

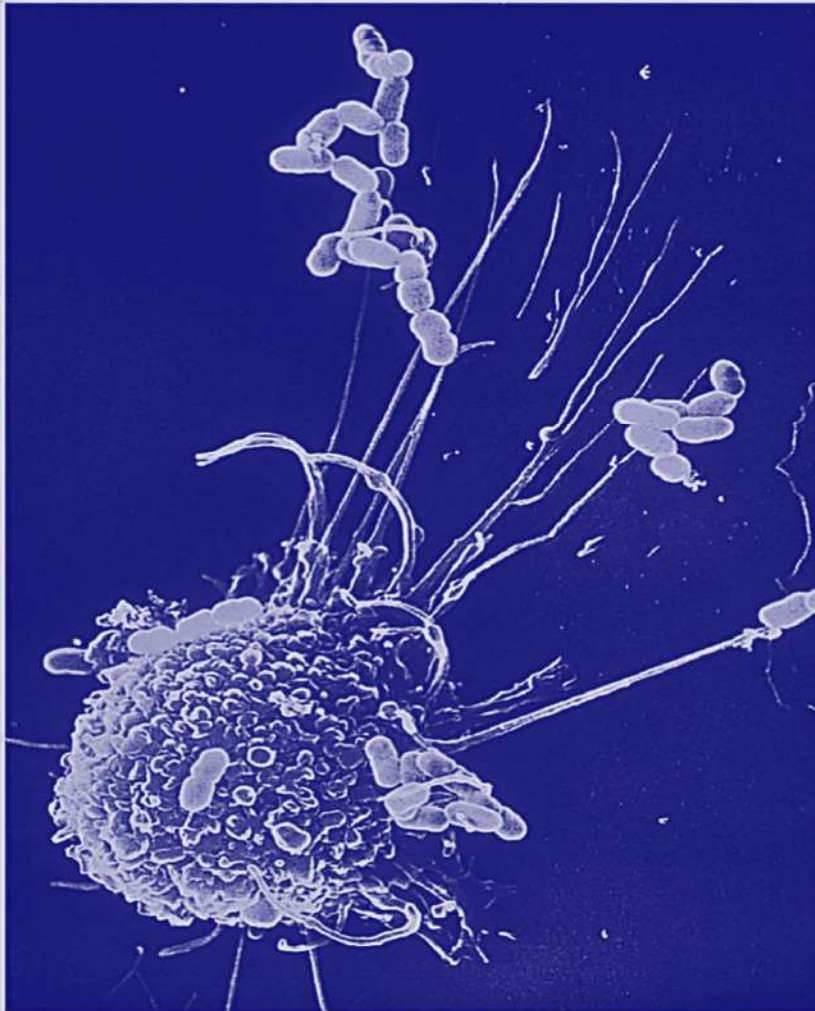
**CELL BIOLOGY &  
PHYSIOLOGY**

جامعة  
الملك سعود  
King Saud University



college of sciences  
Zoology Department

**Cell Biology and Physiology  
ZOO (242)**



A microscopic view of numerous cells, likely yeast or similar unicellular organisms, showing their cell walls and bright blue nuclei. The cells are scattered across the frame, with some in sharp focus and others blurred in the background.

# How cell divides

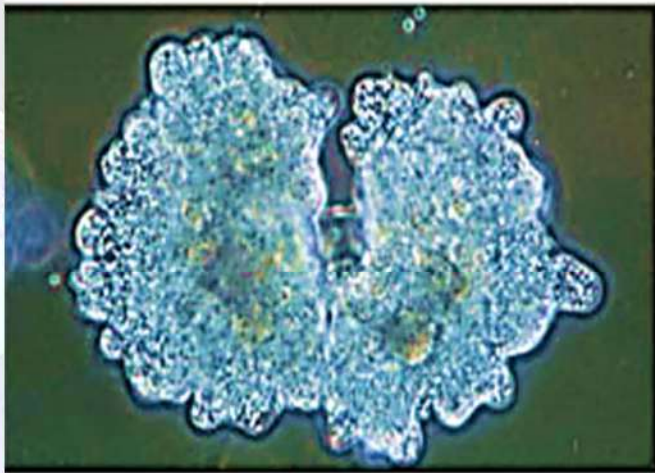
Mitosis



## The function of cell division

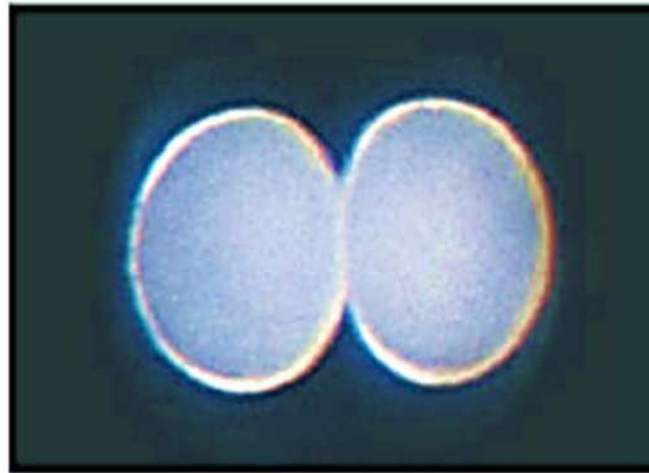
### Reproduction

100  $\mu\text{m}$



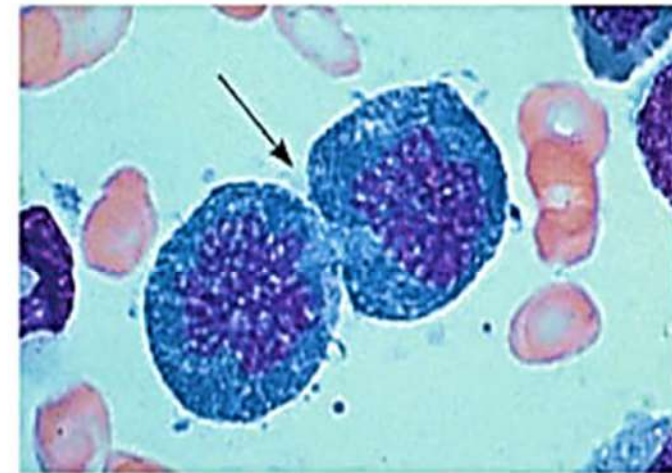
### Growth and Development

200  $\mu\text{m}$



### Tissue Renewal

20  $\mu\text{m}$



**(a) Reproduction.** An amoeba, a single-celled eukaryote, is dividing into two cells. Each new cell will be an individual organism (LM).

**(b) Growth and development.** This micrograph shows a sand dollar embryo shortly after the fertilized egg divided, forming two cells (LM).

**(c) Tissue renewal.** These dividing bone marrow cells (arrow) will give rise to new blood cells (LM).



The “purpose” of mitosis is to **ensure** that each daughter cell **gets** a perfect, full set of chromosomes

- Mitosis is a part of the **cell cycle process** by which chromosomes in a cell nucleus are **separated into two identical sets of chromosomes**, each in its own nucleus.
- In general, **karyokinesis** (division of the **nucleus**) is followed by **cytokinesis** (division of the **cytoplasm**).
- The **sister chromatids** are held together at a specific region of the chromosome called the **centromere**.





- Mitosis is divided into **four stages**:
  - **prophase**, **metaphase**, **anaphase** and **telophase**.
- **Replication** (duplication) of the genetic material occurs during the **S phase** of the cell cycle.
- The timing of the four stages **varies** from species to species and from organ to organ.

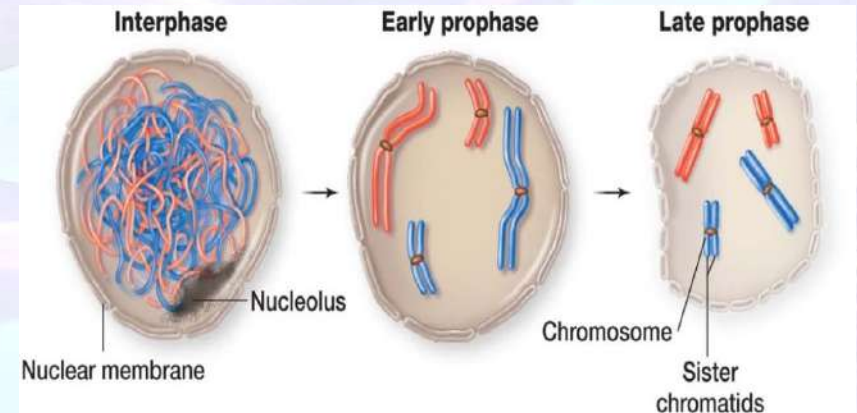




## The phases of Mitotic division:

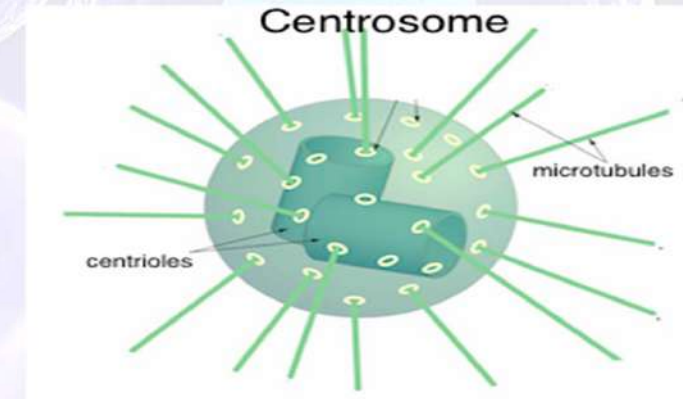
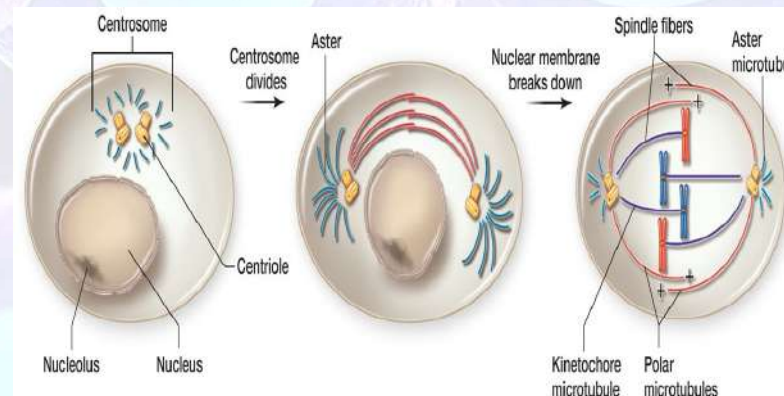
### 1. Prophase:

- The first stage of mitosis begins with the **shorting** and **thickening** of the chromosomes.
- Each chromosome is composed of **two sister chromatids**, which are **identical** double-stranded DNA molecules.
- The **nuclear membrane** breaks down and the **nucleolus** disappears **Figure 1**.



**Figure 1:** Nuclear events during interphase and prophase of mitosis

- The **centrosome** divides and moves to opposite poles of the cell, around the nucleus (Figure 2).
- The newly divided centrosomes radiate **microtubules**, which are called **spindle fibers**.
- Microtubules also spread out from the centrosome in the opposite direction from the spindle itself, forming an **aster microtubule** (Figure 2).
- The **second** microtubules that attach to a kinetochore on a sister chromatid are called **kinetochore microtubules** (Figure 2).



**Figure 2:** The centrosome divides in prophase, and separate halves move to opposite poles of the cell



- The **third** class of microtubules fail to attach to kinetochore are called **polar microtubules**.
- The sister chromatids are held together by a complex called **cohesin**, made up of at least four different proteins (Figure 3).
- Cohesin complexes connect the **arms** and **centromere** of sister chromatids at **the early prophase**.
- At the end of prophase (late prophase), the cohesin complexes holding the **arms** are **released**; however, the sister chromatids **remain connects** only at the **centromere**.





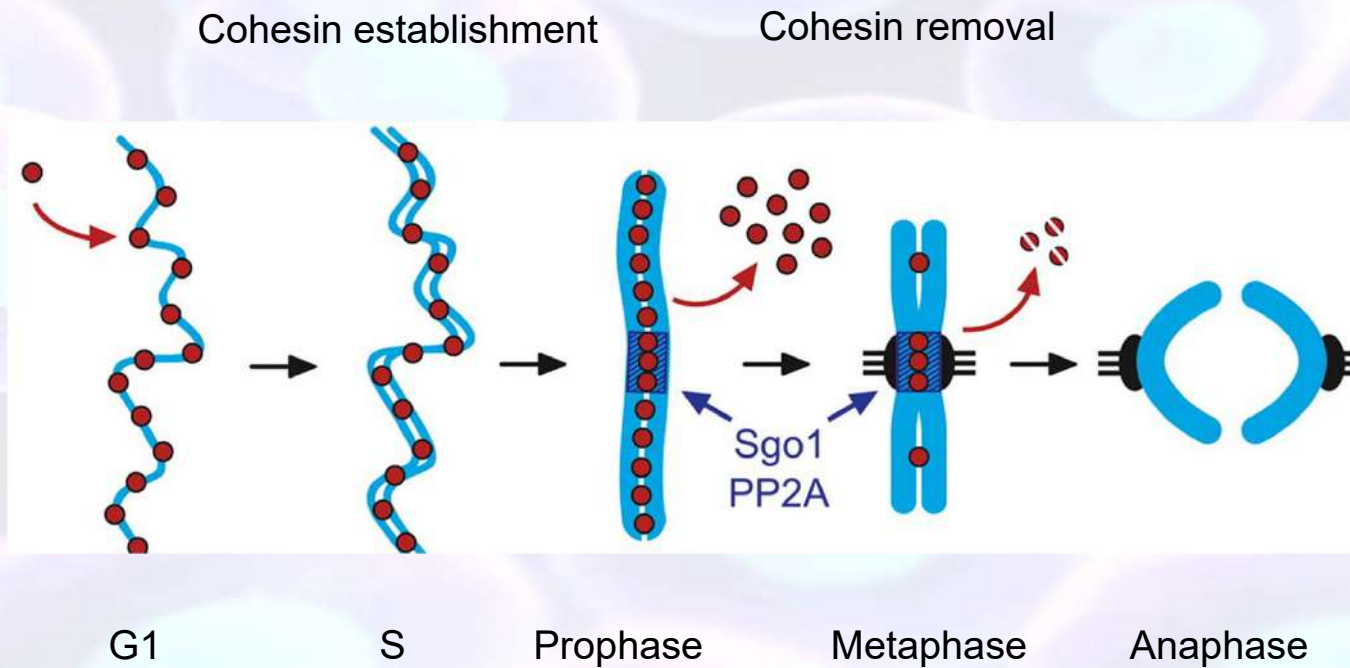


Figure 3: establishment and removal of cohesin complex

## 2. Metaphase:

- The spindle fibers are form and each **centromere** attached to a **kinetochore microtubule** from each **centrosome**.
- The two centrosomes begin pulling the chromosomes towards opposite ends of the cell.
- The resulting tension causes the chromosomes to align along the metaphase plate (Figure 4).

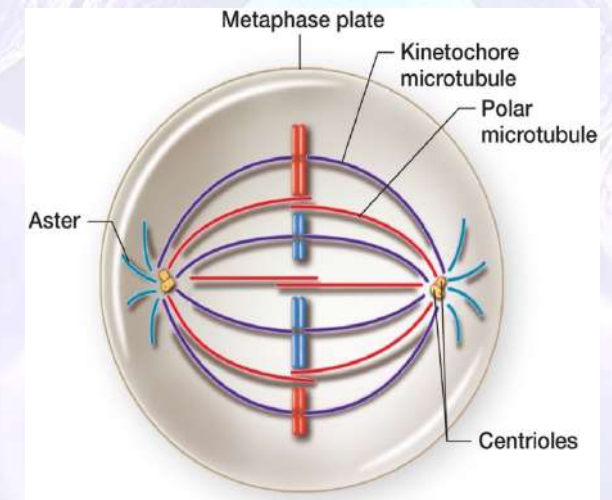


Figure 4: The mitotic spindle fibers during metaphase

### 3. Anaphase:

- Anaphase begins with the **two sister chromatids separating** and moving toward opposite poles on the spindle fibers (Figure 5).

- The **degradation** of cohesin at the **centromere** allowing the sister chromatids to **separate** (Figure 6).

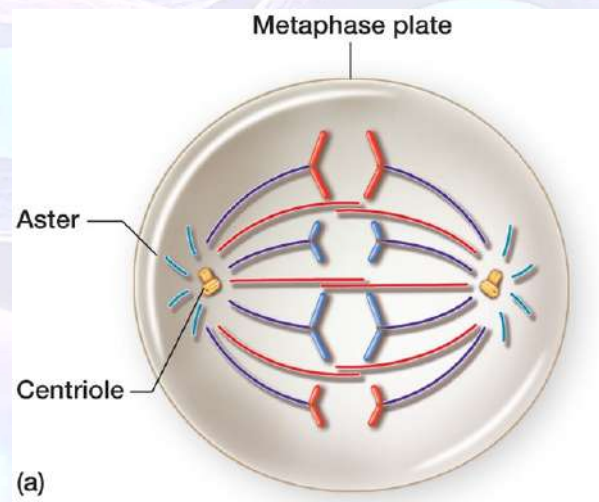


Figure 5: the mitotic spindle fibers during anaphase

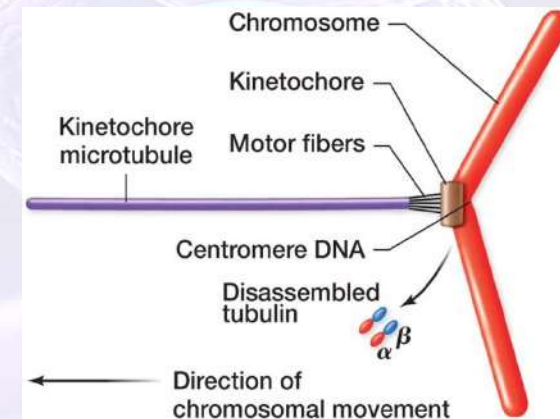


Figure 6: The kinetochore



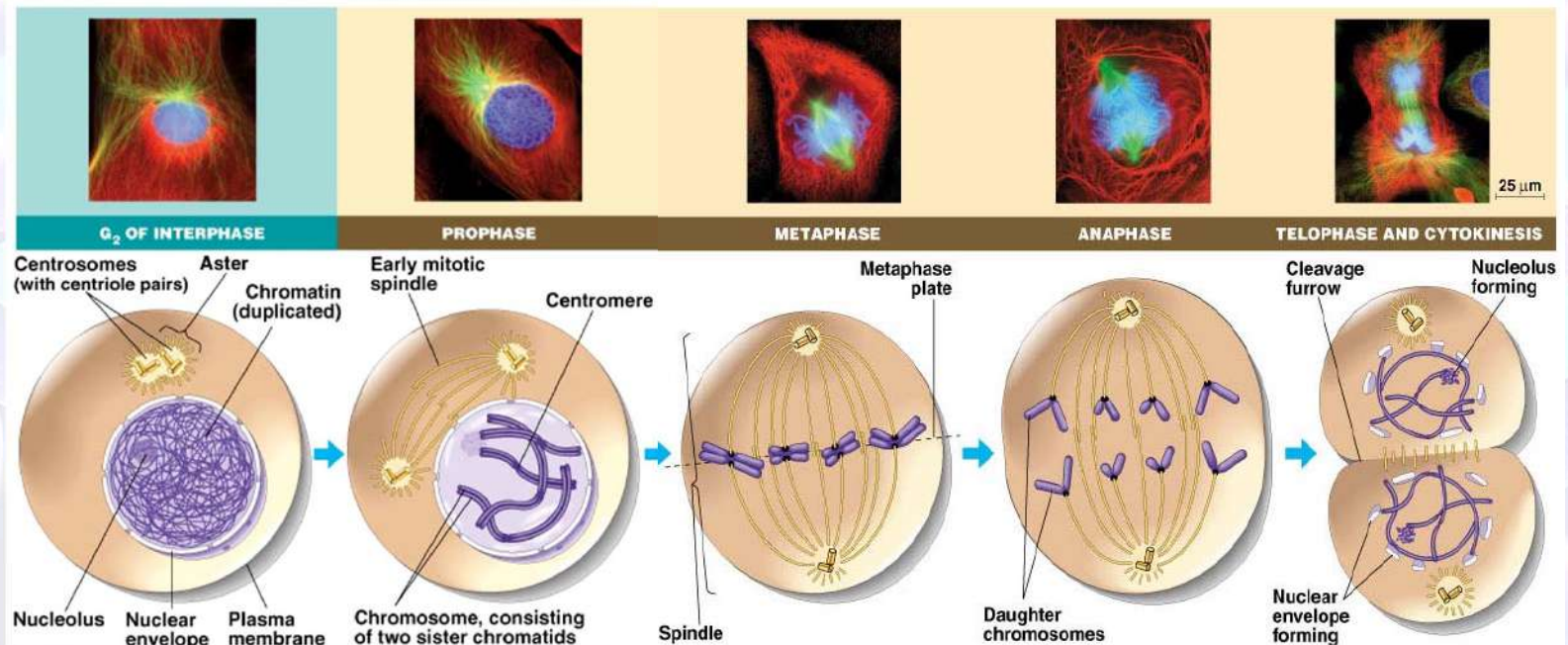


## 4. Telophase:

- In telophase, the **nuclear membrane** reforms around each set of chromosomes and the **nucleus** forms again.
- **Cytokinesis** takes place.
- In **animals**, **cytokinesis** is first apparent by **constriction** between the two poles.
- In **plants**, a **cell plate** grows in the approximate location of the metaphase plate.

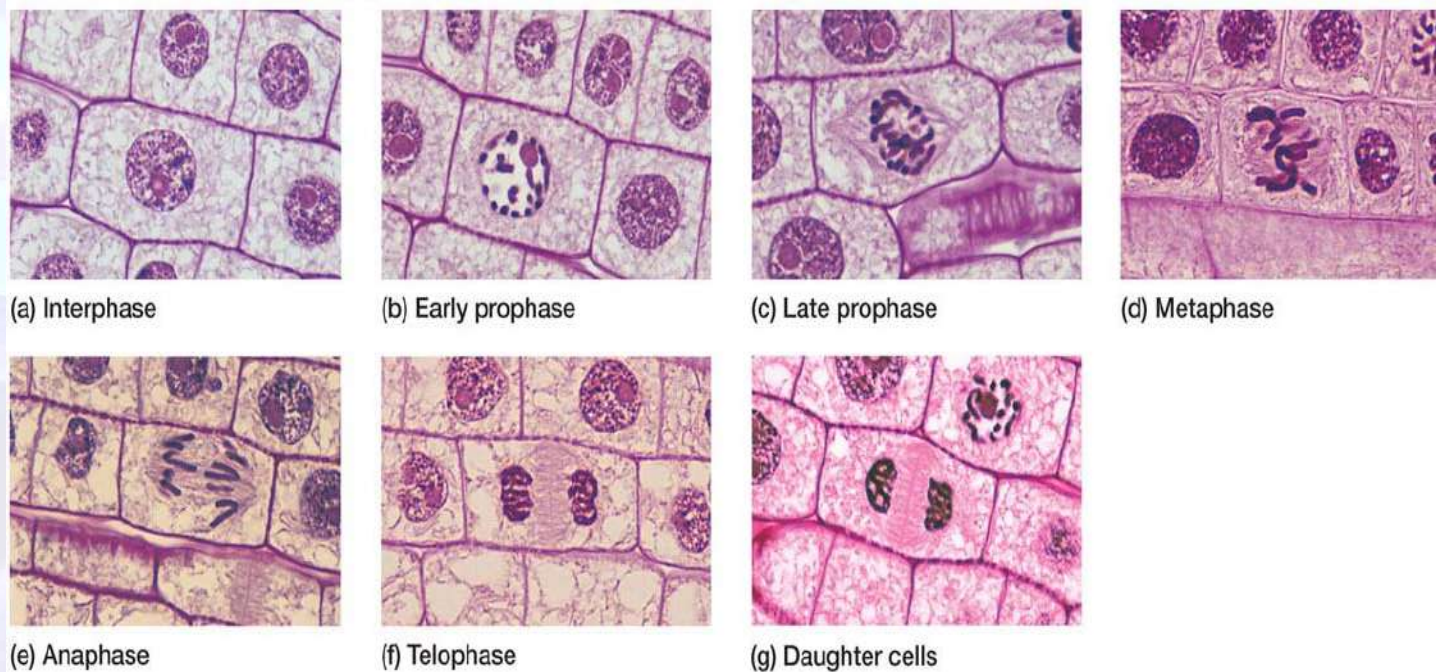


•The phases of mitosis in **animal cells** are summarized in Figure 8.



**Figure 8:** Cells in interphase and in various stages of mitosis in the animal cells

- The phases of mitosis in **onion root tip cells** are summarized in Figure 8.



**Figure 8:** Cells in interphase and in various stages of mitosis in the onion root tip





## References

- **“Cell Cycle” Chapter 12. Biology** by Jane B Reece; Neil A Campbell; et al Boston : Benjamin Cummings / Pearson, ©2011. English : 9th ed.

