Cell Division

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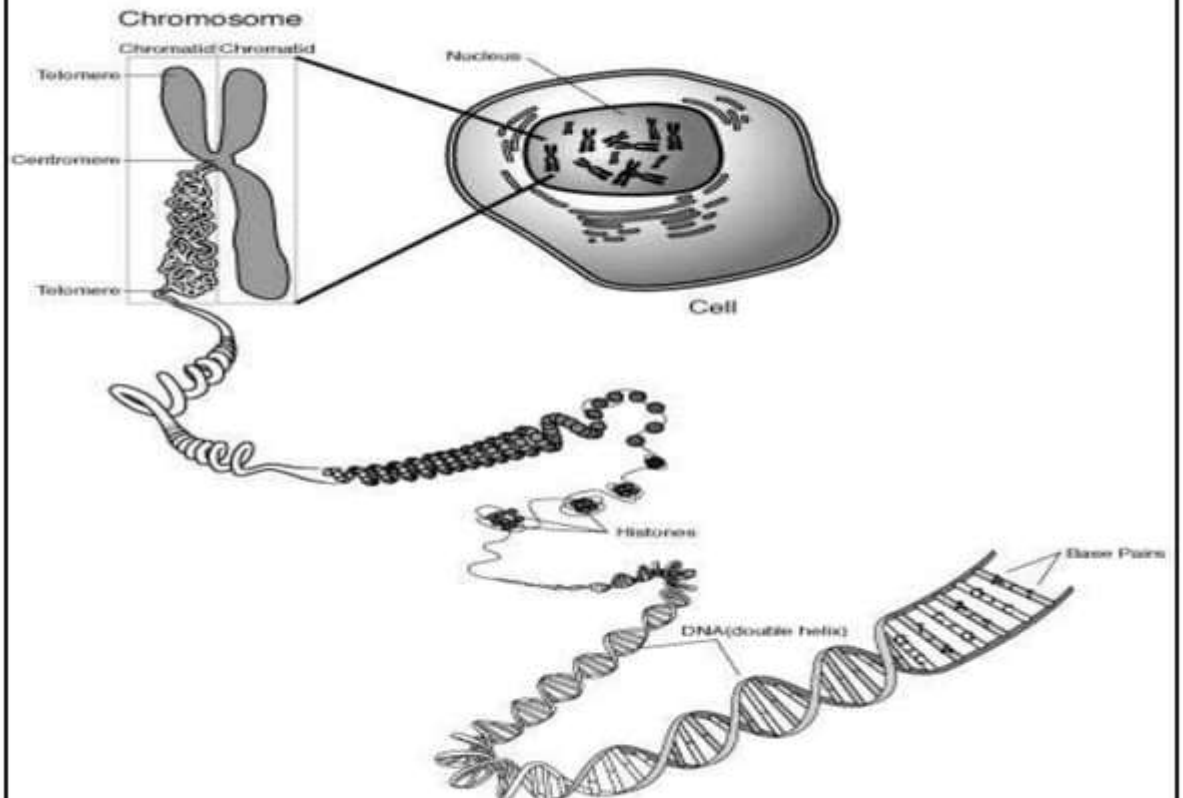

Chromosome
Chromatid
Chromatid
Telomere
Centromere
Telomere
Nucleus
Cell
Histones
Base Pairs
DNA(double helix)

earth

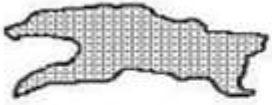
cell

country

chromosome

state

chromosome fragment



city

gene

people

nucleotide base pairs

Comparative Scale of Mapping

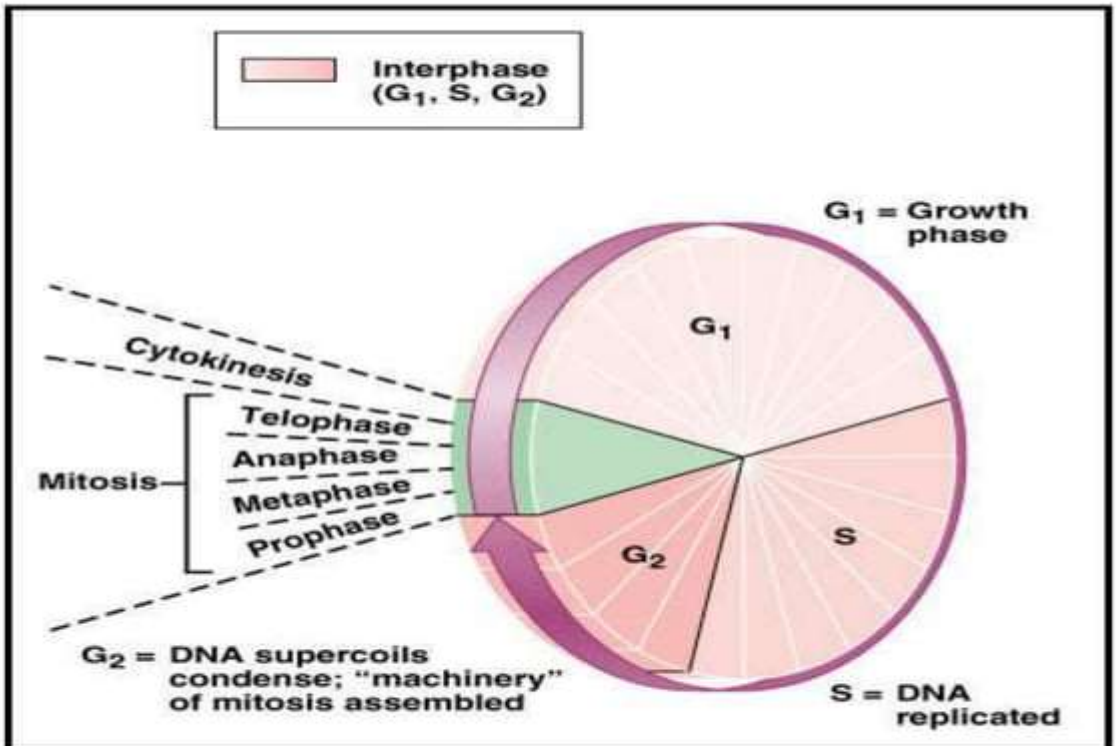
Cell Cycle

- The cell cycle is a sequence of cell growth and division.
- The cell cycle is the period from the beginning of one division to the beginning of the next.
- The time it takes to complete one cell cycle is the generation time.

- Cells divide when they reach a certain size

  NO (nerve, skeletal muscle and red blood cells)
- Cell division involves mitosis and cytokinesis.
- Mitosis involves division of the chromosomes.
- Cytokinesis involves division of the cytoplasm.
- Mitosis without cytokinesis results in multinucleate cells.

- **Eukaryotic cell cycle**
  - Beginning of one division to beginning of next
  - Stages in eukaryotic cell cycle
  - Interphase
    - First gap phase
    - Synthesis phase
    - Second gap phase
  - M phase
    - Mitosis
    - Cytokinesis


Interphase
(G1, S, G2)
G1 = Growth phase
G1
Cytokinesis
Telophase
Anaphase
Metaphase
Prophase
Mitosis
G2
S
G2 = DNA supercoils condense; "machinery" of mitosis assembled
S = DNA replicated

- Chromosomes become duplicated during interphase
- Cells are very active during interphase, synthesizing biological molecules and growing the G_1 (gap) phase
- The S (synthesis) phase is marked by DNA replication
- The G_2 (gap) phase occurs between the S phase and mitosis

- Despite differences between prokaryotes and eukaryotes, there are several common features in their cell division processes.
  - Replication of the DNA must occur.
  - Segregation of the "original" and its "replica" follow.
  - Cytokinesis ends the cell division process.
- Whether the cell was eukaryotic or prokaryotic, these basic events must occur.

Hereditary material is passed on to new cells by mitosis or meiosis

Cell division, growth, and reproduction

Interphase

Mitosis

Cytokinesis

Meiosis

Cell division

- Chromosomal packaging of DNA allows efficient distribution of genetic material during cell division
- Life cycle requires two distinct types of cell division processes: mitosis and meiosis
- Cell division: one cell becomes two cells during an organism's life cycle

Mitosis

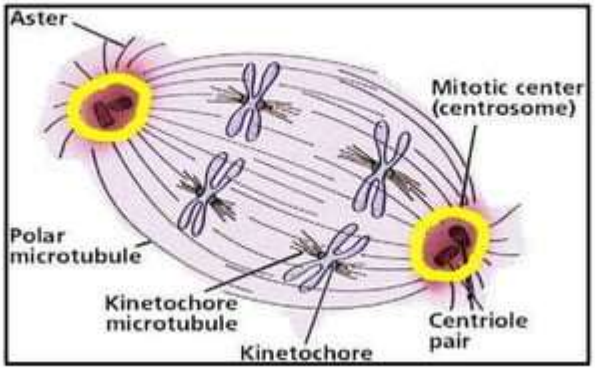
- Mitosis is nuclear division plus cytokinesis, and produces two identical daughter cells during the following steps:
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase.

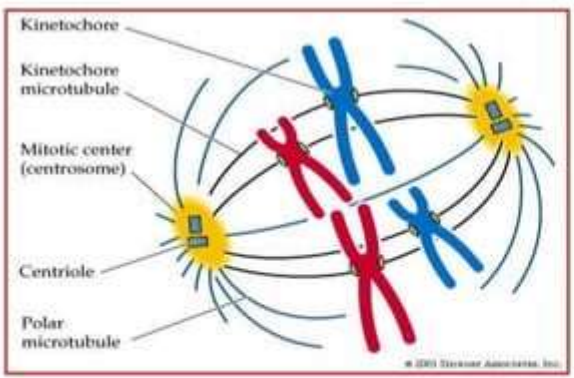
- Interphase is often included in discussions of mitosis, but interphase is technically not part of mitosis, but rather encompasses stages G1, S, and G2 of the cell cycle.

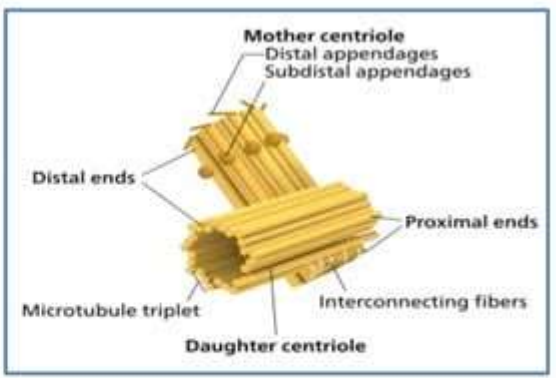
- A **Centriole** is a cylindrical cell structure composed mainly of a protein called tubulin that is found in most eukaryotic cells. Centrioles are involved in the organization of the mitotic spindle and in the completion of cytokinesis

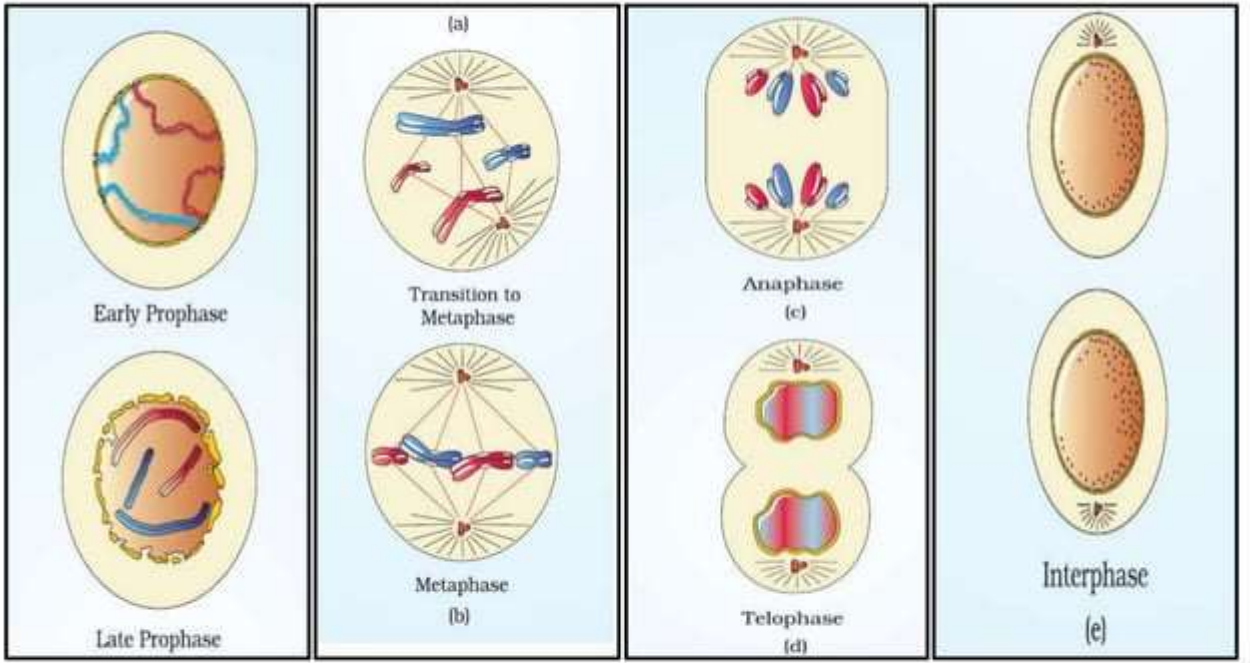
- the **centrosome** is an organelle that serves as the main microtubule organizing center (MTOC) of the animal cell as well as a regulator of cell-cycle progression

- The **centromere** is the part of a chromosome that links sister chromatids.


Aster
Mitotic center
(centrosome)
Polar
microtubule
Kinetochore
microtubule
Kinetochore
Centriole
pair

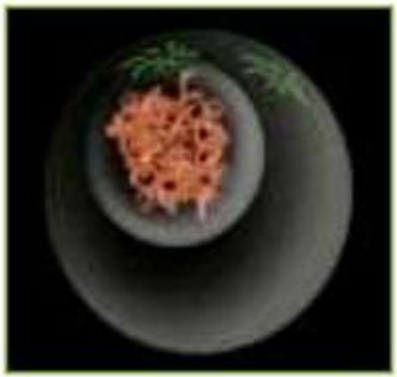

Kinetochore
Kinetochore
microtubule
Mitotic center
(centrosome)
Centriole
Polar
microtubule


Mother centriole
Distal appendages
Subdistal appendages
Distal ends
Proximal ends
Microtubule triplet
Interconnecting fibers
Daughter centriole


Early Prophase
Late Prophase
(a)
Transition to Metaphase
Metaphase
(b)
Anaphase
(c)
Telophase
(d)
Interphase
(e)

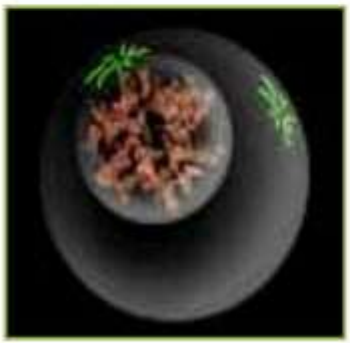
State	Description	Abbv	
Quiescent / senescent	**Gap 0**	**G_0**	A resting phase where the cell has left the cycle and has stopped dividing
Interphase	**Gap 1**	**G_1**	Cells increase in size in Gap 1. The ***G_1 checkpoint*** control mechanism ensures that everything is ready for ***DNA synthesis***.
	Synthesis	**S**	***DNA replication*** occurs during this phase.
	Gap 2	**G_2**	During the gap between DNA synthesis and mitosis, the cell will continue to grow. The **G_2 checkpoint** control mechanism ensures that everything is ready to enter the M (mitosis) phase and divide.
Cell division	**Mitosis**	**M**	Cell growth stops at this stage and cellular energy is focused on the orderly division into two daughter cells. A checkpoint in the middle of mitosis ***(Metaphase Checkpoint)*** ensures that the cell is ready to complete cell division.

Interphase



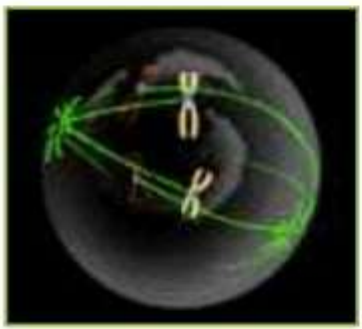
The cell is engaged in metabolic activity and performing its prepare for mitosis (the next four phases that lead up to and include nuclear division). Chromosomes are not clearly discerned in the nucleus, although a dark spot called the nucleolus may be visible. The cell may contain a pair of centrioles (or microtubule organizing centers in plants) both of which are organizational sites for microtubules.

Prophase



- Chromatin in the nucleus begins to condense and becomes visible in the light microscope as chromosomes.
- The nucleolus disappears.
- Centrioles begin moving to opposite ends of the cell and fibers extend from the centromeres.
- Some fibers cross the cell to form the mitotic spindle.

Prometaphase

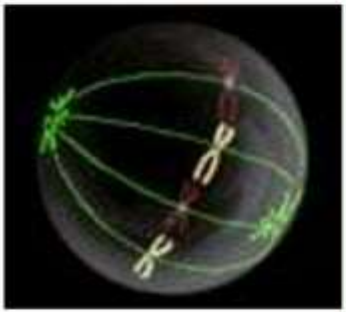


The nuclear membrane dissolves, marking the beginning of prometaphase.

Proteins attach to the centromeres creating the kinetochores.

Microtubules attach at the kinetochores and the chromosomes begin moving.

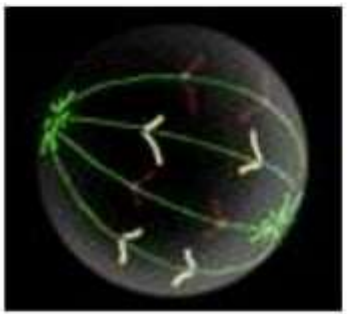
Metaphase



Spindle fibers line the chromosomes along the middle of the cell nucleus. This line is referred to as the metaphase plate.
Polar microtubules extend from the pole to the equator, and typically overlap
Kinetochore microtubules extend from the pole to the kinetochores

This organization helps to ensure that in the next phase, when the chromosomes are separated, each new nucleus will receive one copy of each chromosome.

Anaphase

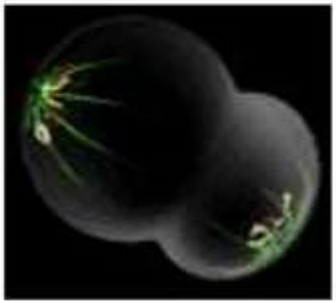


The paired chromosomes separate at the kinetochores and move to opposite sides of the cell.

The chromosomes are pulled by the kinetochore microtubules to the poles and form a "V" shape

Motion results from a combination of kinetochore movement along the spindle microtubules and through the physical interaction of polar microtubules.

Telophase

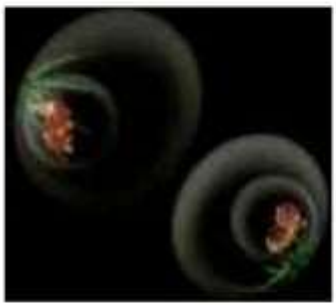


Chromatids arrive at opposite poles of cell, and new membranes form around the daughter nuclei.

The chromosomes disperse and are no longer visible under the light microscope.

The spindle fibers disperse, and cytokinesis will start.

Cytokinesis



In animal cells, cytokinesis results when a fiber ring composed of a protein called actin around the center of the cell contracts pinching the cell into two daughter cells, each with one nucleus.

In plant cells, synthesis of new cell wall between two daughter cells rather than cleavage furrow in

cytoplasm

- Significance of Mitosis:
- Restricted to Diploid Cells only
- Results in production of the diploid daughter cells with identical genetic compliment.
- Restores the Nucleo- cytoplasmic Ratio.

Meiosis

- Sexual reproduction involves fusion of two gametes, each with a complete haploid sets off chromosomes.
- Gametes are formed from special types of diploid cells.
- This specialized cell division that reduces the chromosomes no. to Half is called as meiosis

- Key Features
- Involves two sequential cycles called meiosis I and meiosis II. But only a single cycle of DNA replication.
- Meiosis I is initiated after Parental Chromosomes have replicated to form identical sister chromatids at S Phase.
- Involves pairing of Homologues Chromosomes and recombination between them.
- 4 Haploid cells are formed at the end of the Meiosis II.

Meiotic events can be grouped under the following phases:

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II

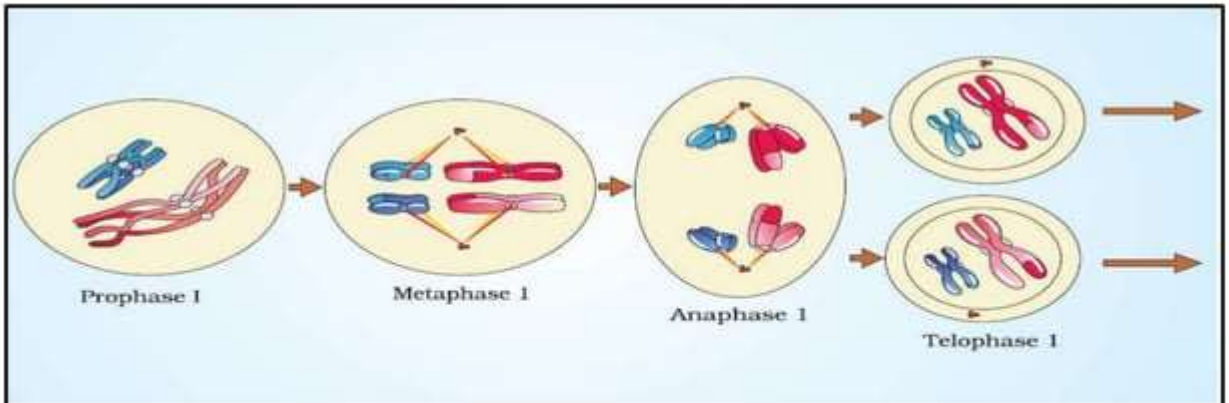


Figure 10.3 Stages of Meiosis I

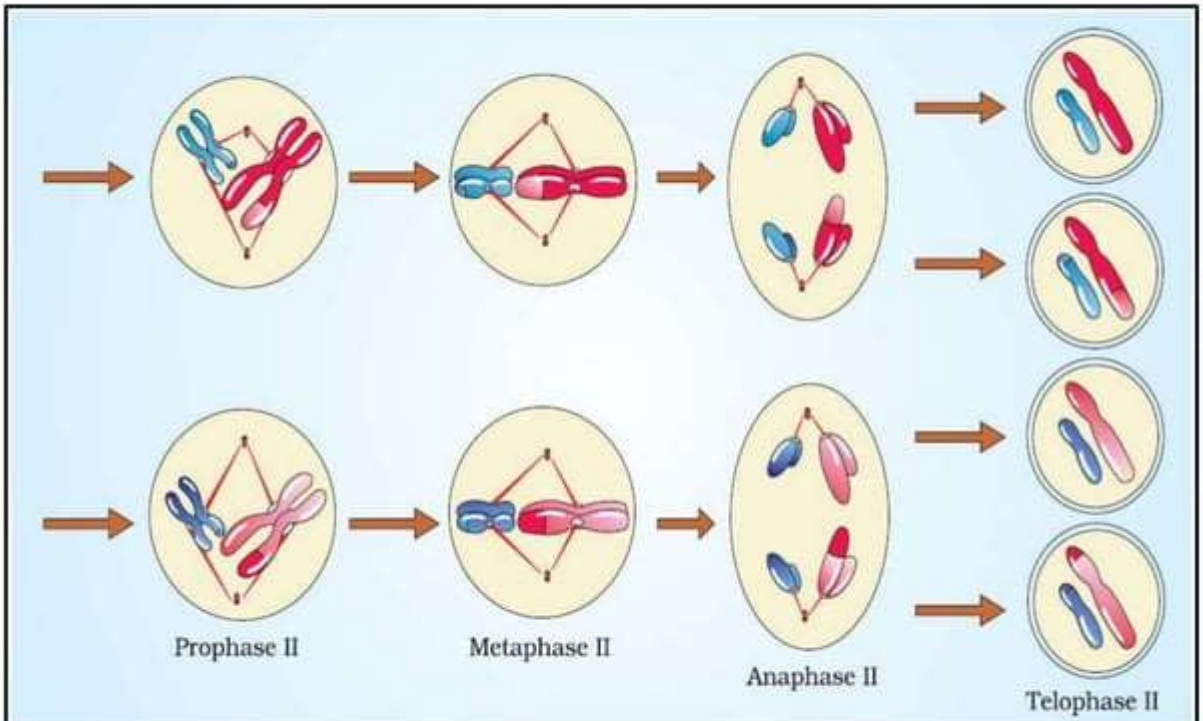
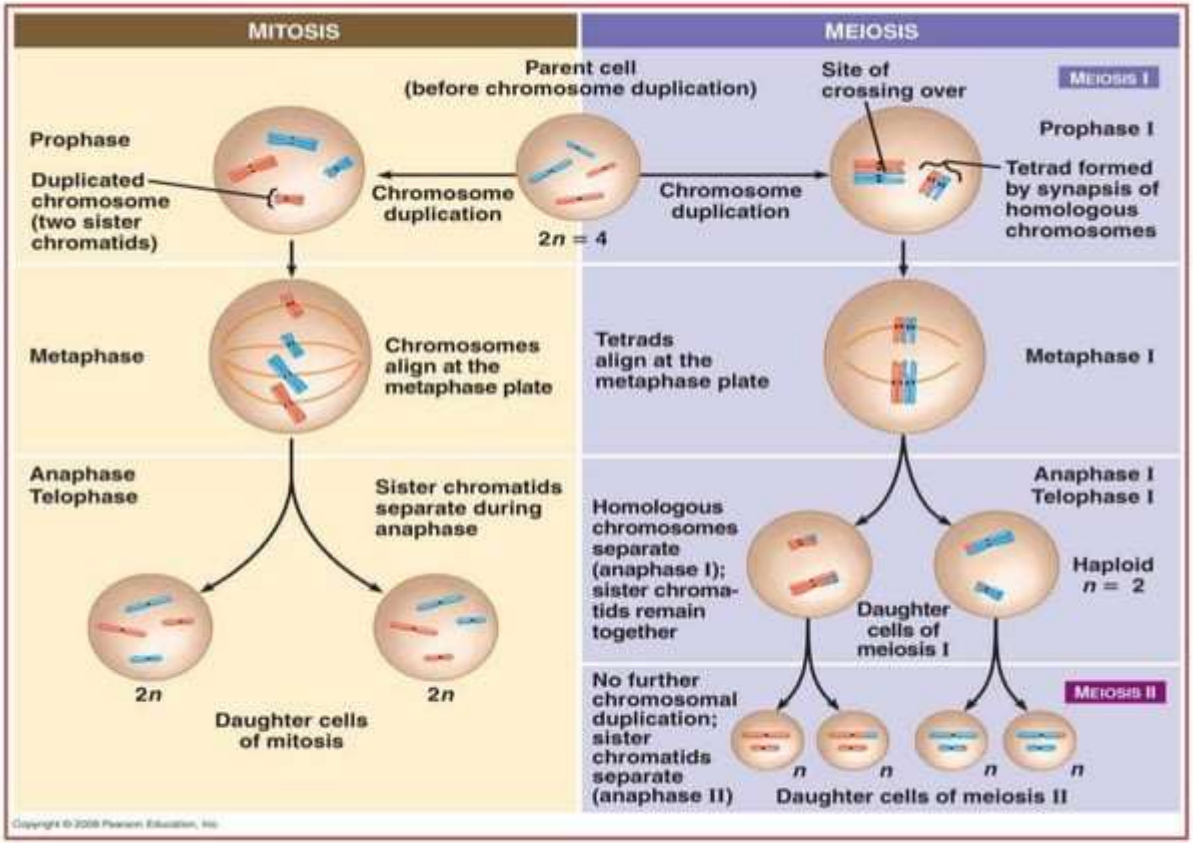


Figure 10.4 Stages of Meiosis II

Mitosis vs. Meiosis

Property	Mitosis	Meiosis
DNA Replication	Occurs during interphase before mitosis begins.	Occurs during interphase before meiosis begins.
Number of divisions	One	Two
Synapsis of homologous chromosomes	Does not occur.	Occurs along with crossing over between non-sister chromatids in prophase I.
Number of daughter cells and genetic composition	Two diploid (2n) daughter cells that are genetically identical to the parent cell.	4 haploid (n) daughter cells, each containing half as many chromosomes as the parent cell. Daughter cells are genetically different from the parent cell and each other.
Role in the animal body	Produces cells for growth and repair.	Produces gametes and assures genetic diversity in sexual reproduction.




thank
thank
thank
thank
you