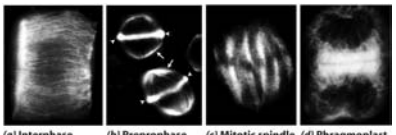
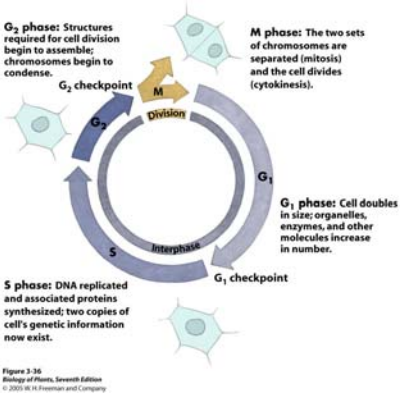
Cell Division I: Mitosis

Cell duplication



(a) Interphase (b) Preprophase band and spindle (c) Mitotic spindle at metaphase (d) Phragmoplast at telophase

The Cell Cycle



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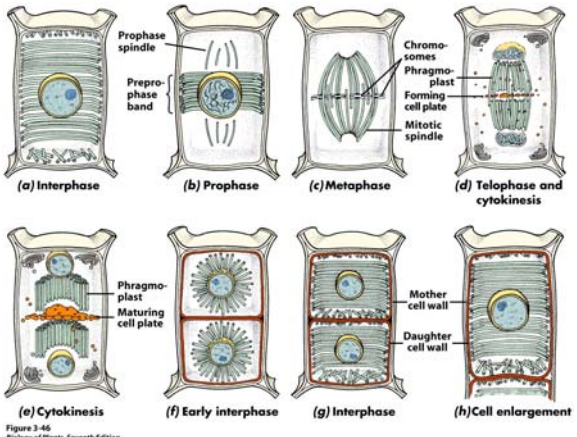

Figure 3-46
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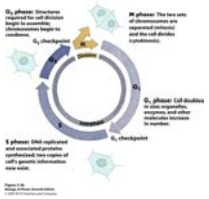
Cell division

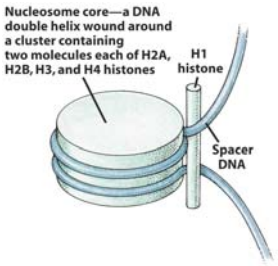
- Interphase, Mitosis, Cytokinesis
- ***Interphase***: phase between successive mitotic divisions
- ***Mitosis***: production of two daughter nuclei from one nucleus (genetically identical)
- ***Cytokinesis***: Division of cells (cytoplasmic portions)

Interphase

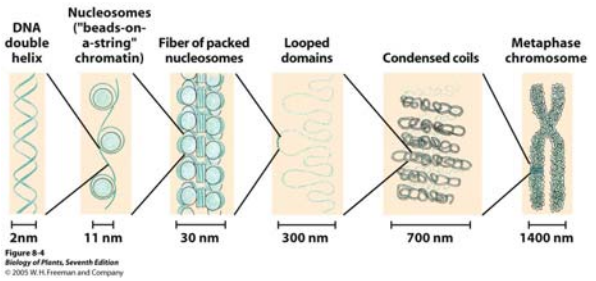
- (G = gap; S = synthesis)
- G1 – cell increases in size
  - Normal cell function
- S – Cell DNA duplicated
- G2 – Condensation of chromosomes
  - Structures for duplication assembled



Packing the DNA



How to Build a Chromosome

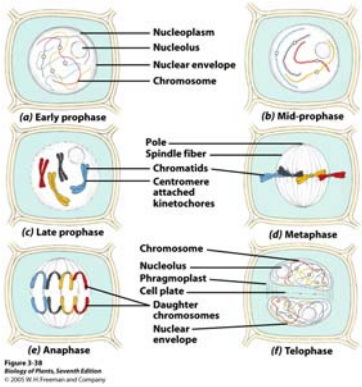


Mitosis: 4 Major Phases

- Prophase
- Metaphase
- Anaphase
- Telophase

  +

- Cytokinesis

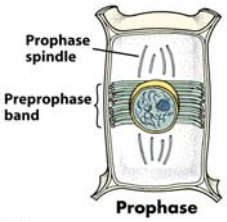


Mitosis

- Nuclei migrate to center of cell
- Anchoring strands merge & form a bisecting transverse sheet of cytoplasm in the plane where it will ultimately divide
  - Phragmosome
  - Unique to plants
- Preprophase band appears right before prophase
- Actin filaments aligned parallel with preprophase band microtubules
- Cell plate (cytokinesis) follows same pattern much later
  - Also unique to plants

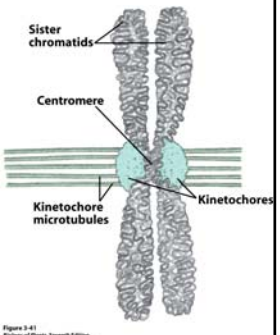
Prophase

- Chromosomes begin to condense
- Each chromosome now 2 sister chromatids
- Joined at centromere by late prophase
- First appearance of mitotic spindle assembly



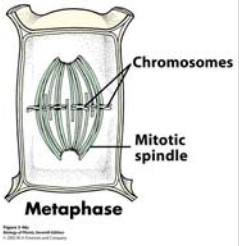
Prophase

- Nucleolus becomes indistinct, then disappears
- Nuclear envelope breaks down
- Kinetochores developed on each centromere
- Prophase ends when the nuclear envelope breaks down



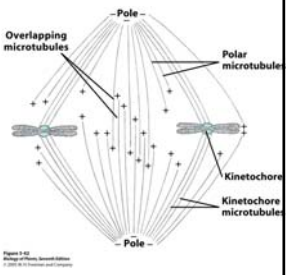
Metaphase

- Spindle = area formerly by the nucleus
- Spindle = polar- & kinetochore microtubules
- Actin filaments intermingled & form elastic cage around spindle during mitosis



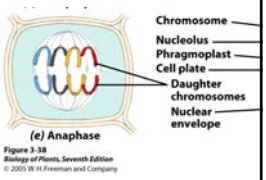
Metaphase

- Kinetochore microtubules attach to kinetochores
- Attached to one pole or another of spindle complex
- Align chromosomes midway between poles
- Kinetochores lie on spindle equatorial plane



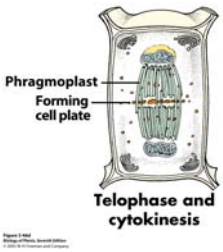
Anaphase

- Shortest phase
- Sister chromatids separate abruptly & simultaneously
  - Now called daughter chromosomes
  - Move to opposite poles
  - Dragged by kinetochores
  - Kinetochores shorten



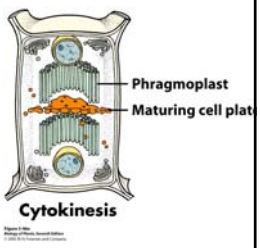
Telophase

- Separation complete
- Formation of nuclear envelopes
- Spindle disappears
- Chromosomes elongate
- Nucleoli reform



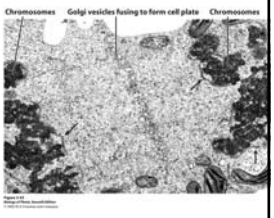
Cytokinesis

- Division of cytoplasm
- In most, cells divide by ingrowth of cell wall (if present) & constriction of plasma membrane, cutting through spindle fibers
- In bryophytes & vascular plants (& a few algae), division occurs by formation of a ***cell plate*** in the middle of the cell that grows outwards



Cytokinesis

- **Phragmoplast (series of microtubules) forms between the daughter nuclei**
- **Cell plate initiated as a disk suspended in the phragmoplast**
- **Grows outwards until reaches the edge**
- **Golgi apparatus involved**



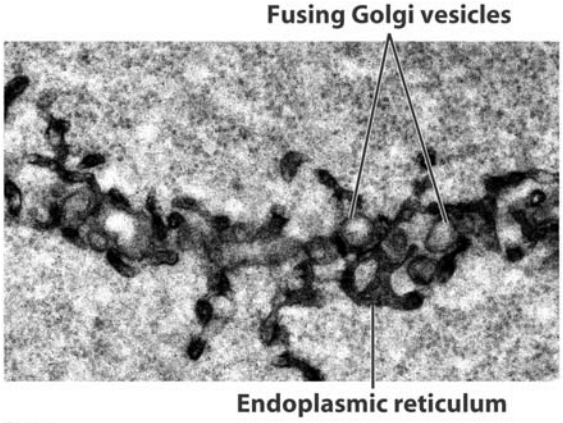


Figure 3-44a
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How Much Time?

Root tip

- **Prophase (1-2 hours)**
- **Metaphase (5-10 mins)**
- **Anaphase (2-10 mins)**
- **Telophase (10-30 mins)**
- **Interphase: 12-30 hours**

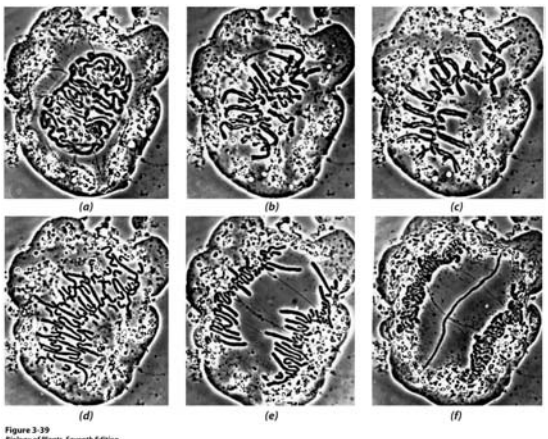

Figure 3-39
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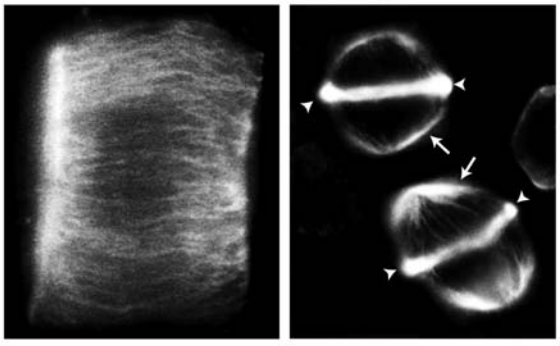

Interphase

Preprophase band and spindle

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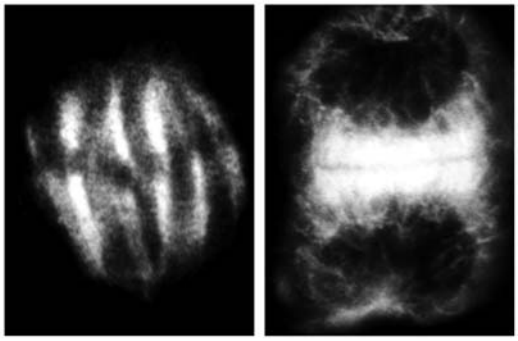

Mitotic spindle at metaphase

Phragmoplast at telophase

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Cell Division II: Meiosis

Gamete Formation
Sexual Reproduction
Understanding Plant Life Cycles

Meiosis

- **2 consecutive nuclear divisions**
- **Meiosis I**
  - **Separation of homologous chromosomes**
- **Meiosis II**
  - **Separation of chromatids of each homolog**

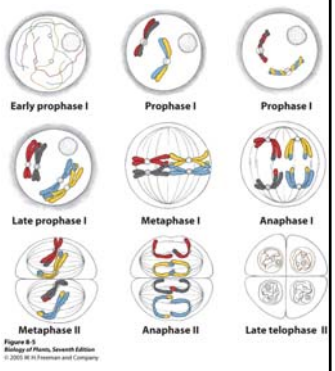

Figure 8-5
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Homologous vs. Chromatids

- Sister chromatids are duplicates of one chromosome
- Homologous chromosomes are a pair of chromosomes containing the same linear gene sequence but are not identical
  - One from each parent

Prophase I

- Chromosomes condense
- Homologous chromosomes pair off (synapsis)
  - Homologous pair = 4 chromatids
  - Homologous chromosomes = bivalents

Figure 8-5 part 1
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Prophase I

- When synaptonemal complex formed & axial cores of a pair of homologous chromosomes are very close to one another, crossing-over can occur

- Bits of chromosomes break off and "swap" with one another
- The X-like configuration is called a chiasma
- Important for genetic variation

Figure 8-5 part 2
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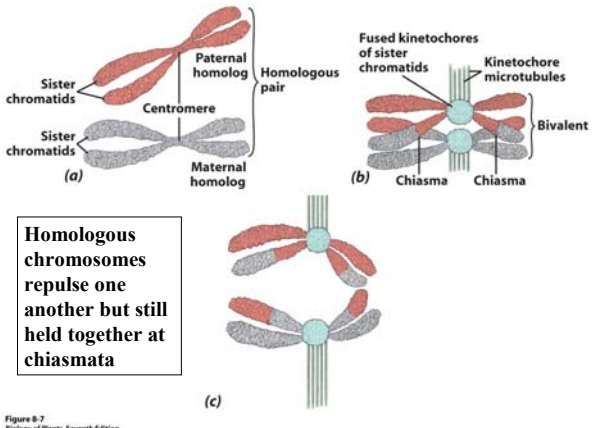

Homologous chromosomes repulse one another but still held together at chiasmata

Figure 8-7
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Figure 8-8
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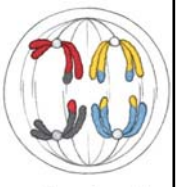
Metaphase I

- Spindle becomes conspicuous
- Kinetochores of sister chromatids fused
- Centromeres of homologous chromosomes line up on opposite sides of the equatorial plane, not all in a line

Metaphase I

Anaphase I

- Homologous chromosomes pulled apart and separated
- However, due to crossing-over, the chromatids are not identical, as they were at the start of meiosis



Anaphase I

Telophase I

- Nuclear envelope reforms, etc.
- Cytokinesis
- No interphase follows this
- One more division to go!

Meiosis II: Separation of Chromatids

- Prophase II: breakdown of nuclear envelopes, etc.
- Metaphase II: Chromosomes line up on equatorial plane

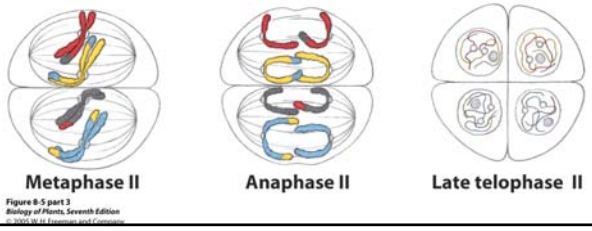


Figure 8-5 part 3
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Meiosis II

- Anaphase II: Sister chromatids separate (daughter chromosomes)
- Telophase II: Nuclear envelope, etc.
- Cytokinesis.
- Enter interphase
- THE CELLS ARE NOW HAPLOID, not diploid

Meiosis

- Meiosis produces genetic variability
  - Independent assortment of chromosomes
  - Crossing-over, so chromatids are not identical
- Meiosis produces nuclei different from starting one
- Mitosis produces an identical set

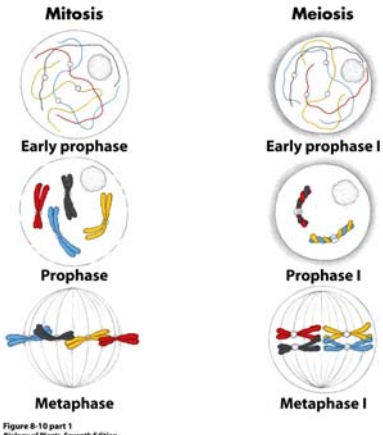

Figure 8-10 part 1
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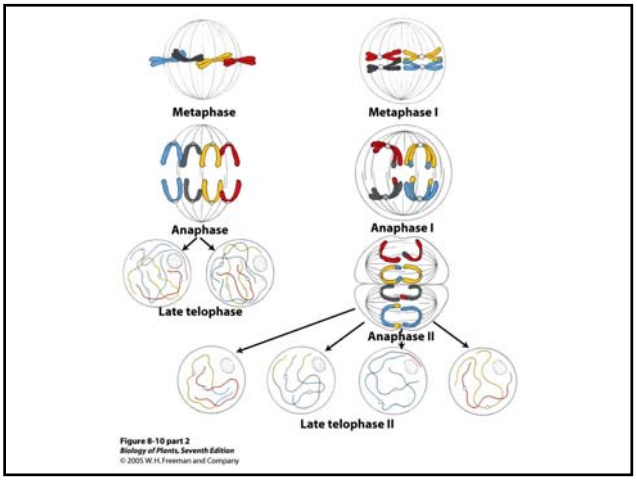

Figure 8-10 part 2
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