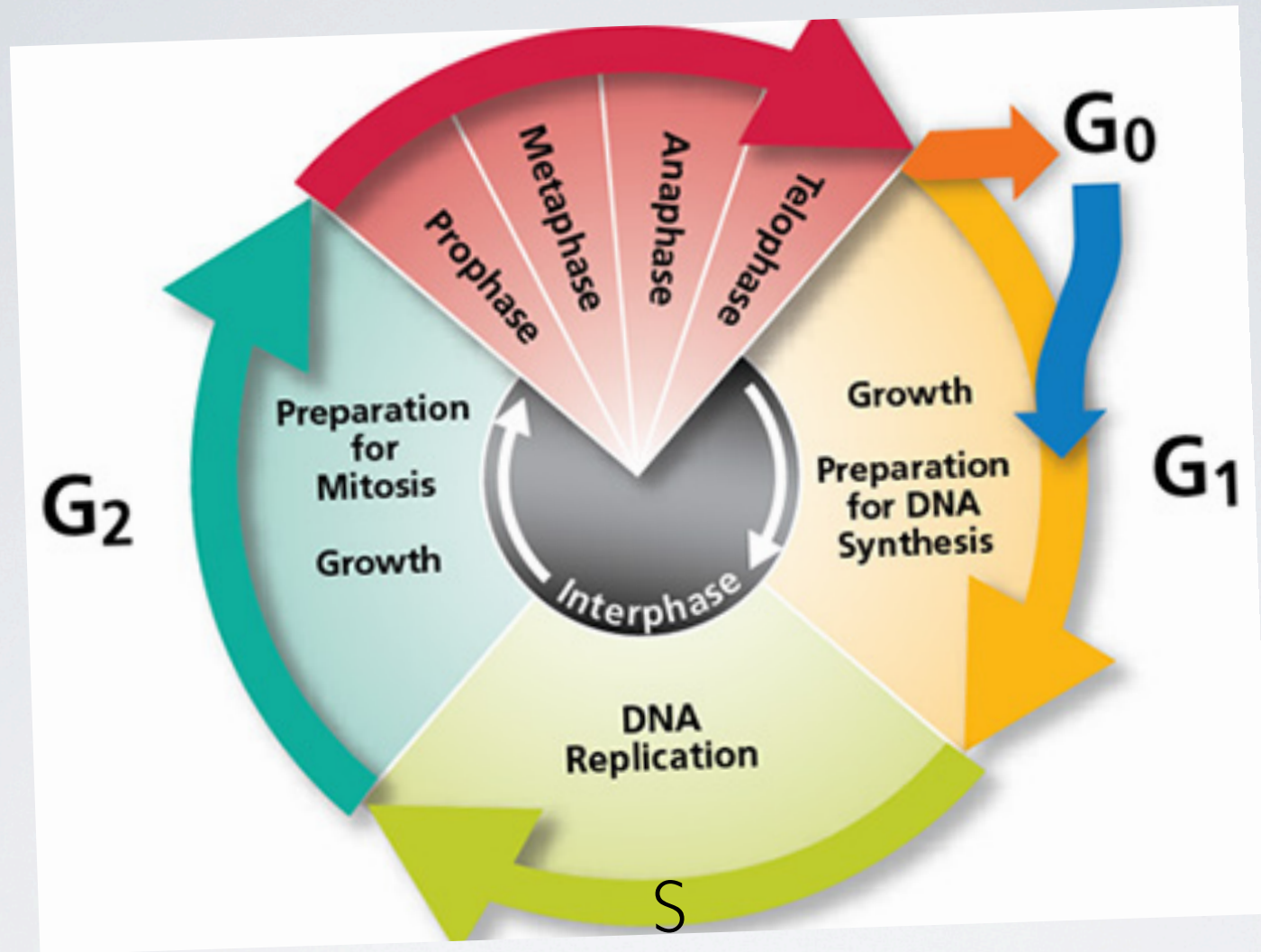


# CELL DIVISION IN PLANT CELLS

interphase and mitosis



# THE CELL CYCLE

# INTERPHASE

- Interphase contains three subphases.
  - Gap 1 Phase (G1)
  - Synthesis Phase (S)
  - Gap 2 Phase (G2)

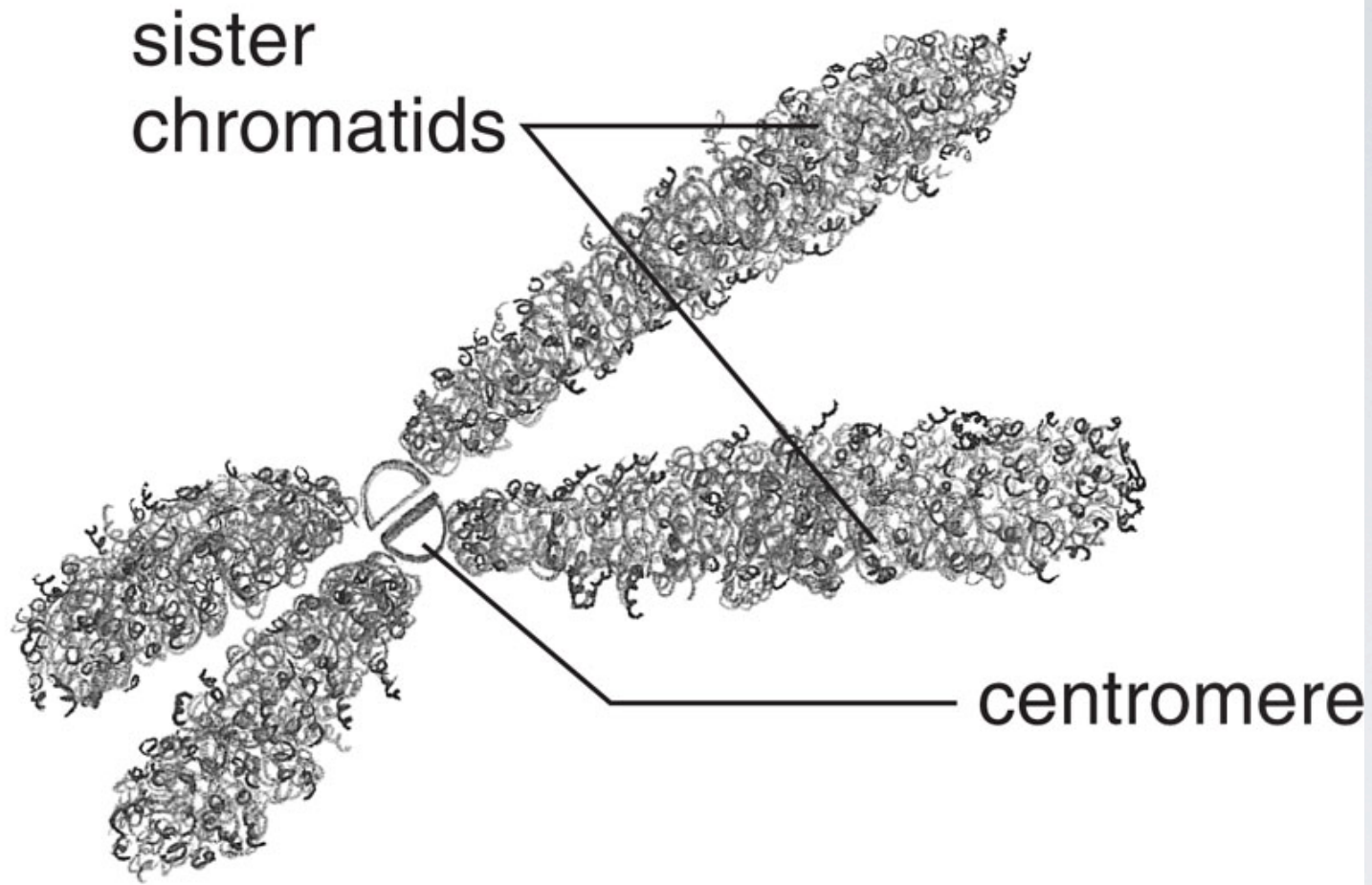
# GAP I

- Plant cells that are alive and functioning, but not dividing are in the Gap I (G1) phase that cells spend most of their time in.
- Period prior to the synthesis of DNA.
- In this phase, the cell increases in mass in preparation for cell division.
- Cells that are going to divide must pass a test, called a checkpoint, before they can exit G1 and enter the next phase of interphase.
- To pass the G1 checkpoint, cells must be big enough, have plenty of nutrients , and have undamaged DNA.

# SYNTHESIS PHASE

- The period during which DNA is synthesized.
- Plant cells copy all their chromosomes so that they will have a complete set to give to a new cell during cell division.
- Cells attach the two copies of each chromosome together with proteins that stick to a region of the chromosome called the centromere.
- In most cells, there is a narrow window of time during which DNA is synthesized.

- After S phase, chromosomes are called replicated chromosomes because each chromosome is actually made of two identical DNA molecules attached together at the centromere.
- Replicated chromosomes are usually drawn as little X's.
- Each half of the X is called a sister chromatid.
- Before S phase and after mitosis, chromosomes are single DNA molecules, but between S phase and mitosis, replicated chromosomes are double DNA molecules.



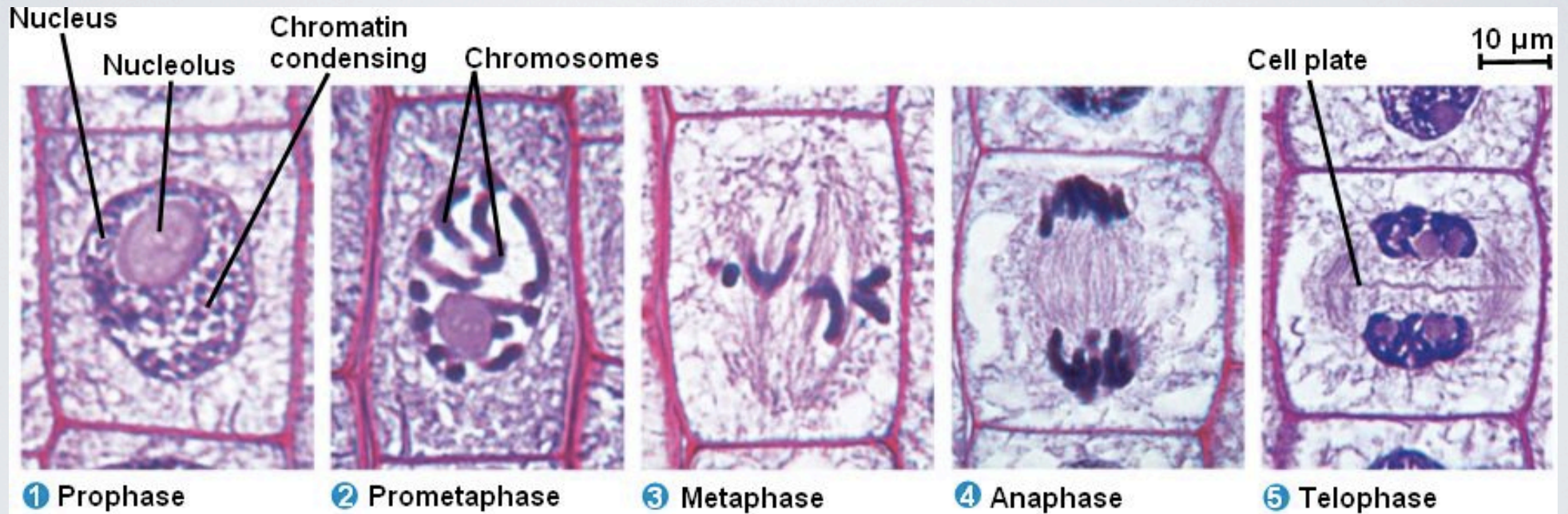
REPLICATED CHROMOSOME

# GAP 2

- G2 is the period after DNA synthesis has occurred but prior to the start of prophase.
- Cells check the work they did during S phase.
- The cell synthesizes proteins and continues to increase in size.
- In order to enter cell division, cells must pass the G2 checkpoint. The G2 checkpoint tests whether the cell copied all the chromosomes correctly.
- If they can't pass the G2 checkpoint, they remain in G2 and try to repair themselves.
- If they can't repair themselves, they may kill themselves via apoptosis.



# PHASES OF MITOSIS



# MITOSIS

- Mitosis is a carefully controlled process that organizes and separates the chromosomes correctly. After the cells separate the chromosomes and build new nuclei, they divide their cytoplasm by cytokinesis and form two distinct cells.

# PROPHASE

- Changes that occur in a cell during prophase:
  - The chromatin condenses into discrete chromosomes by tightly coiling. This process makes the chromosomes visible under a microscope.
  - The nuclear envelope breaks down.
  - Chromatin fibers become coiled into chromosomes with each chromosome having two chromatids joined at a centromere.
  - The mitotic spindle, composed of microtubules and proteins, forms in the cytoplasm.

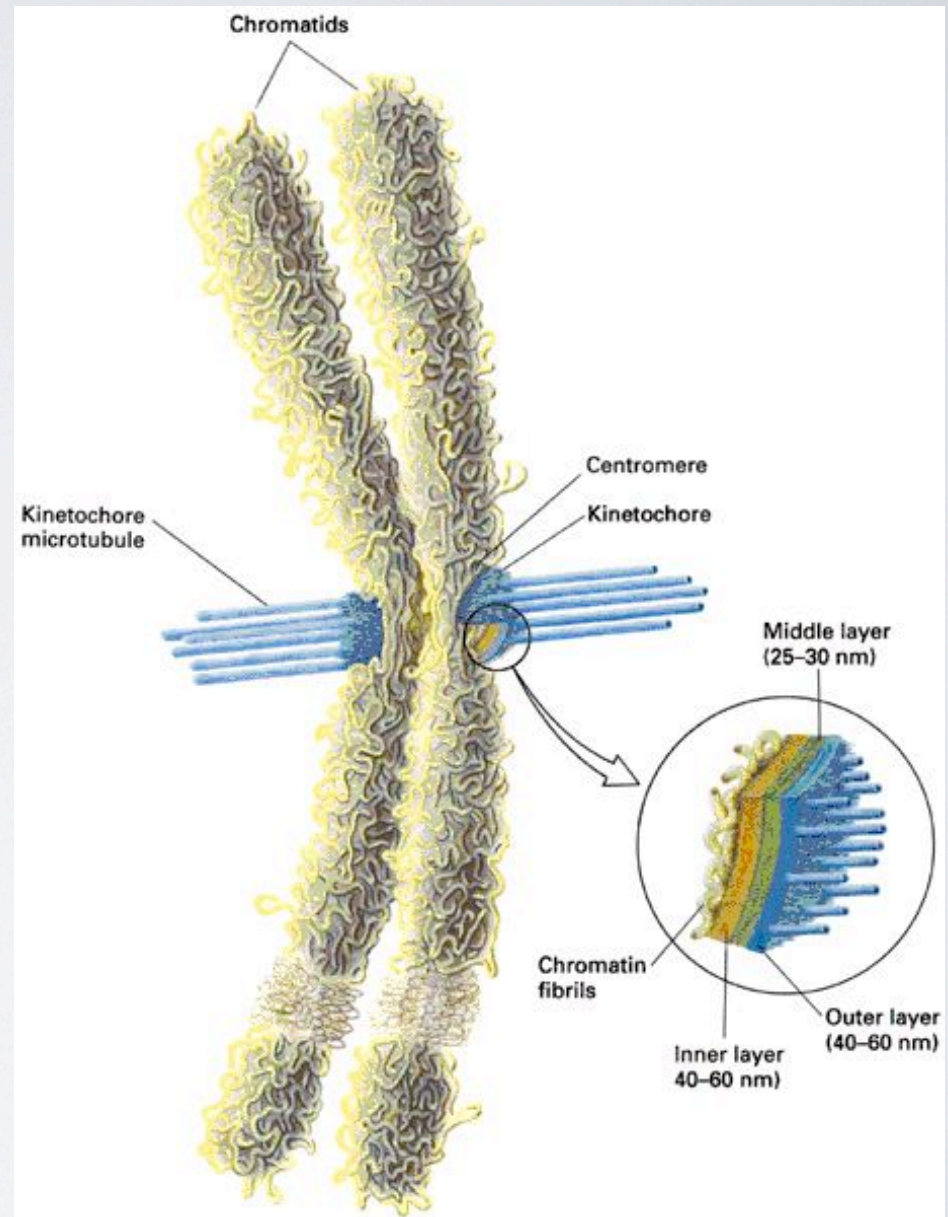
# LATE PROPHASE

Polar fibers, which are microtubules that make up the spindle fibers, reach from each cell pole to the cell's equator.

- Kinetochores, which are specialized regions in the centromeres of chromosomes, attach to a type of microtubule called kinetochore fibers.
- The kinetochore fibers "interact" with the spindle polar fibers connecting the kinetochores to the polar fibers.
- The chromosomes begin to migrate toward the cell center.

# Structure and Localization of the Centromere and Kinetochore

Figure 23-38, p. 1094, Molecular Cell Biology, 3rd ed., Lodish, et al., copyright 1995, W.H. Freeman and Company, reprinted with permission.



# METAPHASE

- Changes that occur in a cell during metaphase:
  - The spindle fully develops.
  - Chromosomes align at the metaphase plate.
  - Chromosomes move randomly until they attach (at their kinetochores) to polar fibers from both sides of their centromeres.
  - At the metaphase checkpoint, cells make sure that all the replicated chromosomes are attached to the mitotic spindle before continuing to anaphase.

# ANAPHASE

- Changes that occur in a cell during anaphase:
  - The paired centromeres in each distinct chromosome begin to move apart.
  - Once the paired sister chromatids separate from one another, each is considered a "full" chromosome. They are referred to as daughter chromosomes.
  - Through the spindle apparatus, the daughter chromosomes move to the poles at opposite ends of the cell.
  - The daughter chromosomes migrate centromere first and the kinetochore fibers become shorter as the chromosomes near a pole.

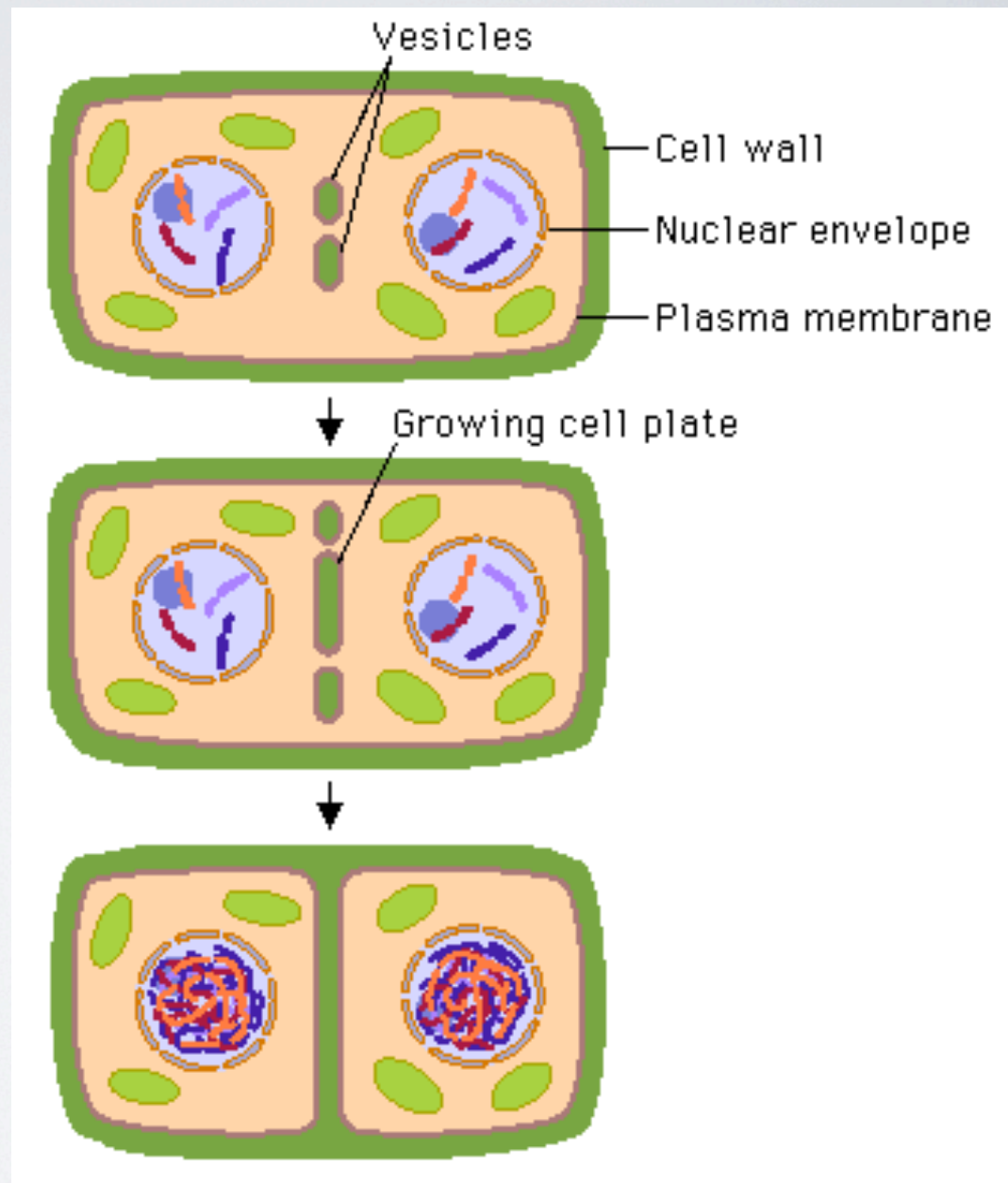
# TELOPHASE

- Changes that occur in a cell during telophase:
  - Nuclei (plural form of nucleus) begin to form at opposite poles.
  - The nuclear envelopes of these nuclei are formed from remnant pieces of the parent cell's nuclear envelope.
  - Nucleoli (plural form of nucleolus) also reappear.
  - Chromatin fibers of chromosomes uncoil.
- After these changes, telophase/mitosis is largely complete and the genetic "contents" of one cell have been divided equally into two.



# CYTOKINESIS IN PLANT CELLS

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# CYTOKINESIS

- After the plant cell separates the sister chromatids and builds new nuclear membranes to create two nuclei, it divides its cytoplasm into two parts by forming new plasma membrane and cell wall down the middle of the cell.
  - The cytoskeleton moves small vesicles containing cell wall material into a line in the middle of the cell.
  - The vesicles fuse together, bringing together the vesicle membranes and the wall material that was inside the vesicles. The vesicle membranes form the new plasma membranes for each cell. The wall material joins together to form the cell plate. The two new cells then secrete cellulose and other materials to build a primary cell wall on either side of the cell plate, which is now called the middle lamella.