# Cell Growth
# Section 10-1

- Living things grow by producing more cells.
- There are two reasons why cells divide rather than continue growing indefinitely:
  1. The larger a cell becomes, the more demands the cell places on its DNA.
  2. The cell has more trouble moving enough nutrients and wastes across the cell membrane.

# DNA "Overload"

- The information that controls a cell's function is stored in a molecule of DNA.
- DNA is found in the nucleus.
- When the cell is small, the information stored in DNA is able to meet all of the cell's needs.
- As a cell increases, it does not make extra copies of DNA.
- If a cell grows without limit, an "information crisis" would occur.

# Exchanging Material

- Food, oxygen, and water enter a cell through its cell membrane and wastes leave the same way.
- If the cell gets too large, it is more difficult to get sufficient amounts of oxygen and nutrients in and waste products out.

# Division of the Cell

- A growing cell divides forming two "daughter" cells.
- Cell division is the process by which a cell divides into two new daughter cells.
- Before division occurs, the cell replicates, or copies, all of its DNA.
- Each daughter cell receives one complete set of genetic information.

# Cell Division
# Section 10-2

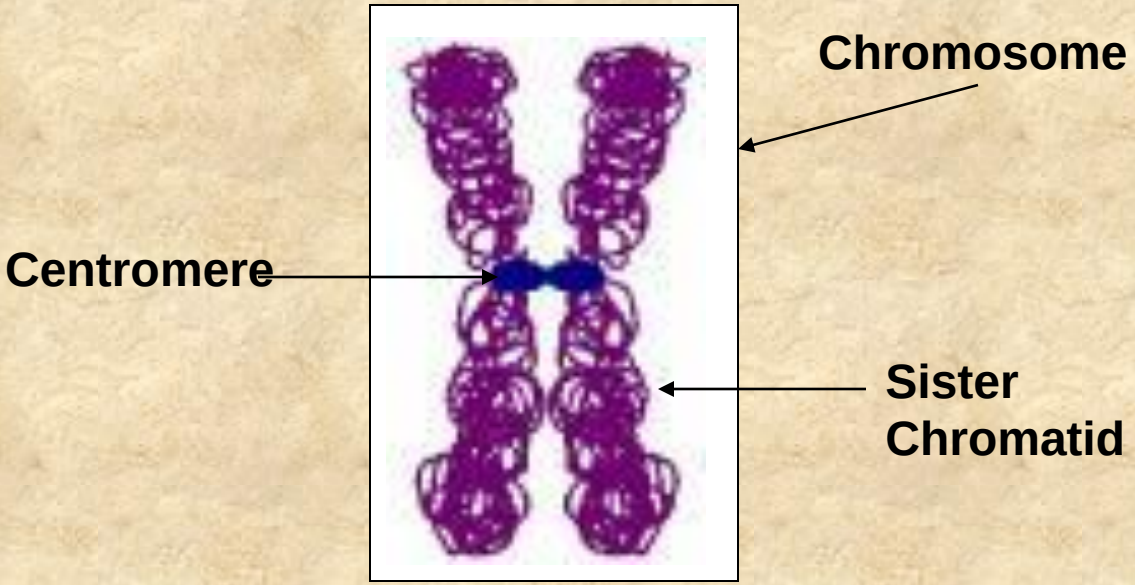
- Every cell must first copy its genetic information before cell division begins.
- Cell division in eukaryotes is complex and occurs in two stages.
  1. The first stage is mitosis, which is the division of the cell nucleus.
  2. The second stage is cytokinesis, which is the division of the cytoplasm.

- Reproduction by mitosis is classified as asexual, since the cells produced are genetically identical to the parent cell.
- Mitosis is also the source of new cells when a multicellular organism grows and develops.

# Chromosomes

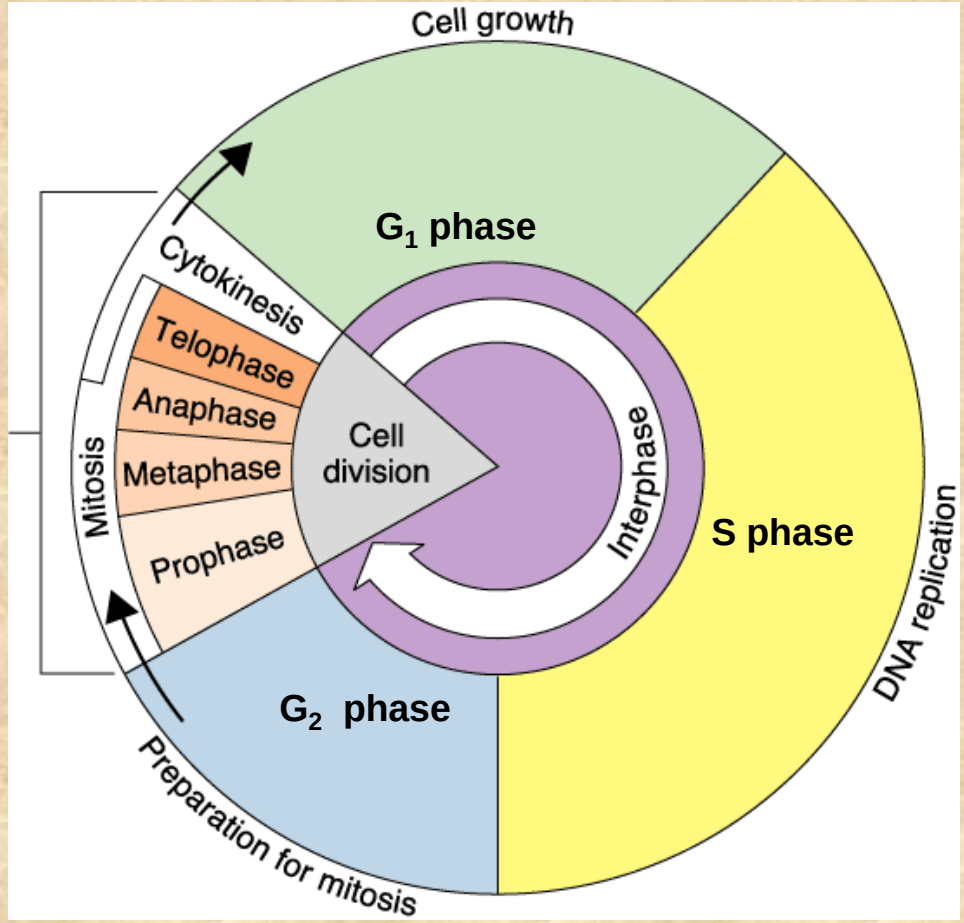
- Carry the genetic information that is passed on from one generation of cells to the next.
- Made up of DNA and proteins
- Every organism has a specific number of chromosomes.
  - Fruit flies - 8
  - Human cells - 46
  - Carrot cells - 18

- Chromosomes are not visible in most cells except during cell division.
- Well before cell division, each chromosome is copied.
- Each chromosome then consists of two identical "sister" chromatids.
- Each pair of chromatids is attached at the centromere.



# The Cell Cycle

M phase



- Interphase is the "in-between" period of growth that occurs when cells are not dividing.
- The cell cycle is a series of events that cells go through as they grow and divide.
- The cell cycle consists of four phases:
  1. M phase - mitosis and cytokinesis
  2. S phase - chromosome replication, or synthesis of DNA
  3. $G_1$ - cell growth
  4. $G_2$ - preparation for mitosis

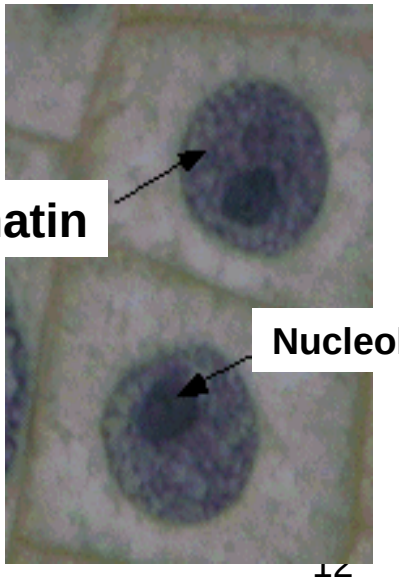
     (G stands for "gap")

# Events of the Cell Cycle

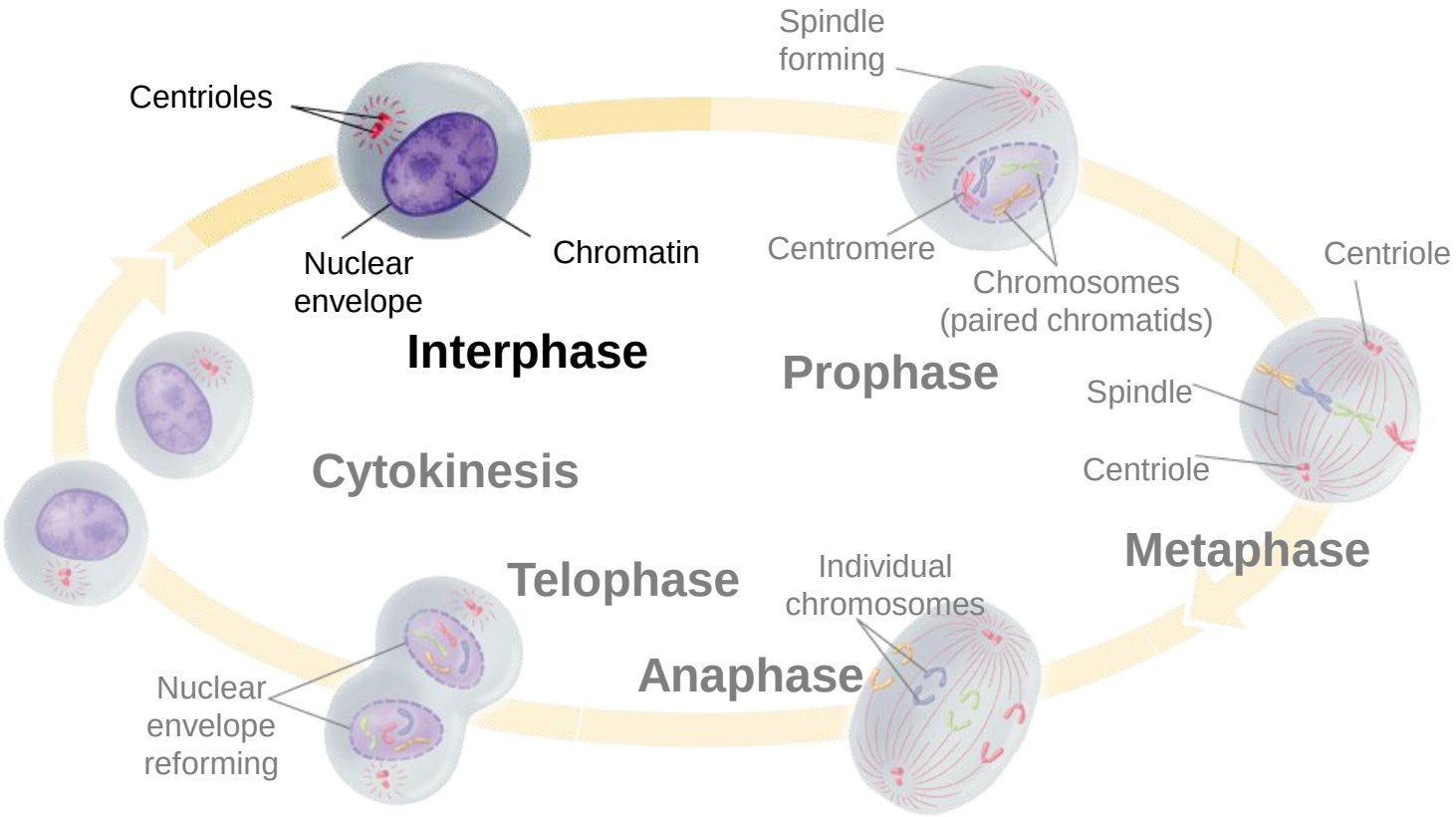
- Interphase can be quite long, whereas cell division takes place quickly.
- Interphase is divided into three phases:
  - $G_1$, S and $G_2$ phases
- During $G_1$, cells increase in size and synthesize new proteins.
- During S , Chromosomes are replicated and DNA is synthesized.
- During $G_2$, (shortest) organelles and proteins required for cell division are made.

# Interphase

- Interphase is the "holding" stage or the stage between two successive cell divisions.
- 90% of a cell's time in the normal cellular cycle may be spent in interphase.
- 3 phases:
  - $G_1$ = Growth
  - S = Synthesis of DNA
  - $G_2$ = Prep for Mitosis



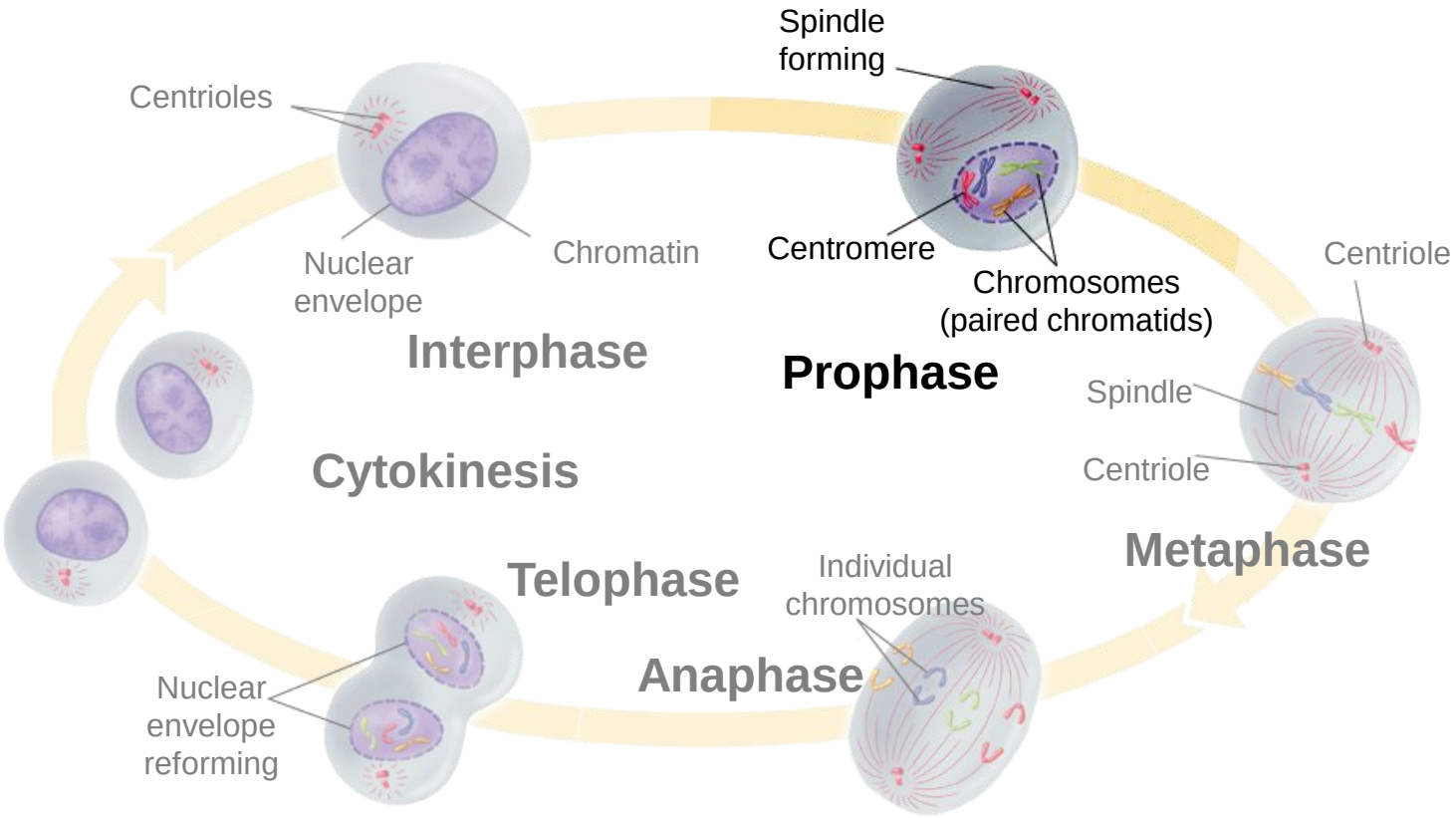
# Interphase


Centrioles
Nuclear envelope
Chromatin
Interphase
Spindle forming
Centromere
Chromosomes (paired chromatids)
Prophase
Centriole
Spindle
Centriole
Metaphase
Individual chromosomes
Anaphase
Telophase
Nuclear envelope reforming
Cytokinesis

# Prophase

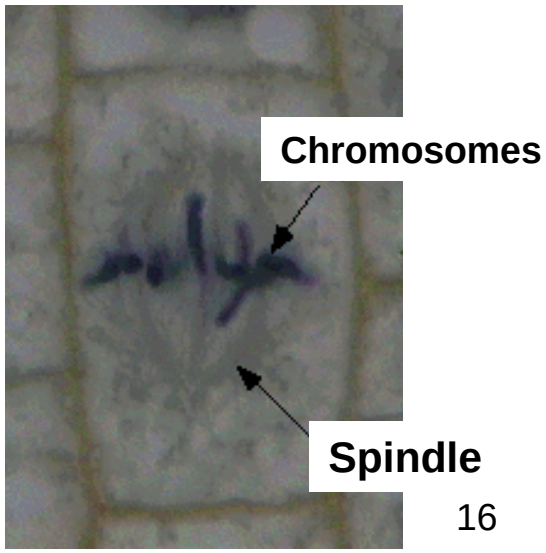
- Prophase is the first and longest phase of mitosis (50-60% of the total time)
- Chromosomes are visible
- Centrioles separate and move to opposite side of the nucleus
- Spindle, a fanlike microtubule helps to separate the chromosomes
- Chromosomes attach to spindle fibers at the centromere of each chromatid
- At the end, chromosomes coil tightly, nucleolus disappears, nuclear envelope breaks down.

# Prophase

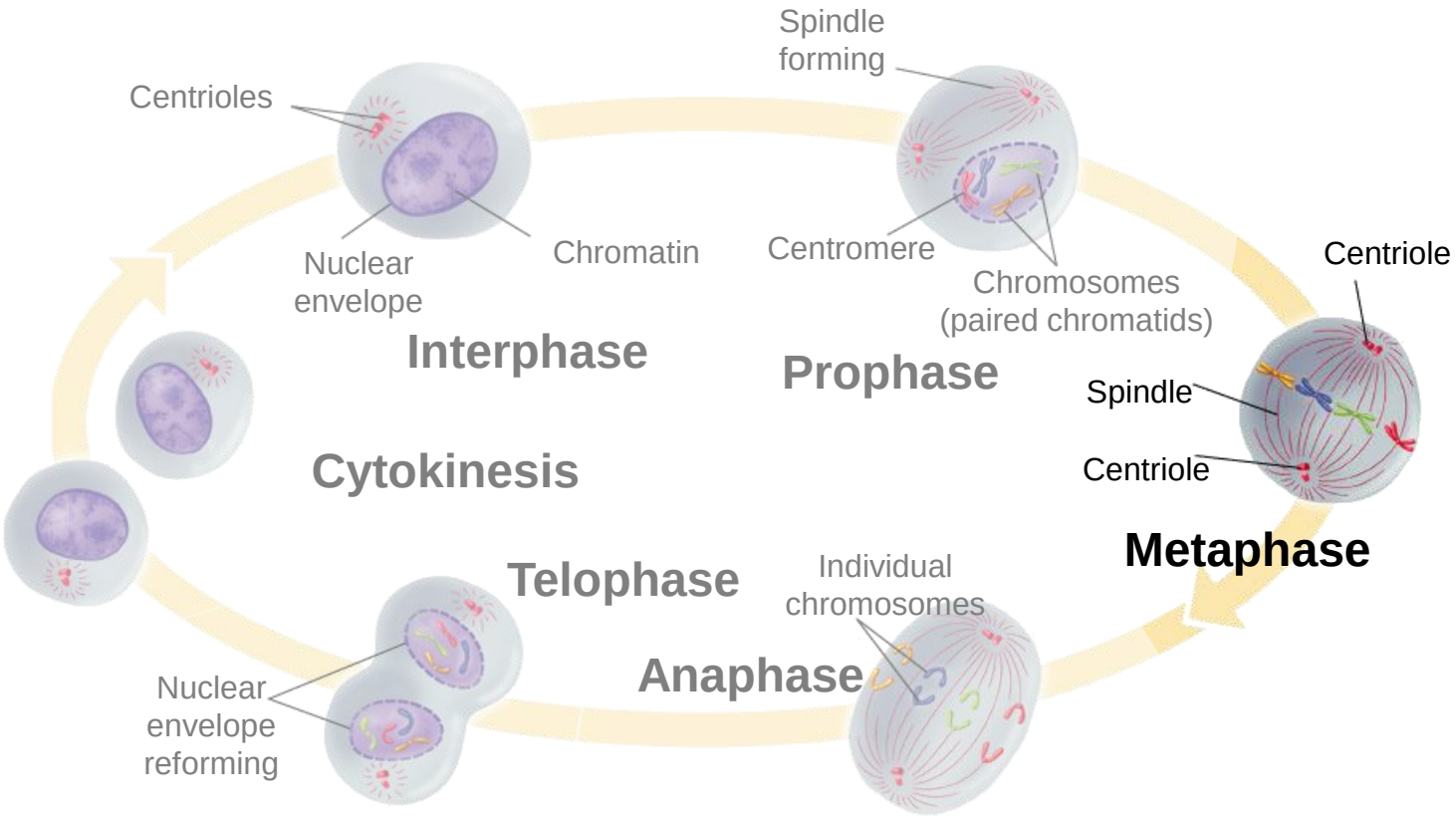

Centrioles
Nuclear envelope
Chromatin
Interphase
Spindle forming
Centromere
Chromosomes (paired chromatids)
Prophase
Centriole
Spindle
Centriole
Metaphase
Individual chromosomes
Anaphase
Telophase
Nuclear envelope reforming
Cytokinesis

# Metaphase

- During metaphase, chromosomes line up across the center of the cell.
- Only lasts a few minutes
- Microtubules connect the centromere to the poles of the spindle.



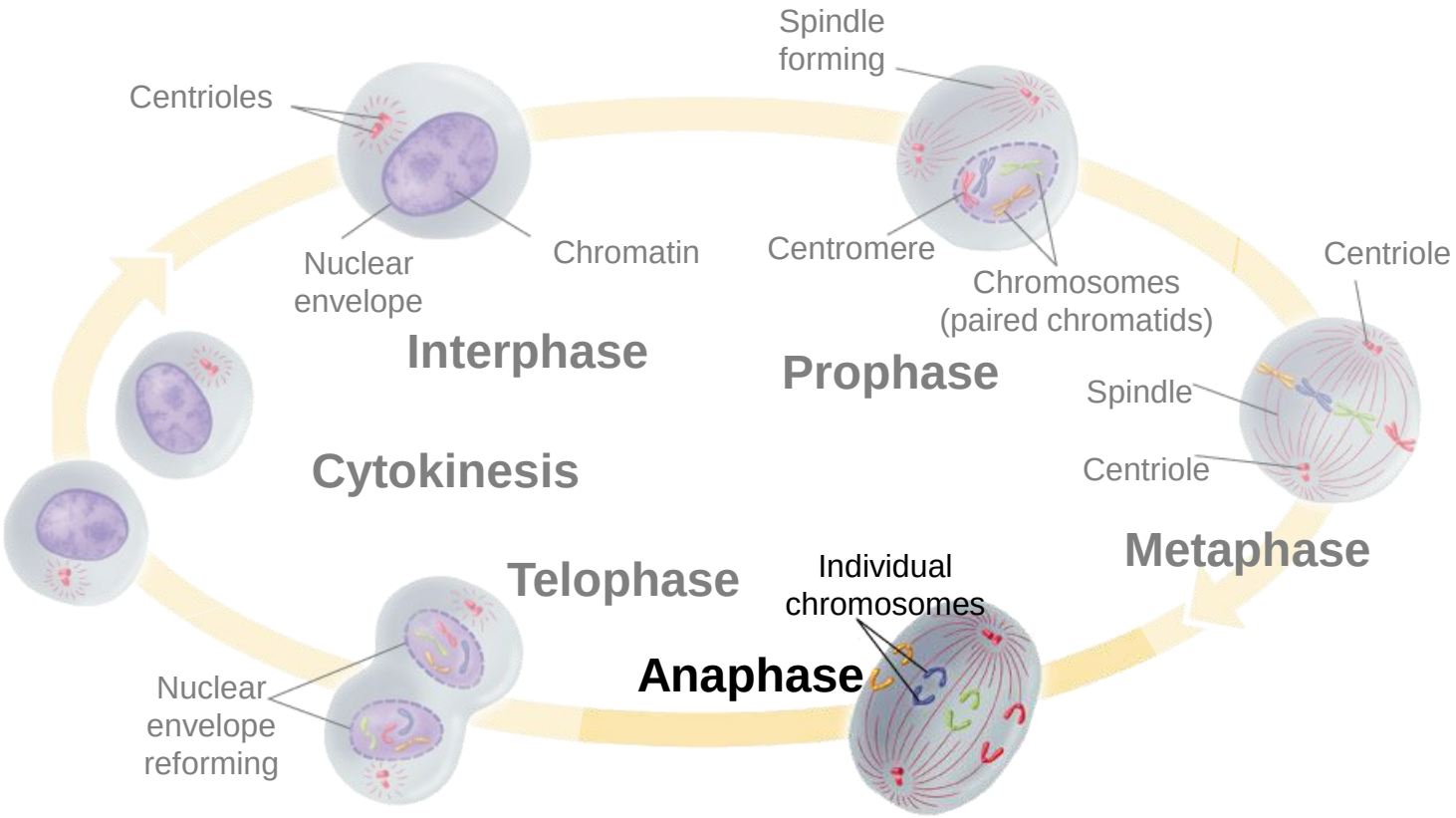
# Metaphase


Centrioles
Nuclear envelope
Chromatin
Interphase
Spindle forming
Centromere
Chromosomes (paired chromatids)
Prophase
Centriole
Spindle
Centriole
Metaphase
Individual chromosomes
Anaphase
Telophase
Nuclear envelope reforming
Cytokinesis

# Anaphase

- During anaphase, the centromeres that join the sister chromatids split, allowing the sister chromatids to separate and become individual chromosomes.
- Chromosomes move until they have separated into two groups near the poles of the spindle.
- Ends when the chromosomes stop moving.

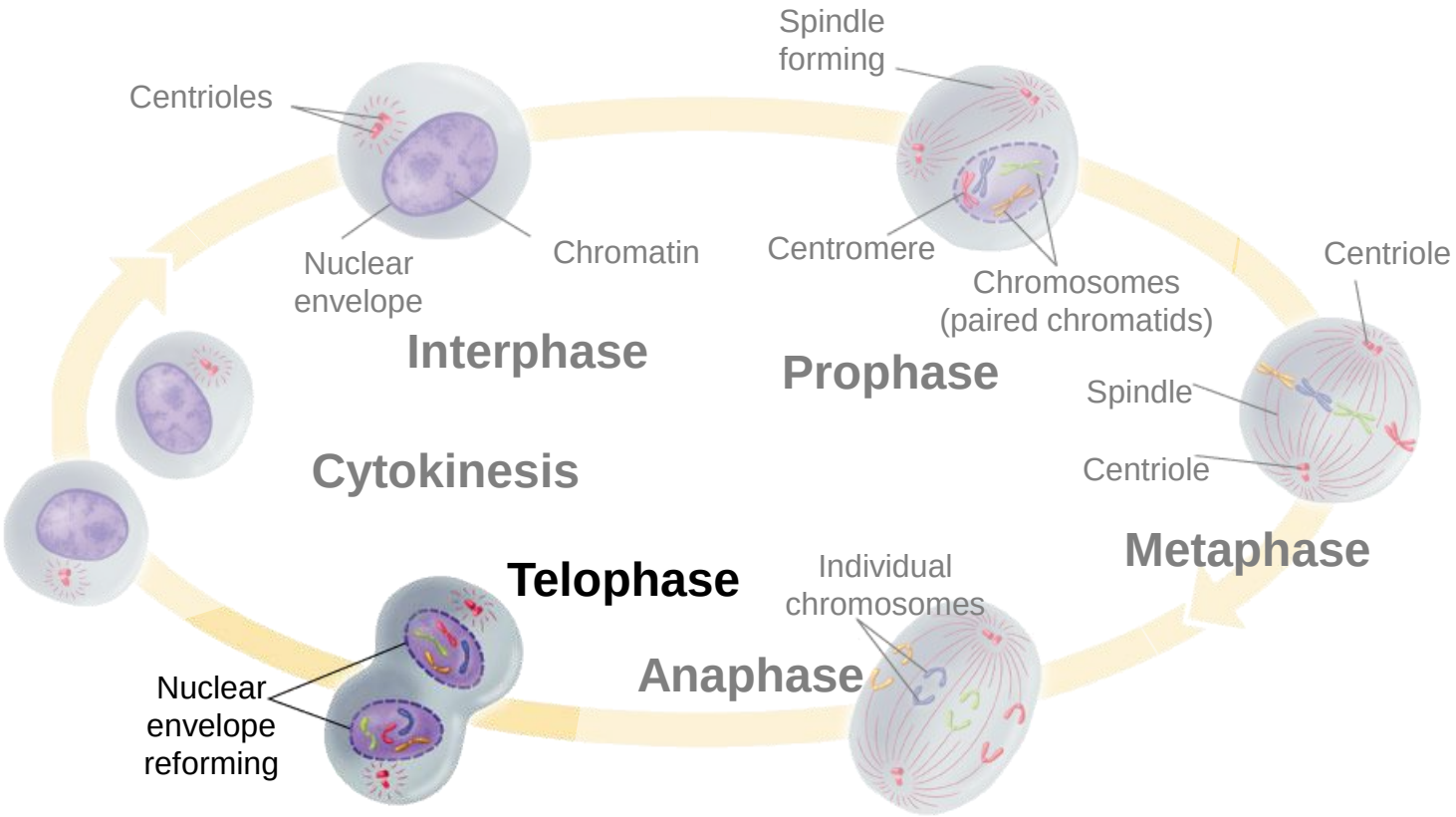
# Anaphase


Centrioles
Nuclear envelope
Chromatin
Interphase
Spindle forming
Centromere
Chromosomes (paired chromatids)
Prophase
Centriole
Spindle
Centriole
Metaphase
Individual chromosomes
Anaphase
Telophase
Nuclear envelope reforming
Cytokinesis

# Telophase

- During telophase, the chromosomes begin to disperse into a tangle of dense material.
- A nuclear envelope re-forms around each cluster of chromosomes.
- The spindle breaks apart, a nucleolus becomes visible in each daughter nucleus making mitosis almost complete.

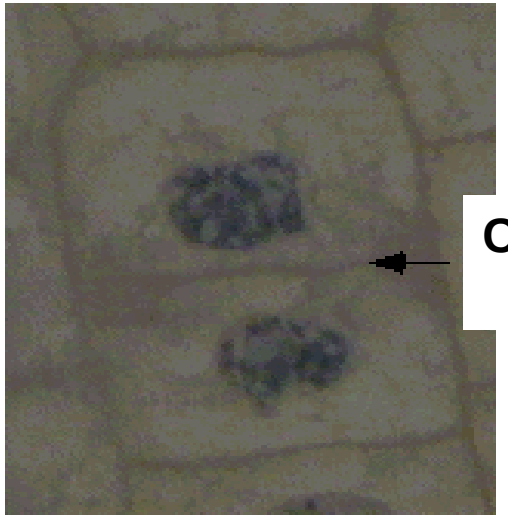
# Telophase


Centrioles
Nuclear envelope
Chromatin
Interphase
Spindle forming
Centromere
Chromosomes (paired chromatids)
Prophase
Centriole
Spindle
Centriole
Metaphase
Individual chromosomes
Anaphase
Telophase
Nuclear envelope reforming
Cytokinesis

# Cytokinesis

- As a result of mitosis, two nuclei are formed, usually within the cytoplasm of a single cell.
- The final step is the division of the cytoplasm itself.
- Cytokinesis usually occurs at the same time as telophase.

- In animal cells, the cell membrane is drawn inward until the cytoplasm is pinched into two nearly equal parts.



# Cytokinesis