

Understanding Meiosis II

The Mitosis-Like Division

PROPHASE II & METAPHASE II

Nuclear envelope breaks down, and spindle apparatus forms. Chromosomes, each consisting of two sister chromatids, align individually at the metaphase plate.

KEY TAKEAWAY: SISTER CHROMATIDS

Crucially, sister chromatids separate during Anaphase II, similar to mitosis, ensuring each new cell receives one chromatid from each chromosome.

SPINDLE APPARATUS

METAPHASE PLATE

CENTROMERE

DAUGHTER CHROMOSOMES

ANAPHASE II & TELOPHASE II

Centromeres split, and sister chromatids are pulled to opposite poles by shortening spindle fibers. Nuclear envelopes reform around the four sets of chromosomes.

WARNING: CHROMOSOMAL NON-DISJUNCTION

Failure of sister chromatids to separate can lead to aneuploidy, resulting in gametes with an abnormal number of chromosomes.

FINAL STAGE

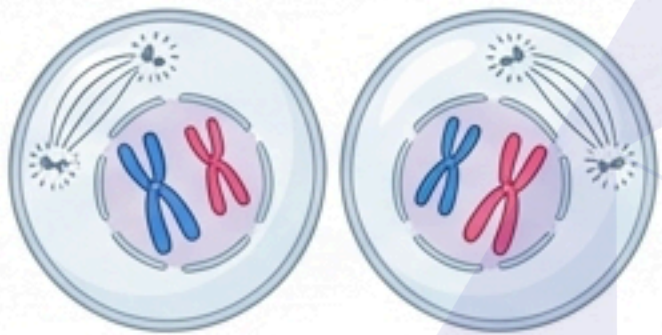
CYTOKINESIS: The cytoplasm divides, resulting in four genetically distinct haploid daughter cells, each containing half the number of chromosomes as the original parent cell.



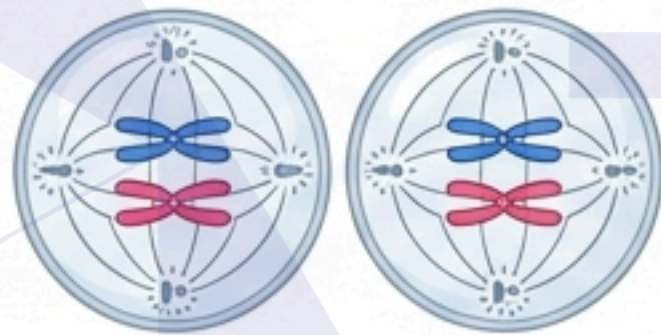
HAPLOID DAUGHTER CELL

The Sequential Timeline of Meiosis II

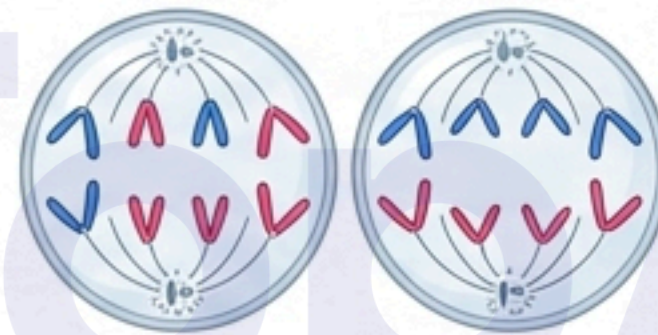
Prophase II



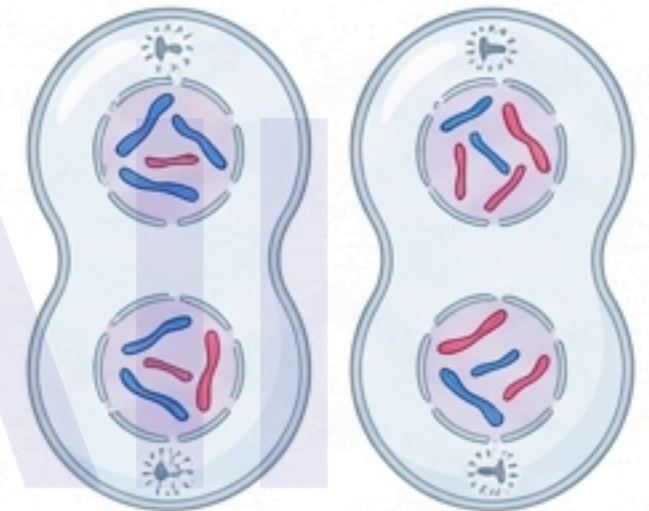
Metaphase II



Anaphase II

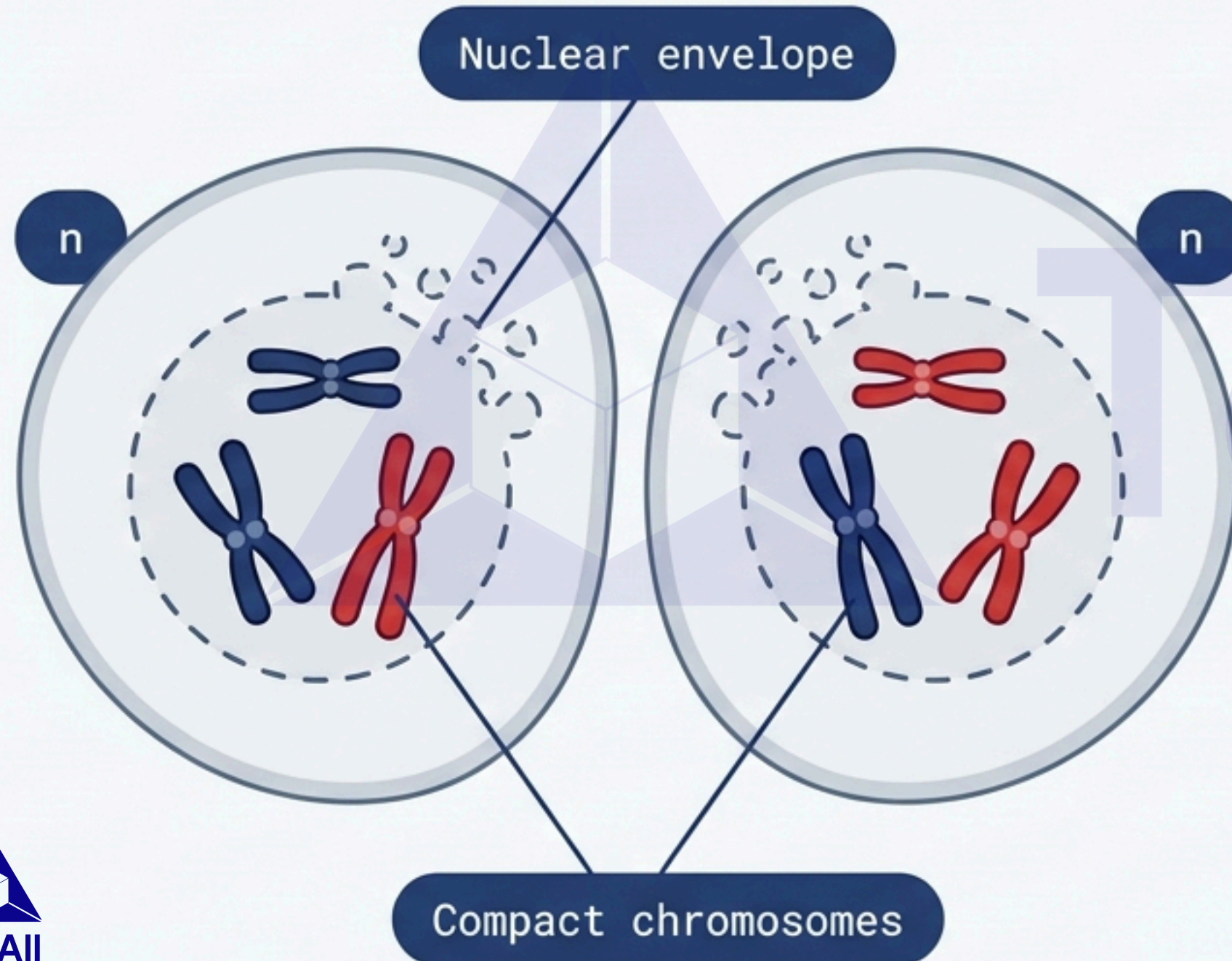


Telophase II



Meiosis II is initiated immediately after cytokinesis of Meiosis I. Unlike the complex reduction division of Meiosis I, this phase closely resembles a normal mitosis.

Prophase II: Compaction and Preparation



Membrane Dissolution

- **Action:** The nuclear membrane breaks down.
- **Result:** Chromosomes are exposed to the cytoplasm by the end of the phase.

Chromosome Compaction

- **Action:** Chromatin fibres tightly coil.
- **Result:** Chromosomes once again become highly compact and distinctly visible.



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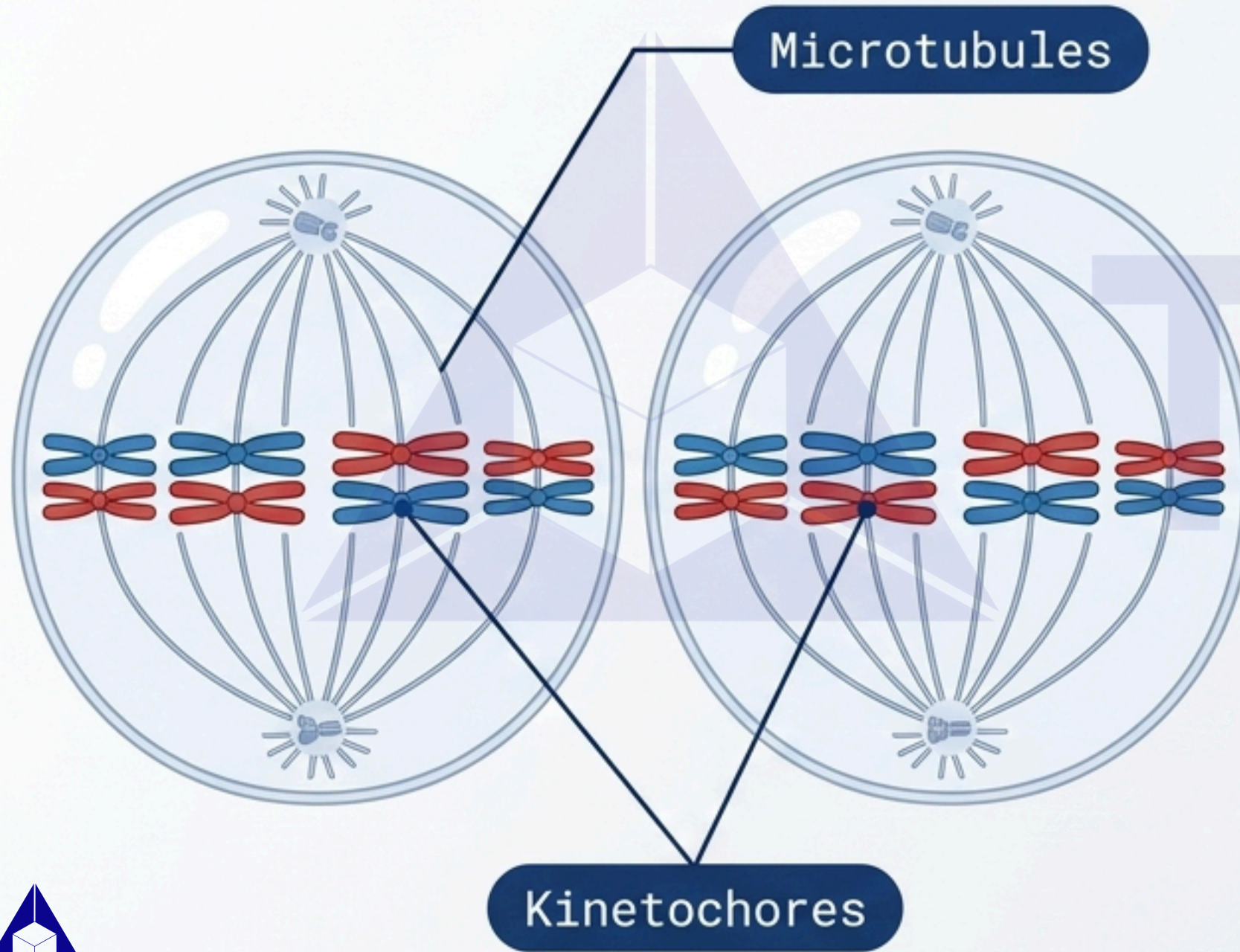
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Metaphase II: Equatorial Alignment

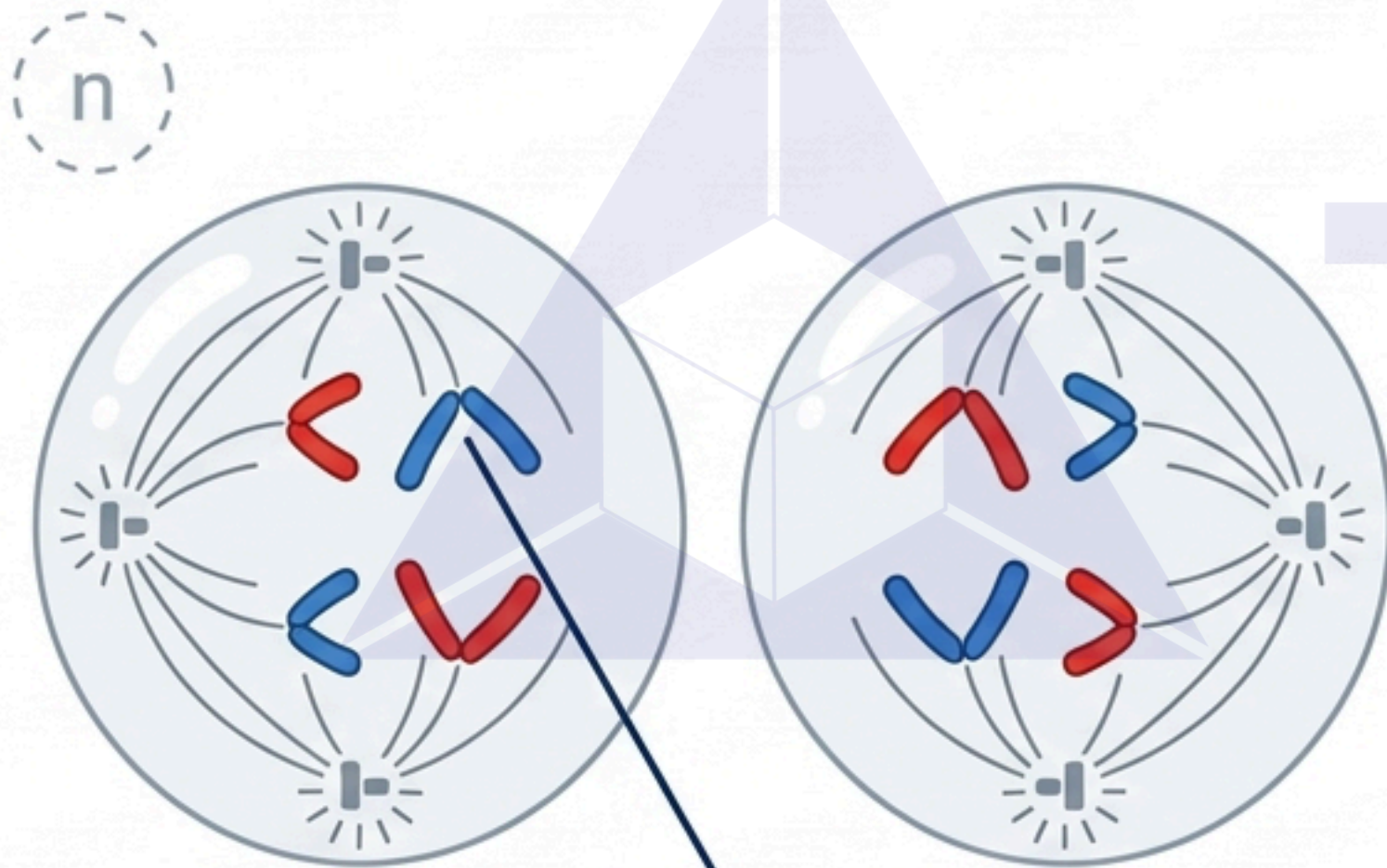


The Alignment Mechanism

- **Action:** Microtubules extend from opposite poles of the spindle.
- **Result:** They firmly attach to the kinetochores of the sister chromatids, aligning them perfectly at the cellular equator.

CRITICAL DISTINCTION: Microtubules here attach to the kinetochores of sister chromatids, whereas in Metaphase I, they attached to homologous chromosomes.

Anaphase II: Sister Chromatids Separate



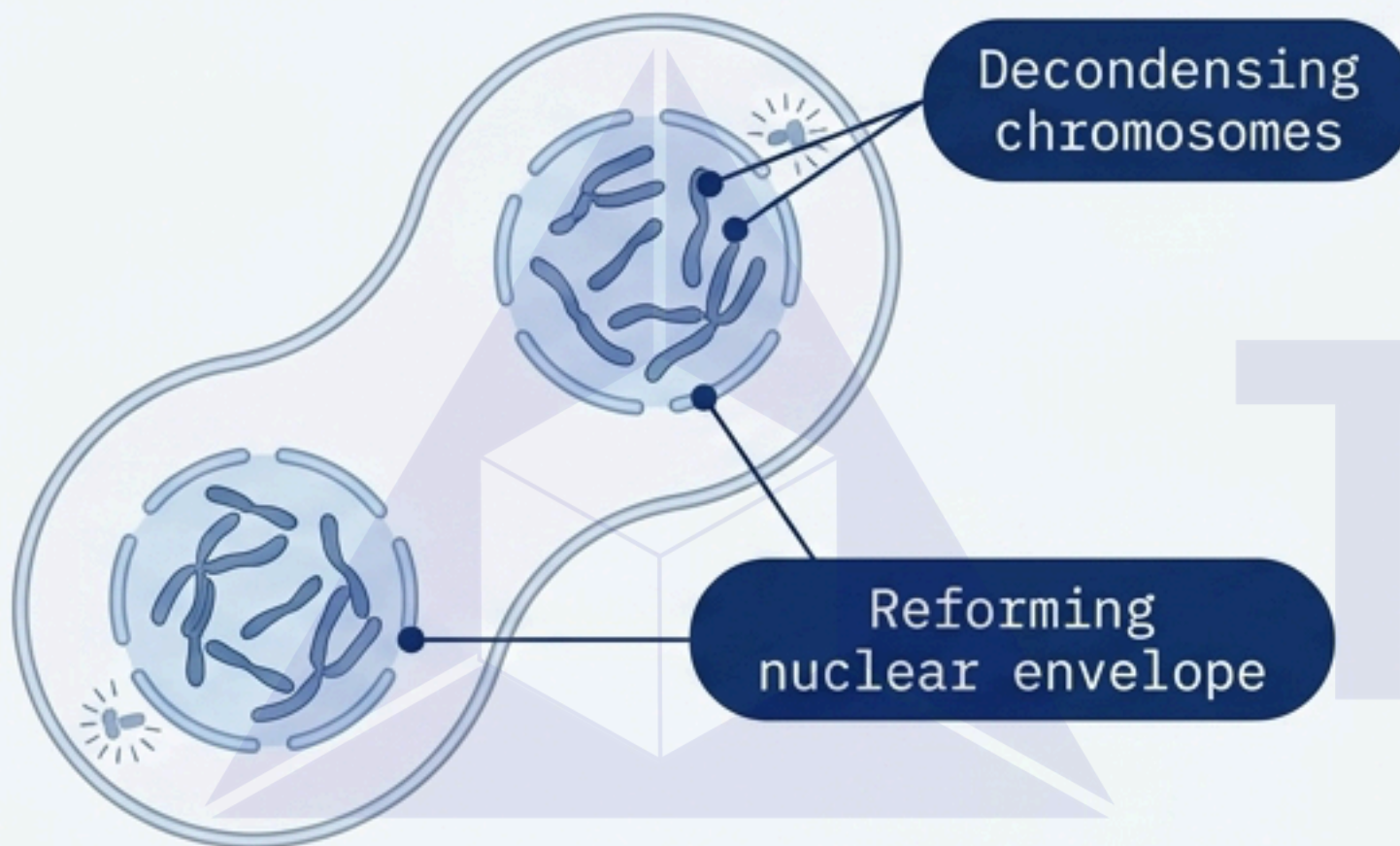
Centromere split

SIMULTANEOUS SPLIT: The anaphase phase begins exclusively with the simultaneous splitting of the centromere of each individual chromosome.

The Migration

- ✓ **Action:** Attached kinetochore microtubules shorten.
- ✓ **Result:** Sister chromatids (now individual chromosomes) are pulled toward opposite poles of the cell.

Telophase II: Rebuilding Boundaries

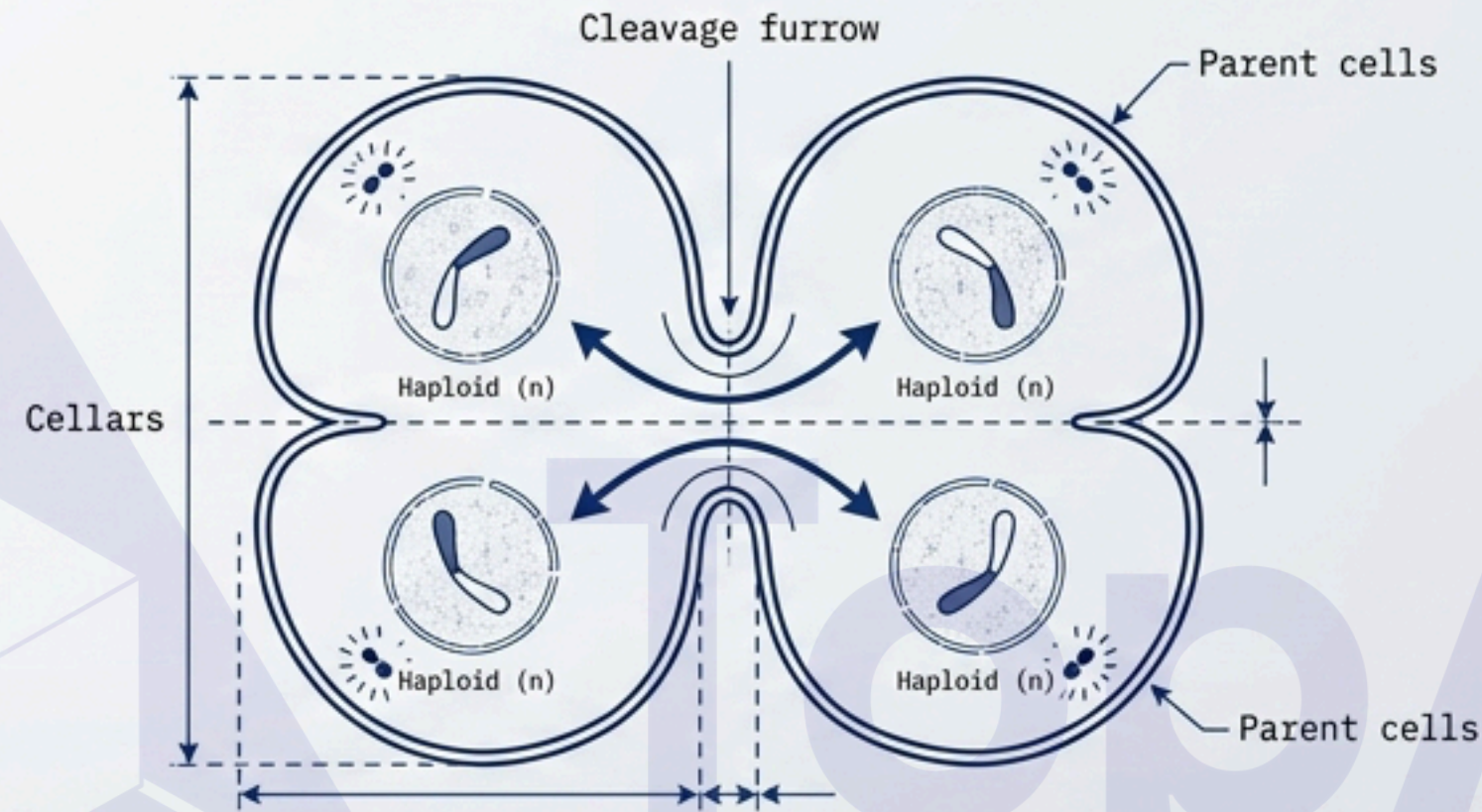


Enclosure

- **Action:** Chromosomes group at the poles.
- **Result:** They are once again enclosed by a newly formed nuclear envelope.

Telophase II marks the official end of karyokinesis (nuclear division). The genetic material is now fully separated and enclosed, setting the stage for the final physical split of the cells.

Cytokinesis: The Physical Separation



Karyokinesis vs. Cytokinesis

While Telophase II divided the nucleus, Cytokinesis physically divides the cytoplasm.

The Final Cut

The plasma membrane invaginates, completely separating the internal environments and finalizing the creation of distinct, independent cells.

Final Tetrad: Four Haploid Daughter Cells



**Original Parent Cell
(Before Meiosis)**

Diploid ($2n$)

Double Chromatids

**Final Daughter Cells
(After Meiosis II)**

Haploid (n)

Single Chromatids

THE ULTIMATE SIGNIFICANCE: Meiosis successfully reduces the chromosome number by half, conserving the specific chromosome number across generations upon fertilization, while simultaneously introducing vital genetic variability for evolutionary adaptation.



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