

CELL DIVISION

Cell division

process whereby a mother cell divides into two daughter cells

Reasons Cells Must Divide

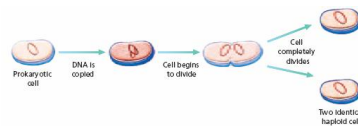
- Limitation is due to relationship between volume and surface area of cell membrane
- If membrane is stretched too large:
 - cytoplasm will flow out of cells
movement of materials in and out of cell would not be controlled (suffocation and waste poisoning)
 - cell would not be able to supply enough materials needed for life
 - not enough RNA would be able to be produced
 - eventually cell would burst and die

Types Cell Reproduction

1. Asexual: purely cell division

- no exchange of genetic material
- daughter cells have exact genetic info as mother (identical)

Ex: **binary fission**: unicellular organisms, bacteria
Mitosis: DNA + organelles duplicated



2. sexual: joining of two reproductive or sex cells (gametes or germ cells)

- resulting offspring has combination of info from both sets of parents

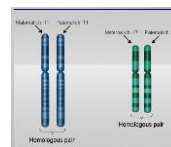
- **fertilization**: joining of 2 gametes to form a zygote

Gamete (mom) + gamete (dad) → zygote
egg + sperm



Chromosome Number

- **somatic cells**: non sex cells, contain pairs of homologous chromosomes
- **homologous chromosomes**: two copies of each autosome, similar in size, shape, and genetic material



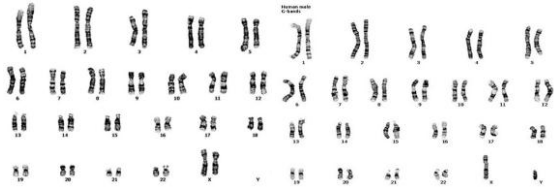
- **diploid number (2n)**: full set of homologous chromosomes

ex:	somatic	germ
humans	46	23
corn	10	5
goldfish	96	48
fruit flies	8	4

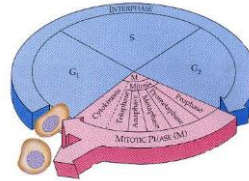
Karyotype

Photo of metaphase chromosomes

- used to help determine if there are abnormalities or mutations



The Cell Cycle



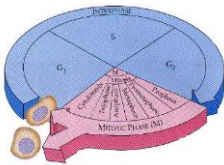
- DNA and organelles must be duplicated before the cell can divide

Cell Cycle: period from beginning of one mitosis to beginning of next

Goal: to produce two genetically identical cells from one mother cell

Phases of the Cell Cycle

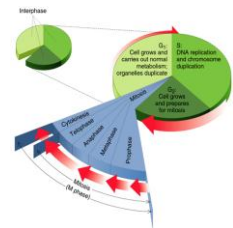
- Before mitosis actually occurs, there is a period between cell divisions



Interphase:

- time between mitosis (preparation for mitosis)
- can be a very long period of time (approx. 90% of cell cycle)

- G₁ (gap 1) phase:** cell growth and development
 - after cytokinesis, daughter cells are very small and low on ATP
 - uses this phase to grow and gain ATP
- S phase (synthesis):** DNA replicates
 - only occurs after cell is large enough and has enough ATP



3. G₂ (gap 2) phase:

- S phase drains energy so cell must grow and gain energy again.
- mRNA synthesis
- ATP made and used in cell division
- synthesis of organelles
- chromosomes doubled
- centrioles divide (2 pair of protein microtubules that form spindle)

4. M phase: mitosis

- Cytokinesis:** division of cytoplasm

[cell cycle animation](#)

Uncontrolled Cell Division

- Most healthy body cells grow and divide a certain number of times (approx. 20-50X), and then die

- tumors

- benign (do not metastasize)
- malignant (metastasize)



- cancer:

- uncontrolled rapid cell division
- do not respond normally to cell cycle checkpoints
- will continue to grow and divide even when forming in contact with other cells
- "immortal"

[cancer animations](#)

- how cancer begins
 - changes in genes that influence cell cycle
 - 2 types genes
 1. **proto-oncogenes** "cancer genes"
 - start out coding normal proteins and turn bad
 - codes for proteins that stimulate cell division
 2. **tumor suppressor genes**
 - codes for proteins that restrain cell division
 - inactivated by mutation (2 copies must be mutated)

Cancer Causes

- x rays
- asbestos
- UV radiation
- chemicals (cigarettes)
- viruses

Therapies

- Chemotherapy: more rapidly taken up in rapidly dividing cells
- Anti-angiogenesis: cut off blood supply to tumors
- Heat
- Radiation

Cell Division

Mitosis

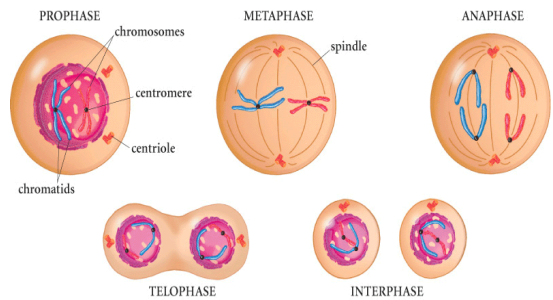
Process whereby materials of the parent (mother) cell's nucleus duplicate and divide into 2 equal sets to be given equally to 2 daughter cells

- daughter cells are identical and carry same genetic material as mother cell

Cytokinesis

Process by which cytoplasm divides creating two distinct cells

Mitosis Overview



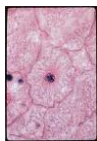
Carlyn Iverson

Phases of Mitosis Detail



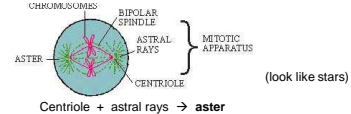
I. Prophase

- first stage that shows mitosis is starting
- longest phase (50 – 60% total time)
- most events happen during this phase



Events:

1. **centrioles** move to opposite poles outside nuclear membrane
2. **aster** forms: protein fibers (astral rays) form around centrioles
3. chromosomes continue to grow shorter and thicker and begin to pair up (sister chromatids – identical)
4. **sister chromatids** become attached
5. **nucleolus** disappears
6. **nuclear membrane** disintegrates

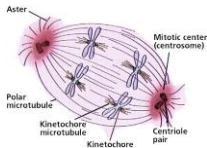


7. **Centrioles** form spindle

Spindle: football shaped structure made up of microtubule protein fibers

Types of fibers:

- **Spindle (polar):** from centriole to centriole
- **Traction:** from centriole to equator



8. **paired chromatids** begin to move to equator



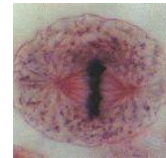
II. Metaphase

- shortest stage:
only a few minutes

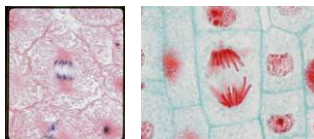
1. sister chromatids line up at equator of cell



2. **centromeres** of identical chromatids attach to **traction fibers** that lead to opposite poles



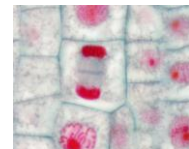
III. Anaphase



1. centromeres that join sister chromatids split and they become individual chromosomes
2. matching (homologous) chromosomes repel each other
3. chromosomes start to move to opposite poles (centromeres are pulled by traction fibers that begin to shorten)
4. anaphase ends when chromosomes reach the poles and stop moving (mechanism still a mystery)

IV. Telophase and Cytokinesis

1. chromosomes uncoil and lengthen – become tangled mass of chromatin again
2. nucleolus and nuclear membrane reform
3. spindle breaks apart
4. A. animal cells: **cleavage furrow** forms: protein belt pinches cell membrane inward
- B. plant cells: **cell plate** forms from inside and spreads to cell wall
5. **Cytokinesis** occurs: cytoplasm divides



- **result: 2 exact duplicate cells (daughter cells) same genetic info as mother cells**

Difference in Mitosis

Animal Cells	Plant Cells
Cleavage furrow	Cell plate
Equal size daughter cells	Unequal size daughter cells
Centrioles form spindle	No centrioles (spindle formed from cell wall)

[Mitosis animation](#)

IMPORTANCE OF CELL DIVISION

- completion of cell cycle produces new organisms and they grow by adding more cells
- if cell division ceases
 - unicellular organism: will die immediately
 - multicellular organism: will die within a few days
- cell cycle ensures that life will always be able to produce more life in an organized fashion.