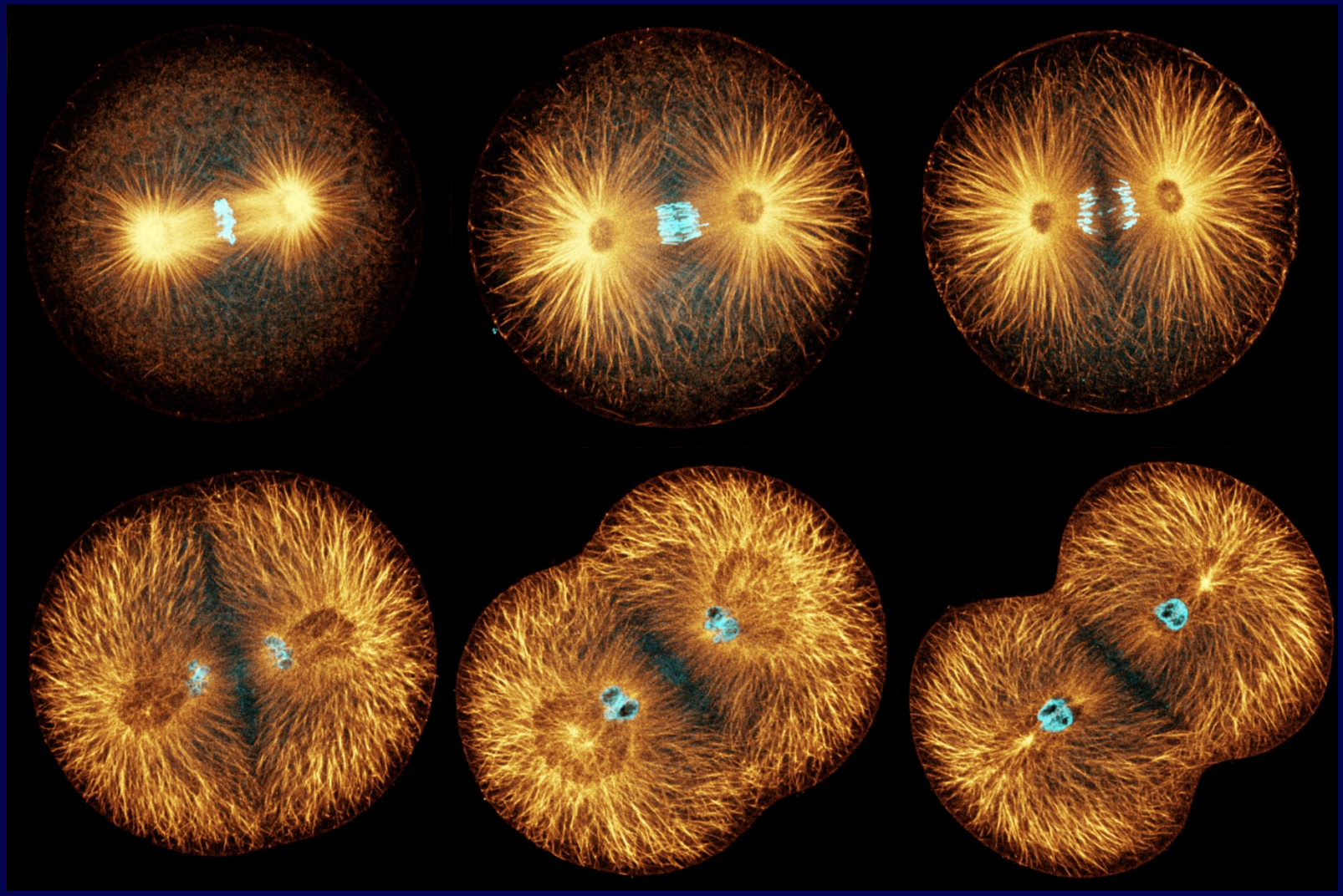
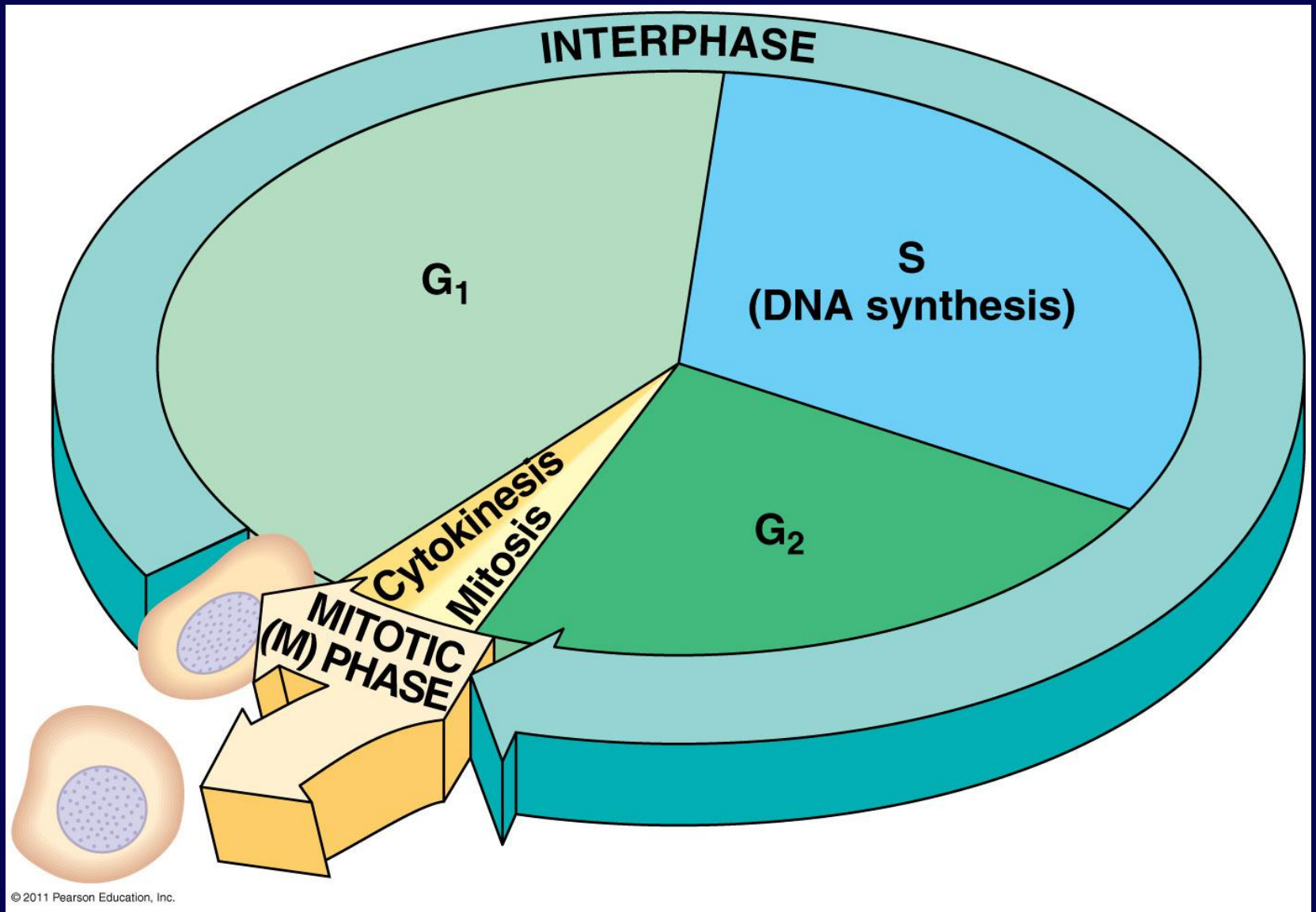
The Cell Cycle



- The cell cycle consists of
  - Interphase – normal cell activity
  - The mitotic phase – cell division



Functions of cell division

1. Reproduction – i.e. skin cells
2. Growth – i.e. to adulthood
3. Repair – i.e. injured tissue renewal

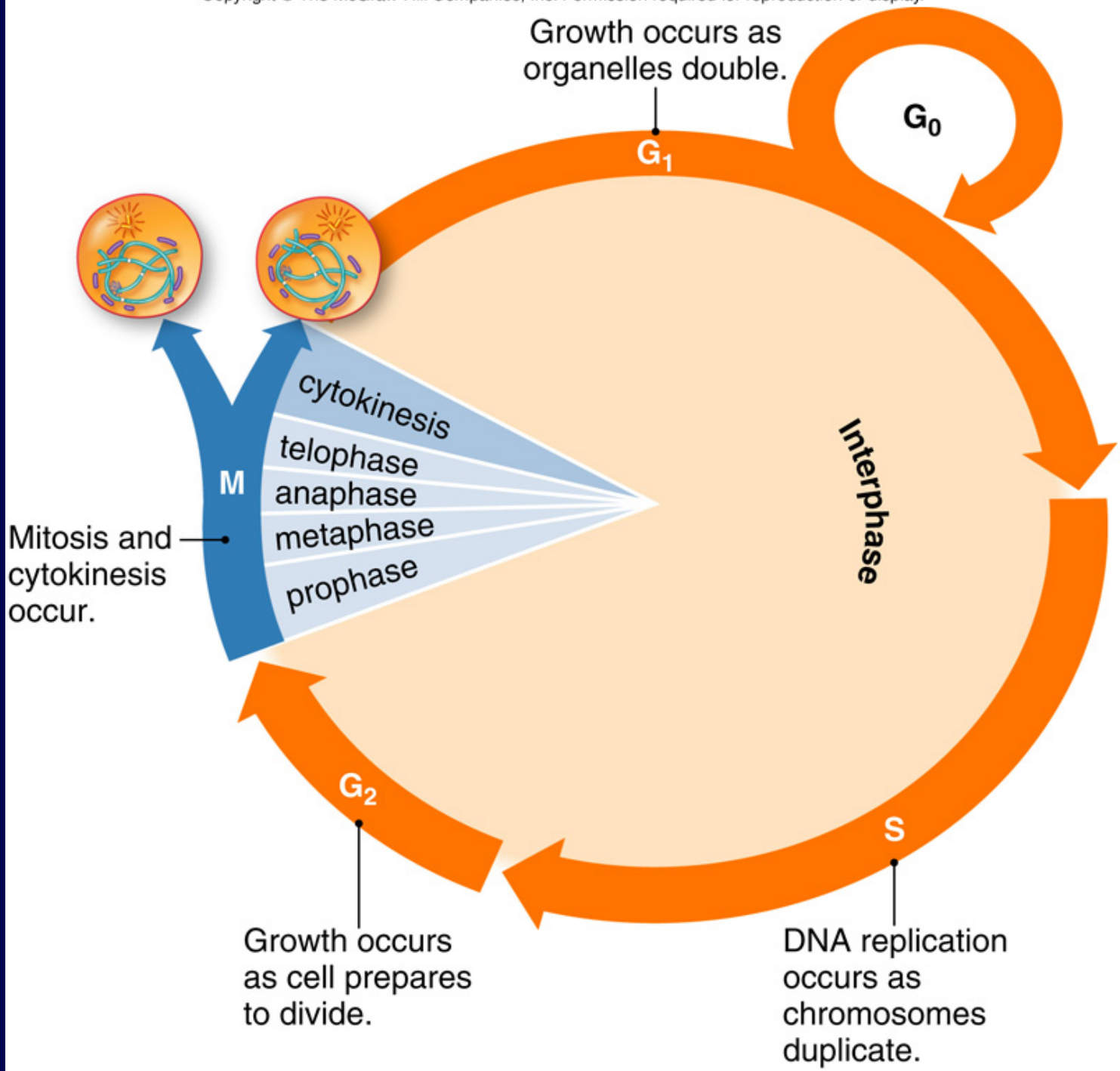
Phases of the Cell Cycle

Interphase (normal cell activity)

1. G1 phase (gap 1): the cell grows
2. S phase (synthesis): the DNA replicates. 46 chromosomes become 92 sister chromatids having the familiar ‘X’ shape.
3. G2 phase (gap 2): the cell continues to grow, and synthesizes all the protein parts necessary for mitosis.

Mitosis (reproduction)

1. Prophase (pro=before): chromosomes condense (appear as 2 sister chromatids) and nuclear envelope is disassembled
2. Metaphase (meta=across): chromosomes/chromatids line up at equatorial plane
3. Anaphase (ana=back, against): sister chromatids separate
4. Telophase (telos=end): chromosomes reach opposite poles and unravel, nuclear envelopes reform



Memory Devices

Interphase, prophase, metaphase, anaphase, telophase

I Played My Accordion Today

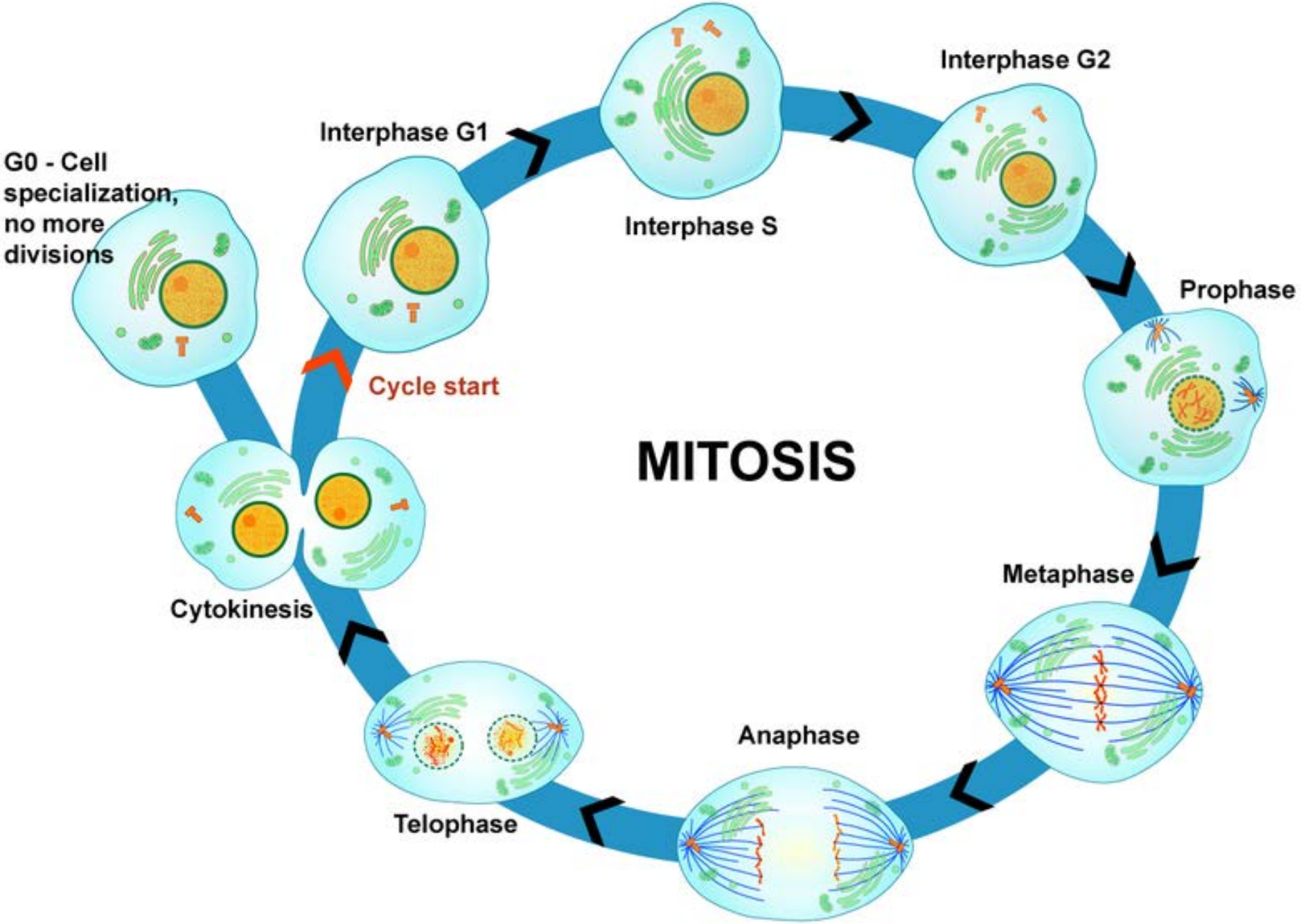
Interval between cell division

Chromosomes first aPPear

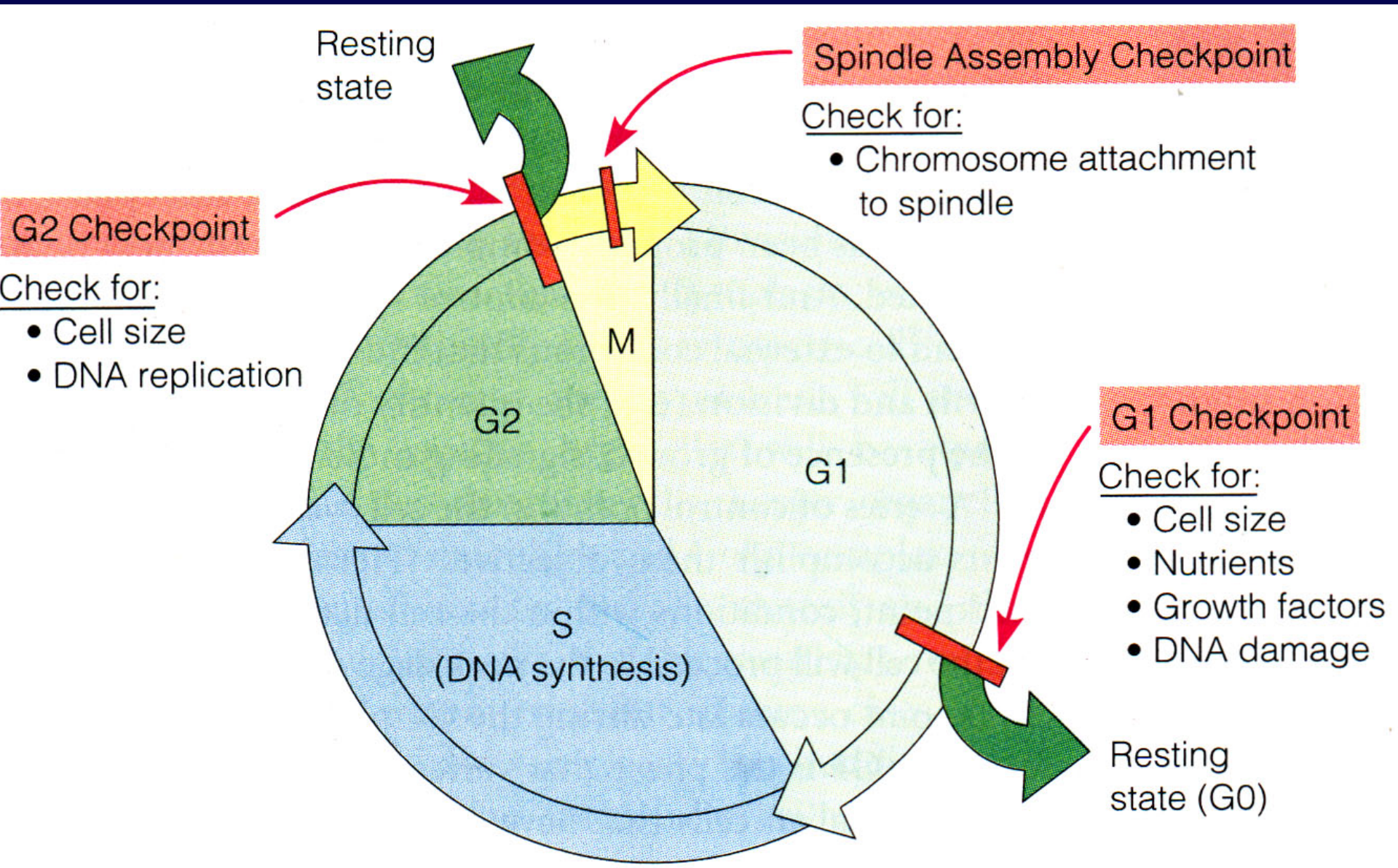
Chromosomes line up in the Middle

Chromosomes move Away

You now have Two


Interphase G2
Interphase G1
G0 - Cell specialization, no more divisions
Interphase S
Prophase
Cycle start
MITOSIS
Metaphase
Cytokinesis
Anaphase
Telophase

Quality Control "Checkpoints"



The Genome

Word origins

Genome (gene=race + ome=totality of)

Chromosome (chroma=color + soma=body)

Chromatid (chroma=color, -id=particle)

Centriole (center + little)

Kinetochore (kineto=movement + khoros=place)

Aster (=star)

Mitosis (mitos=thread + osis=process)

Spindle (spin=to twist)

Cytokinesis (cell, container + movement

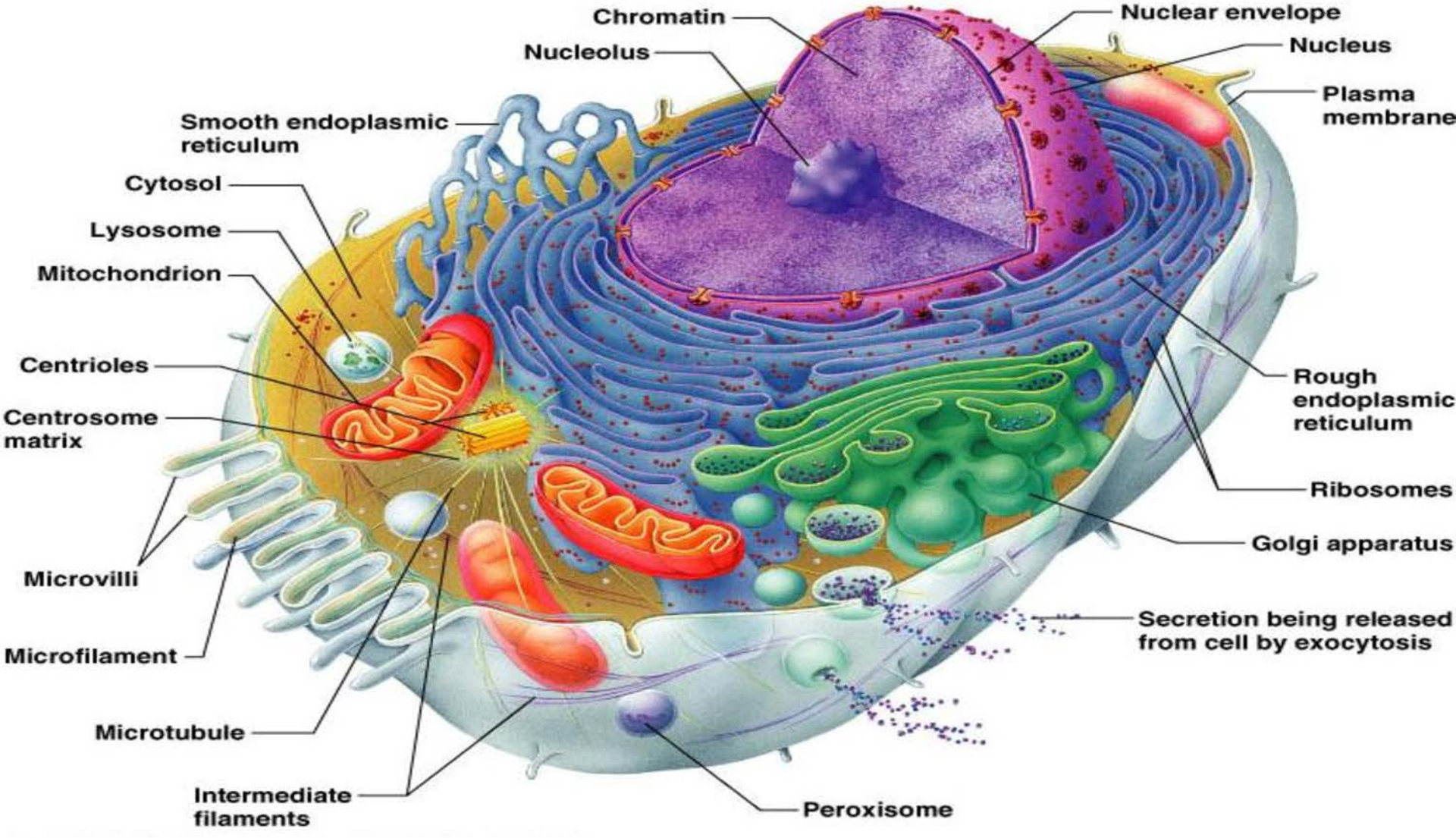
Karyotype (nut, nucleus + type, mark)

Centromere (center + part)

Diploid (double + form)

Haploid (haplos=single + form)

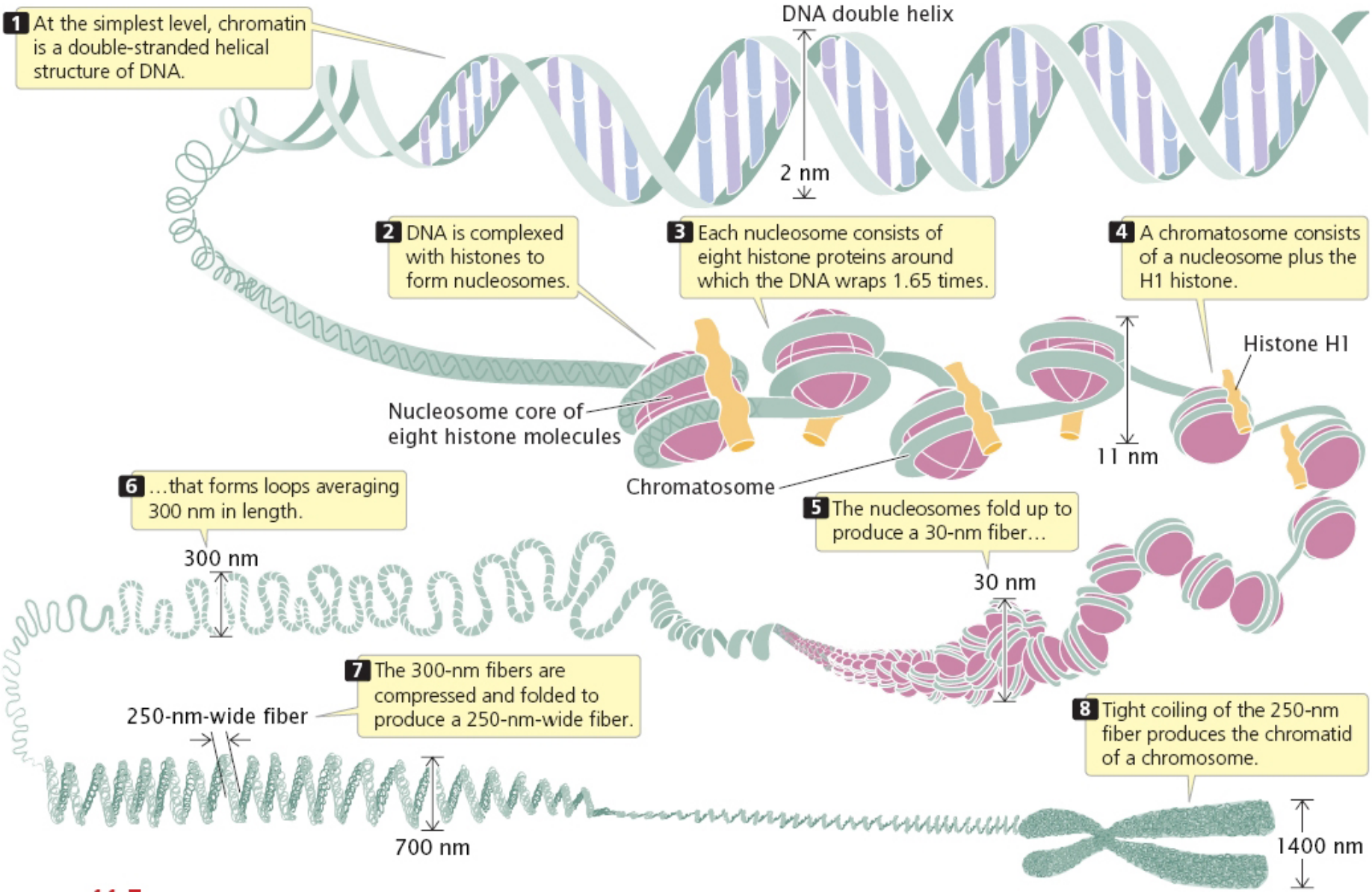
Structure of a Generalized Cell



The cell as a factory

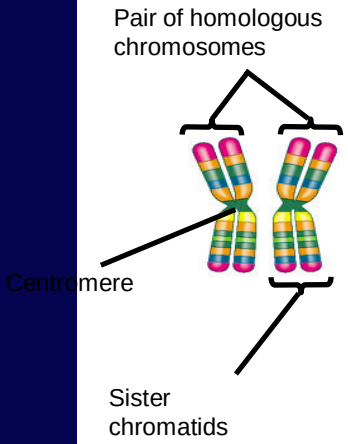
Nucleus = corporate headquarters
Nucleolus = the corner office
DNA = master parts list
mRNA = fabrication order
Nuclear envelope = central office security
Endomembrane system = fabrication area
Ribosomes = assembly work cell
tRNA = assembly jig
Simple enzyme = work bench
Complex enzyme = CNC machine tool
Golgi apparatus = packaging & shipping
Mitochondria = power plant (Chloroplast = solar panel)
Microtubules = highways
Motor proteins = trucks
Lysosome = janitorial
Plasma membrane = international border
Transport proteins = customs checkpoint
Receptor proteins = communications
Marker proteins = marketing

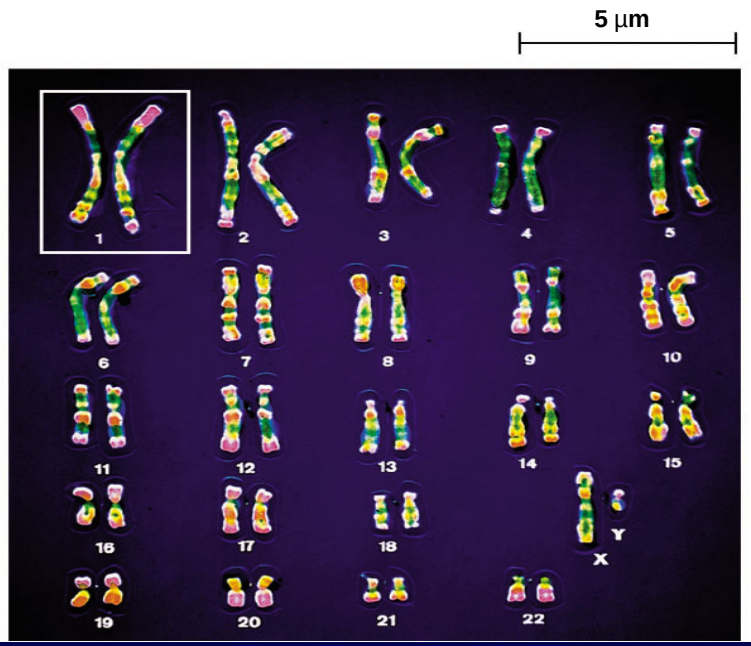
DNA Packaging



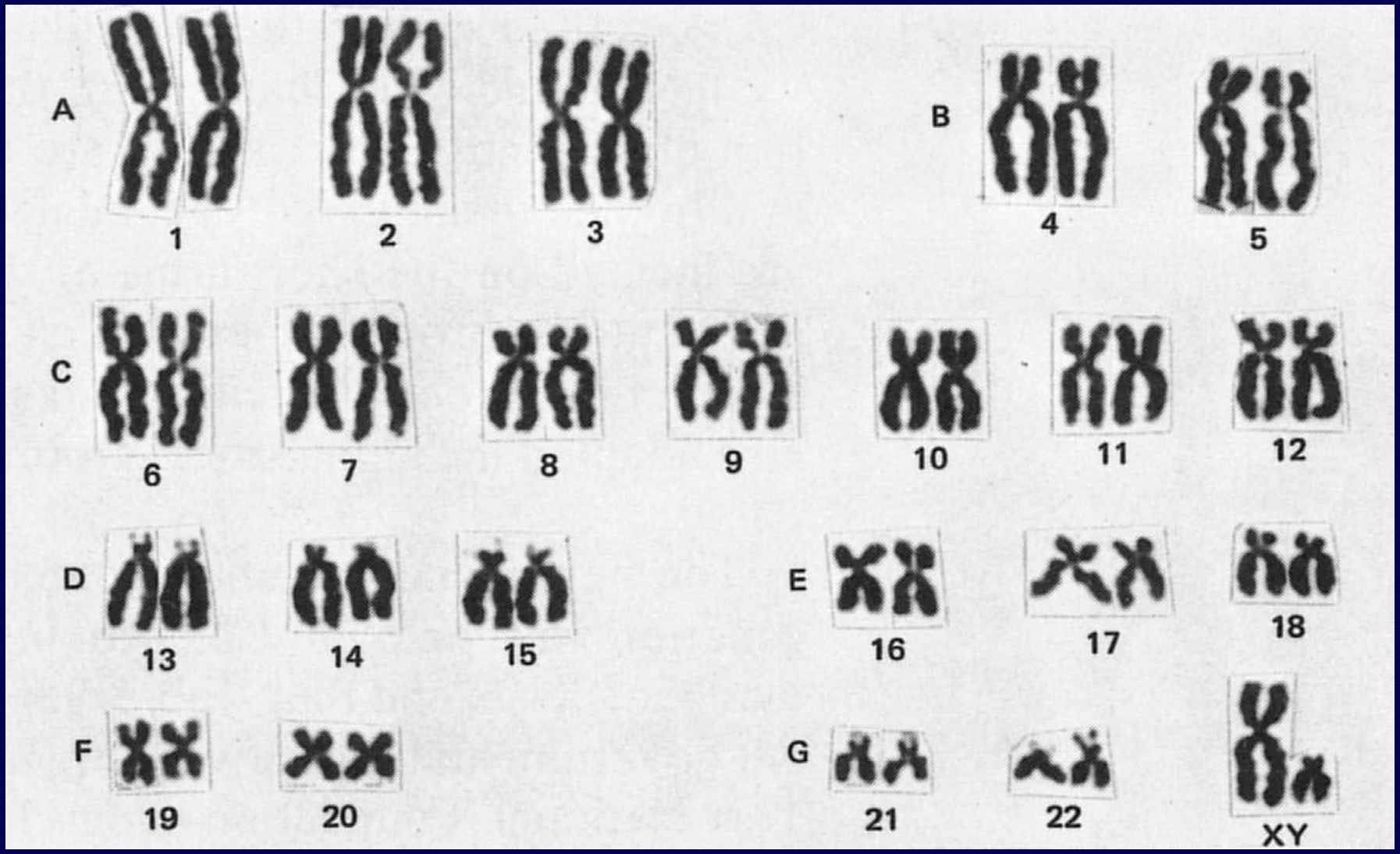
Karyotype

- An ordered, visual representation of the chromosomes in a cell
- Chromosomes are photographed when they are highly condensed, then photos of the individual chromosomes are arranged in order of decreasing size:



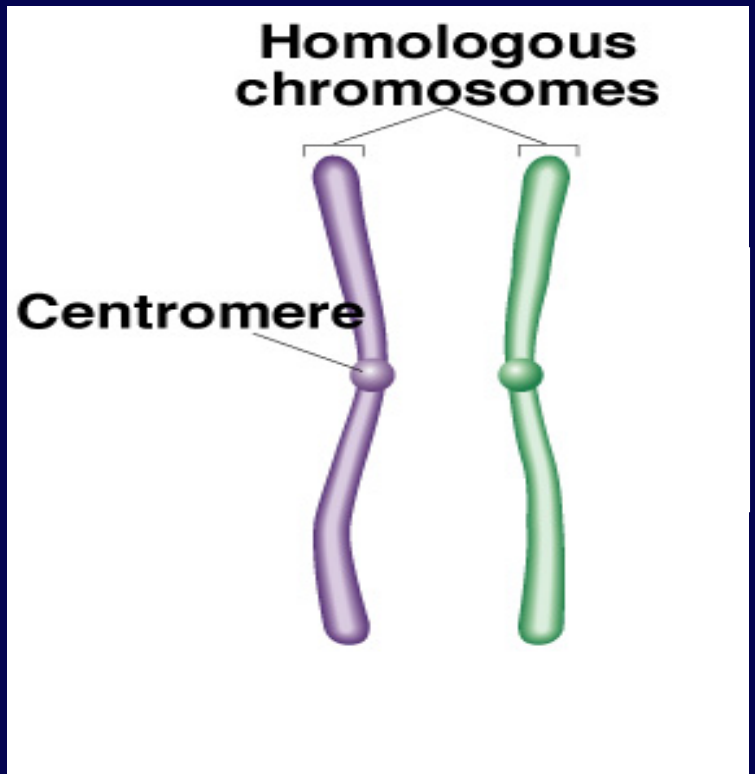


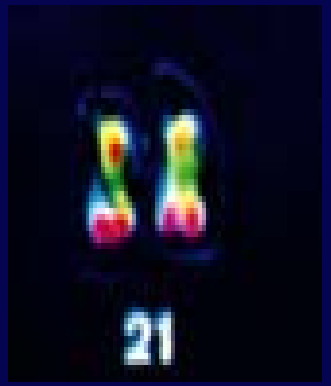
Human karyotype



Homologues

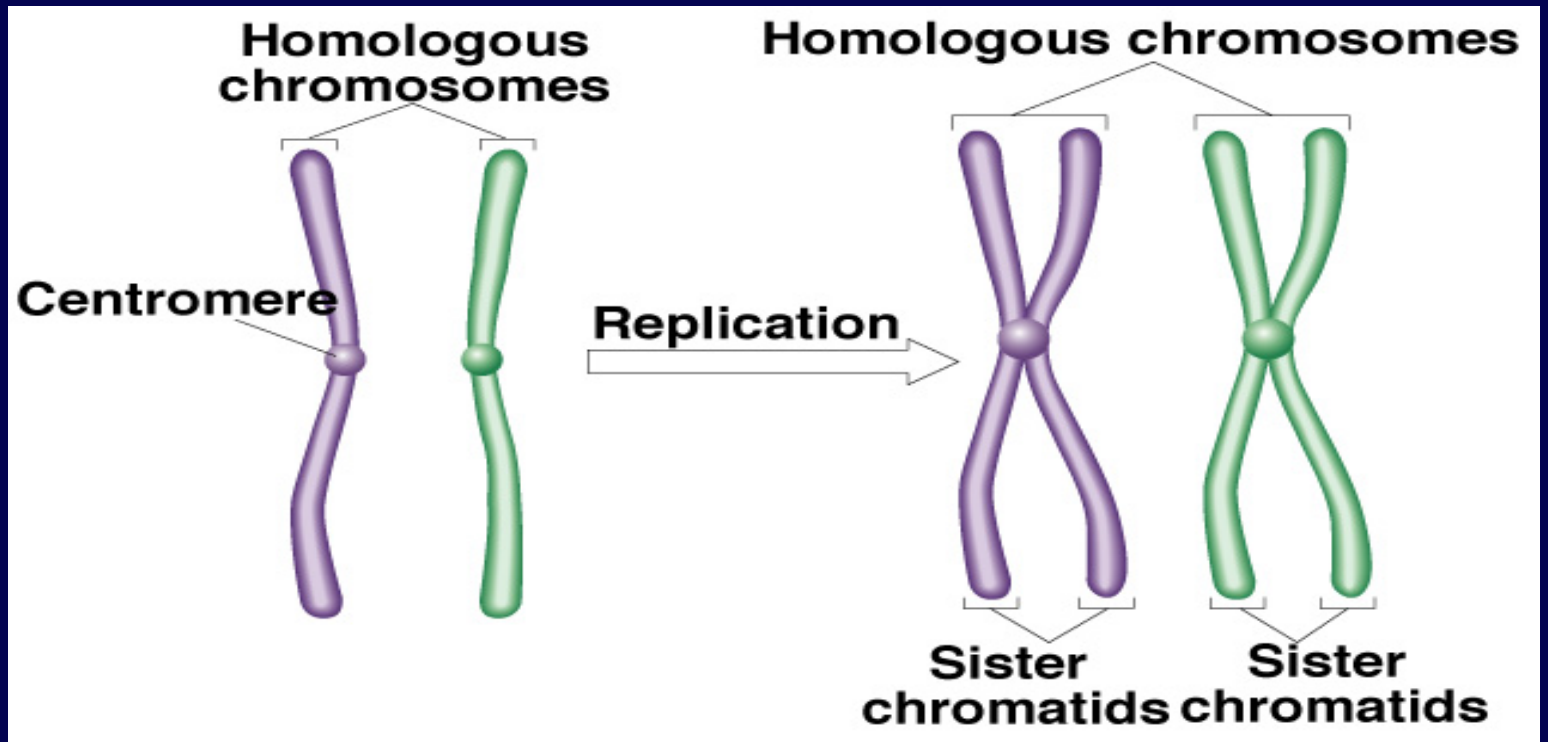
- Look the same
- Control the same traits (code for the same proteins)
- Gene's on the homologues differ slightly
- One from each parent





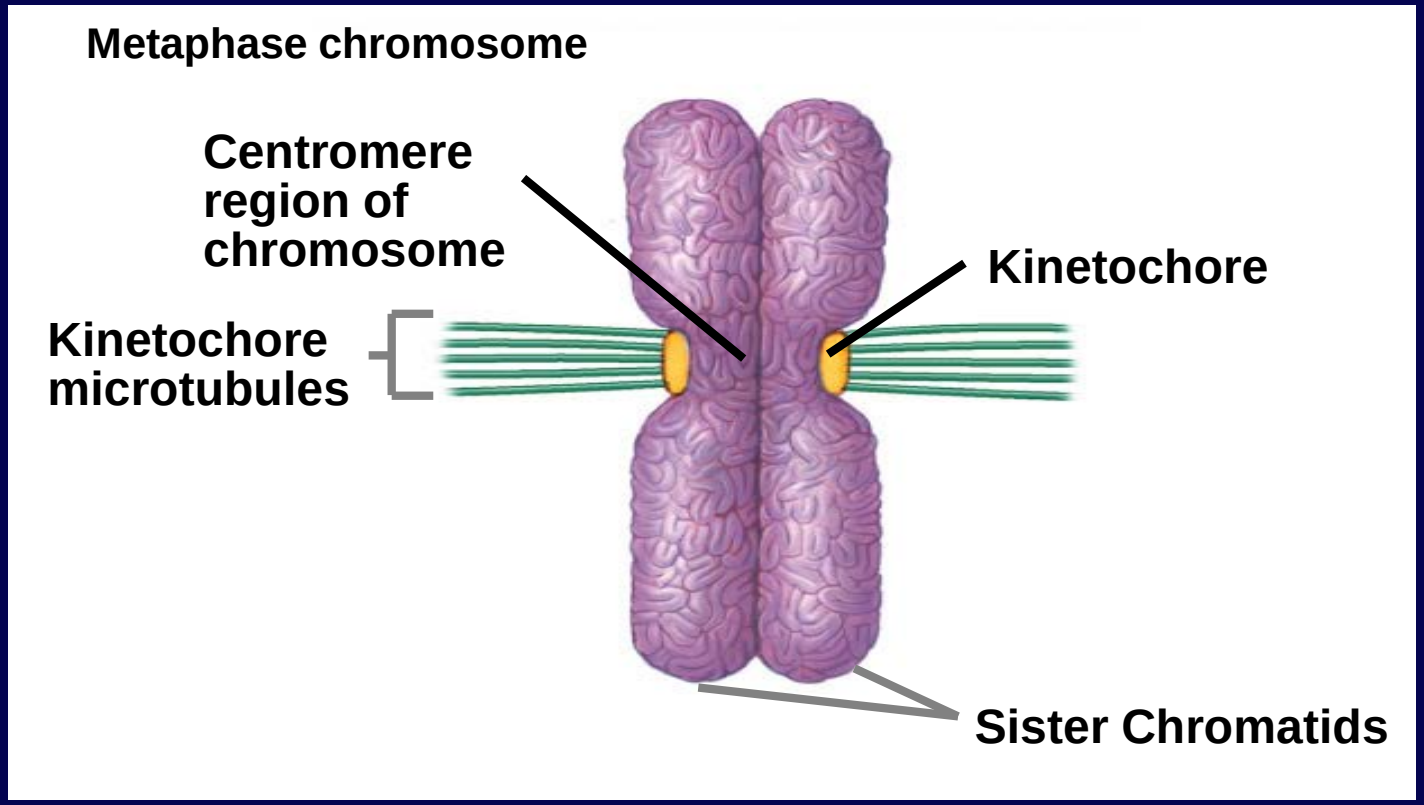
Some terms

- Diploid - A cell possessing two copies of each chromosome (human body cells).
- Homologous chromosomes are made up of sister chromatids joined at the centromere.
- Haploid - A cell possessing a single copy of each chromosome (sex cells: sperm, ova).



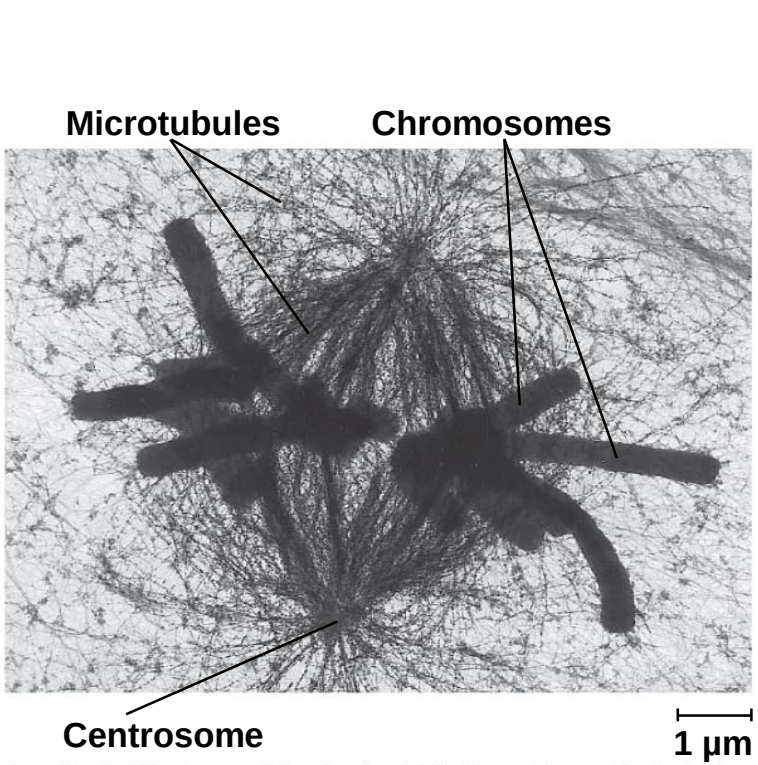
Centromere & Kinetochore

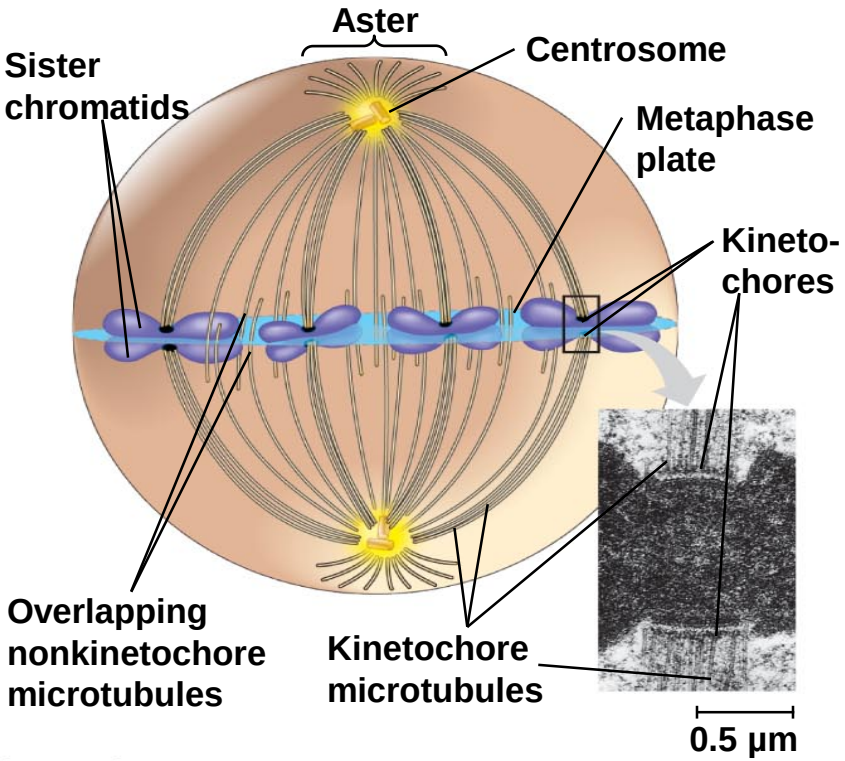
- The centromere is a constricted region of the chromosome containing a specific DNA sequence, to which is bound 2 discs of protein called kinetochores.
- Kinetochores serve as points of attachment for microtubules that move the chromosomes during cell division:



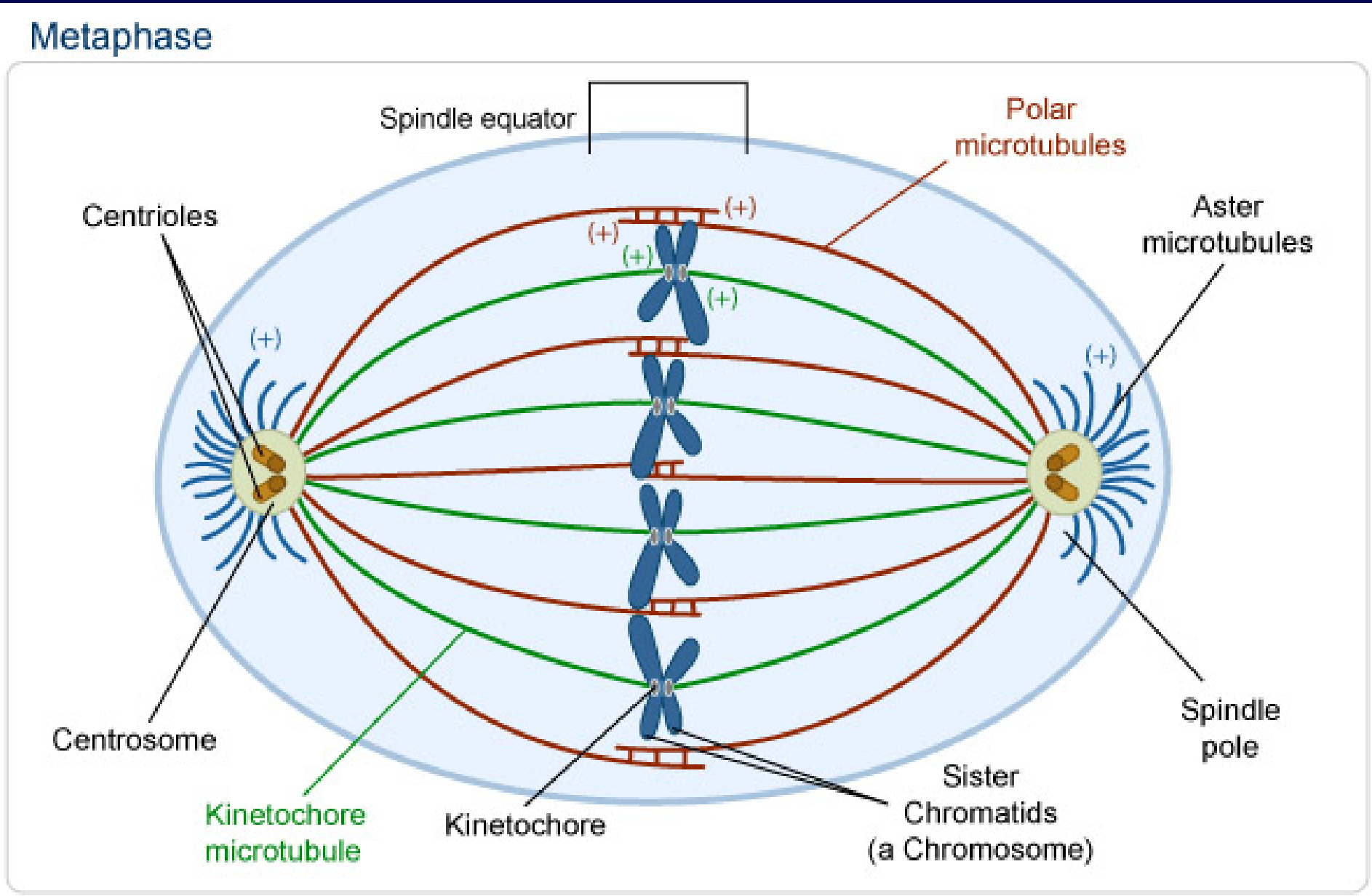
The Mitotic Spindle

- Microtubules attach to the kinetochores of chromosomes and move the chromosomes to the equatorial plate (Metaphase)
- Sister chromatids separate (Anaphase) and move along the kinetochore microtubules toward opposite ends of the cell

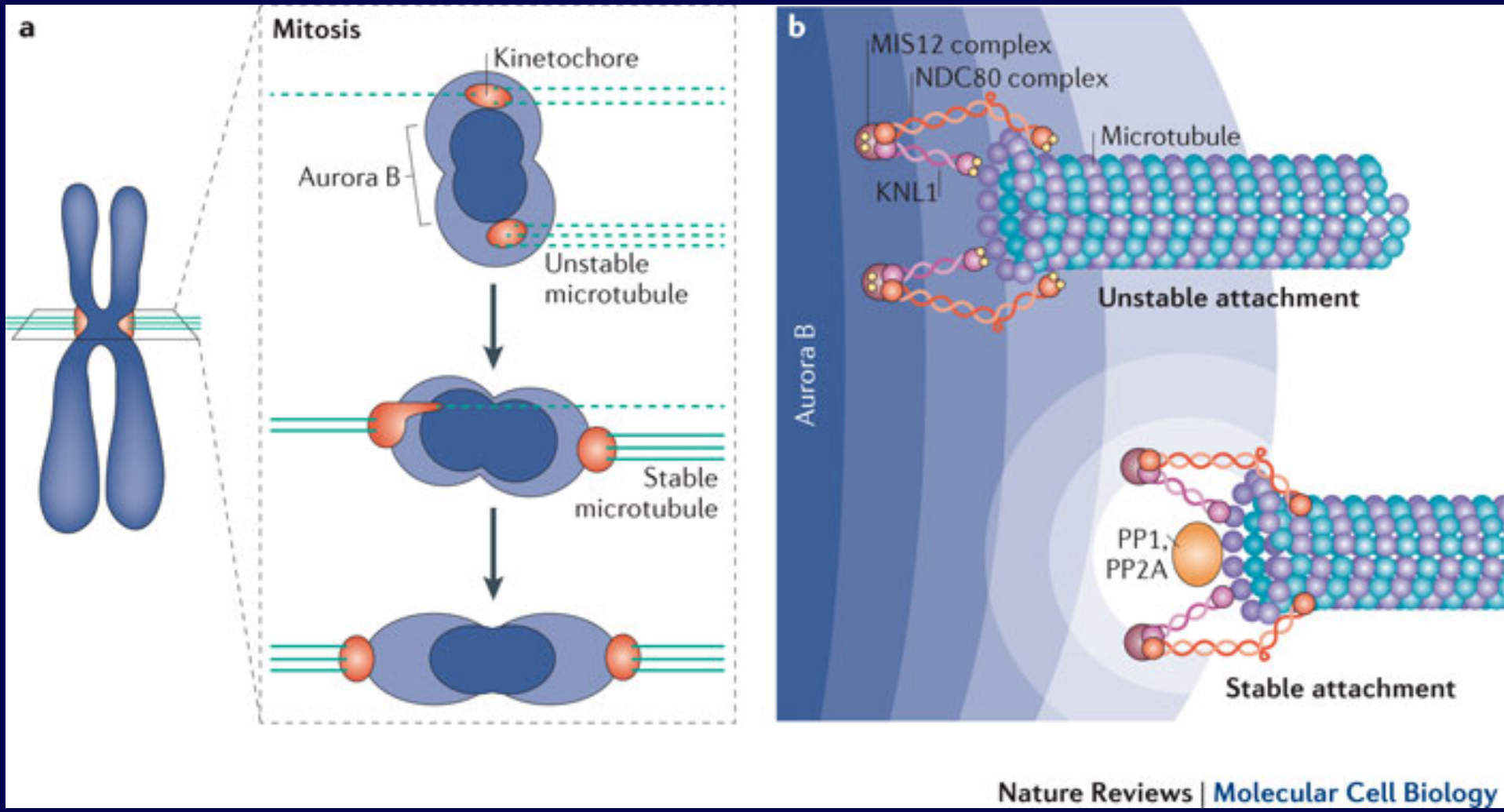




Spindle apparatus



Microtubule attachment details

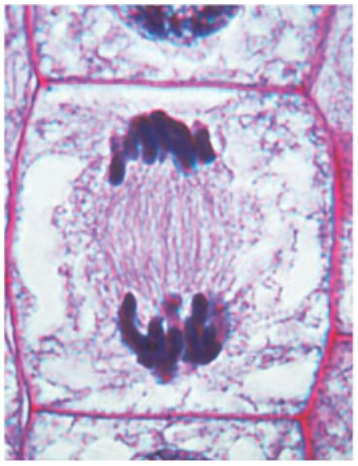


Mitosis in a plant cell

Prophase. The chromatin is condensing. The nucleolus is beginning to disappear. Although not yet visible in the micrograph, the mitotic spindle is staring to from.

Prometaphase. We now see discrete chromosomes; each consists of two identical sister chromatids. Later in prometaphase, the nuclear envelop will fragment.

Metaphase. The spindle is complete, and the chromosomes, attached to microtubules at their kinetochores, are all at the metaphase plate.

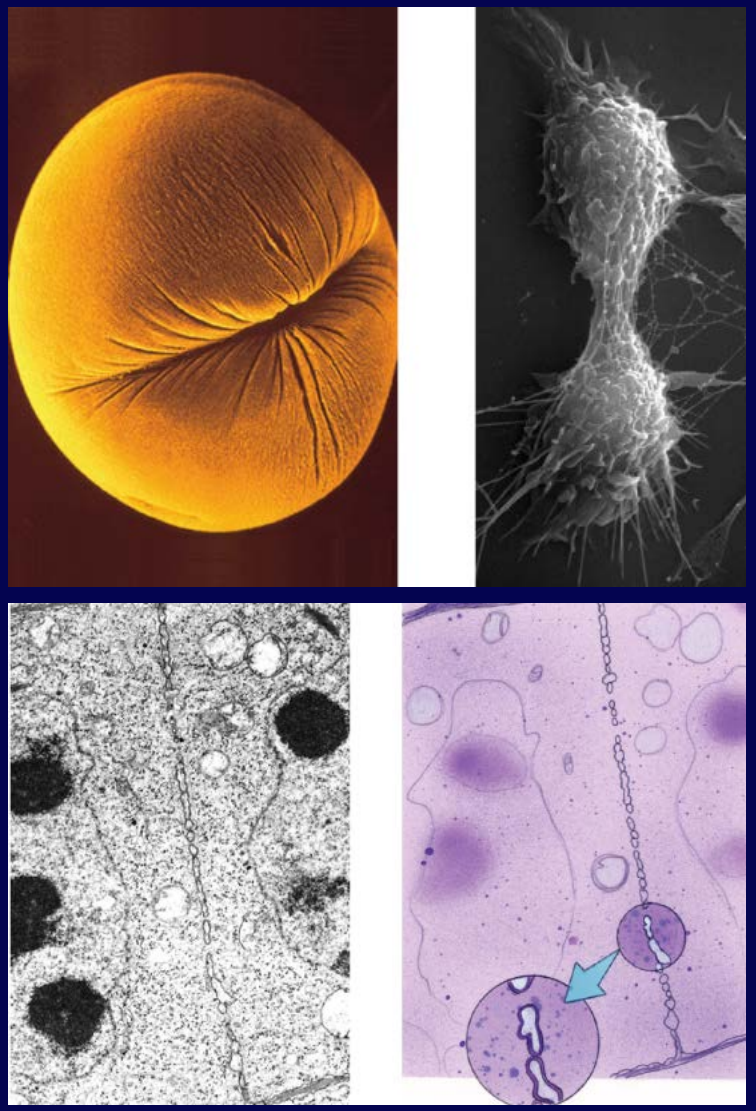


Anaphase. The chromatids of each chromosome have separated, and the daughter chromosomes are moving to the ends of cell as their kinetochore microtubles shorten.

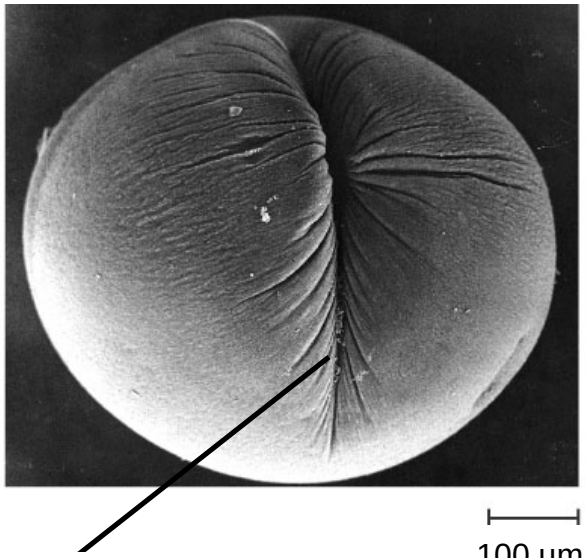
Telophase. Daughter nuclei are forming. Meanwhile, cytokinesis has started: The cell plate, which will divided the cytoplasm in two, is growing toward the perimeter of the parent cell.

Cytokinesis

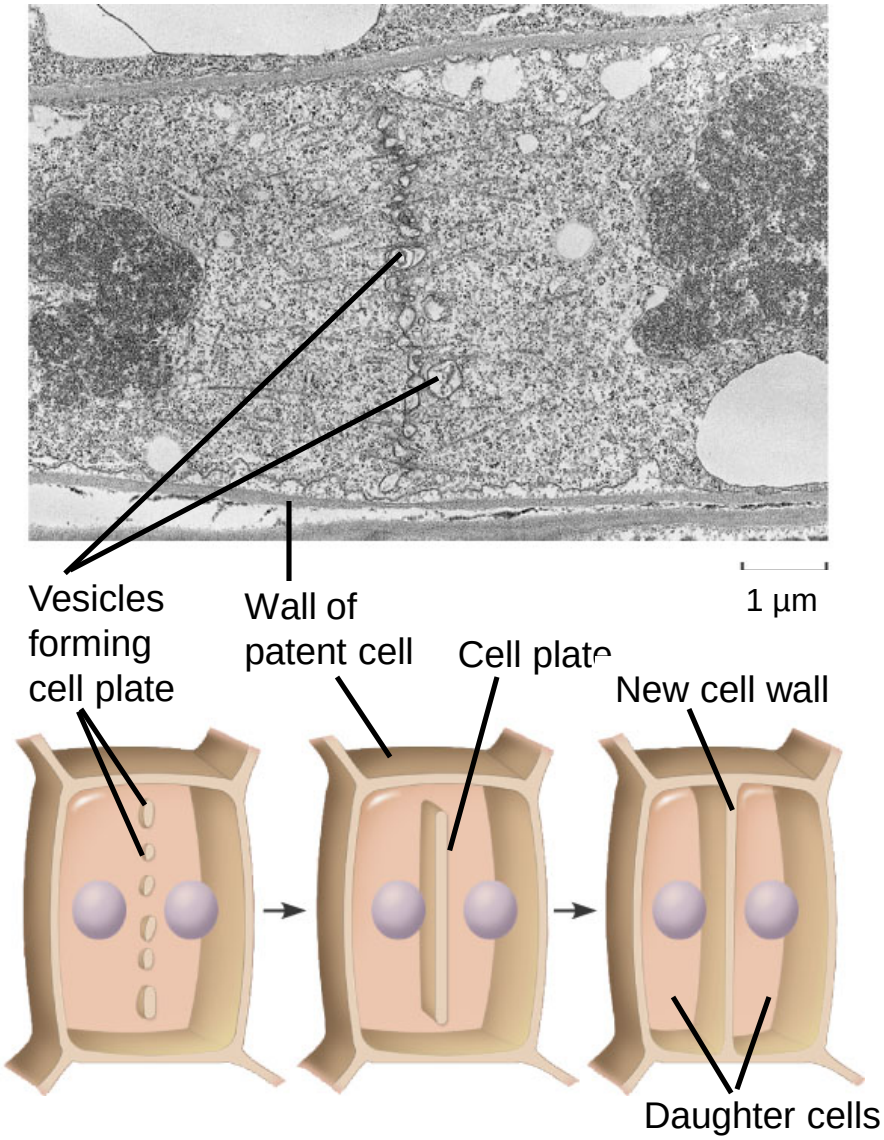
- Cleavage of cell into two halves
  - Animal cells
    - Constriction belt of actin filaments
  - Plant cells
    - Cell plate
  - Fungi and protists
    - Mitosis occurs within the nucleus



Cytokinesis In Animal And Plant Cells



(a) Cleavage of an animal cell (SEM)



(b) Cell plate formation in a plant cell (SEM)