

Meiosis

& Sexual Reproduction

Cell Cycle

- In body cells: Interphase, Mitosis, Cytokinesis
 - DNA is copied once
 - Nucleus and cytoplasm divide once
 - Produces two diploid (2n) daughter cells
 - Diploid cells have pairs of chromosomes called homologous chromosomes
 - Each chromosome in the homologous pair came from a different parent

Homologous Chromosomes

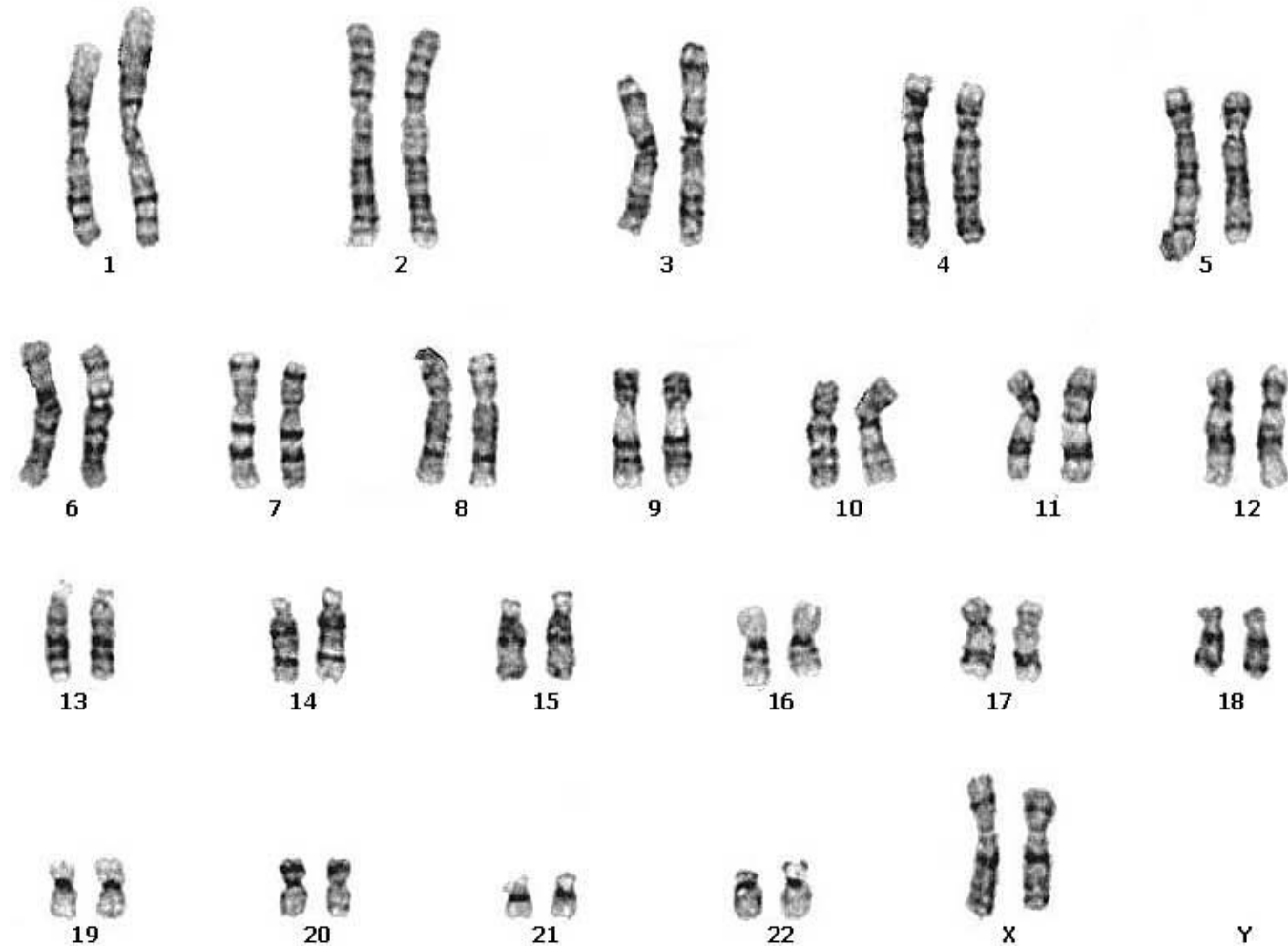
- Chromosomes that carry genes for the same traits.



A pair of homologous chromosomes

Human body cells have 23 pairs of homologous chromosomes (46 total)

Human Female
G-bands

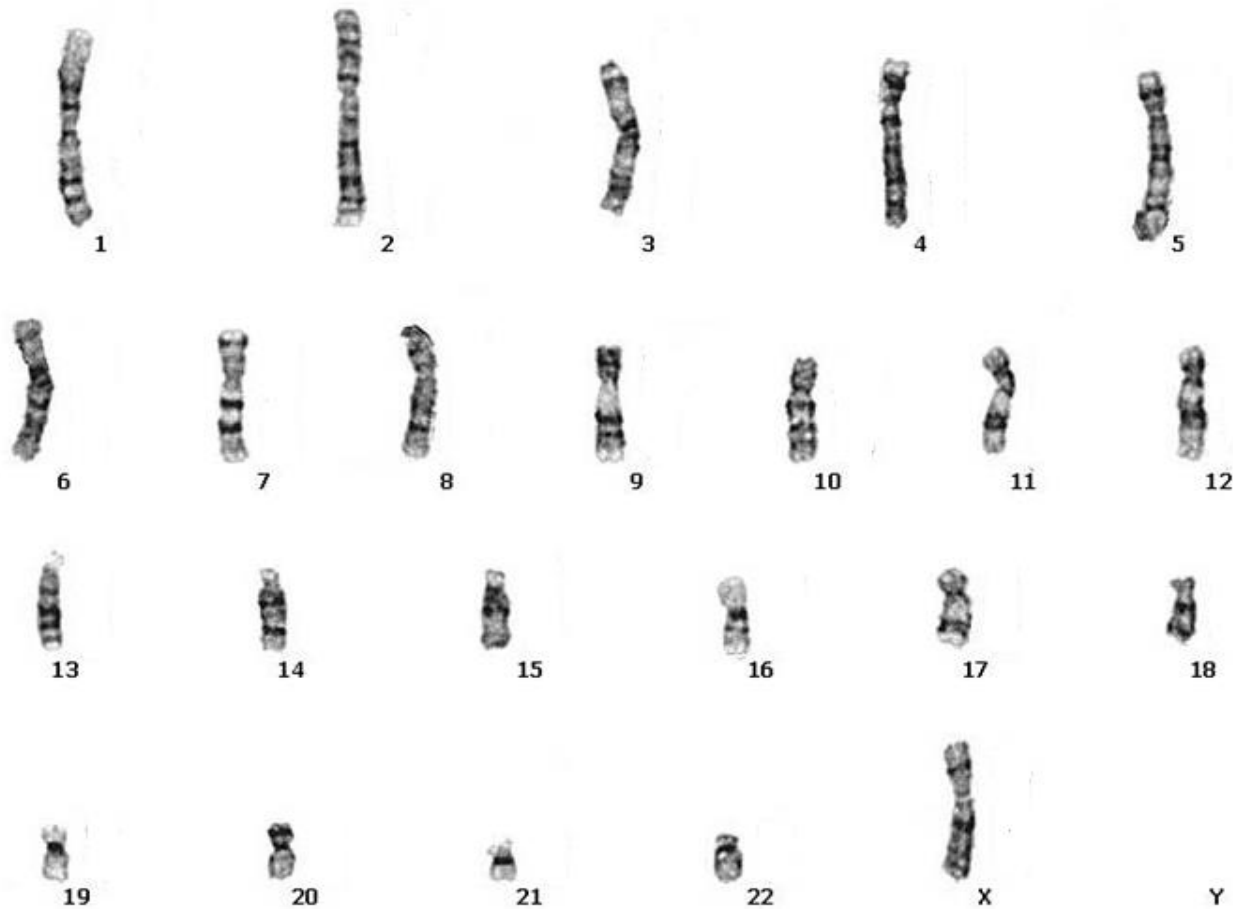


Cell Cycle

- In germ cells: Interphase, Meiosis, Cytokinesis
 - DNA is copied once
 - Nucleus and cytoplasm divide twice
 - Produces four haploid (n) daughter cells called gametes or sex cells (i.e. sperm & egg)
 - Haploid cells have one chromosome from each pair homologous chromosomes
 - In *n* gametes the normal diploid ($2n$) number of chromosomes is divided in half

Human sex cells have one chromosome from each homologous pair (23 total)

Human Female
G-bands

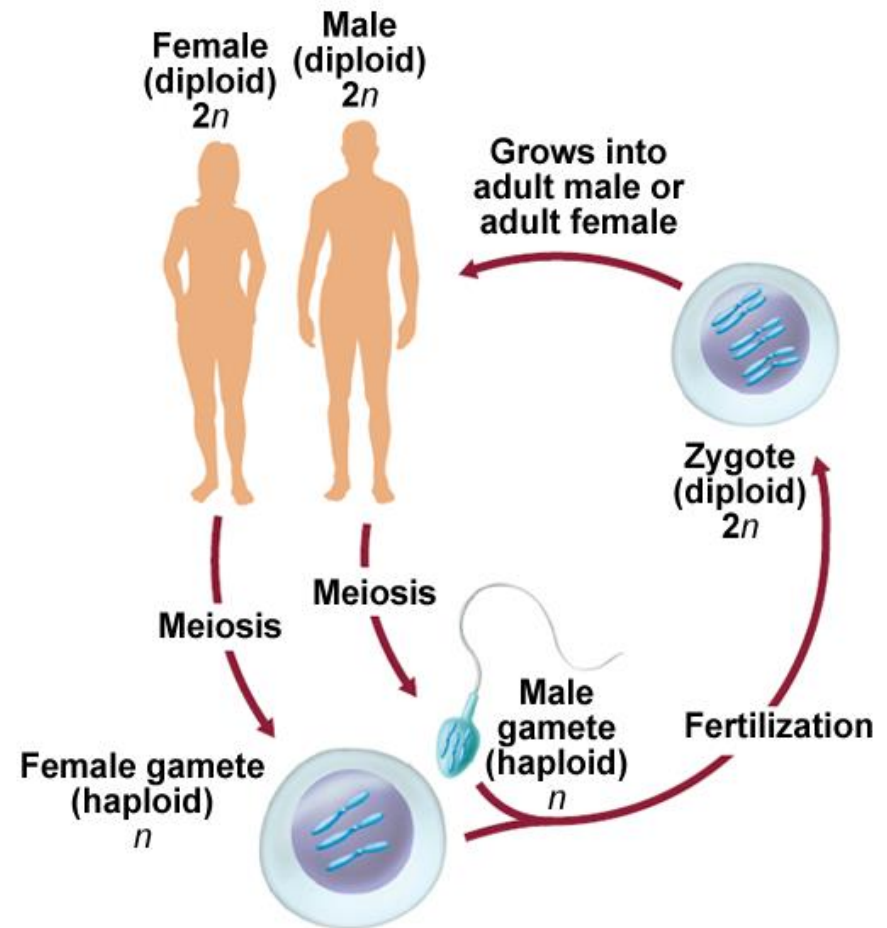


Sexual Reproduction

- Disadvantages
 - Requires 2 parents
 - Takes a relatively long time to produce offspring
 - Requires a relatively large amount of resources
- Advantages
 - Produces offspring that are genetically different from the parents and from one another. Half of an offspring's chromosomes come from its father and half comes from its mother
 - Increases the genetic diversity of a species. This makes a species less prone to extinction due to environmental change

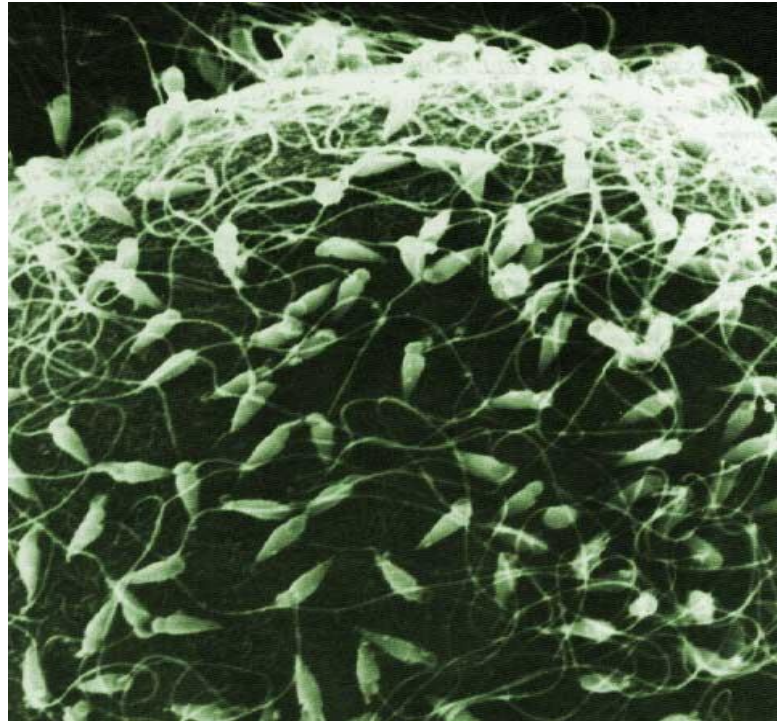
Sexual Reproduction

- Organisms that reproduce sexually use haploid (n) gametes (sperm & egg)



Sexual Reproduction

- Gametes combine *randomly* at fertilization ($n + n$) to produce a zygote with the diploid ($2n$) number of chromosomes

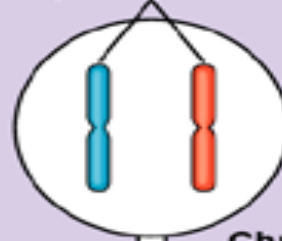


Meiosis

- In meiosis, a diploid cell (2n) goes through two divisions to form four haploid (n) cells
- During the first division, homologous chromosomes are separated from each other
- During the second division, sister chromatids are separated from each other

Interphase I of Meiosis

Homologous pair of chromosomes
in diploid parent cell



Chromosomes
replicate

Homologous pair of replicated chromosomes

Sister
chromatids



Diploid cell with
replicated
chromosomes

Meiosis I



① Homologous
chromosomes
separate



Haploid cells with
replicated chromosomes

Meiosis II

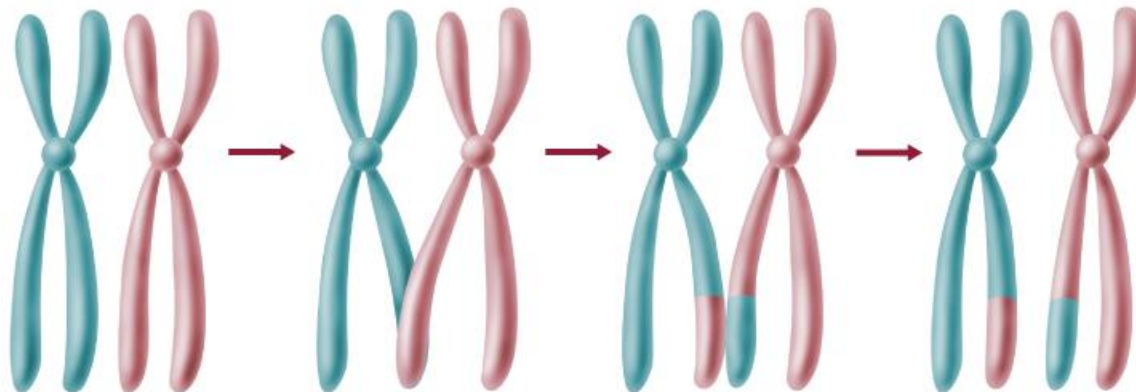
② Sister chromatids
separate



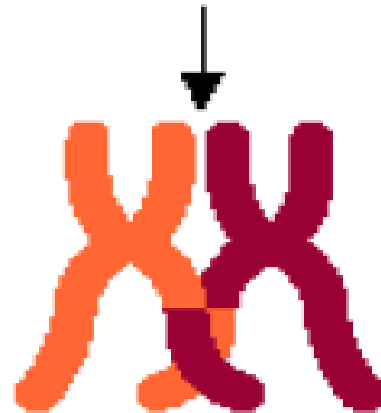
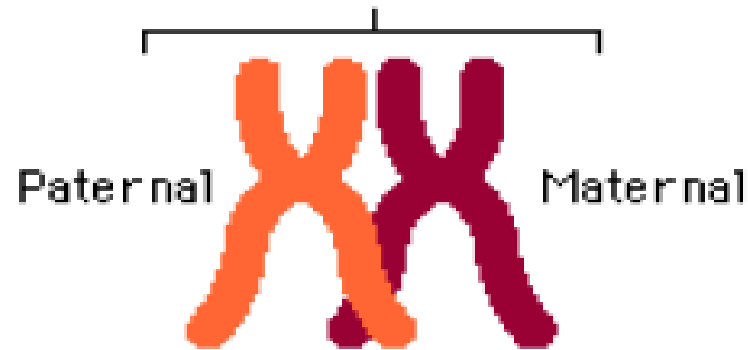
Haploid cells with unreplicated chromosomes

Crossing Over

- Before the first division, homologous chromosomes are very close together
- During this time, crossing over can happen
- Crossing over is the exchange of genetic information between homologous chromosomes



homologous chromosomes



Crossing over



Crossing over
leads to
genetic
variation!

Meiosis Produces Variation

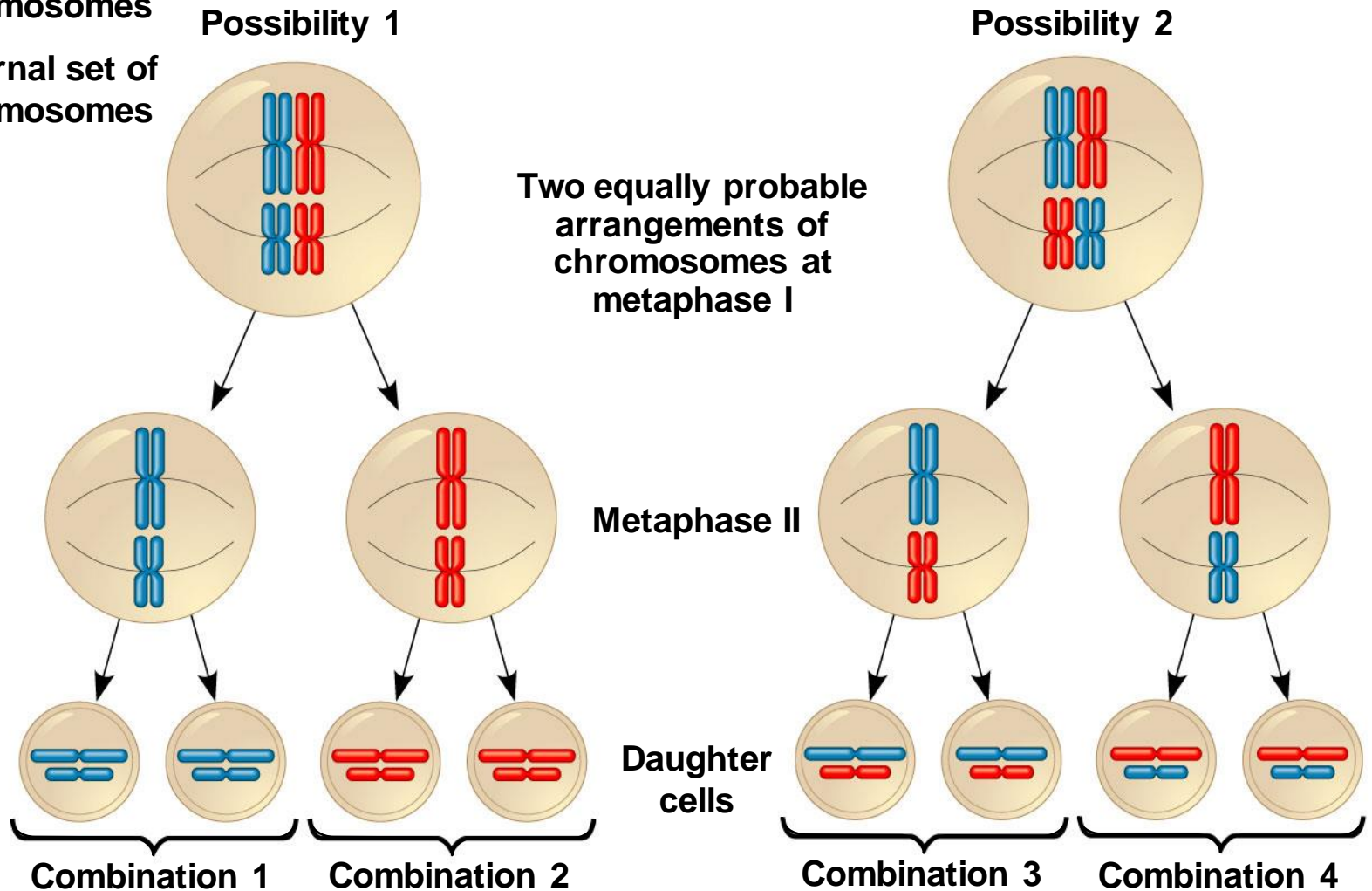
- Crossing Over
- Depending on how chromosomes line up at the equator, 4 gametes with 4 different combinations of chromosomes could result
- Random Fertilization

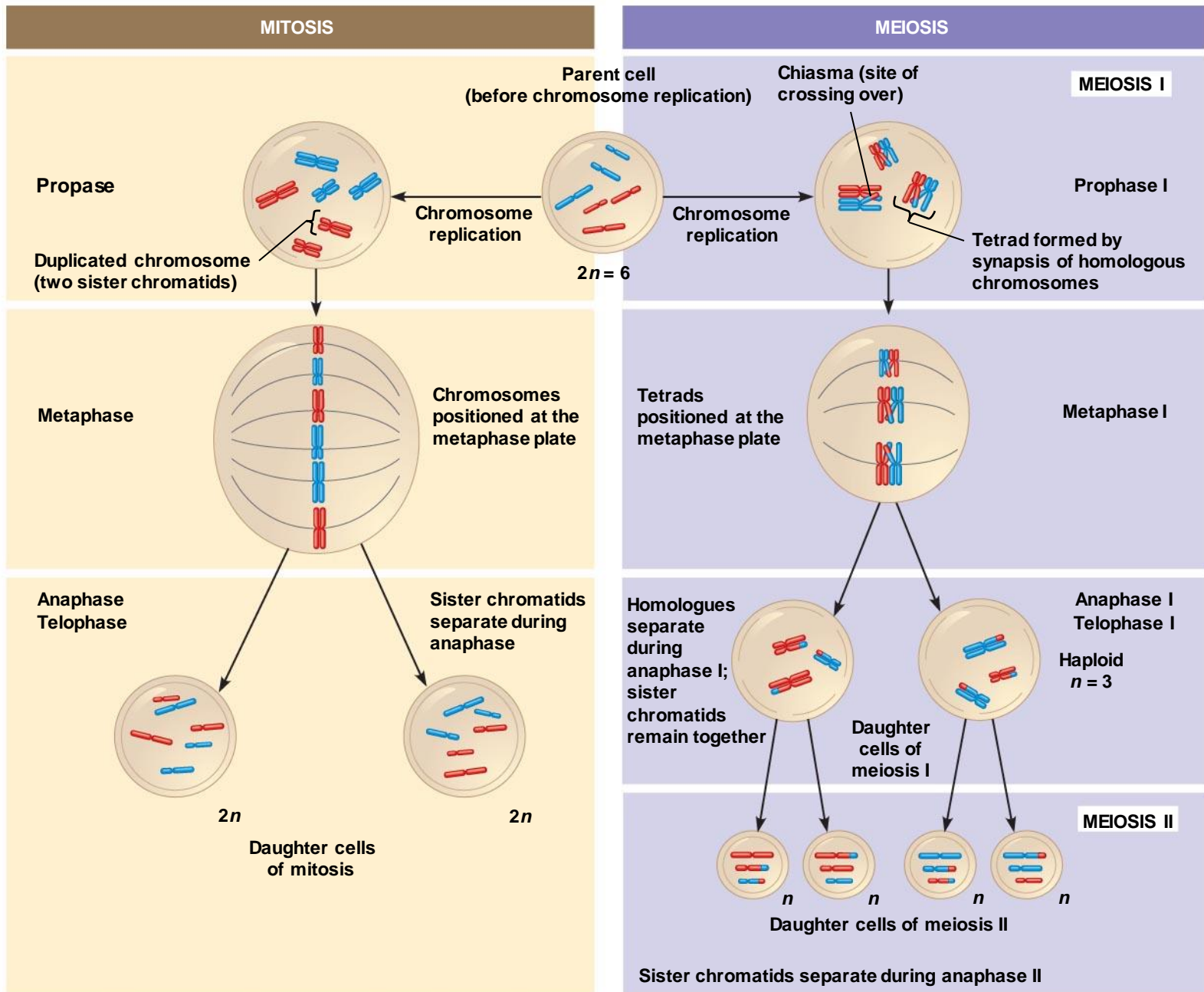
Independent Assortment

Key

 Maternal set of chromosomes

 Paternal set of chromosomes





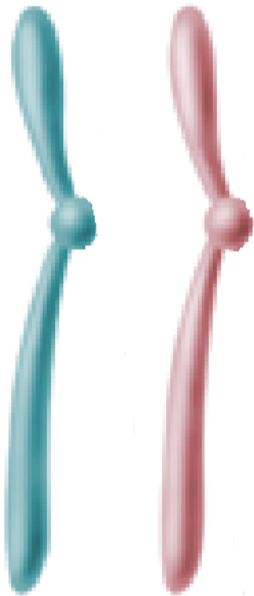
Mitosis vs. Meiosis

SUMMARY

Event	Mitosis	Meiosis
DNA replication	Occurs during interphase before nuclear division begins	Occurs once, during the interphase before meiosis I begins
Number of divisions	One, including prophase, metaphase, anaphase, and telophase	Two, each including prophase, metaphase, anaphase, and telophase
Synapsis of homologous chromosomes	Does not occur	Synapsis is unique to meiosis: During prophase I, the homologous chromosomes join along their length, forming tetrads (groups of four chromatids); synapsis is associated with crossing over between nonsister chromatids
Number of daughter cells and genetic composition	Two, each diploid ($2n$) and genetically identical to the parent cell	Four, each haploid (n), containing half as many chromosomes as the parent cell; genetically nonidentical to the parent cell and to each other
Role in the animal body	Enables multicellular adult to arise from zygote; produces cells for growth and tissue repair	Produces gametes; reduces chromosome number by half and introduces genetic variability among the gametes

Pairs of Homologous Chromosomes

Homologous Chromosomes



Unduplicated

Homologous Chromosomes



Duplicated