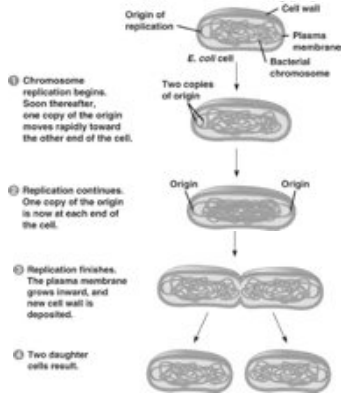
Topics

- Cell cycle
  - DNA structure
  - Mitosis/Meiosis introduction
  - Interphase

Prokaryotes- Binary fission

- **Asexual reproduction**: the creation of offspring from a single parent.
  -Produces two daughter cells genetically identical to the parent cell.



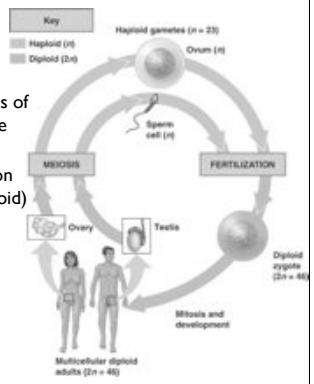
Sexual Reproduction

- Fusion of 2 specialized cells (**gametes**)
- **Haploid** (1n) versus **diploid** (2n)

- Gametes (haploid) form by **meiosis**- process of cell division resulting in cells with only half the genetic material
- All other cells not specialized for reproduction are **somatic cells**, 2 sets of homologs (diploid)

Haploid cells alternate with
Diploid during life cycle of humans

All sexual reproductive cycles
Involve meiosis to produce 1n cells

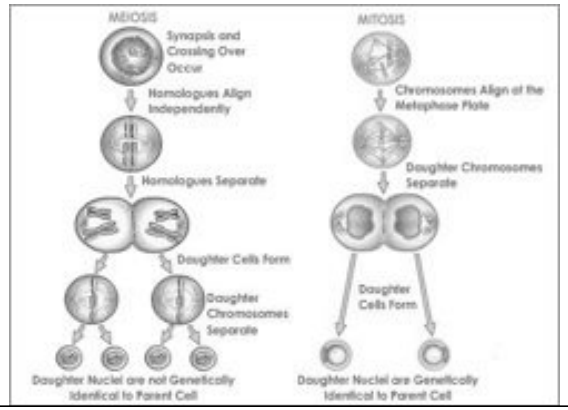


2 basic strategies for reproduction

	Asexual reproduction	Sexual reproduction
Basic process	Binary fission	
# of parents	1 (male or female)	2 (male and female)
Offspring	genetically identical (to parent and other offspring)	genetically different
Cell division process	normal cell division following nuclear division (by mitosis)	special cell division (meiosis) produces gametes: after fertilization all divisions by mitosis
Advantages	Rapid colonization of new growth areas	produces variation - the basis of evolution
Disadvantages	disease may affect all, only variation due to mutations	slower - needs special processes to form a complex organism

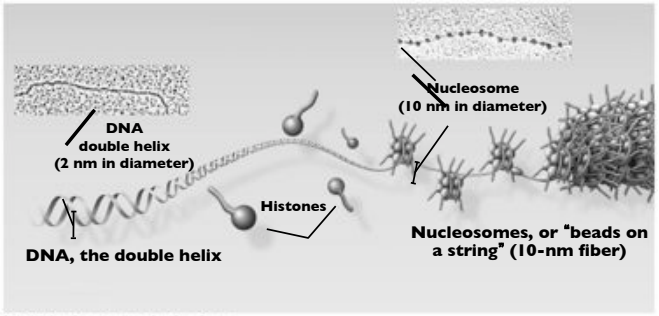
Sexual Reproduction- Eukaryotic cells

- Meiosis
- Mitosis

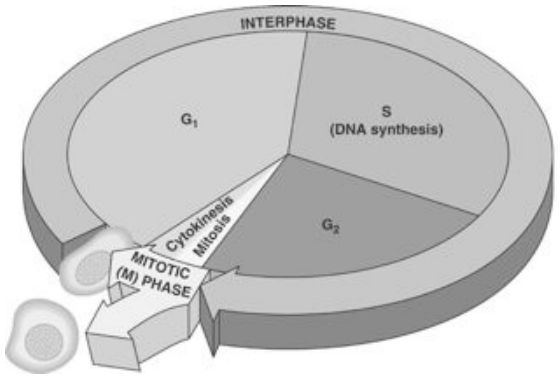


DNA structure

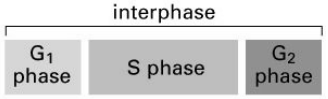
DNA is capable of being unwound into **chromatin** and further compressed into **chromosomes**

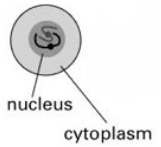


The Cell Cycle



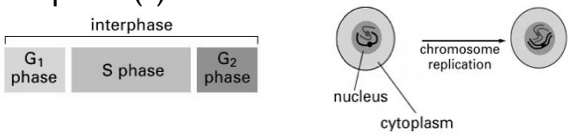
Interphase (G1)





- G1, called "gap 1" is typically the longest part of interphase
- G1 is a growth phase. The cell is creating extra copies of organelles to pass on to the daughter cell.
- Mitochondria and chloroplasts divide, and extra ribosomes, golgi, etc. are created.

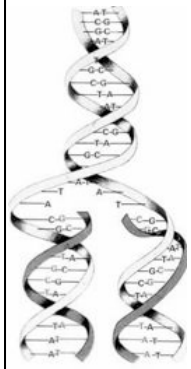
Interphase (S)



S phase, for "synthesis", is when the chromosomes are duplicated

This is a **critical phase** of the cell cycle, which is why it was just discussed (DNA replication)

DNA Replication in S-phase



1) DNA double helix is unwound

2) DNA synthesis: New nucleotides form complementary base pairs with the template strand

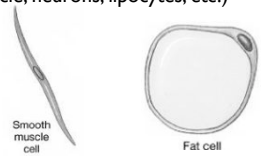
Sister chromatids

Interphase (G2)

• G2, or "gap 2" is another short growth phase before mitosis, it consists of last-minute protein synthesis and as a brake if needed (e.g. **checkpoints**)

Cell Cycle and G_0

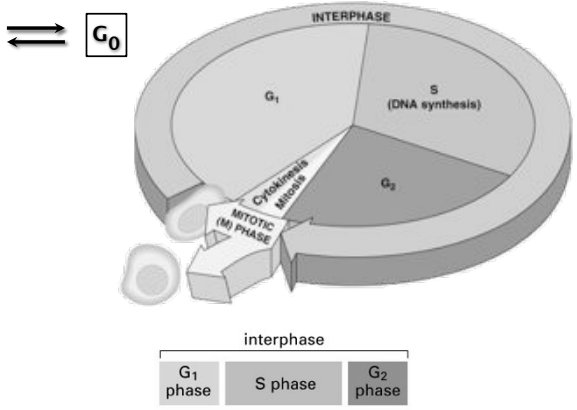
• Many cell types reach a finite number of cells or are limited in division. (muscle, neurons, lipocytes, etc.)



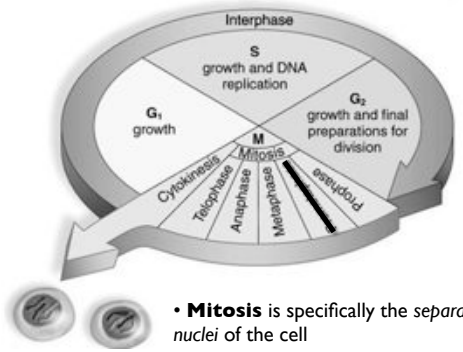
• Some cells have no division limit
(skin, gut epithelia, bone marrow stem cells, etc.)

• G_0 cells are cells that are not preparing for division (not "cycling")

The Division of the Nucleus is Critical

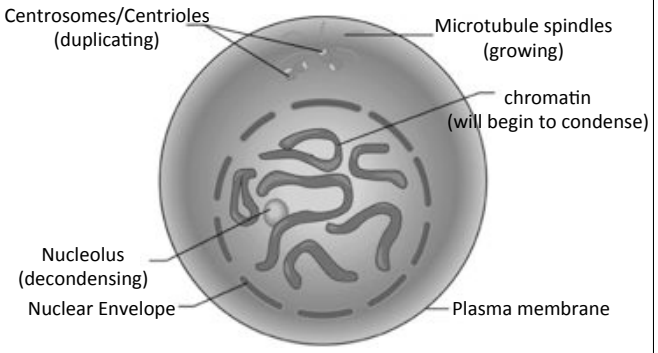


Mitosis



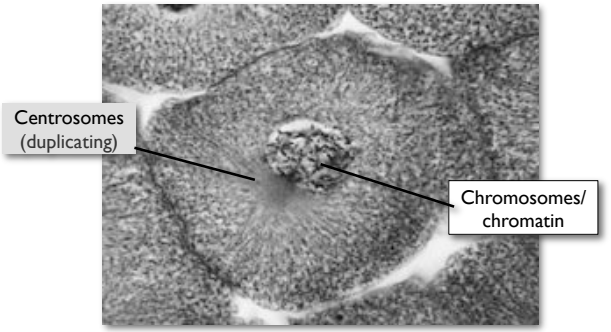
- **Mitosis** is specifically the *separation of the nuclei* of the cell
- Mitosis is only the separation of the nuclei, **cytokinesis** is the separation of the cytoplasm.

Cell Preparing for Division

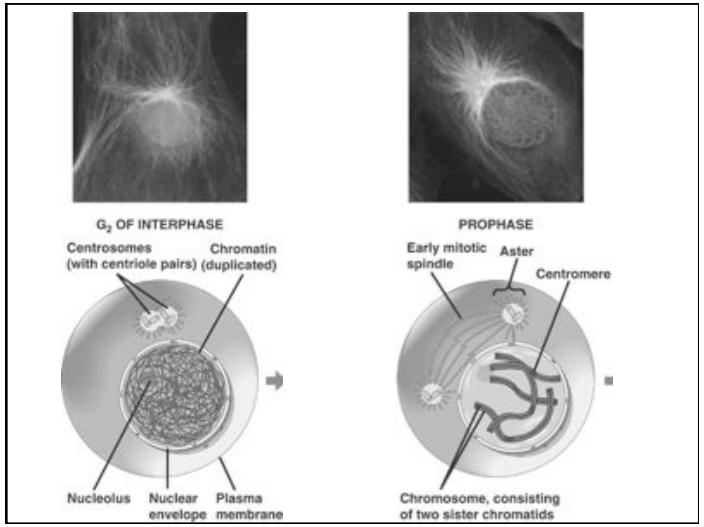


Interphase

Cell Preparing for Mitosis

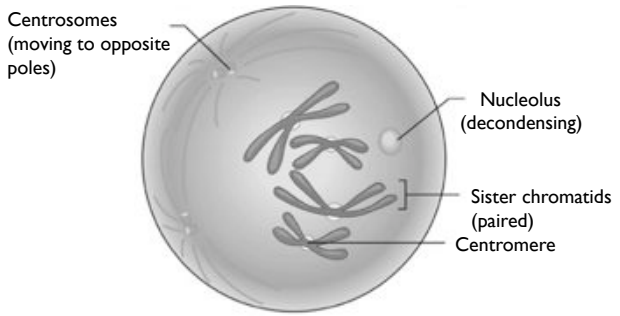


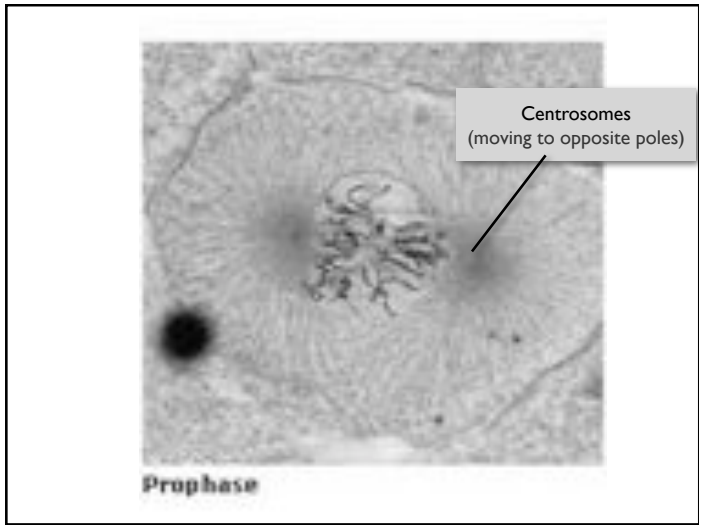
Interphase



Early Prophase

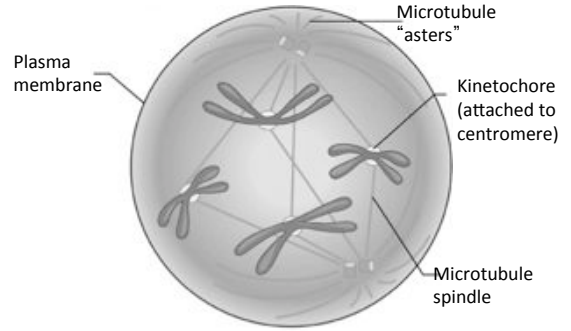
- Chromosomes begin to appear
- Duplicated centrosomes begin moving to opposite poles



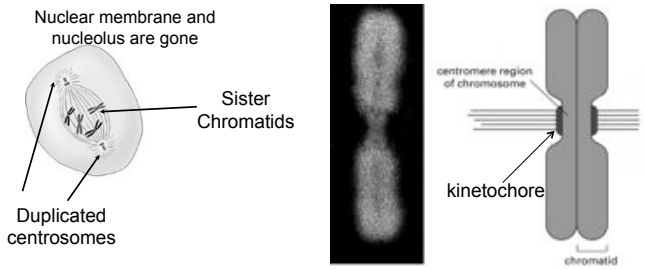


Late Prophase ("prometaphase")

- Chromosomes easily visible
- Nuclear envelope completely broken down
- **Chromosomes begin moving via spindle fibers**

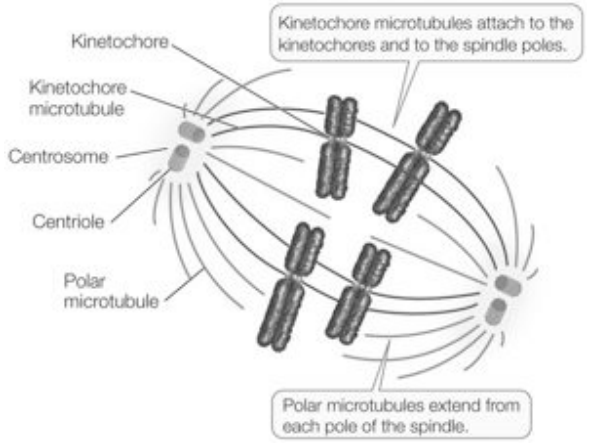


Mitosis (Prophase)



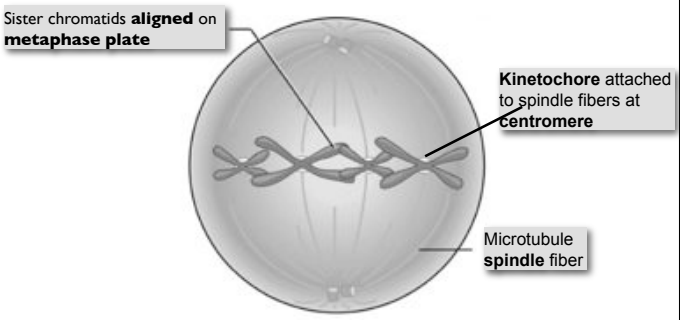
- The duplicated chromosomes stay together (joined at centromere) and are called **sister chromatids**. Sister chromatids are identical.
- Proteins that the microtubules bind at the centromere are called **kinetochores**

Mitotic Spindle Structure



Metaphase

- The **sister chromatids** have lined up at the "metaphase plate"
- Centromere/kinetochores aligned in single plane at "equator"



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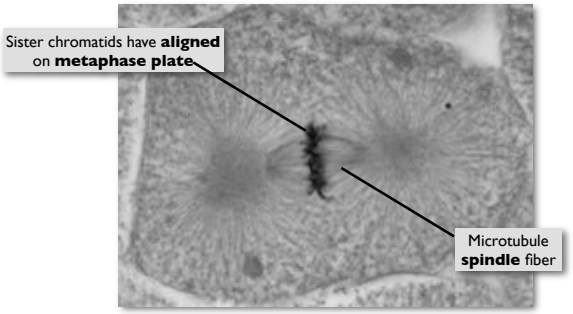
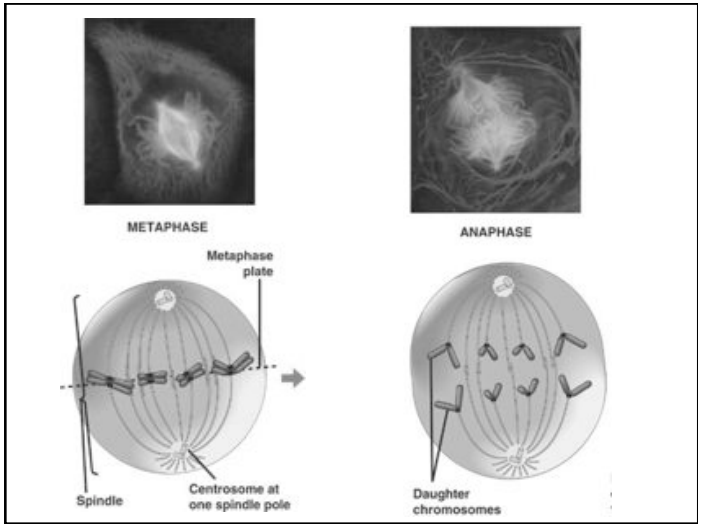
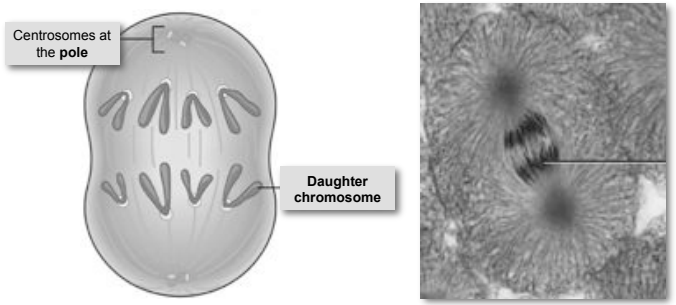




Anaphase

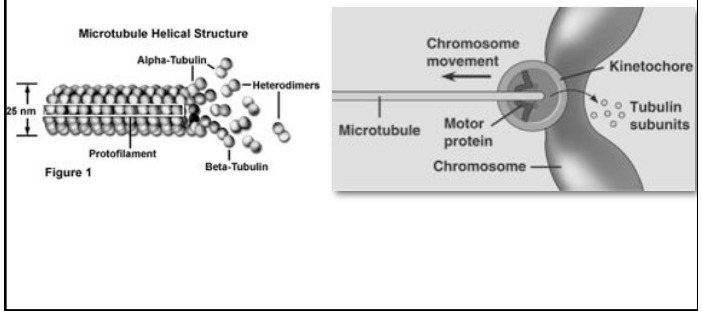
- The sister chromatids are "pulled" apart at the centromere via the mitotic spindle
- The first appearance of **daughter chromosomes**

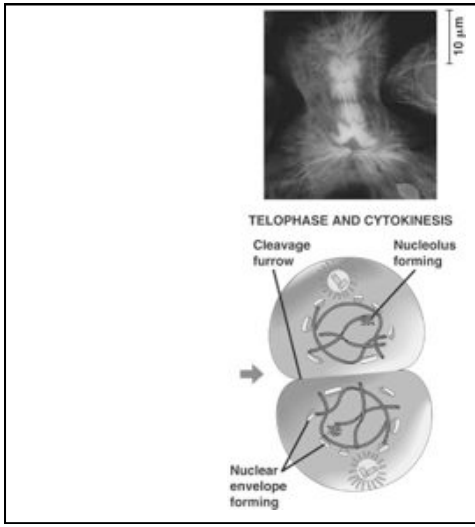


Anaphase- chromatid movement

1) Motor proteins move the daughter chromosome toward the pole
"dynein" uses energy from ATP hydrolysis

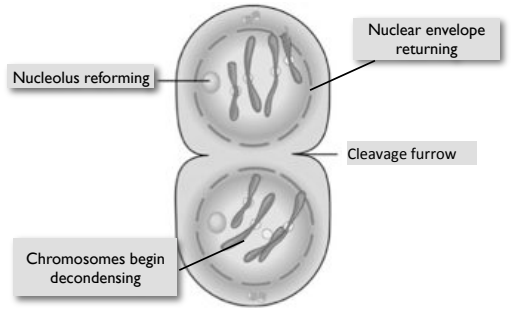
2) The kinetochore microtubules mostly shorten from the poles

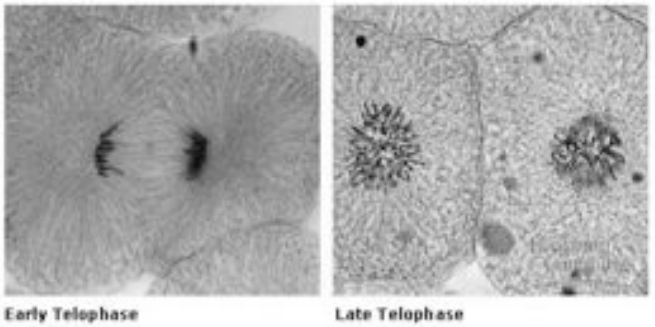




Telophase

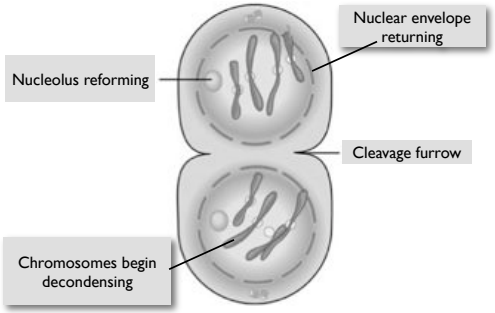
- Daughter chromosomes reach the poles
- Nucleolus returns
- Nuclear membrane reforming around daughter chromosomes
- Cleavage furrow develops, preceding cytokinesis





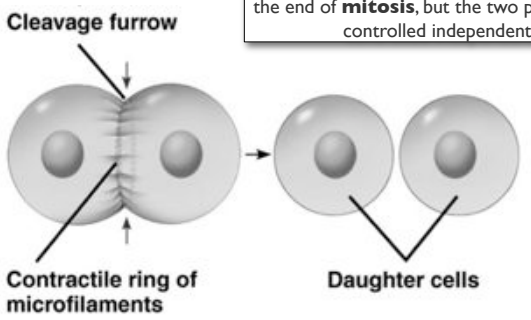
Telophase

This is the end of mitosis! *Cytokinesis* is **not** separation of the nucleus, so it is not mitosis (but it happens during the same timeframe)

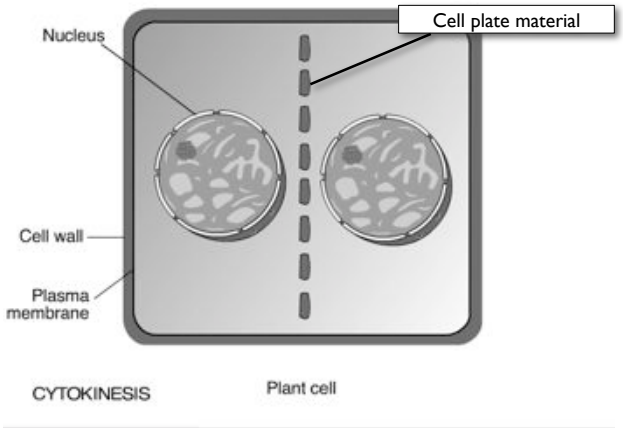


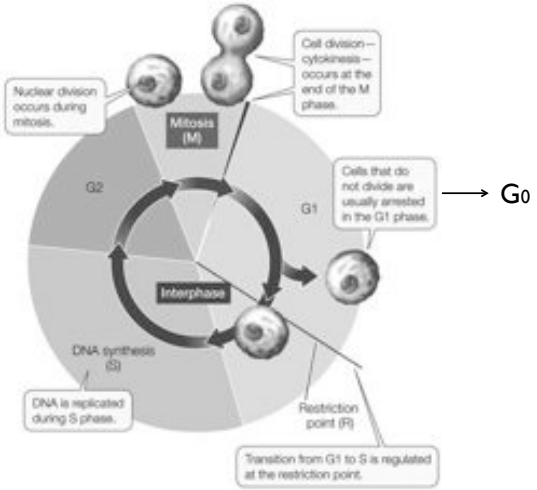
Cytokinesis

Cytokinesis may occur simultaneously with the end of **mitosis**, but the two processes are controlled independently

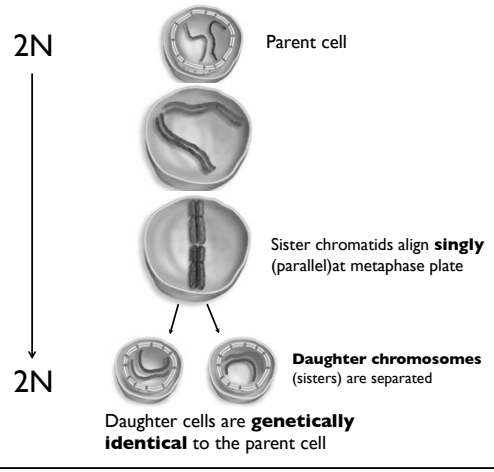


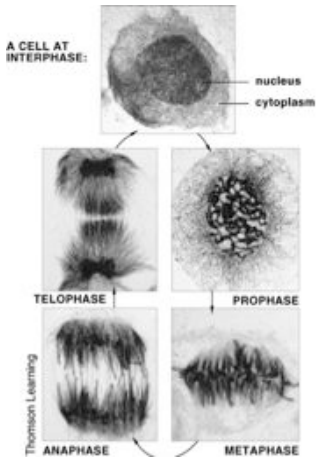
Cytokinesis in Plant Cells





Mitosis

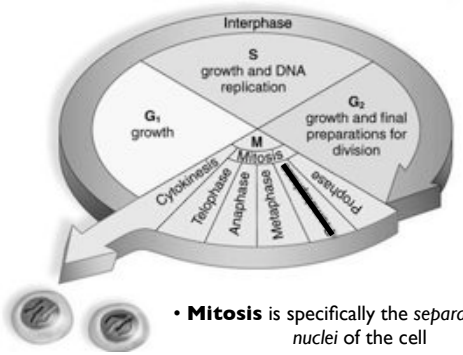




Importance???

- Growth
- Replacement
- Regeneration of…
- Cancer

Mitosis



• **Mitosis** is specifically the *separation of the nuclei* of the cell

• Mitosis is only the separation of the nuclei, **cytokinesis** is the separation of the cytoplasm.

Cell cycle regulation

•Progression through the cell cycle stages is tightly regulated.

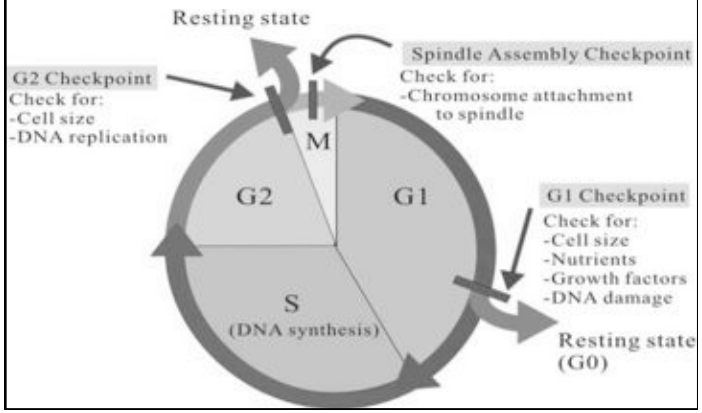
•G1-S transition = **restriction point** Once passed cell will divide.

•Protein kinases (**cyclin-dependent kinases**) control the cell cycle

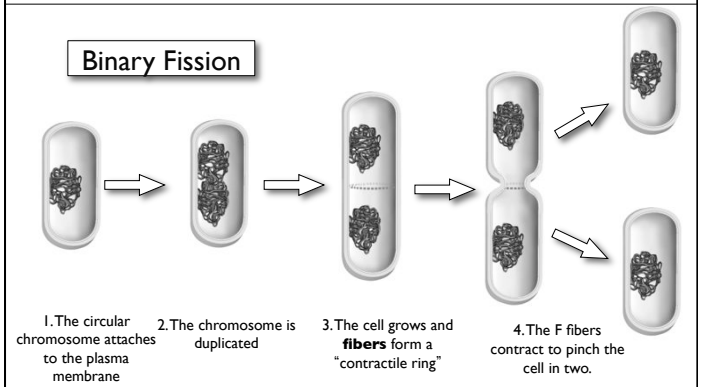
Cell cycle regulator + ATP (cyclin) → (Cdk) → Cell cycle regulator-P

Cell cycle regulation

Cell cycle checkpoints



Compare Asexual Prokaryotic Replication



Q: Are the daughters cells genetically identical to each other or are they different?