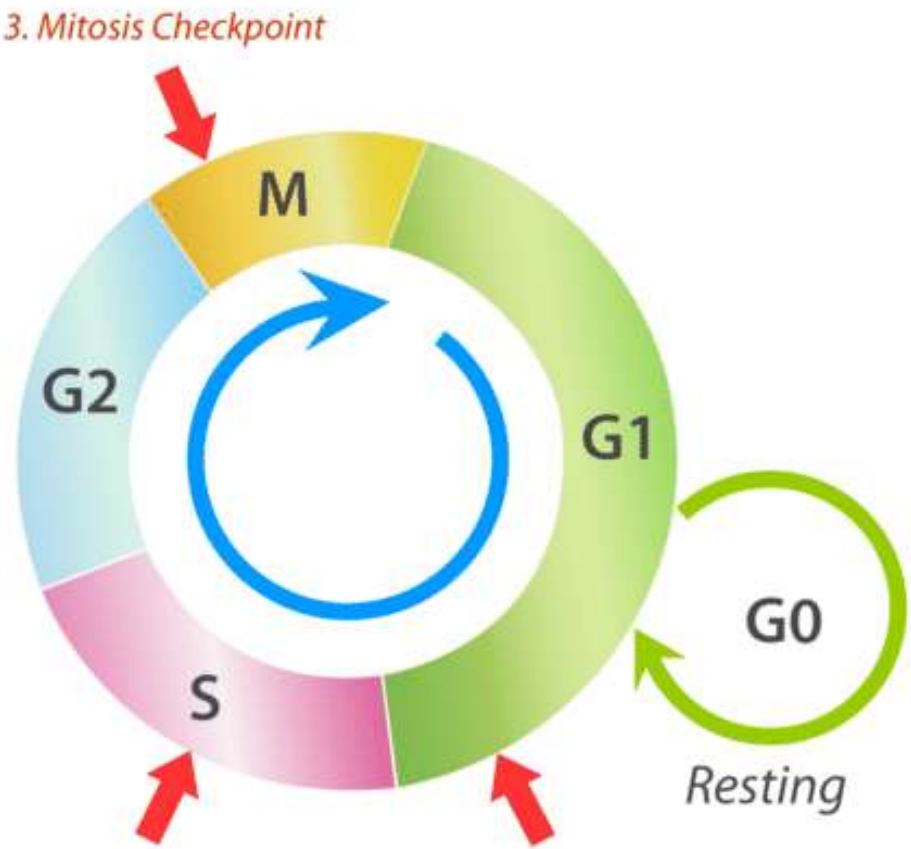
✓ S – synthesis; DNA replicated

✓ G_2 - secondary growth phase

collectively these **3 stages** are **called interphase**

- **Mitotic (M) phase**

The Cell Cycle and the Checkpoints



1. Cell Growth Checkpoint

- Occurs toward the end of growth phase 1 (G1).
- Checks whether the cell is big enough and has made the proper proteins for the synthesis phase.
- If not, the cell goes through a resting period (G0) until it is ready to divide.

2. DNA Synthesis Checkpoint

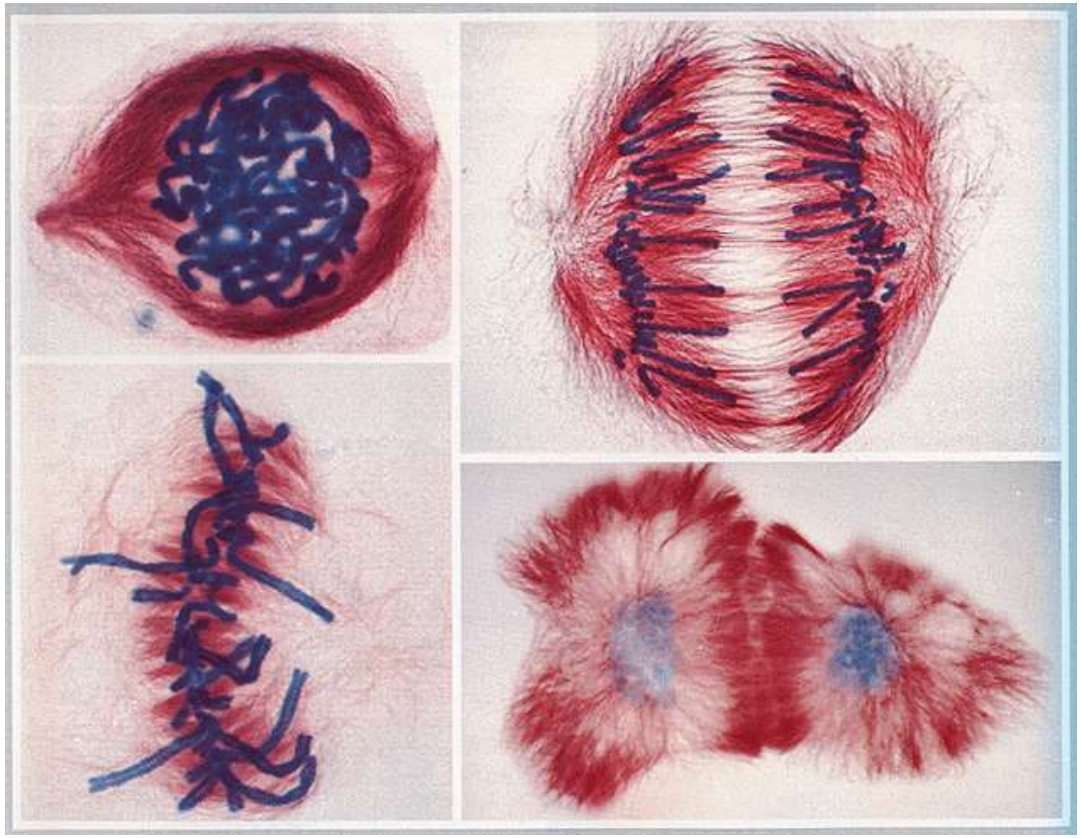
- Occurs during the synthesis phase (S).
- Checks whether DNA has been replicated correctly.
- If so, the cell continues on to mitosis (M).

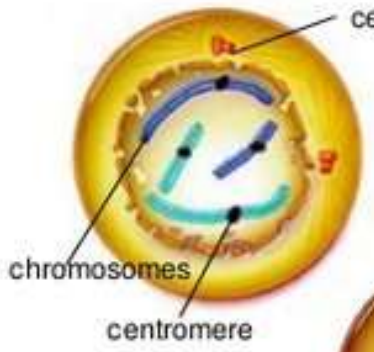
3. Mitosis Checkpoint

- Occurs during the mitosis phase (M).
- Checks whether mitosis is complete.
- If so, the cell divides, and the cycle repeats.

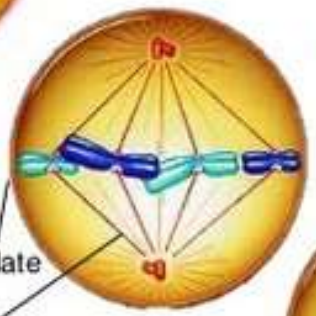
Mitosis

- ✓ **Division of the nucleus called karyokinesis**
- ✓ **Division of the cytoplasm called Cytokinesis**

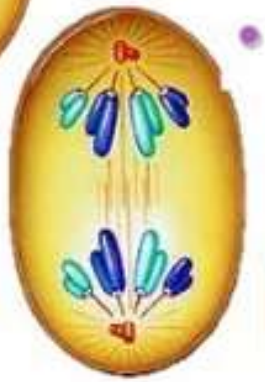




- **Prophase**



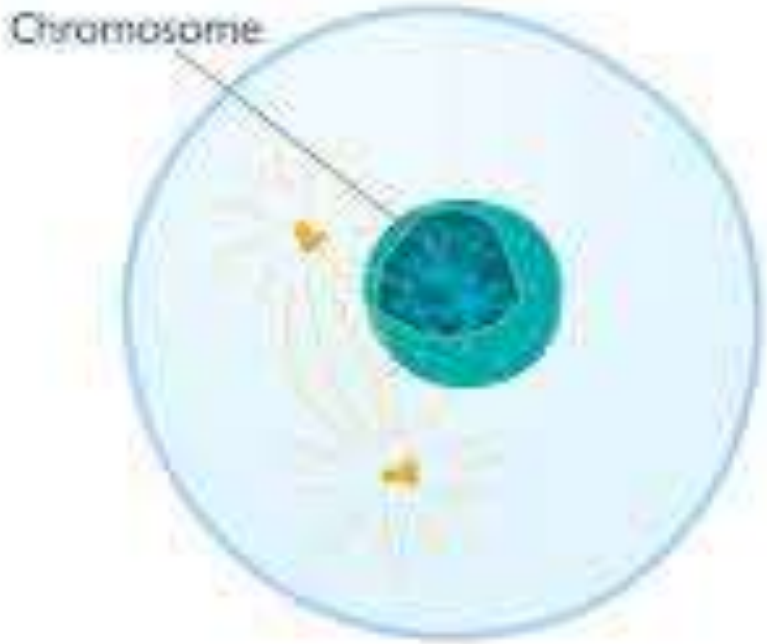
- **Metaphase**



- **Anaphase**

- **Telophase**

Mitosis

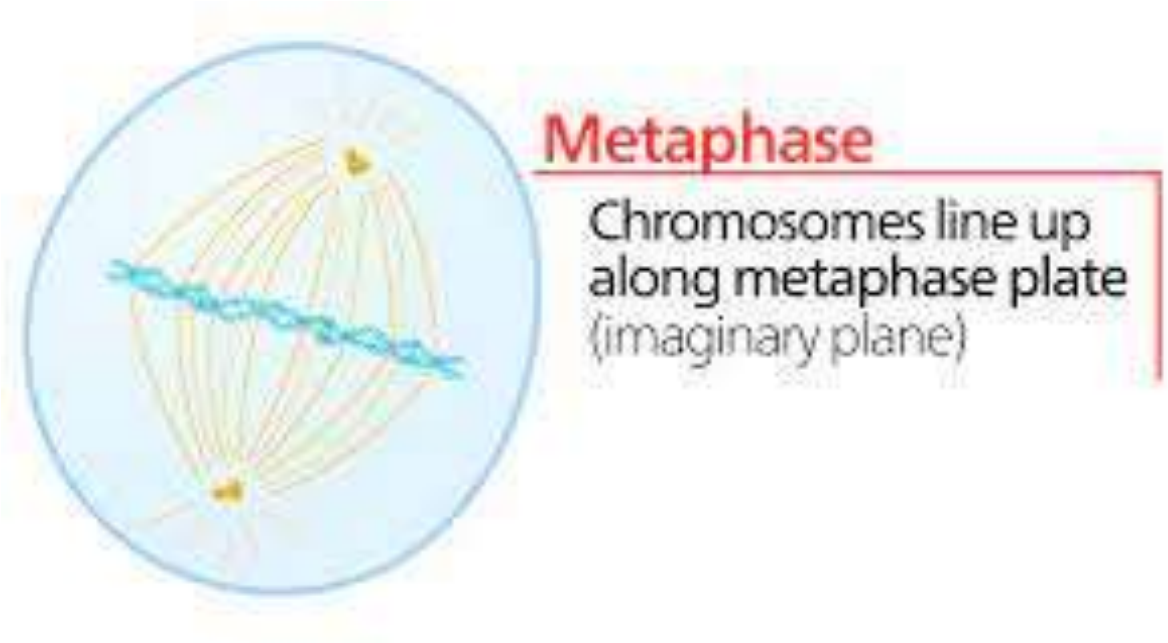


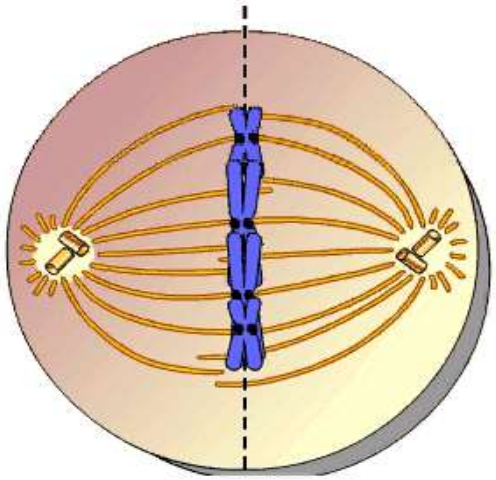
Prophase

Chromatin condenses into **chromosomes**

Nucleolus disappears

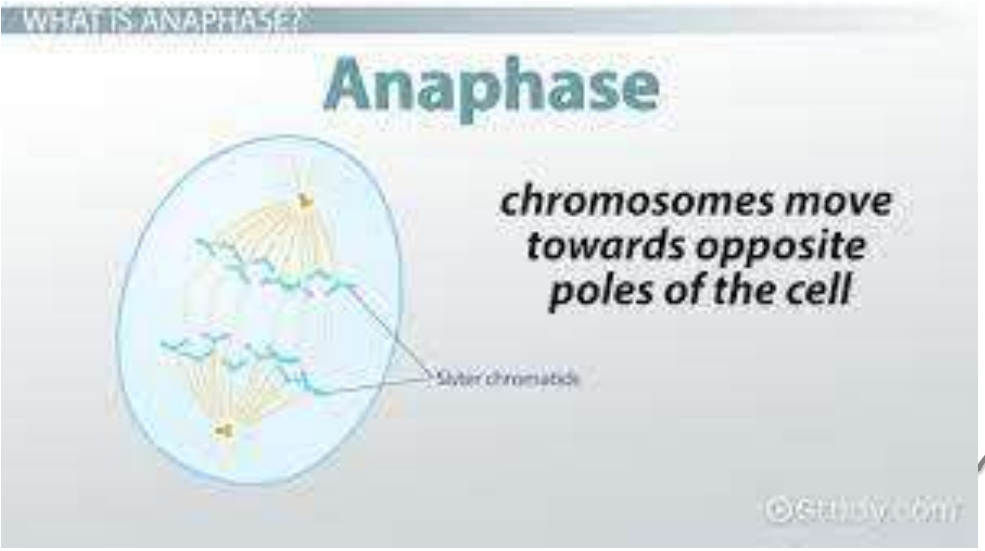
Metaphase





The best stage at which the total number of chromosomes can be counted in any species is metaphase

3-Anaphase



- Each centromere splits making two chromatids free
- Each chromatid moves toward a pole
- Cell begins to elongate, caused by microtubules not associated with the kinetochore

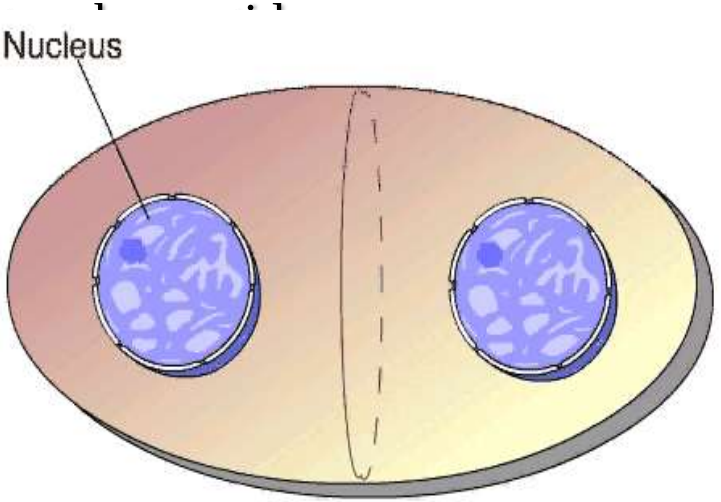
✓Occurs rapidly

✓Sister chromatids are pulled apart to opposite poles of the cell by kinetochore fibers

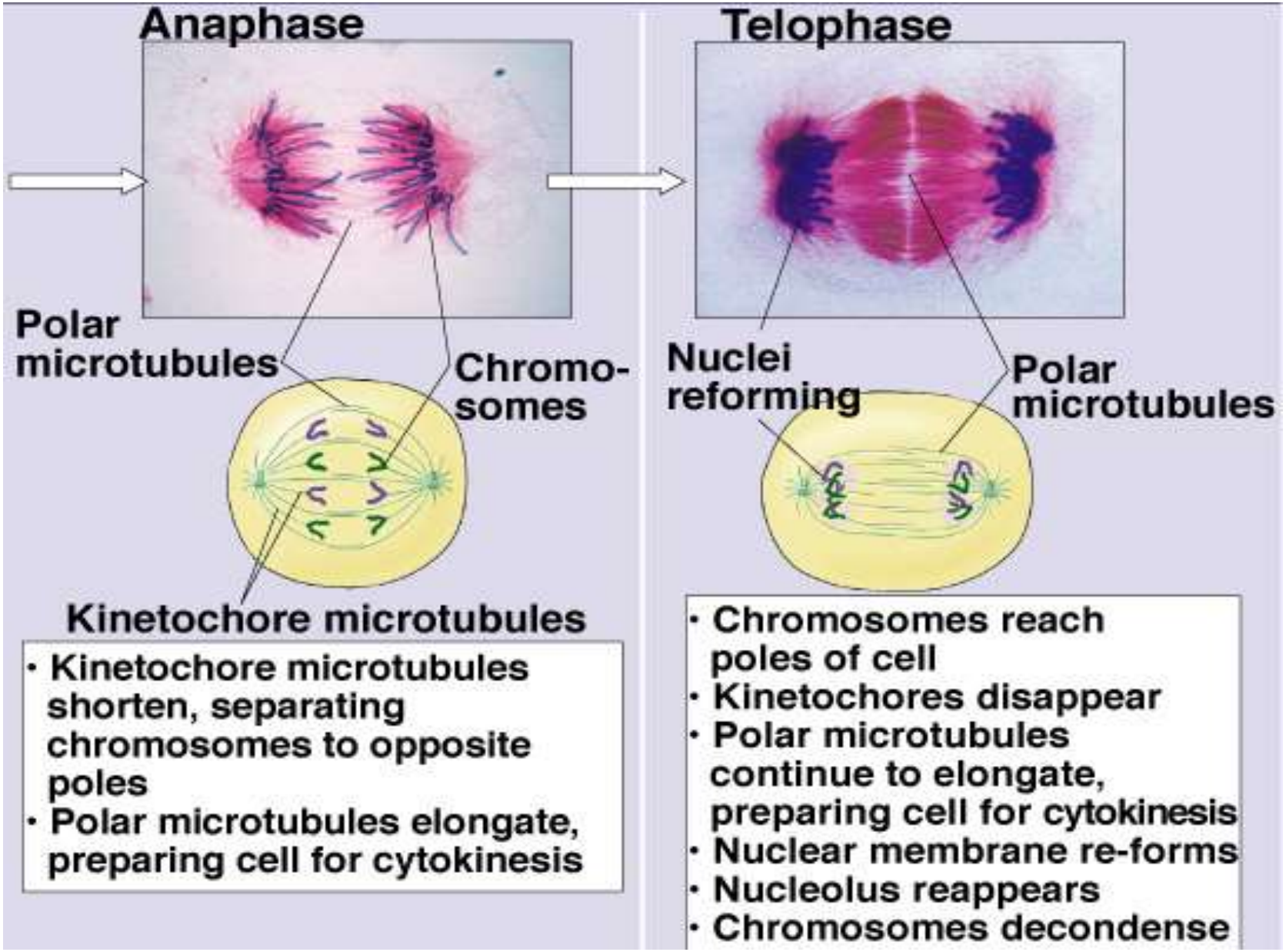
4. Telophase

- Formation of nuclear membrane and nucleolus
- Short and thick chromosomes begin to elongate to form long and thin chromatin
- Formation of the cleavage furrow - a shallow groove in the cell near the old metaphase plate
- **Formation of cell plate starts at telophase**

- **Cytokinesis =** division of the cytoplasm
  - ✓Sister chromatids at opposite poles
  - ✓Spindle disassembles
  - ✓Nuclear envelope forms around each set of sis
  - ✓Nucleolus reappears
  - ✓CYTOKINESIS occurs
  - ✓Chromosomes reappear as chromatin



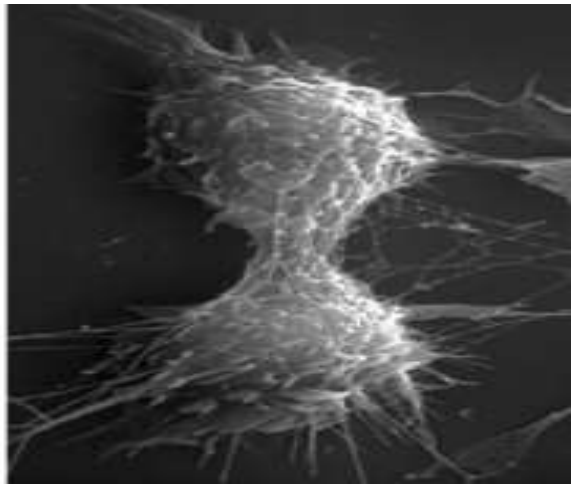
Comparison of Anaphase & Telophase



Cytokinesis

- ✓ Means division of the cytoplasm
- ✓ Division of cell into two, identical halves called daughter cells
- ✓ cleavage furrow forms to split cell
- Nuclear membranes form around the two new sets of chromosomes.
- The spindle fiber disappears.
- Chromosomes start to uncoil (chromatin) and become less visible.
- Cell starts to make a groove (furrow) in the middle to eventually split into two identical cells.

❑ If cells undergo mitosis and not cytokinesis, this will result in cell with two nuclei.



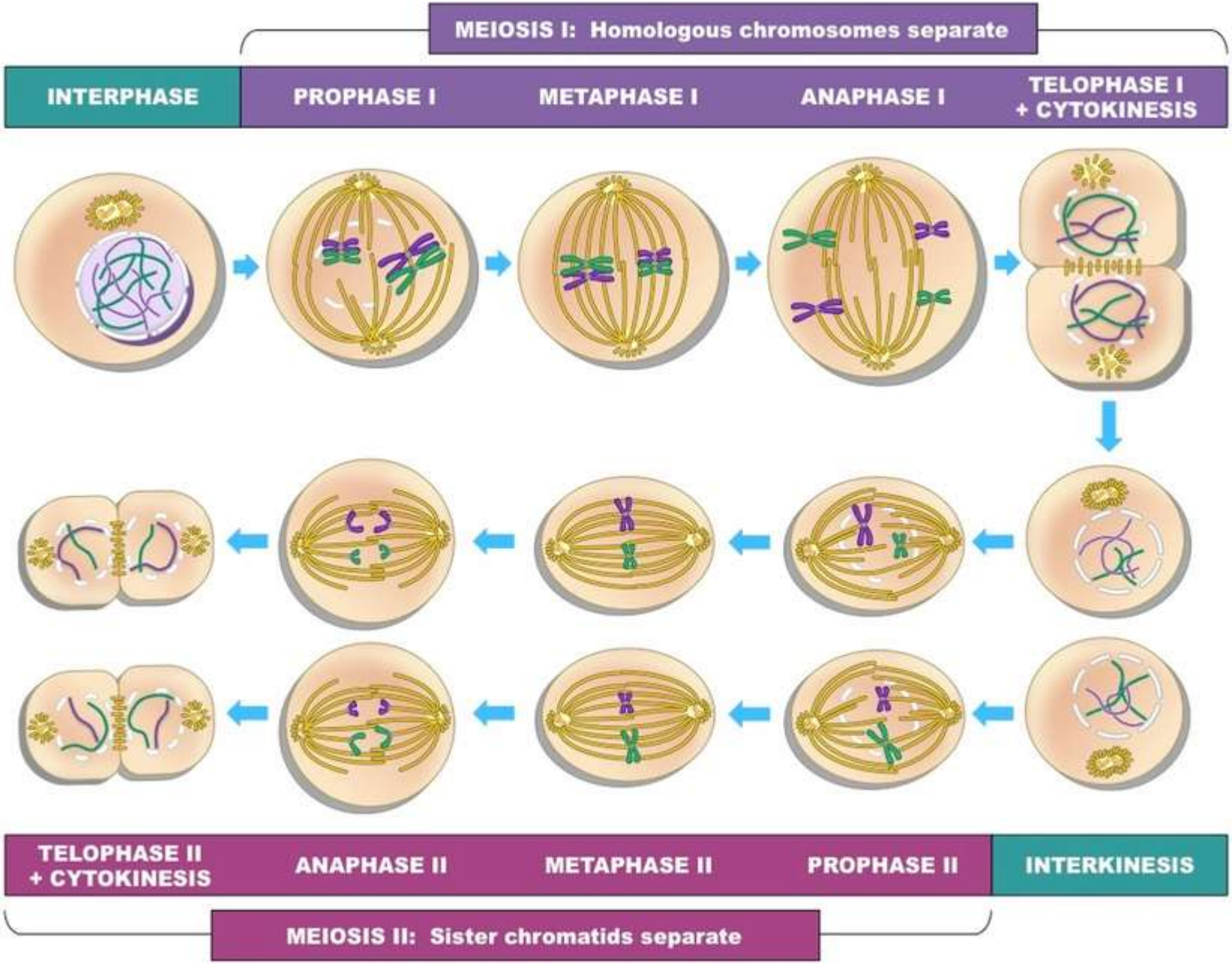
The Key Roles of Cell Division

- The ability of organisms to produce more of their own kind best distinguishes living things from nonliving matter
- The **continuity of life** is based on the reproduction of cells, or **cell division**
- In unicellular organisms, division of one cell reproduces the entire organism
- Multicellular organisms depend on cell division for
  - Development from a fertilized cell
  - Growth
  - Repair
- Cell division is an integral part of the **cell cycle**, the life of a cell from formation to its own division
- **Most cell division results in genetically identical daughter cells**
- Most cell division results in daughter cells with identical genetic information, DNA
- The exception is meiosis, a special type of division that can produce sperm and egg cells

Cell-division- **Meiosis**

Comparison of Divisions

	Mitosis	Meiosis
Number of divisions	1	2
Number of daughter cells	2	4
Genetically identical?	Yes	No
Chromosome	Same as parent	Half of parent
Where	Somatic cells	Germ cells
When	Throughout life	At sexual maturity
Role	Growth and repair	Sexual reproduction


MEIOSIS I: Homologous chromosomes separate
INTERPHASE
PROPHASE I
METAPHASE I
ANAPHASE I
TELOPHASE I + CYTOKINESIS
TELOPHASE II + CYTOKINESIS
ANAPHASE II
METAPHASE II
PROPHASE II
INTERKINESIS
MEIOSIS II: Sister chromatids separate

Prophase I

- Longest and most complex phase
- 90% of the meiotic process is spent in Prophase I
- This stage is composed of **5 stages:**

1- Leptotene(thin threads)

2- Zygotene (Homologus bivalent = **synapsis**)

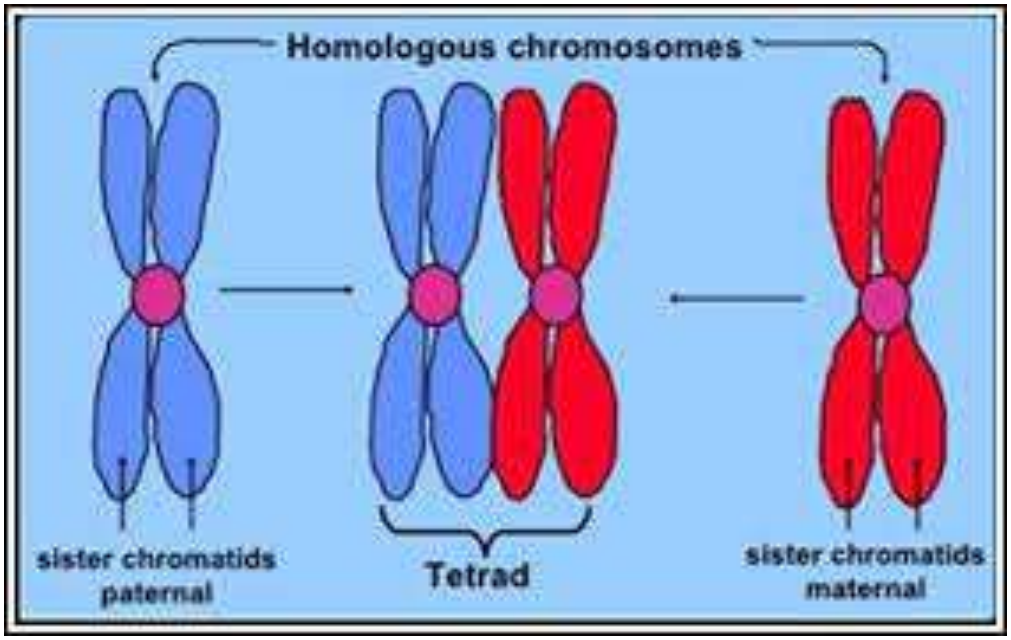
3- Pachytene (condense short &thick)

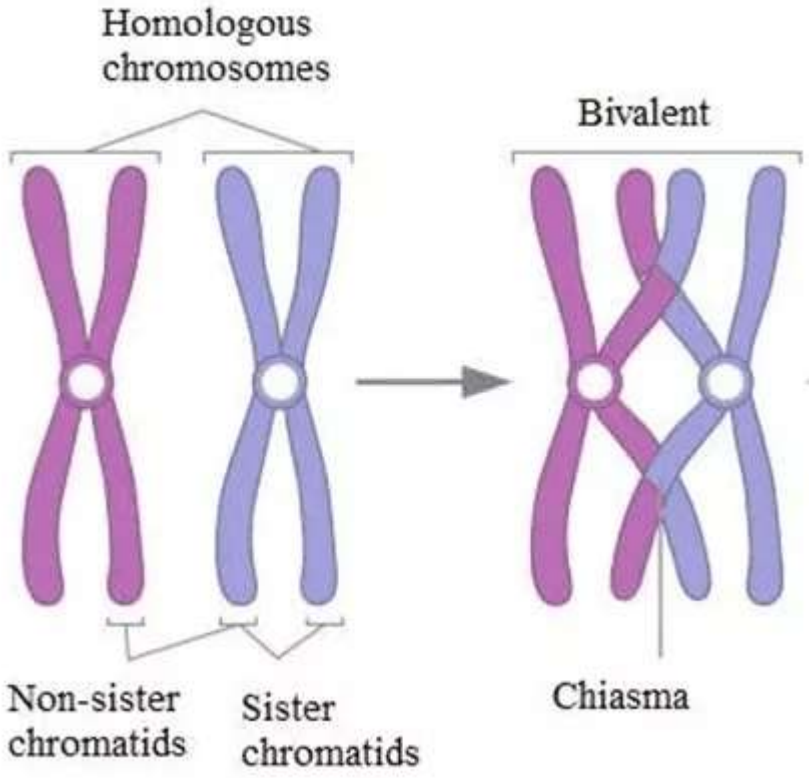
4- Diplotene (**crossing –over**)

5- Diakinesis + (nuclear memb & nucleoles disappear)

- **Chromosomes** condense.
- **Synapsis** occurs: homologous chromosomes come together to form a tetrad.
- **Tetrad** is two chromosomes or four chromatids

Tetrads Form in Prophase I



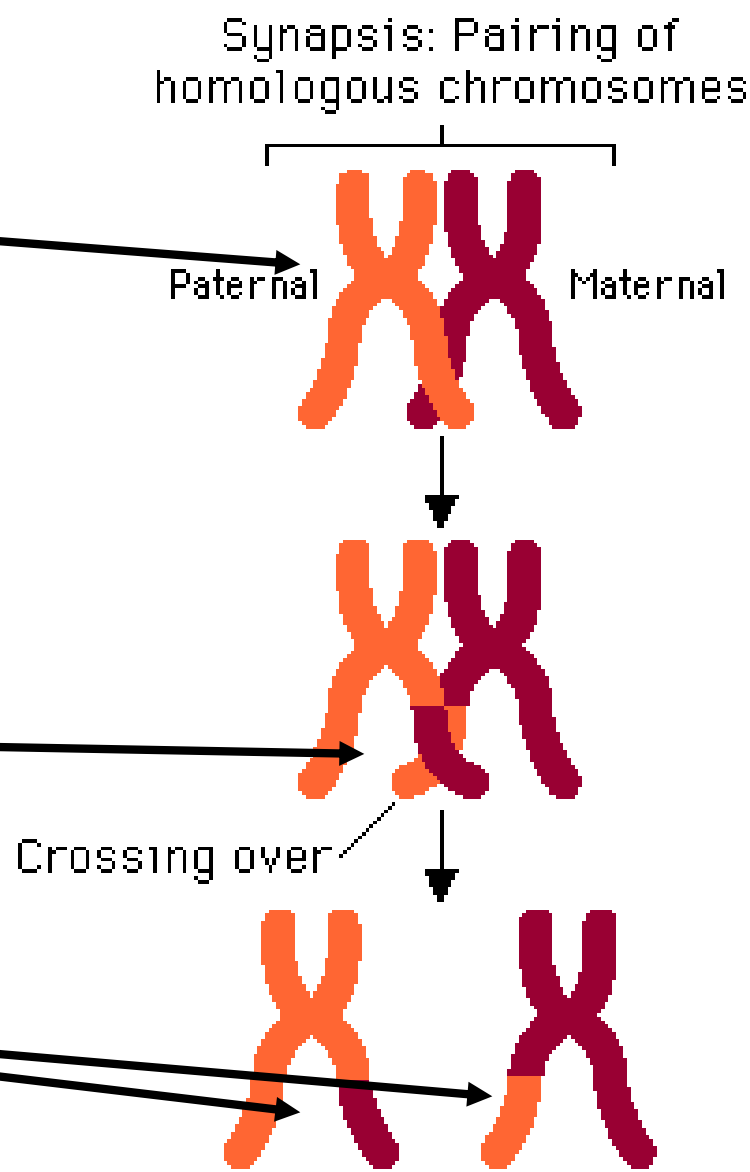


Crossing-Over

Homologous chromosomes in a tetrad cross over each other

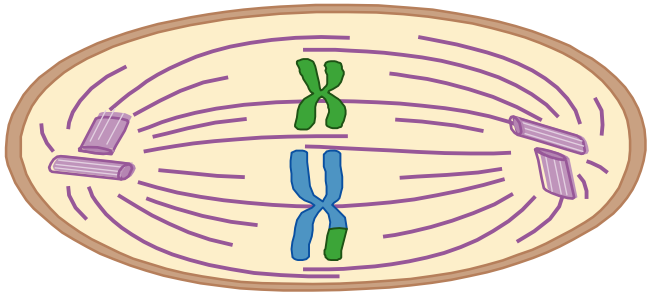
Pieces of chromosomes or genes are exchanged

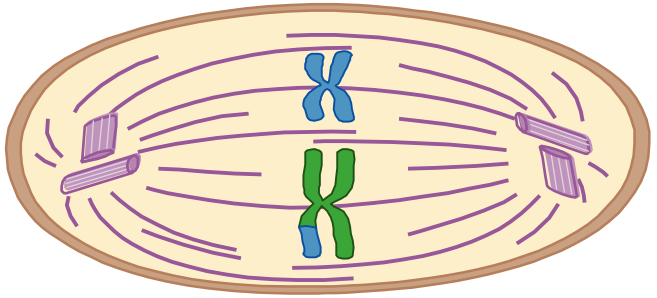
Produces Genetic recombination in the offspring



Metaphase II

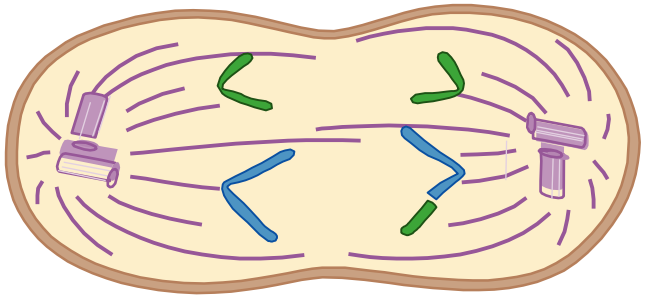
- The chromosomes are positioned on the metaphase plate in a mitosis-like fashion
- Chromosomes align
- along equator of cell

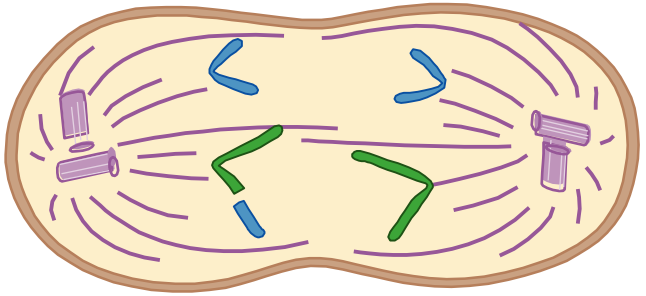




Anaphase II

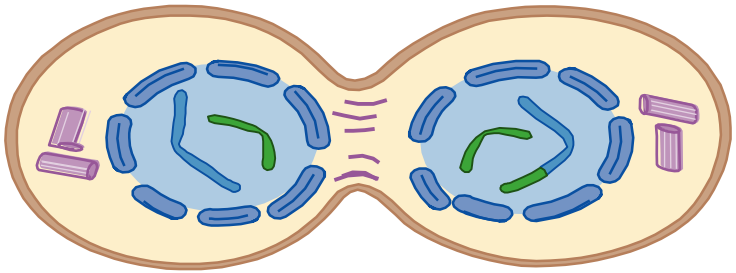
- The centromeres of sister chromatids finally separate
- The sister chromatids of each pair move toward opposite poles
- Sister chromatids separate and move to opposite poles.

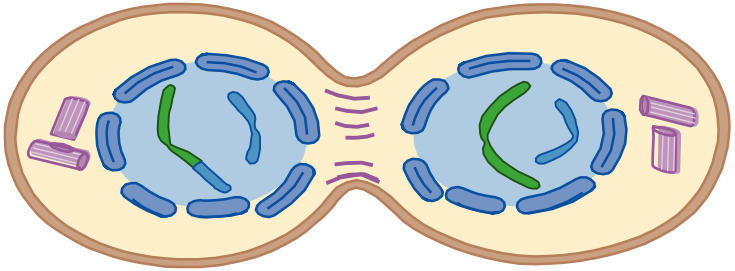




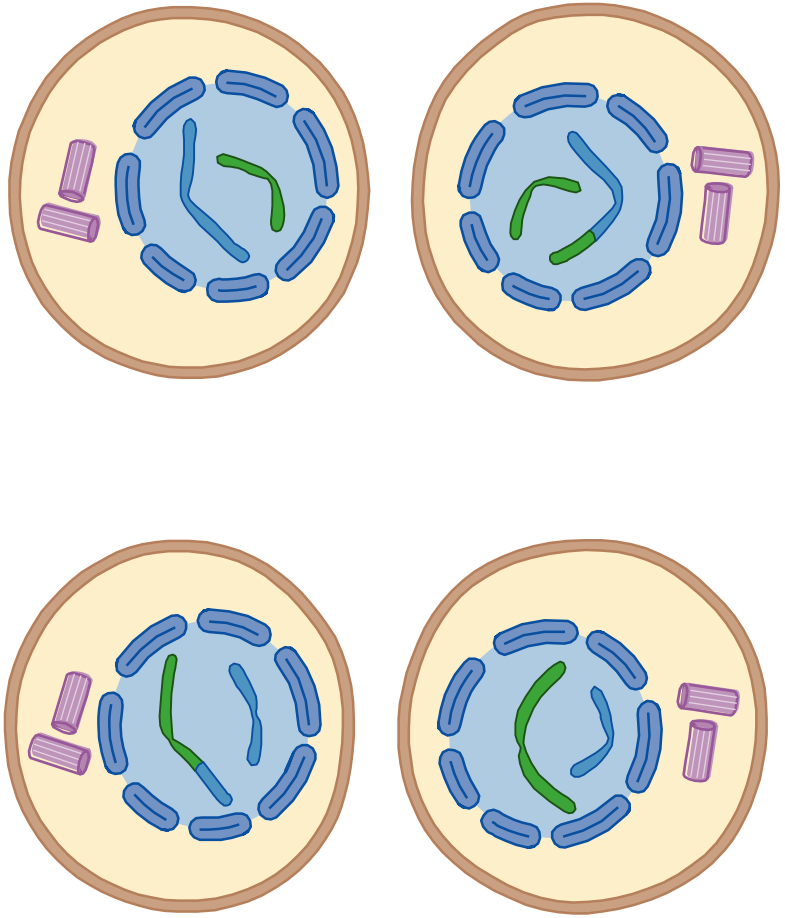
Telophase II and Cytokinesis

- **Nuclei form at opposite poles of the cell and cytokinesis occurs**
- **After completion of cytokinesis there are four daughter cells**
  - **All are haploid (n)**
- Nuclear envelope assembles.
- Chromosomes decondense.
- Spindle disappears.
- Cytokinesis divides cell into two.





Results of Meiosis



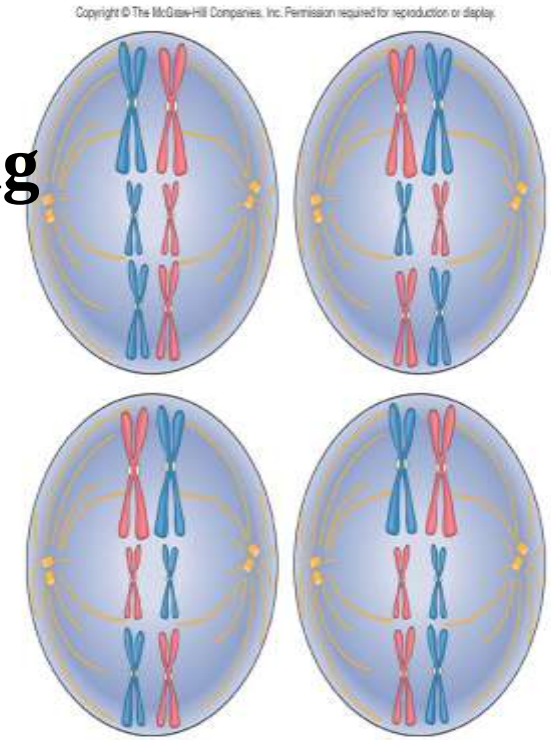
Gametes (egg & sperm) form

Four haploid cells with one copy of each chromosome

Different combinations for different genes along the chromosome

Genetic Diversity

- Meiosis increases genetic diversity.
- Genetic Variation Among Offspring
- **Two points of genetic recombination.**
  - **Crossing-over** of non sister chromatids—Prophase 1
  - **Independent assortment** of homologous chromosomes during Metaphase 1



Independent assortment