



**Mitosis** is the process that partitions newly replicated chromosomes equally into separate parts of a cell.

The last step in the cell cycle, mitosis takes about 1 hour in an actively dividing animal cell

In that period, the cell builds and then disassembles a specialized microtubule structure, the **mitotic apparatus**.

Larger than the nucleus, the mitotic apparatus is designed to

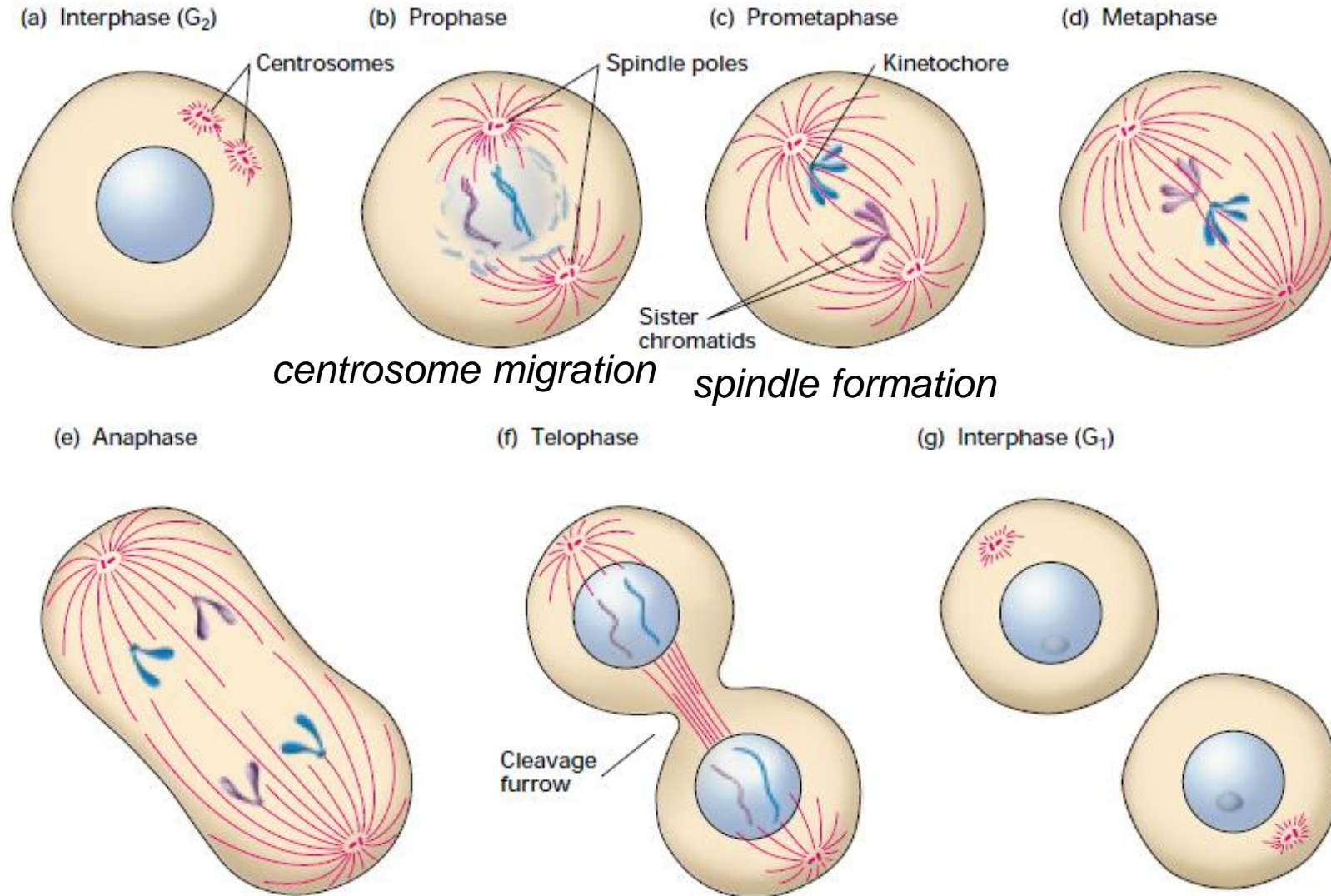
- attach and capture chromosomes,
- align the chromosomes, and
- then separate them so that the genetic material is evenly partitioned to each daughter cell.

four substages: **prophase**, **metaphase**, **anaphase**, and **telophase**.

The beginning of mitosis is signaled by the appearance of condensing chromosomes, first visible as thin threads inside the nucleus.

By late prophase, each chromosome appears as two identical filaments, the **chromatids** (often called *sister chromatids*), held together at a constricted region, the **centromere**.

Each chromatid contains one of the two new daughter DNA molecules produced in the preceding S phase of the cell cycle; thus each cell that enters mitosis has four copies of each chromosomal DNA, designated  $4n$ .



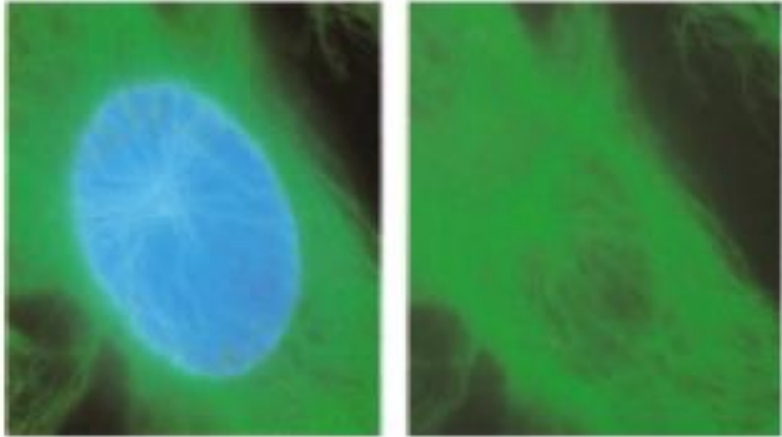
*chromosome alignment*

*centrosome migration* *spindle formation*

*chromosome separation*

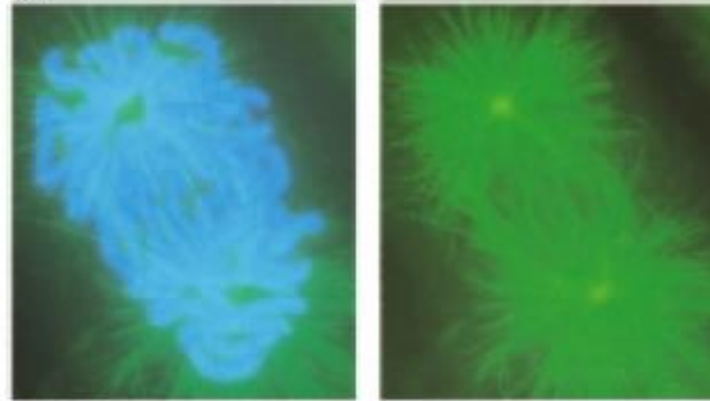
The spindle disappears as the microtubules depolymerize,

(a)



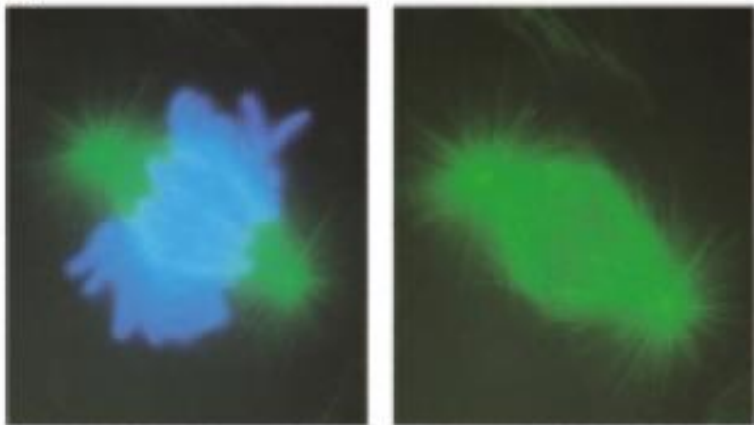
Early prophase

(b)



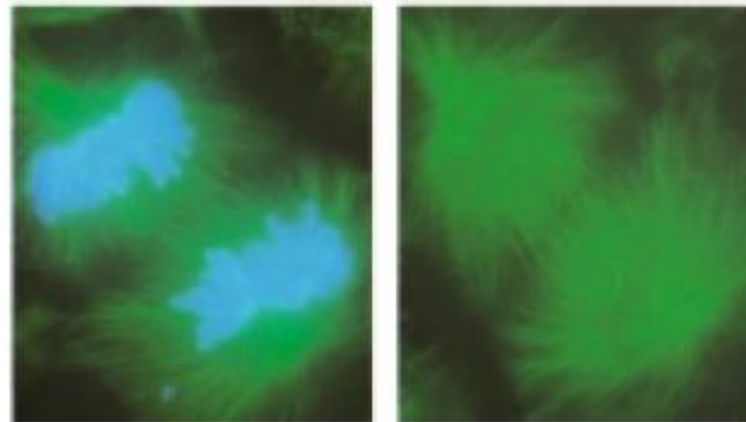
Prometaphase

(c)

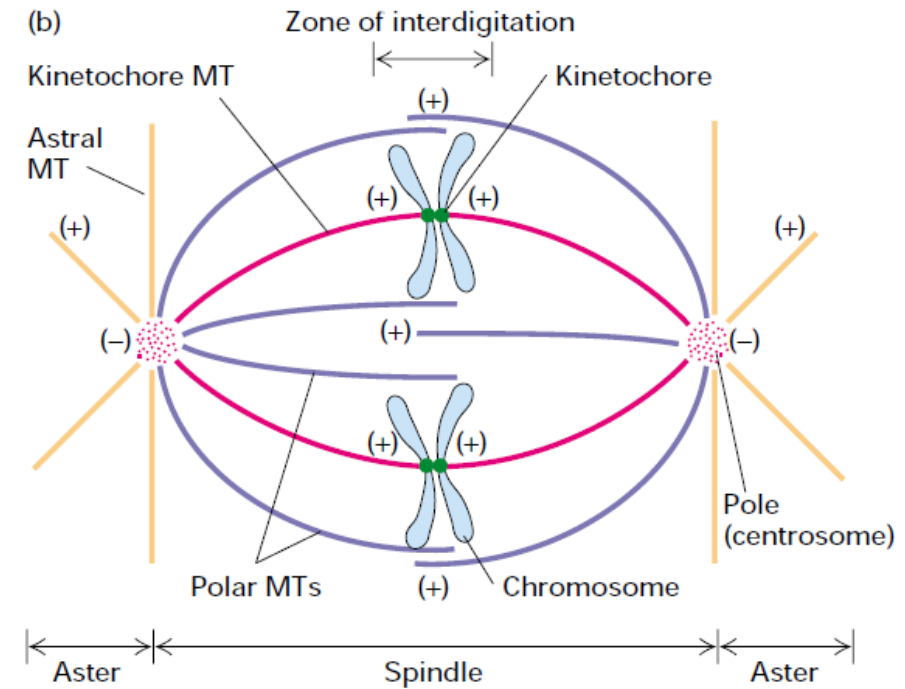
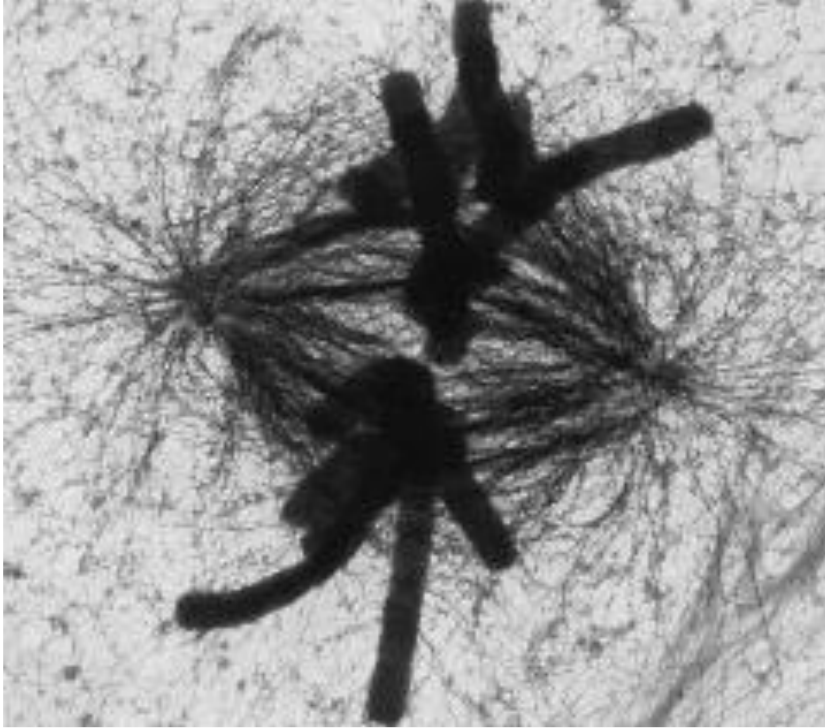


Metaphase

(d)



Anaphase



Three sets of microtubules (MTs) make up the mitotic apparatus. All the microtubules have their (-) ends at the poles (centrosomes). Astral microtubules project toward the cortex and are linked to it. Kinetochore microtubules are connected to chromosomes (blue). Polar microtubules project toward the cell center with their distal (+) ends overlapping.

Unlike microfilaments and microtubules, however, intermediate filaments do not contribute to cell motility.

There are no known examples of IF-dependent cell movements or of motor proteins that move along intermediate filaments.

*Intermediate filament-associated proteins* (IFAPs) cross-link intermediate filaments with one another, forming a bundle or a network, and with other cell structures, including the plasma membrane.