

**Aim: What happens during mitosis?**



# Mitosis is the reproduction of two identical cells

- Asexual reproduction involves the creation of identical daughter cells from an original parent cell. It occurs in two stages:
  - Mitosis – the division of the cell's duplicated genetic material
  - Cytokinesis – the division of the cell's cytoplasm
- Human somatic (non-sex) cells contain 46 chromosomes (2 sets = diploid) They are produced by mitosis.
- Human sex cells contain 23 chromosomes (1 set = monoploid or haploid) They are produced by meiosis.



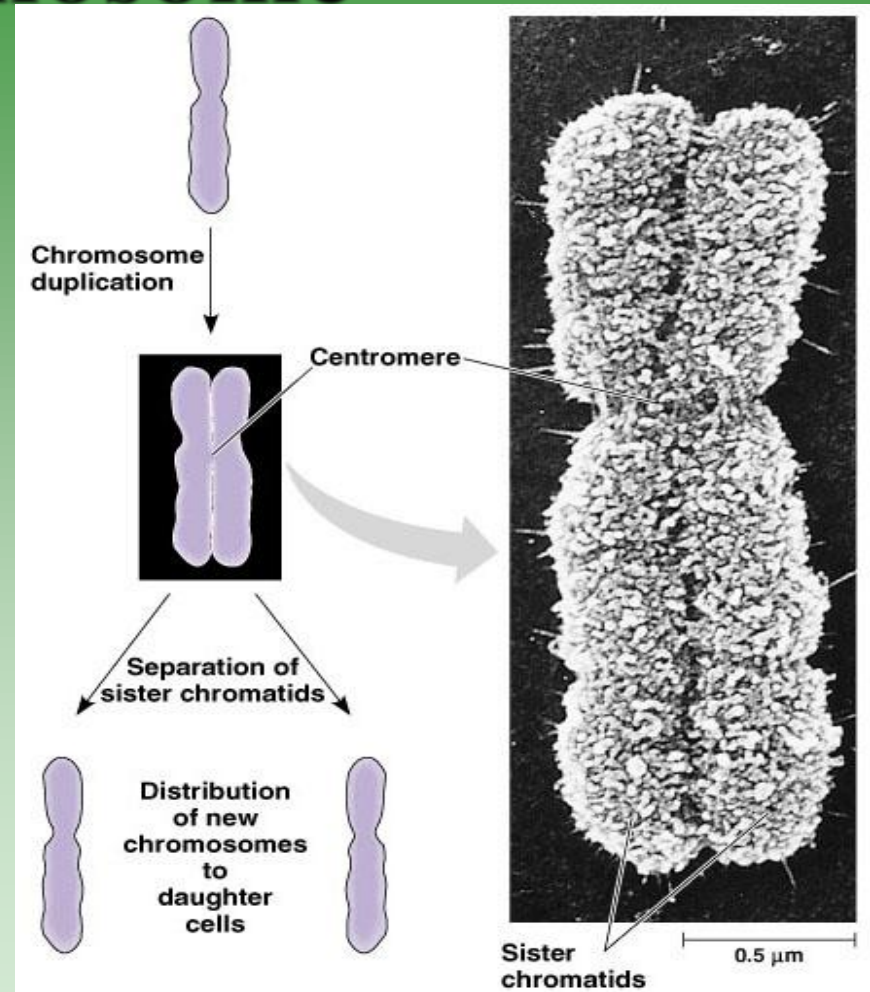
# What are the stages in mitosis?

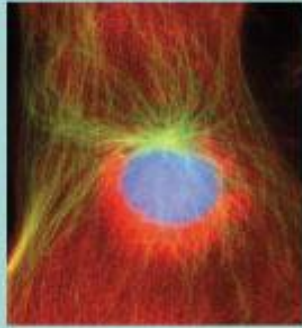
- Mitosis is a continuous process but is often described as a series of stages that occur until the onset of cytokinesis.
- Stage I – Prophase
  - 1) chromatin condenses into chromosomes. The chromatin was already duplicated during the S stage of interphase.
  - 2) The nucleoli disappear.
  - 3) a mitotic spindle consisting of microtubules extending from two polar centrosomes begins to form in the cytoplasm.



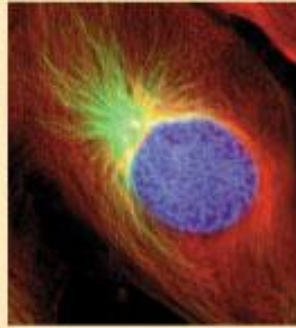
# Structure of a duplicated chromosome

- Each duplicated chromosome consists of two **sister chromatids** which contain identical copies of the chromosome's DNA.
- The region where the strands connect is the **centromere**.

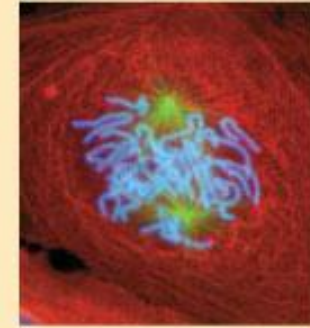




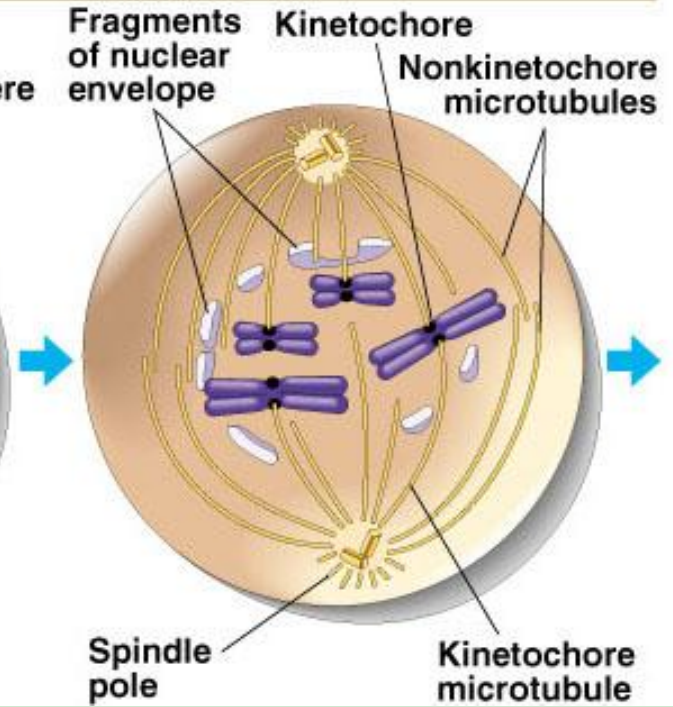
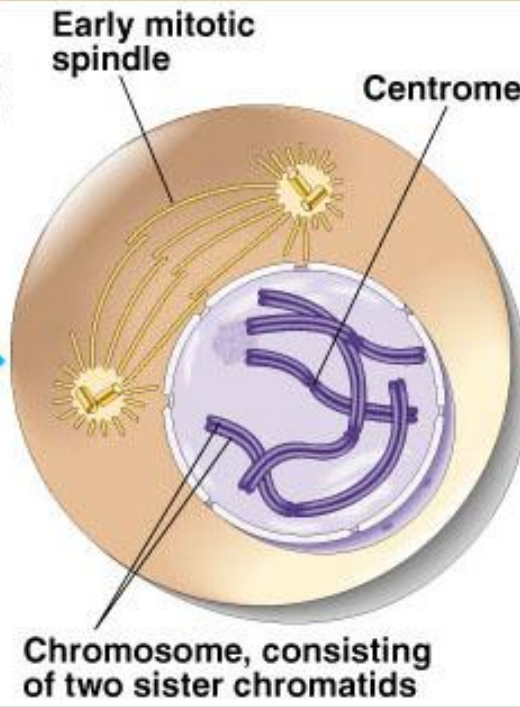
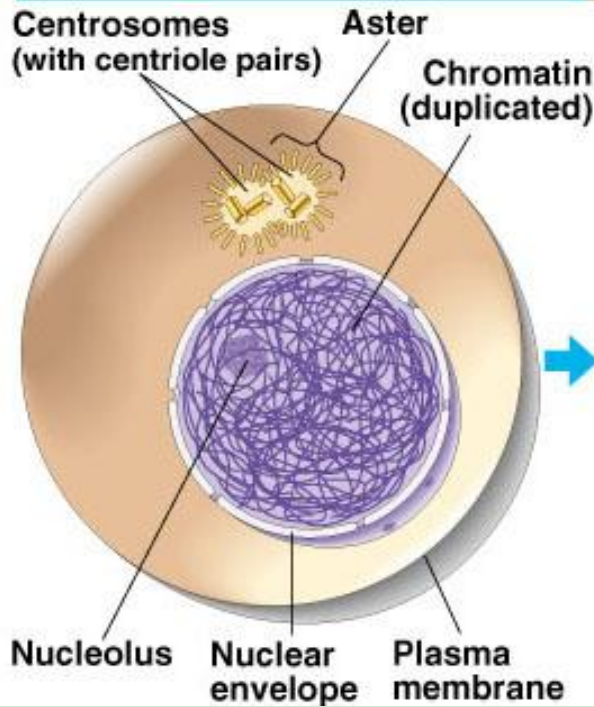
**G<sub>2</sub> OF INTERPHASE**



**PROPHASE**



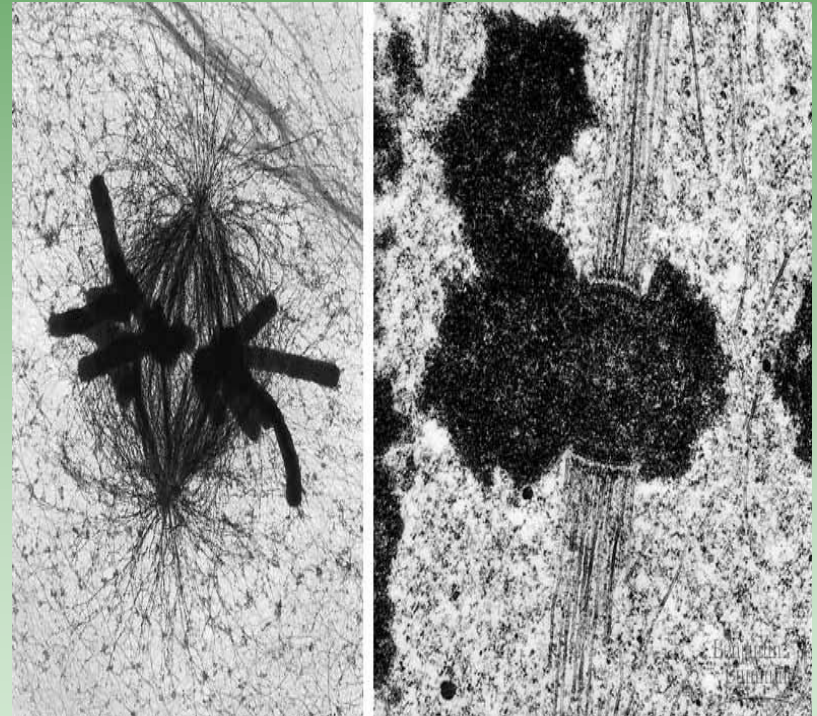
**PROMETAPHASE**

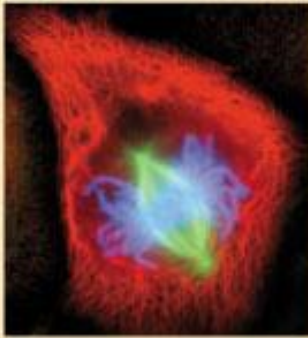




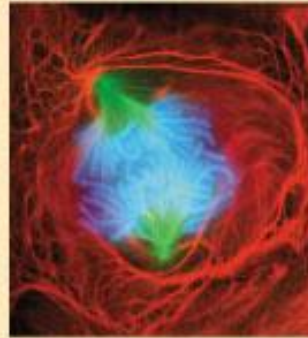
# Prometaphase

- During prometaphase:
- 1) the nuclear envelope fragments
- 2) spindle fibers begin to attach to the chromatids.
- Each chromatid has an attachment site in the centromere region which binds to spindle fibers.
- This attachment site is called a *kinetochore*

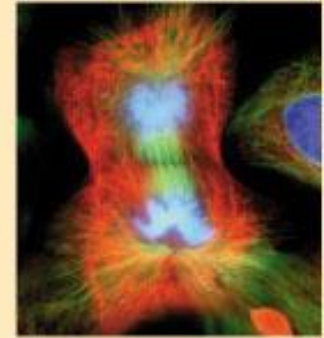




**METAPHASE**

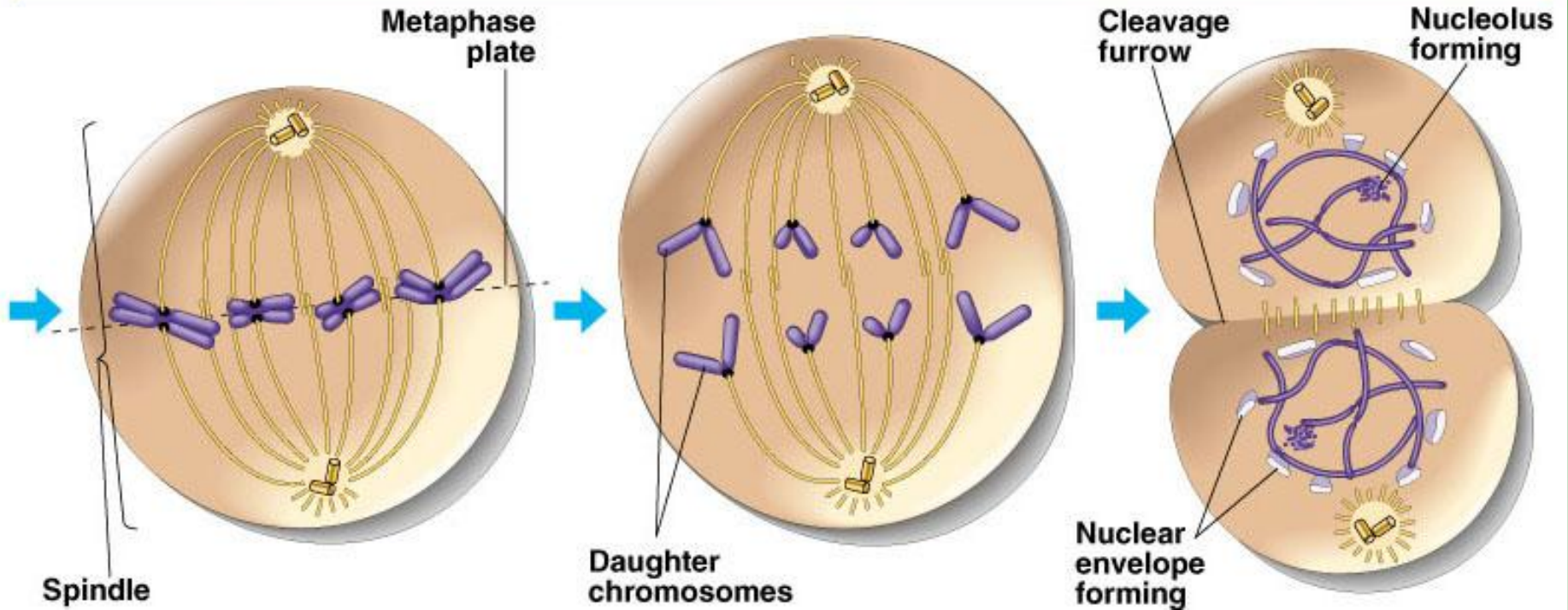


**ANAPHASE**

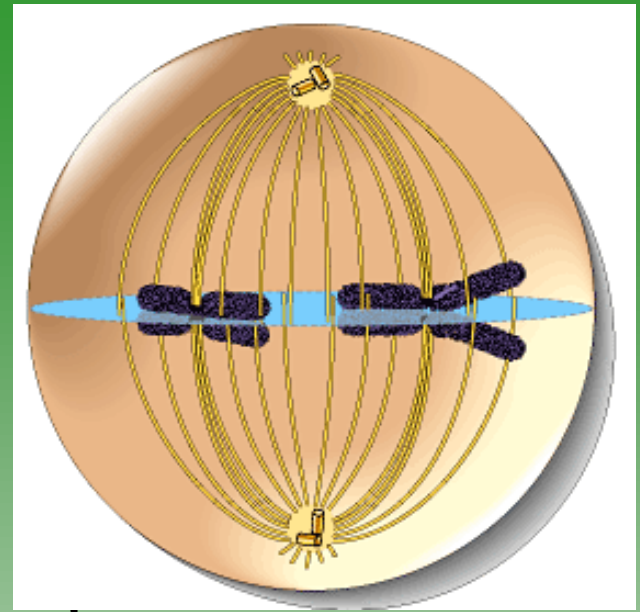


25  $\mu$ m

**TELOPHASE AND CYTOKINESIS**



# Metaphase



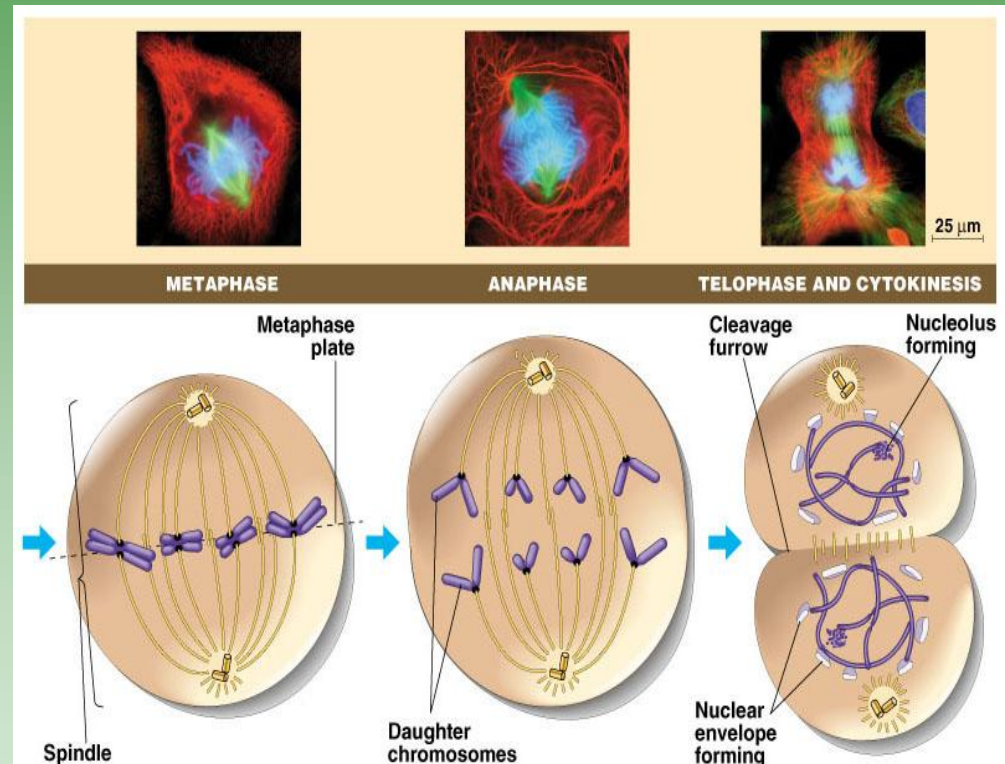
- During metaphase:
- 1) centrioles have moved to the poles
- 2) duplicated chromatids line up on the *metaphase plate* at the equator of the cell
- 3) all kinetochores from all chromosomes have been attached to spindle fiber microtubules.





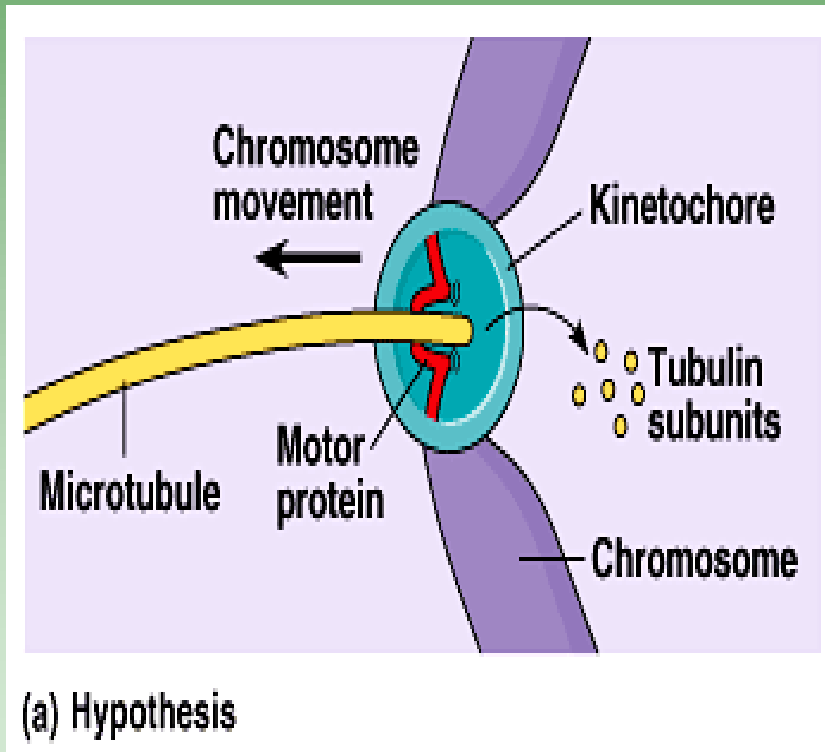
# Anaphase

- In anaphase:
- 1) sister chromatids separate as they are pulled by kinetochore spindle fibers to the poles
- 2) nonkinetochore spindle fibers expand and elongate the cell.



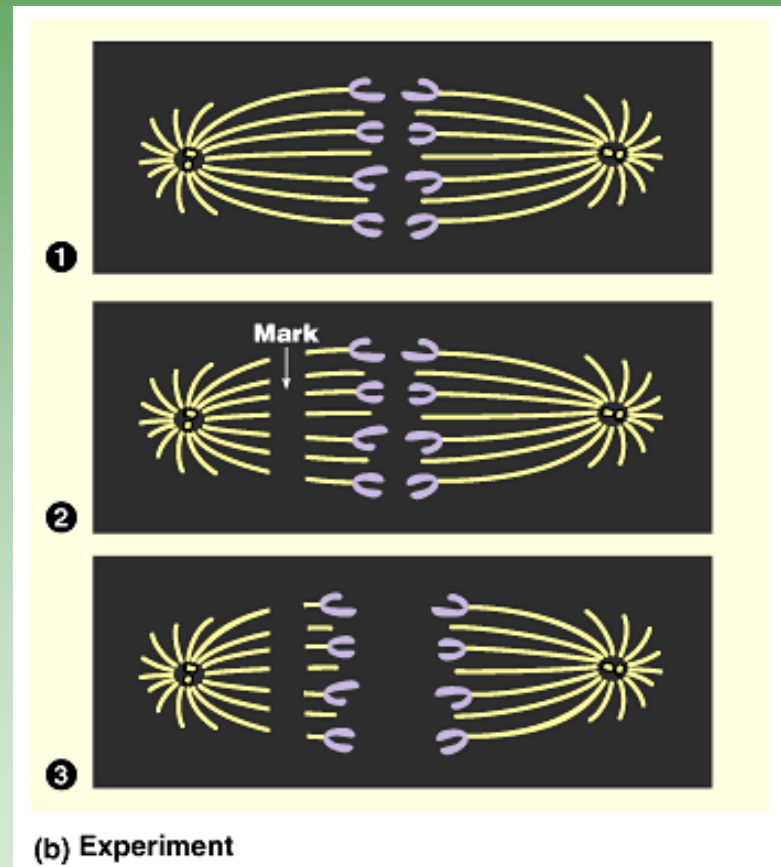
# The mechanics of anaphase

- One hypothesis for the movement of chromosomes in anaphase is that motor proteins at the kinetochore “walk” the attached chromosome along the microtubule toward the opposite pole



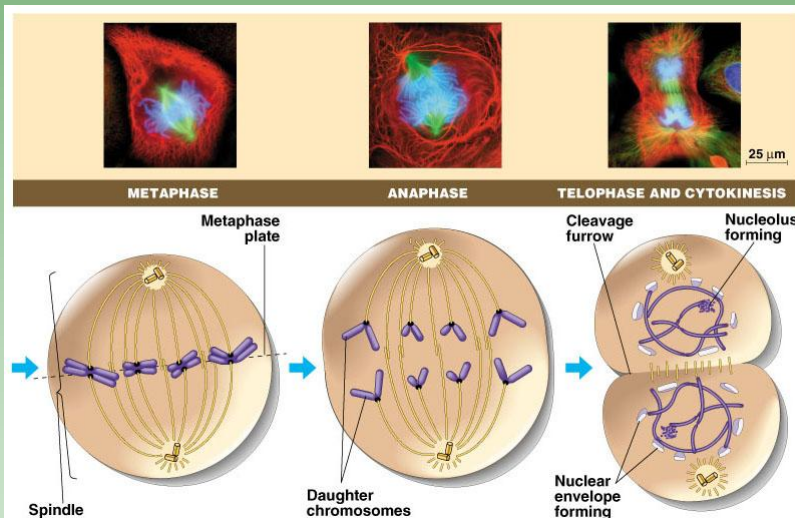
# The mechanics of anaphase

- Experiments support the hypothesis that spindle fibers shorten during anaphase from the end attached to the chromosome, not the centrosome



# Telophase

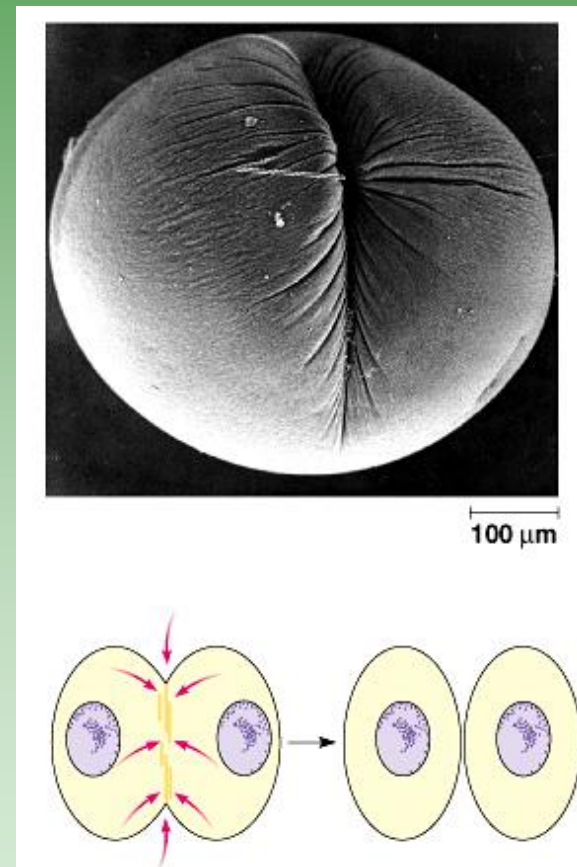
- During telophase:
- 1) nuclear envelopes reform
- 2) chromosomes loosen and become chromatin
- 3) cytokinesis begins





# Cytokinesis in animal cells

- On the cytoplasmic side of the cleavage furrow a contractile ring of actin microfilaments and the motor protein myosin form.
- Contraction of the ring pinches the cell in two.



# Cytokinesis in plant cells

- During telophase, vesicles from the Golgi coalesce at the metaphase plate, forming a **cell plate**.
  - The plate enlarges until its membranes fuse with the plasma membrane at the perimeter, with the contents of the vesicles forming new wall material in between

