Karyokinesis in Mitosis

- newly formed DNA in S and G_2 phase are indistinct and intertwined.
- consists of 4 phases
  1. Prophase → early / middle / late prophase.
  2. Metaphase
  3. Anaphase
  4. Telophase.

Early prophase

- chromatin —condensation (by condensin)→ chromosome

chromatin ⇓ chromosomal material (NCERT)

chromosome ⇓
- longest, thinnest
- chromatids are not visible
- telomeres are not visible

↓ ∴

chromosomes appear like a ball of wool.

↓ ∴

early prophase is called Spireme stage.

(NCERT: Prophase marked by initiation of chromosomal material.)

- daughter centrosomes move away towards opposite poles.
- formation of astral rays, aster.
  - astral rays: made of MT; ensures the correct positioning of centrosome
  - aster → centrosome + astral rays.
- cell division in
  - (A) Animal cells → Amphiastral (2 asters)
  - (B) plant cells → Anastral (no aster).
- Nucleolus, ER, GB start to disappear.

Middle prophase

- further condensation chromosomes.
  ↓ result
  chromatids become visible.
- Two sister chromatids of each chromosome appear to be attached at centromere.
- Nuclear membrane starts to disappear.

Late prophase

- condensation of chromosomes continues.
- complete disappearance of nuclear membrane.

↓ result

chromosomes spread in cytoplasm.

- complete disappearance of ER, GB, nucleolus.
- 2 asters have reached opposite poles and start to produce spindle fibres.

mitotic apparatus ⇒ 2 asters + spindle fibres.

Metaphase

- Complete disappearance (disintegration) of nuclear envelope marks the start of metaphase.
- By this phase condensation of chromosomes complete
  ↓ ∴
  Chromosomes → thickest, shortest.
- This is the best phase to study chromosome
  ↓
  structure, number, (shape)

- **Note**

* If only shape of chromosome is asked in exam choose anaphase.
* If shape of chromosome along with other features like structure, number is asked, then choose metaphase.

- Spindle fibres produced in late prophase get bind to kinetochore of chromosome.
- Each chromosome is attached to spindle fibres coming from 2 spindle poles.
- Spindle fibres bring all chromosomes brought at spindle equator by the process called congression to form metaphasic (equatorial) plate
  ↳ plane of alignment of chromosomes at metaphase.
  ↳ Arms of chromosomes are oriented variously but their centromeres lie on a single line.
  ↳ Smaller chromosomes → periphery
  larger chromosomes → centre.

Anaphase

Maturation promoting factor (MPF)

↓ activates

Anaphase promoting complex (APC)

↓ inactivates

inhibits anaphase inhibitors

↓ result

onset of anaphase

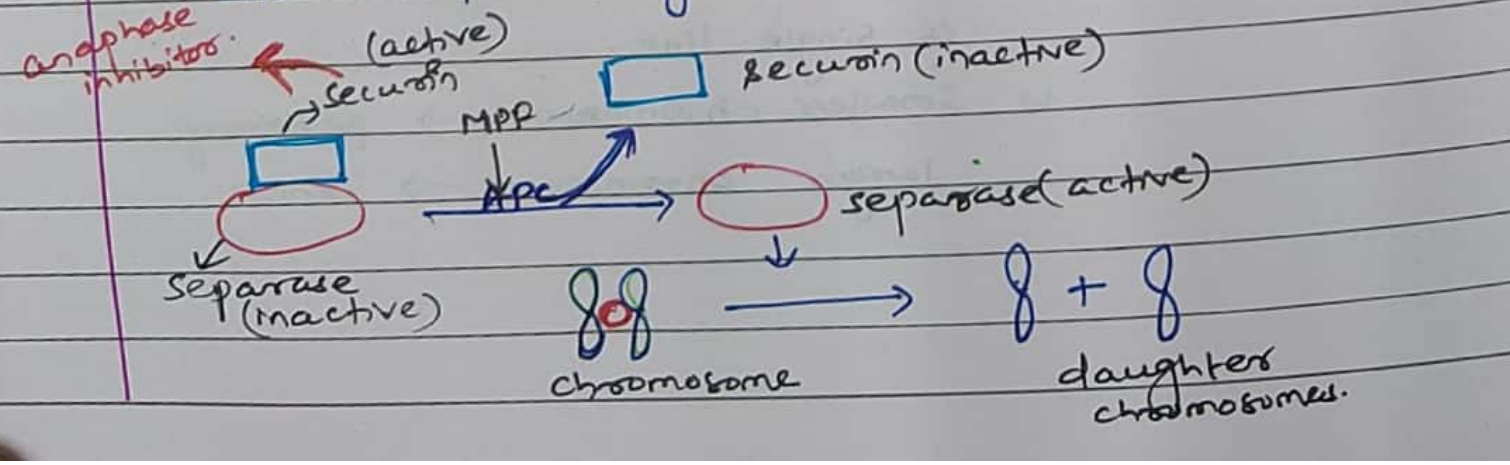
↓

cohesin protein break down and centromere of all chromosomes split simultaneously

↓ result

2 daughter chromosomes are formed from chromosome.

- Sister chromatids when get separated, they are called daughter chromosomes.



NCERT:

- Onset of anaphase is marked by simultaneous splitting of all chromosomes of metaphasic plate; and the two daughter chromatids are now called daughter chromosome of future nuclei.
- The chromosomes (daughters) move towards poles due to
  - (i) pulling → by chromosomal spindle fibres.
  - (ii) pushing → by interzonal spindle fibres.
- During movement of chromosomes towards poles their
  - ↳ centromeres → towards poles.
  - arms → trailed behind (towards centre).

Anaphase is characterised by

- Splitting of centromeres and separation of sister chromatids.
- chromatids move towards opposite poles.

Telophase

- Reverse of prophase.
- chromosomes ⟹ decondense ⟹ chromatin

↓ ∴

chromosome loose their identity.

- Nuclear envelope, nucleolus, GB, ER reappear.
- Spindle fibres disappear
  - ↳ except interzonal spindle fibres in plants