



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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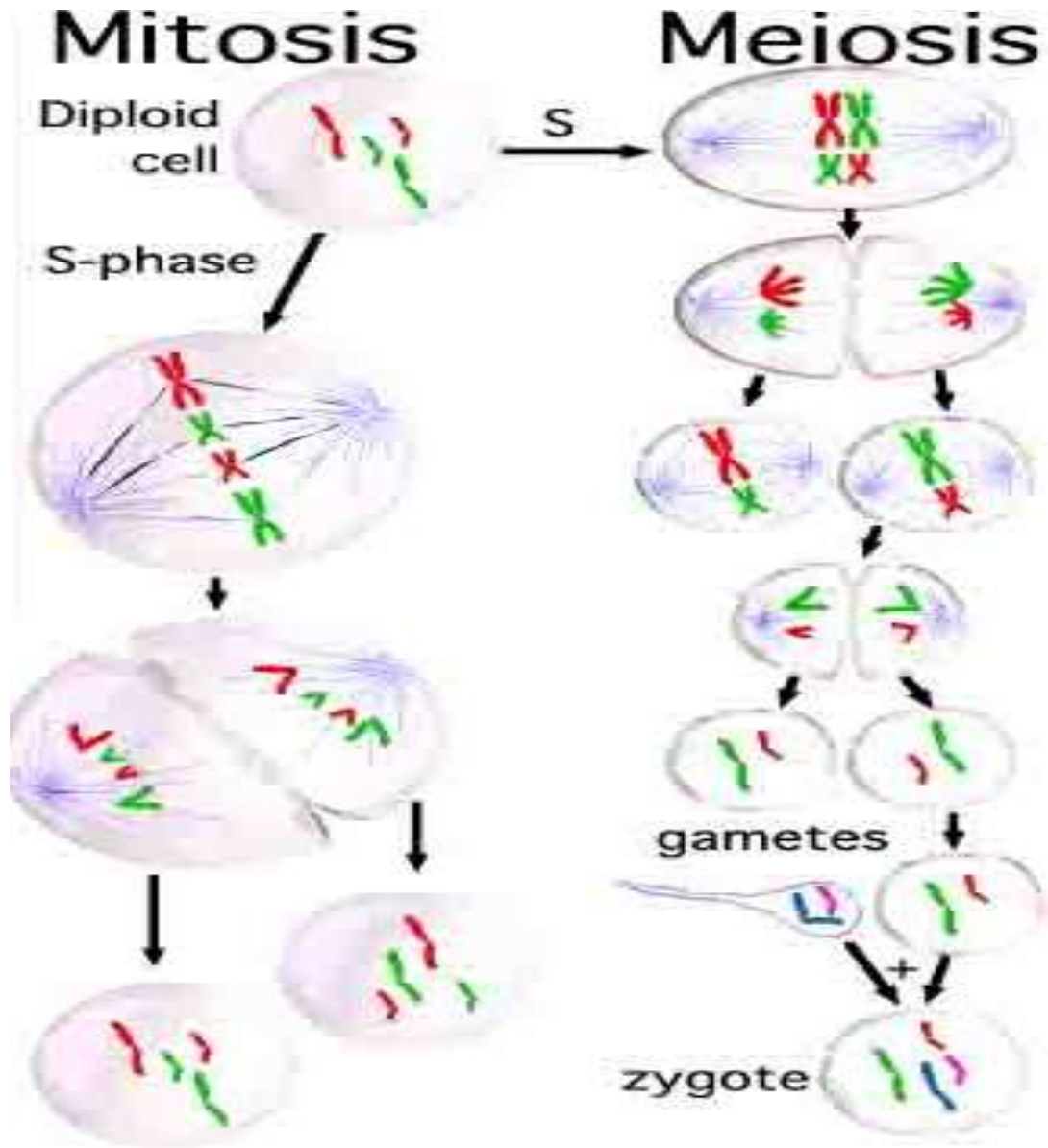


19GET277 / Biology For Engineers

IV YEAR / VII SEMESTER

UNIT-III: GENETICS AND IMMUNE SYSTEM

MITOSIS AND MEIOSIS



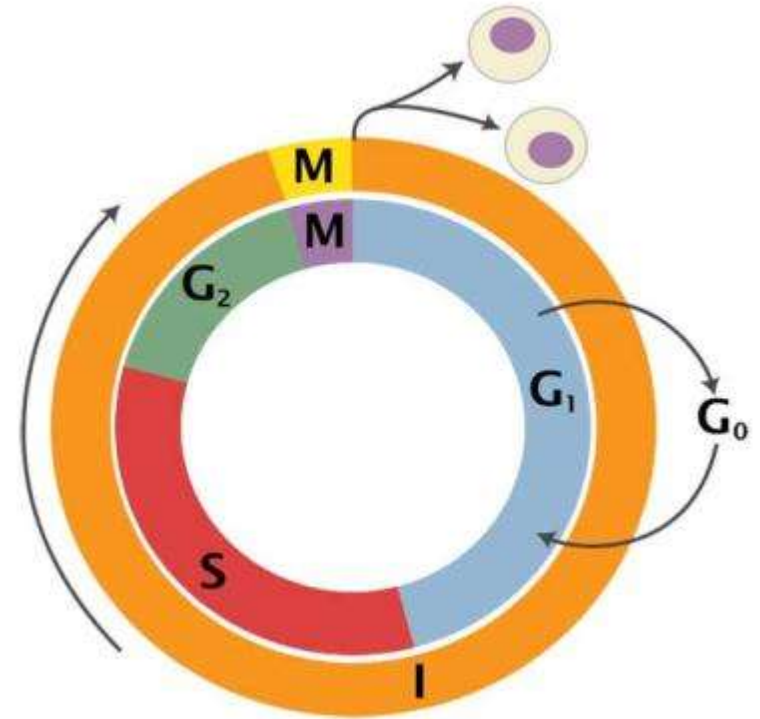
Cell Division

Mitosis & Meiosis

Eukaryotic Cell Cycle

- Cell grows.
- DNA is replicated.
- Mitotic cell division produces daughter cells identical to the parent.
- Repeat.

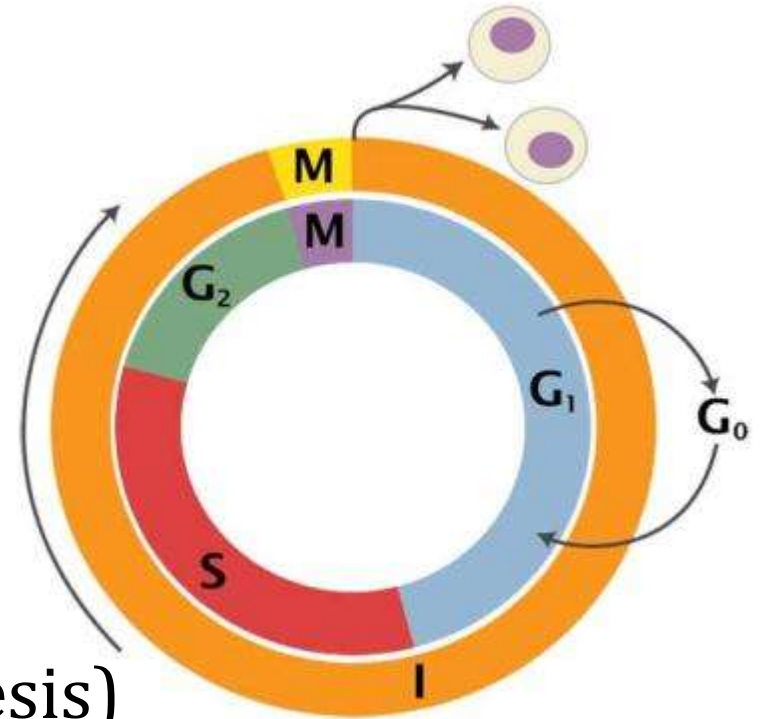
The timing of replication and cell division is highly regulated.

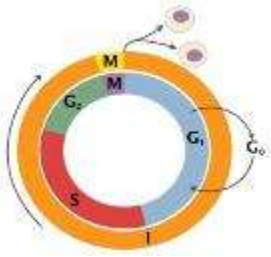


Eukaryotic Cell Cycle

2 major phases:

- **Interphase** (3 stages)
 - DNA is not condensed
- **Mitosis** (4 stages + cytokinesis)
 - Nuclear division & division of cytoplasm
 - DNA condensed





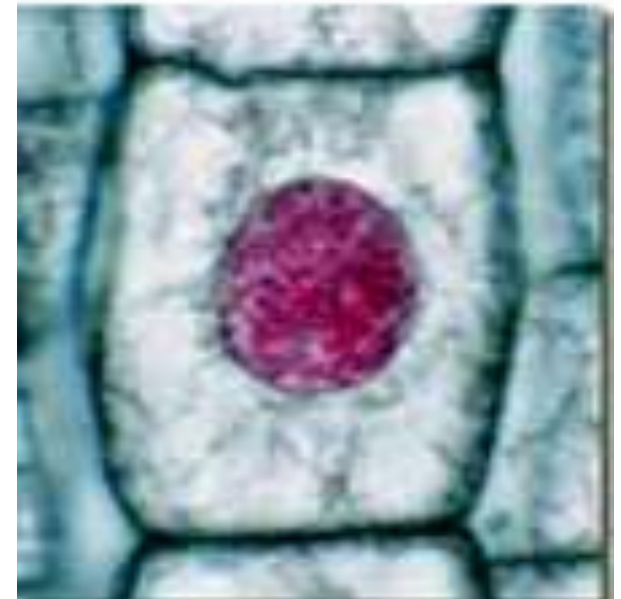
Interphase

**Non-dividing state
with 3 sub-stages:**

Gap 1 – cell grows in size
– organelles replicated

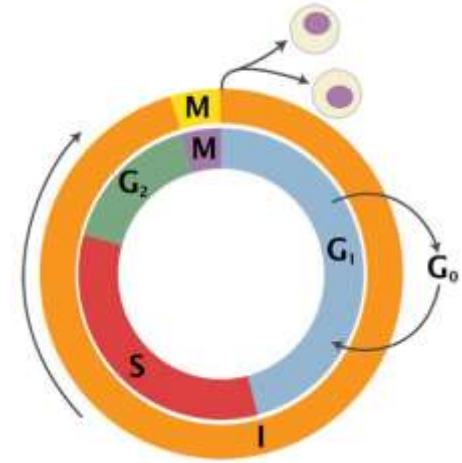
Synthesis – replication of DNA
– synthesis of proteins
associated with DNA

Gap 2 – synthesis of proteins
associated with mitosis



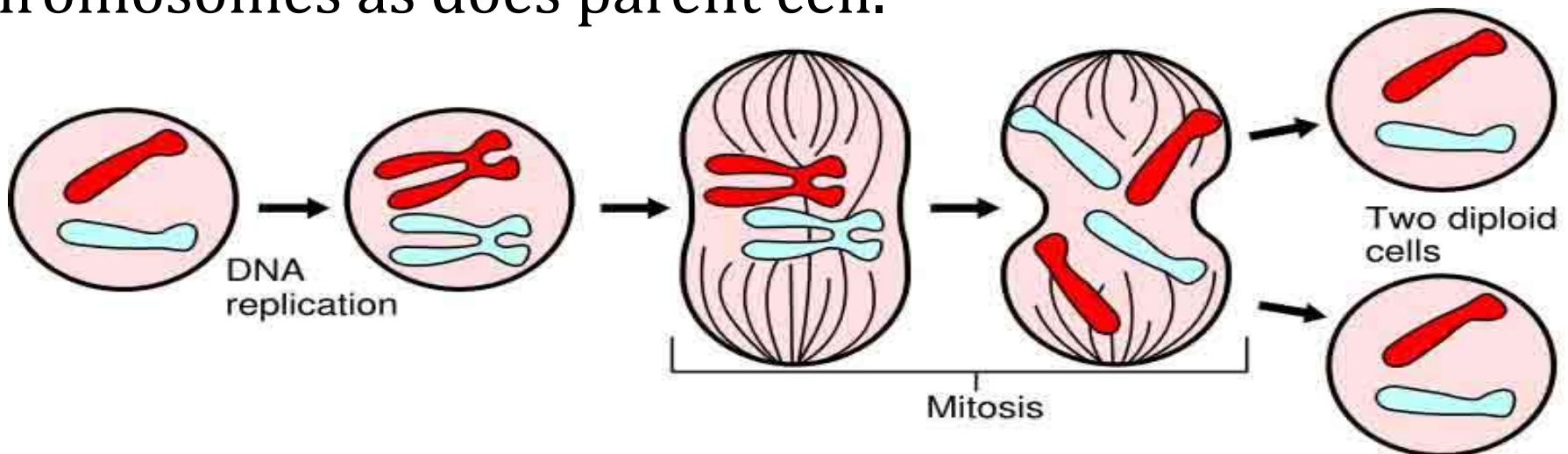
Mitosis

Division of **somatic** cells (non-reproductive cells) in eukaryotic organisms.



A single cell divides into two identical daughter cells.

Daughter cells have same number of chromosomes as does parent cell.



Mitosis

4 sub-phases:

1st – Prophase

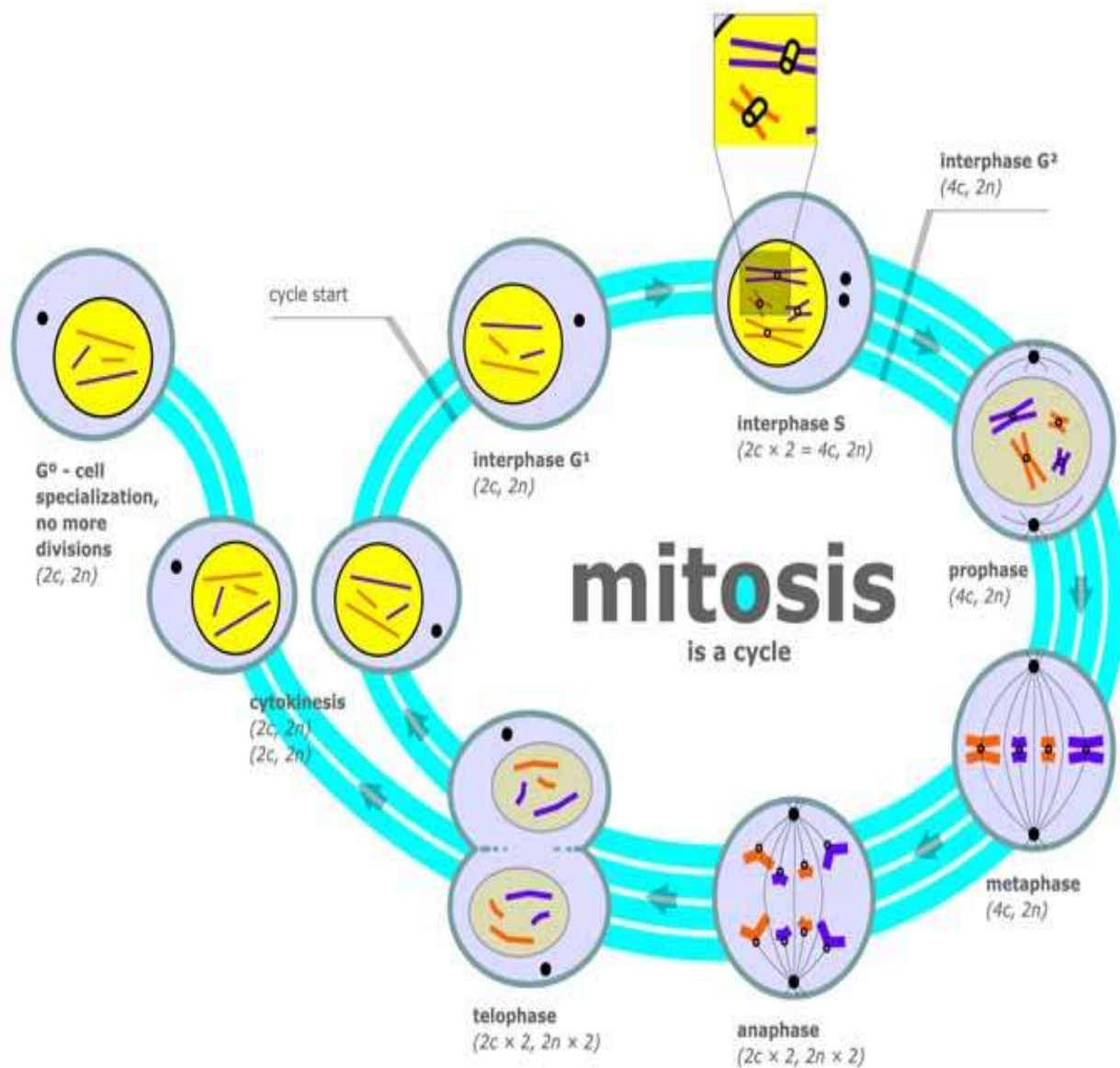
2nd – Metaphase

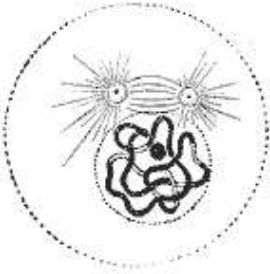
3rd – Anaphase

4th – Telophase

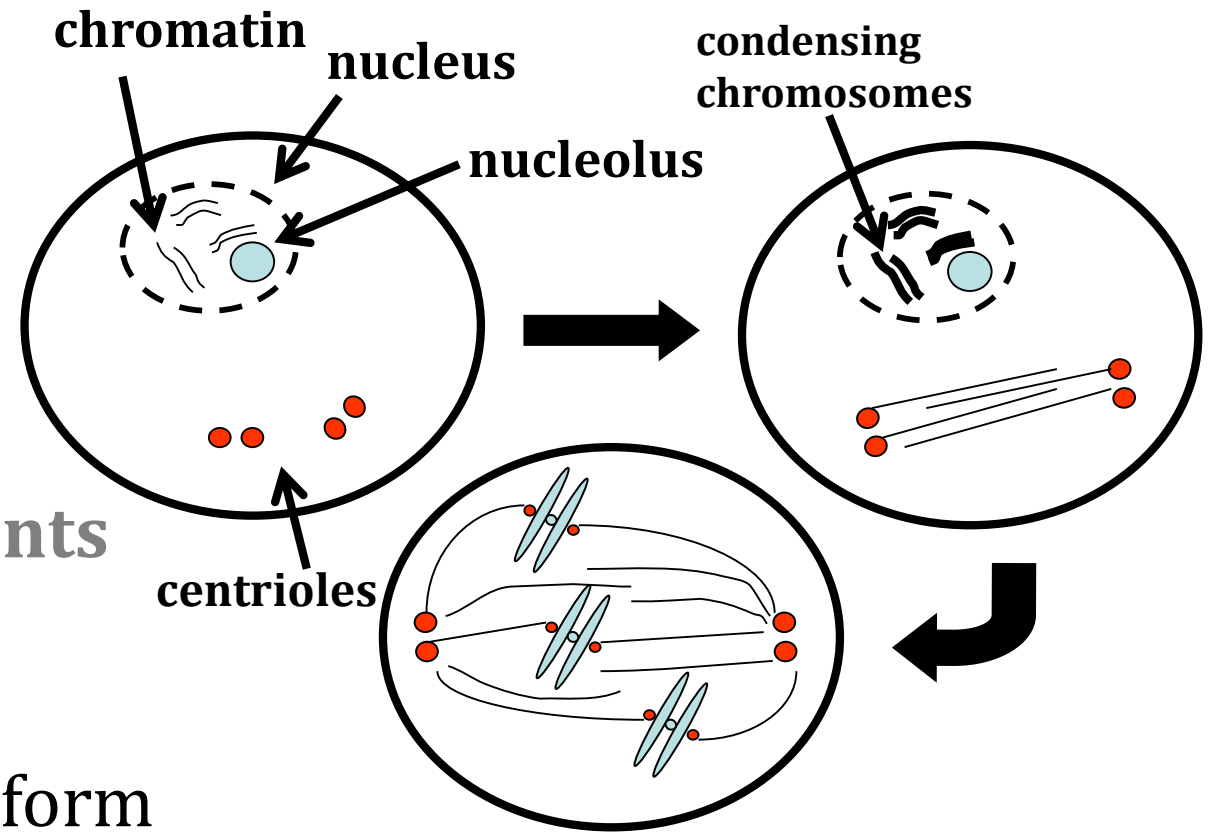
followed by

Cytokinesis



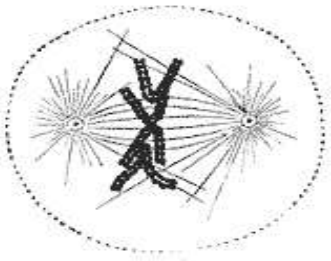


1. Prophase

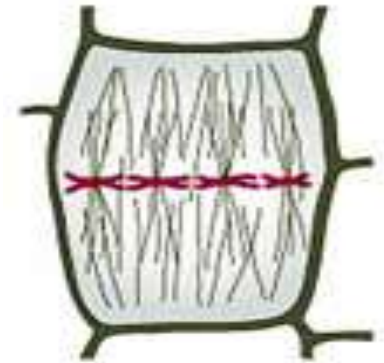


Three Major Events

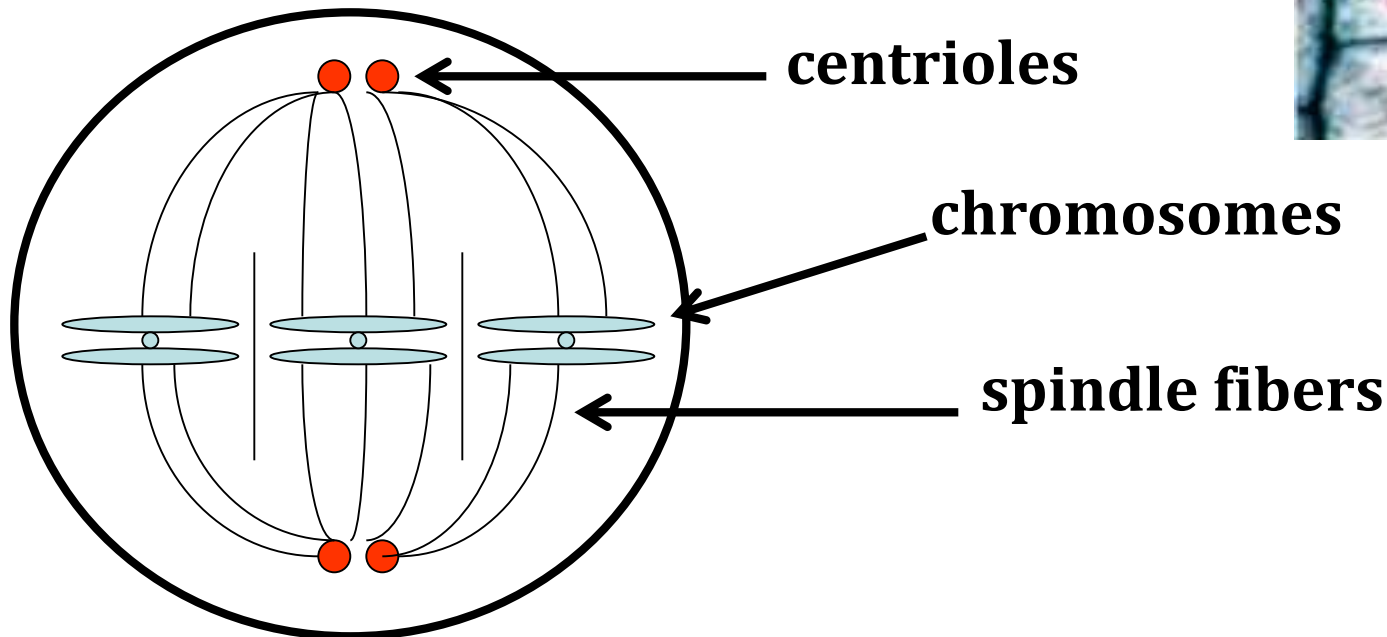
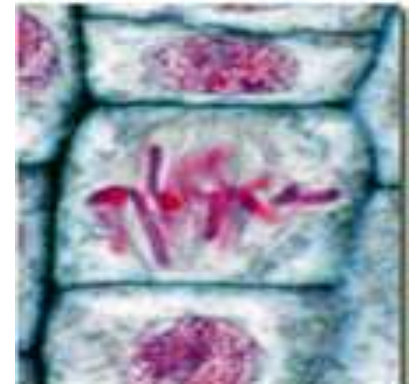
1. chromosomes condense
2. spindle fibers form
 1. (spindle fibers are specialized microtubules radiating out from centrioles)
3. chromosomes are captured by spindle

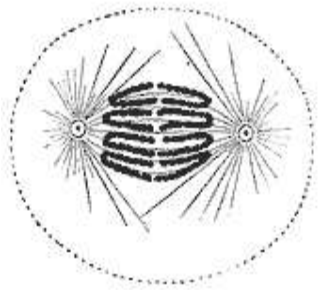


2. Metaphase



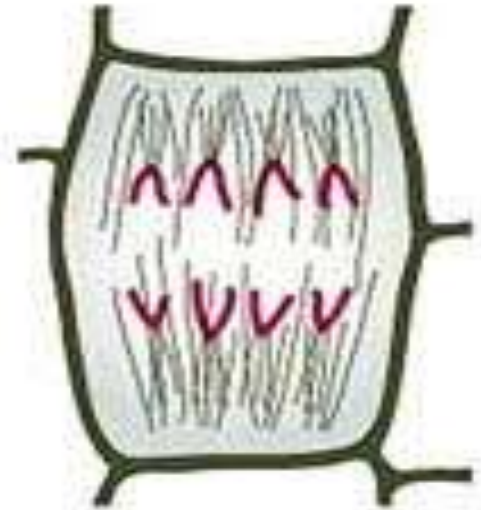
- chromosomes align along the equator of the cell, with one chromatid facing each pole

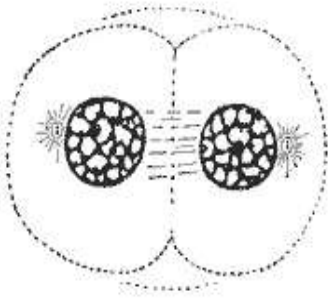




3. Anaphase

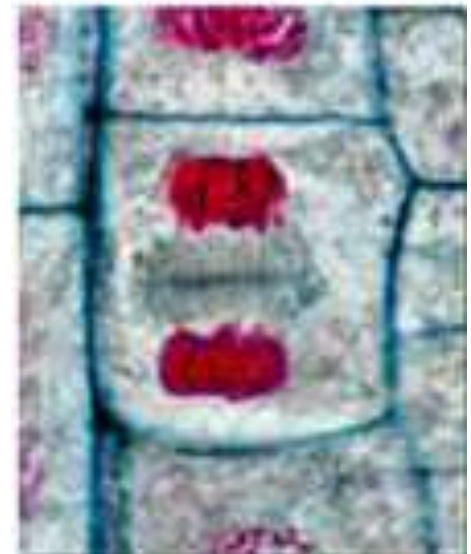
- sister chromatids separate
- spindle fibers attached to kinetochores **shorten** and **pull** chromatids towards the poles.
- free spindle fibers **lengthen** and **push** the poles of the cell apart

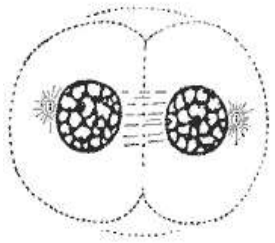




4. Telophase

- spindle fibers disintegrate
- nuclear envelopes form around both groups of chromosomes
- chromosomes revert to their extended state
- cytokinesis occurs, enclosing each daughter nucleus into a separate cell





Cytokinesis – Plant vs. Animal Cell



- **Plant cells** undergo cytokinesis by forming a cell plate between the two daughter nuclei.
- **Animal cells** undergo cytokinesis through the formation of a cleavage furrow. A ring of microtubules contract, pinching the cell in half.

Genetics Terminology



SEXually reproducing eukaryotes have two types of body cells...



1. **somatic cells**

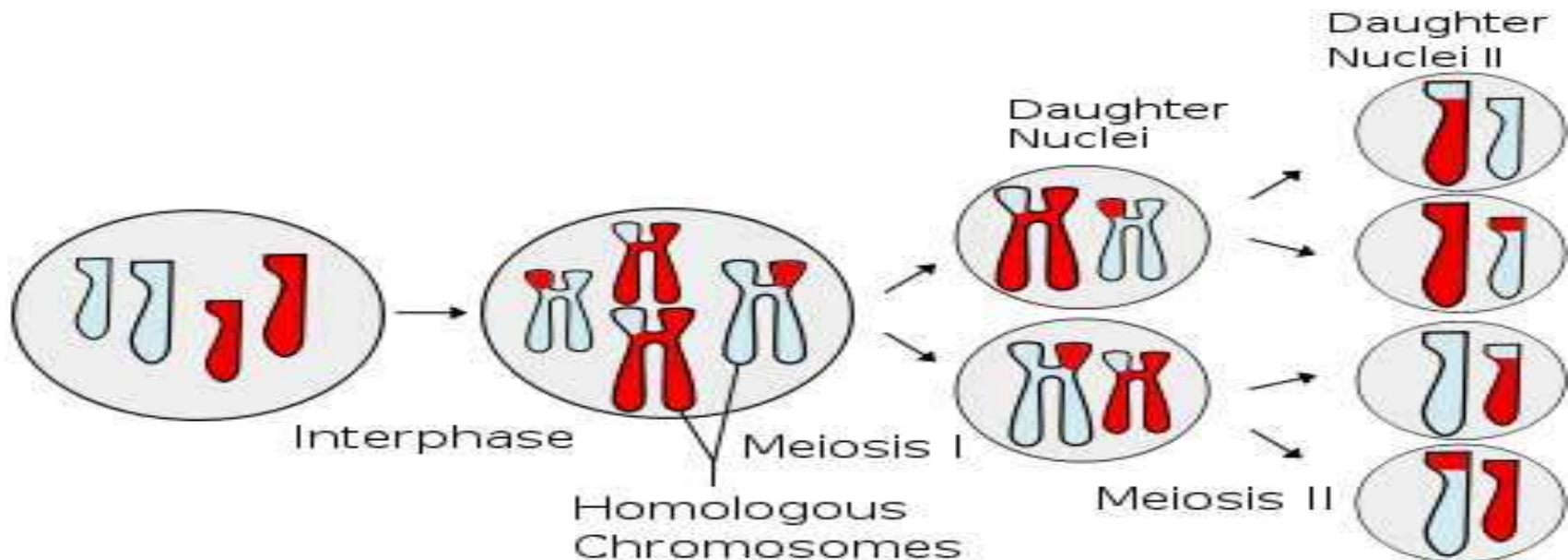
2. **sex cells**

(a.k.a. gametes, germline)

What is cell division of gametes called?

Meiosis

- A single germ cell divides into four unique daughter cells.
- Daughter cells have half the # of chromosomes as parent cell, so they are considered **haploid**.

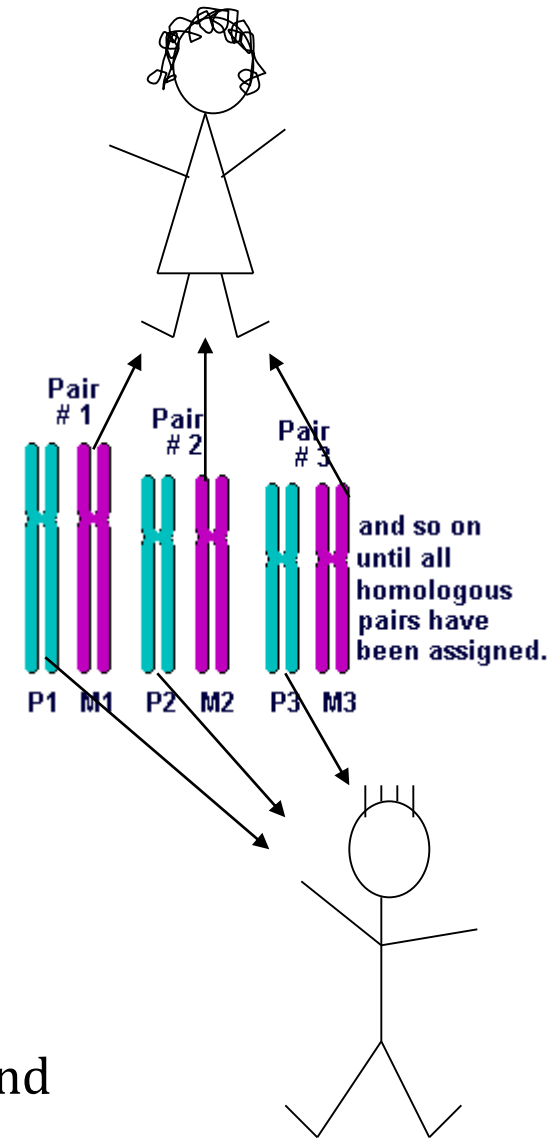


Genetics Terminology: Ploidy

Refers to the number of sets of chromosomes in cells.

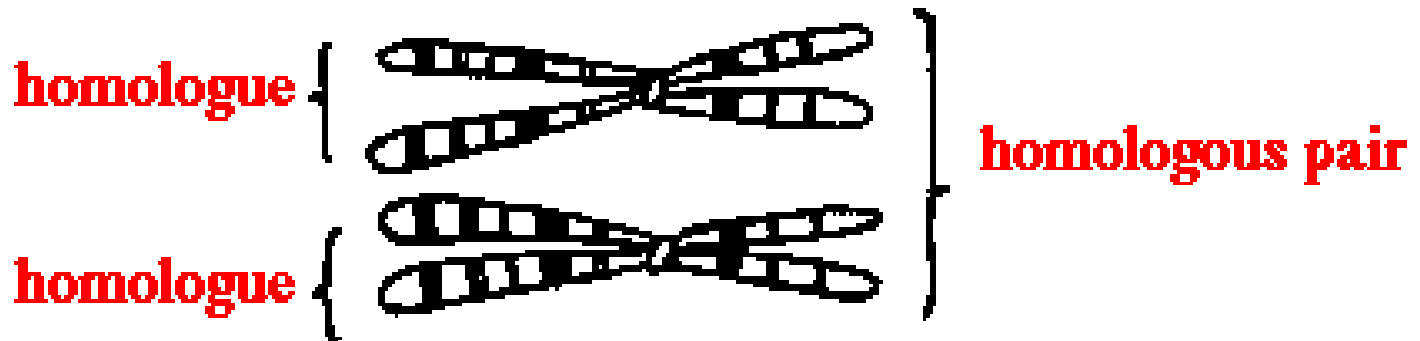
- **Haploid** – one copy of each chromosome
 - designated as “ n ”, the number of chromosomes in one “set”
 - gametes
- **Diploid** – two sets of chromosomes (two of each chromosome)
 - designated as “ $2n$ ”
 - somatic cells

Diploid organisms receive one of each type of chromosome from female parent (maternal chromosomes) and one of each type of chromosome from male parent (paternal chromosomes)



Genetics Terminology: **Homologues**

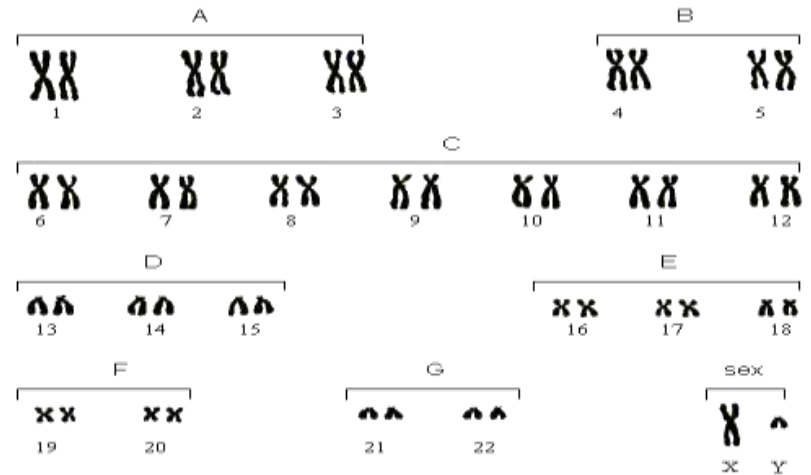
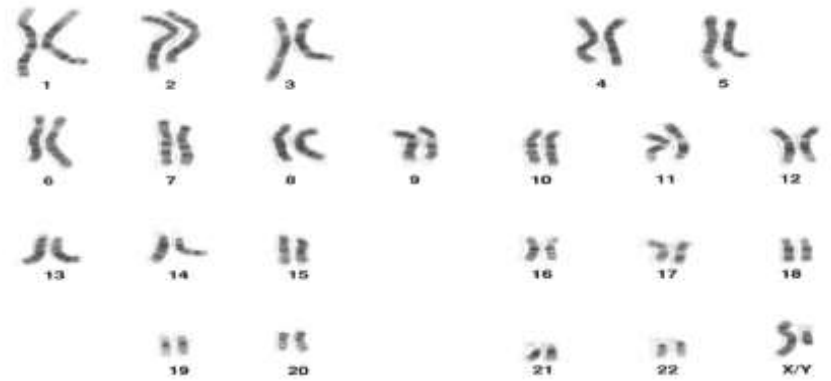
Chromosomes exist in homologous pairs in diploid ($2n$) cells.



Exception: **Sex chromosomes** (X, Y).

All other chromosomes (**autosomes**) have homologues.

Karyotype



- **Q:** How many homologous pairs are in each karyotype?
- **Q:** How is the bottom karyotype different from the top two?

Sexual Reproduction

- Fusion of two **gametes** to produce a single zygote.
- Introduces greater genetic variation, allows genetic recombination.
- Zygote has gametes from two different parents (except in cases of self-fertilizing organisms).

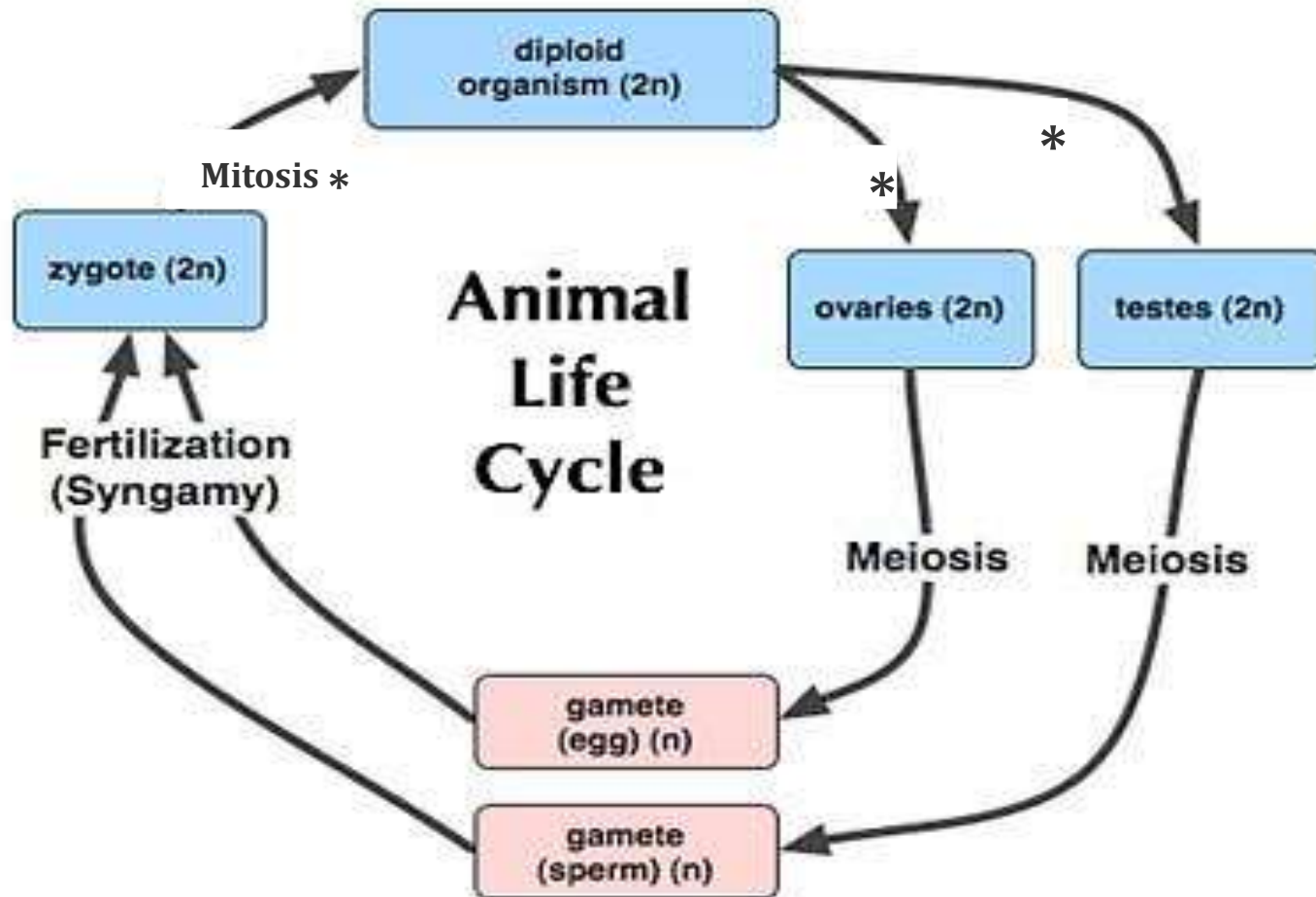
(Rose + Greg = Steven)

Sexual reproduction in humans ...

- At fertilization, 23 chromosomes are donated by each parent.
(total = 46 or 23 pairs).
- **Gametes** (sperm/ova):
 - Contain 22 autosomes and 1 sex chromosome.
 - Are haploid (haploid number “ n ” = 23 *in humans*).
- Fertilization results in diploid zygote.
 - Diploid cell; $2n = 46$. ($n = 23$ *in humans*)
- **Q:** Most cells in the body are produced through what type of cell division?
(Remember, only *gametes* are produced through **meiosis**)



Meiosis & Sexual Reproduction Life Cycle



Genetic shuffling of Meiosis I

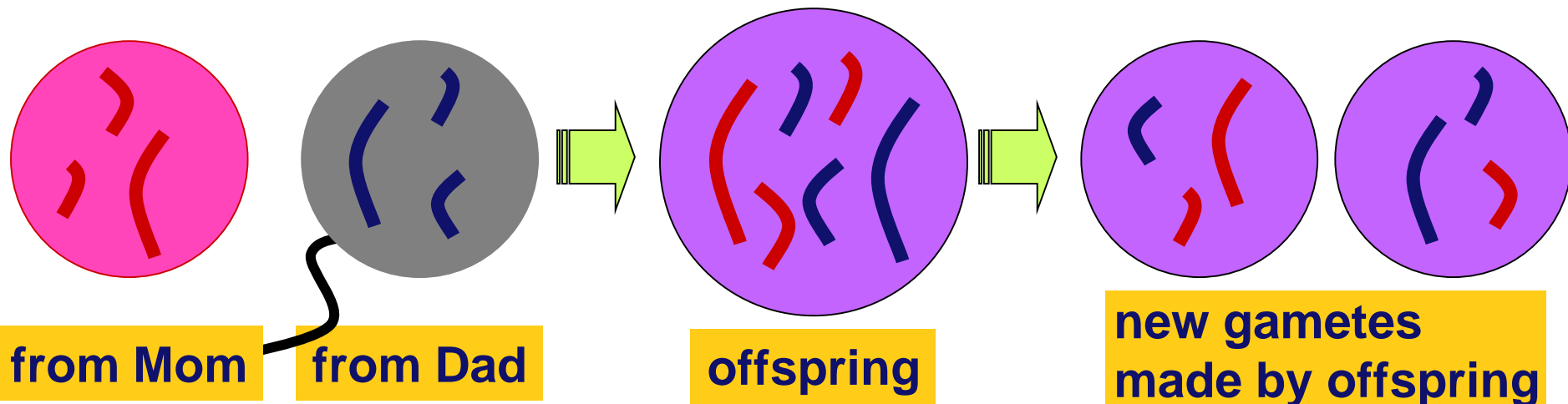
In addition to a new combination of chromosomes resulting from **fertilization**, there are also events in Meiosis I that shuffle the genes.

1. **Crossing over** in Prophase I.

2. **Independent assortment** in Metaphase I.

Variation from genetic recombination

- Independent assortment of chromosomes
 - meiosis introduces genetic variation
 - gametes of offspring do not have same combination of genes as gametes from parents
 - random assortment in humans produces 2^{23} (8,388,608) different combinations in gametes



Mitosis

vs.

Meiosis

- $2n$
- Clone
- Same genetic information in parent cell and daughter cell.
- Give me another one just like the other one!

- $1n$
- Daughter cells different from parent cell and from each other.
- Daughter cells have $\frac{1}{2}$ the number of chromosomes as somatic cell.
- Shuffling the genes
(Mix it up!)

