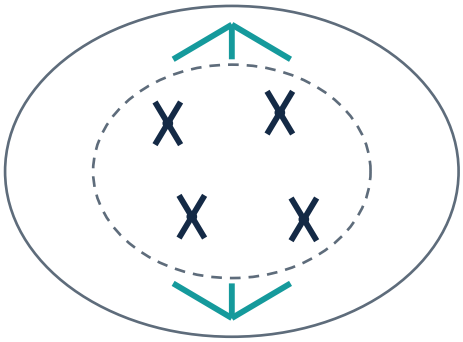
Condense, align, separate, reform

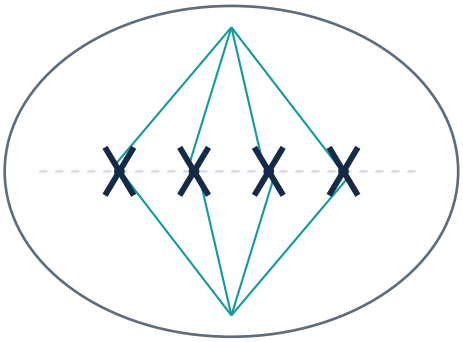
Mitosis distributes the copies made in S phase into two daughter nuclei. Follow the same four chromosomes through this simplified sequence.

1. PROPHASE



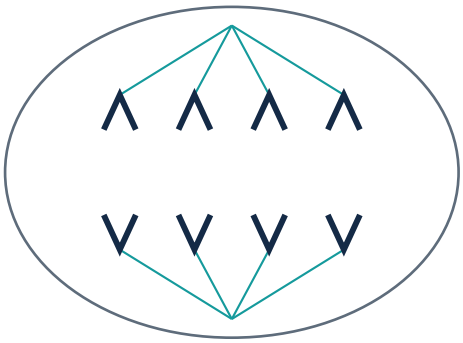
Chromosomes condense; the spindle forms.

2. METAPHASE



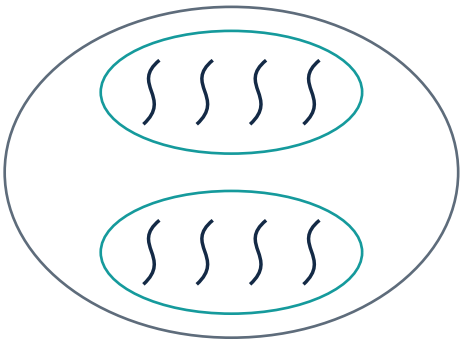
Replicated chromosomes align at the equator.

3. ANAPHASE



Sister chromatids move to opposite poles.

4. TELOPHASE



Two nuclei reform; chromosomes decondense.

Schematic, not to scale. Navy = chromosomes. Teal = selected spindle fibres or new nuclear envelopes. Outer outline = cell surface membrane; top and bottom = spindle poles.

BEFORE MITOSIS

DNA replication occurs during S phase, not during prophase. Each replicated chromosome has two sister chromatids.

Stage sequence and structures: OpenStax Biology 2e, section 10.2.

Scope: Cambridge Biology 9700 syllabus, section 5.2, outcome 1, p. 23.

Track three structures at each stage

Describe chromosomes, the nuclear envelope and the spindle together. The cell surface membrane remains around the cell while the nuclear envelope breaks down.

1. PROPHASE

Chromosomes shorten and thicken as chromatin condenses. Each has two sister chromatids. The spindle forms and the nuclear envelope breaks down, allowing spindle attachment. The nucleolus disappears.

2. METAPHASE

Chromosomes align individually at the equator, not as homologous pairs. Spindle microtubules attach to kinetochores at centromeres; sister chromatids connect to opposite poles. The nuclear envelope is absent.

3. ANAPHASE

Sister chromatids separate at their centromeres. Each is now a daughter chromosome and moves centromere-first towards its pole. Spindle microtubules help move the chromosomes apart.

4. TELOPHASE

Chromosomes arrive at opposite poles and decondense. A nuclear envelope forms around each set; nucleoli reappear. The mitotic spindle disassembles, leaving two daughter nuclei with matching chromosome complements.

The four-stage scheme groups nuclear-envelope breakdown and spindle attachment with late prophase. Some texts name this interval prometaphase. Stage boundaries are gradual, except for the coordinated start of chromatid separation.

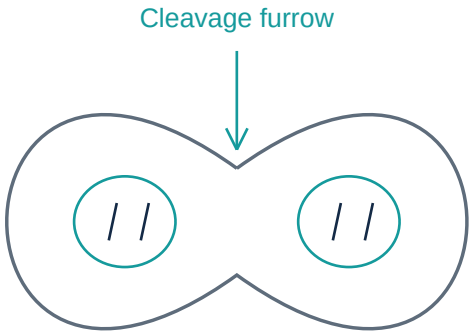
Chromosome and spindle events: Alberts et al., Mitosis.
Sister-chromatid terminology: NHGRI, Chromatid.

Scope: Cambridge Biology 9700 syllabus, section 5.2, outcome 1, p. 23.

Same nuclear division, different split

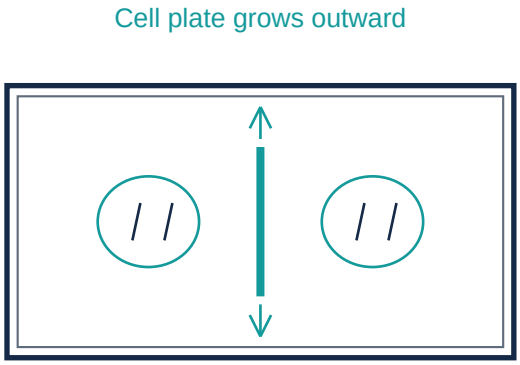
Plant and animal cells share the main chromosome movements in mitosis. Cytokinesis divides the cytoplasm and often overlaps late mitosis.

ANIMAL CELL



The cell surface membrane pinches inward at a cleavage furrow until the cytoplasm separates.

PLANT CELL



Vesicles fuse into a cell plate. It expands to the existing boundary, forming new membranes and a dividing wall.

Two daughter nuclei are shown schematically; chromosome numbers are not represented in these cytokinesis drawings.

1. PRESERVE THE CHROMOSOME COMPLEMENT

In the four-chromosome model on page 1, metaphase has four replicated chromosomes. Anaphase has eight daughter chromosomes in the whole cell, with four moving to each pole. Each new nucleus receives four.

2. DISTINGUISH THE TWO MEMBRANES

The nuclear envelope breaks down and reforms around each chromosome set. The cell surface membrane encloses the cytoplasm throughout. Most higher plant cells form a spindle without centrioles; a spindle is not exclusive to animal cells.

Animal and plant cytokinesis: Alberts et al., Molecular Biology of the Cell.
Cell-cycle context and plant spindles: OpenStax Biology 2e, section 10.2.

Scope: Cambridge Biology 9700 syllabus, section 5.2, outcome 1, p. 23.