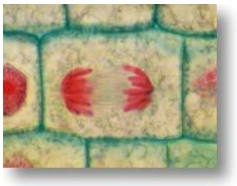
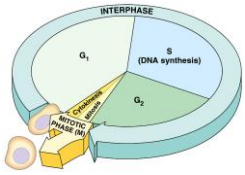
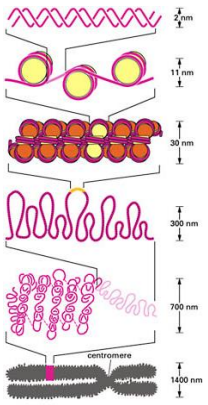
Chapter 11.3
Cell Division





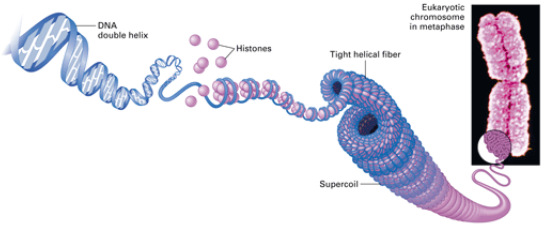
A bit about DNA

- DNA is organized in chromosomes
  - double helix DNA molecule
  - associated proteins = histone proteins
  - DNA-protein complex = chromatin
    - organized into long thin fiber



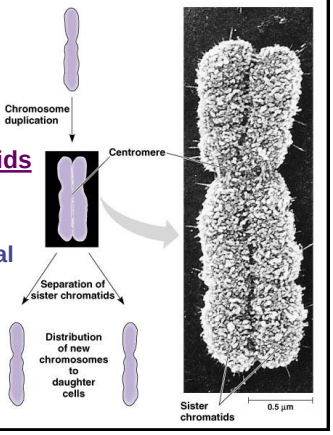
Copying DNA with care…

- After DNA duplication chromatin condenses
  - coiling & folding to make a smaller package
  - from DNA to chromatin to highly condensed mitotic chromosome



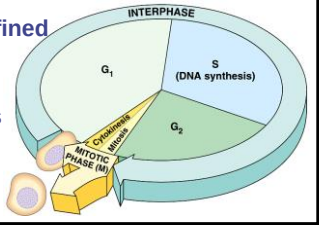
Chromosome

- Duplicated chromosome consists of 2 sister chromatids
  - narrow at their centromeres
  - contain identical copies of the chromosome's DNA



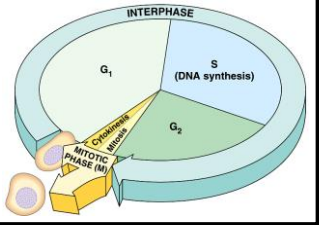
Interphase

- 90% of cell life cycle
  - cell doing its "everyday job"
    - produce RNA, synthesize proteins
  - prepares for duplication if triggered
- Characteristics
  - nucleus well-defined
  - DNA loosely packed in long chromatin fibers

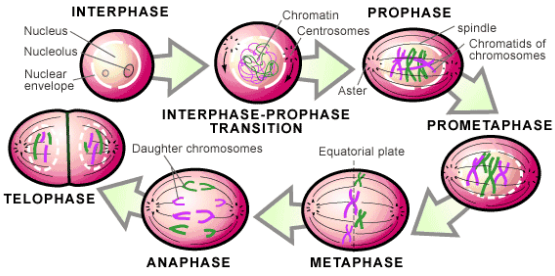


Mitosis

- copying cell's DNA & dividing it between 2 daughter nuclei
- Mitosis is divided into 4 (5) phases
  - prophase
  - (prometaphase)
  - metaphase
  - anaphase
  - telophase

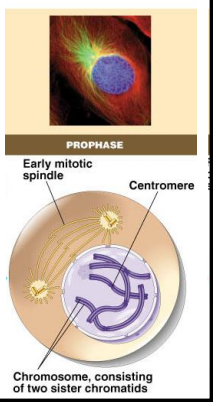


Mitosis Overview



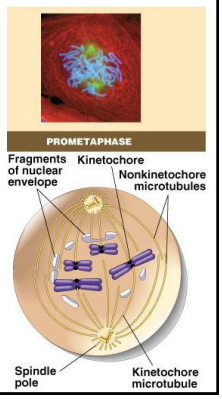
Prophase

- Chromatin (DNA) condenses
  - visible as chromosomes
    - chromatids
  - fibers extend from the centromeres
- Centrioles move to opposite poles of cell
- Fibers (microtubules) cross cell to form mitotic spindle
  - actin, myosin
- Nucleolus disappears
- Nuclear membrane breaks down



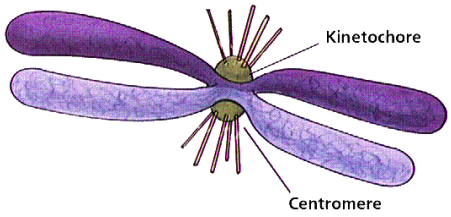
Prometaphase

- Proteins attach to centromeres
  - creating kinetochores
- Microtubules attach at kinetochores
  - connect centromeres to centrioles
- Chromosomes begin moving



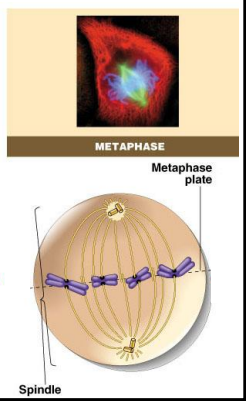
Kinetochores

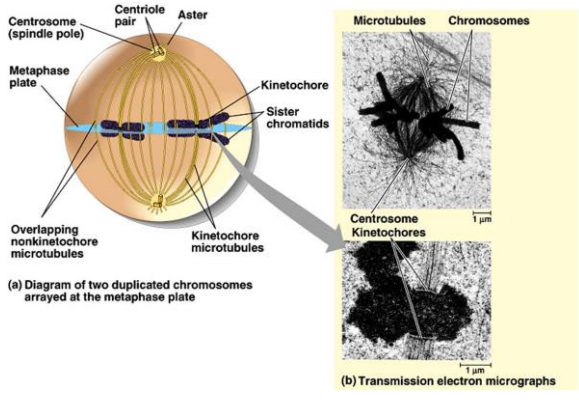
- Each chromatid has own kinetochore proteins found at the centromere
  - microtubules attach to kinetochore proteins



Metaphase

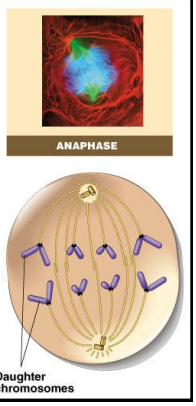
- Spindle fibers align chromosomes along the middle of cell
  - meta = middle
  - metaphase plate
  - helps to ensure chromosomes separate properly
    - so each new nucleus receives only 1 copy of each chromosome





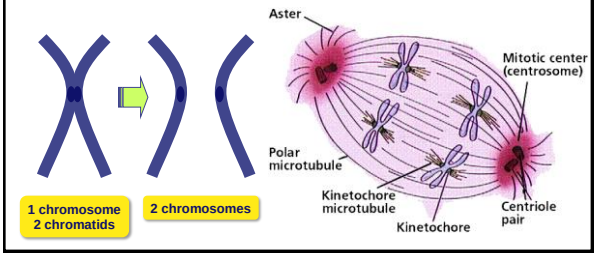
Anaphase

- Sister chromatids separate at kinetochores
  - move to opposite poles
  - pulled at centromeres
  - pulled by motor proteins "walking"along microtubules
    - increased production of ATP by mitochondria
- Poles move farther apart
  - polar microtubules lengthen



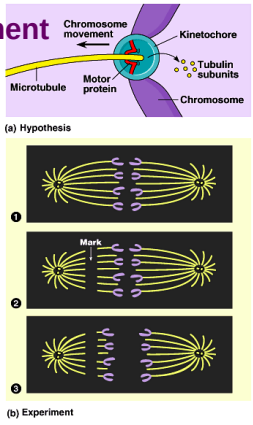
Separation of Chromatids

- In anaphase, proteins holding together sister chromatids are inactivated
  - separate to become individual chromosomes
  - separase and securin



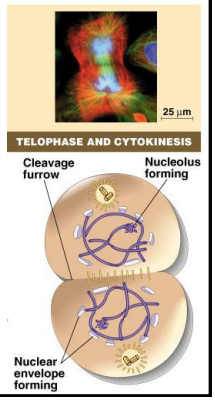
Chromosome Movement

- Kinetochores use motor proteins that "walk" chromosome along attached microtubule
  - microtubule shortens by dismantling at kinetochore (chromosome attachement) end



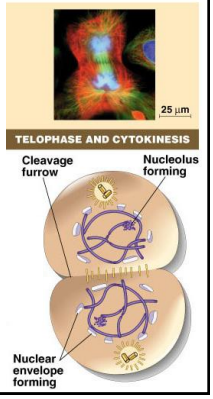
Telophase

- Chromosomes arrive at opposite poles
  - daughter nuclei form
  - nucleoli from
  - chromosomes disperse
    - no longer visible under light microscope
- Spindle fibers disperse
- Cytokinesis begins
  - cell division

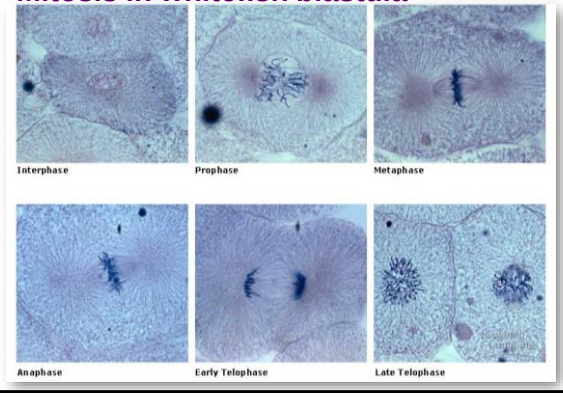


Cytokinesis

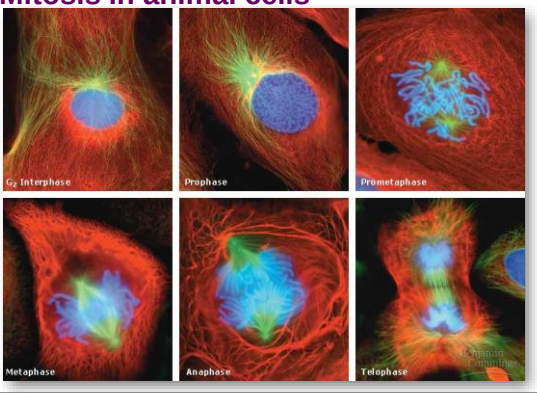
- Animals
  - cleavage furrow forms
  - ring of actin microfilaments forms around equator of cell
    - myosin proteins
  - tightens to form a cleavage furrow, which splits the cell in two
    - like tightening a draw string



Mitosis in whitefish blastula

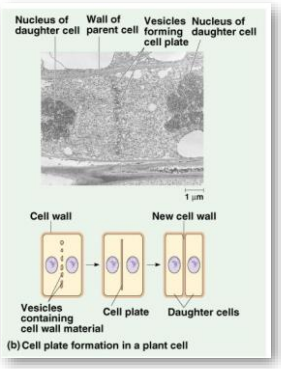


Mitosis in animal cells

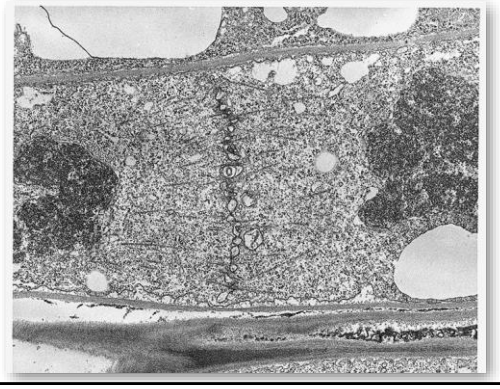


Cytokinesis in Plants

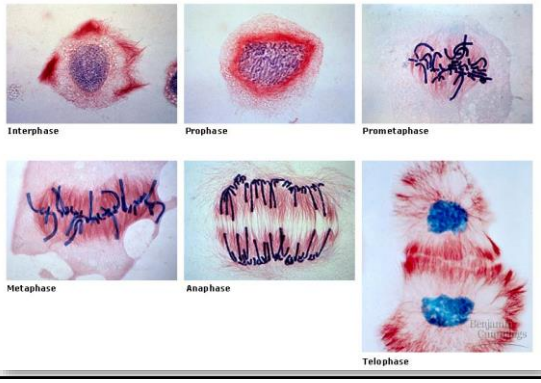
- Plants
  - vesicles move to equator line up & fuse to form 2 membranes = cell plate
    - derived from Golgi
  - new cell wall is laid down between membranes
    - new cell wall fuses with existing cell wall



Mitosis in plant cells

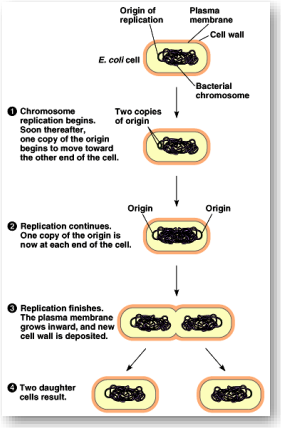


Mitosis in plant cells



Evolution Link

- Mitosis in eukaryotes likely evolved from binary fission in bacteria
  - single circular chromosome
  - no membrane-bound organelles



Evolution Link

- Mechanisms intermediate between binary fission & mitosis seen in modern organisms
  - protists