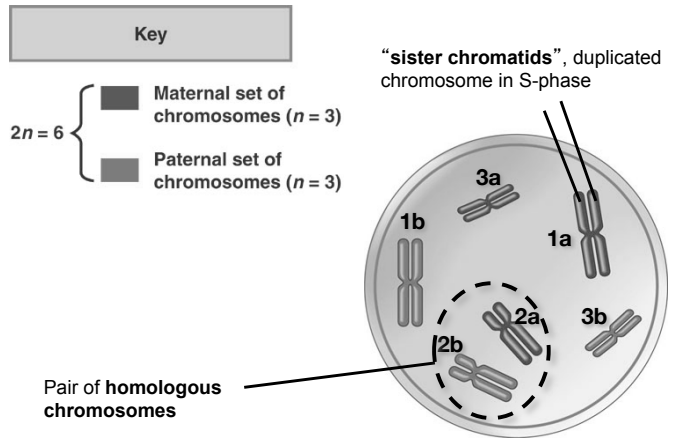
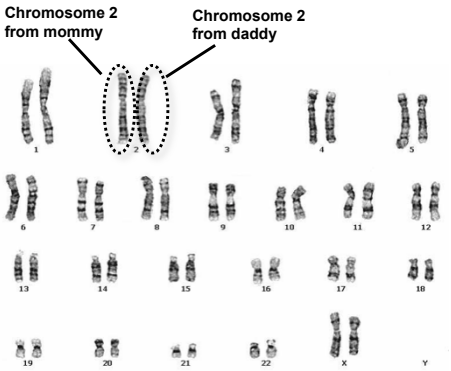
Topics

- Mitosis
  - Cytokinesis
  - Checkpoints
- Meiosis
  - Gametogenesis
  - Stages
  - Genetic variation

Homologous Chromosomes



Humans Are Diploid



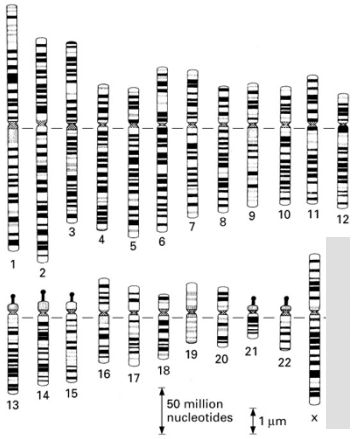
- Two **homologous** chromosomes make the cell **diploid**
- Human cells are **2n**, **n=23**

Humans have 46 total chromosomes

Humans Are Diploid

- In S-phase all chromosomes are duplicated, the cell then contains 92 **chromatids** (but still 46 chromosomes)
- Because **sister chromatids** are **identical** copies of each chromosome, the cell is still **diploid**

Humans are Diploid



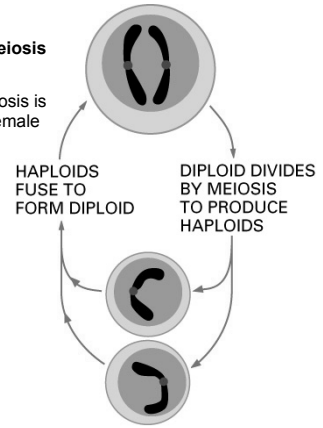
- This set would be **haploid**, **1n**, which is the ploidy of human **gametes**.

Stated simply... reproductive cells (e.g. sperm and eggs) contain **one** of each chromosome, mommy's **OR** daddy's, but not both.

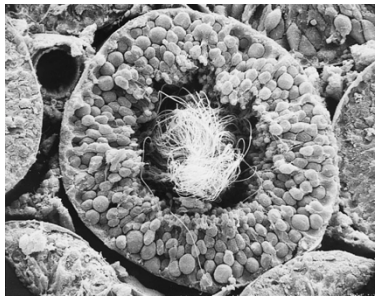
Gametogenesis

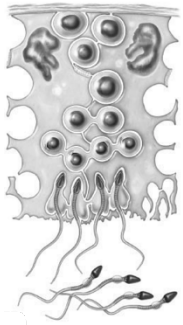
(the production of **gametes** - reproductive cells, sperm and egg)

- Gametes are produced through germ cell **meiosis**
- The formation of male gametes through meiosis is called **spermatogenesis**; the production of female gametes is called **oogenesis**.
- **Somatic** cells contain homologous pair; they are called **diploid** (46 total)
- Reproductive cells (some **germ cells** and **gametes**) have only 23 chromosomes and are called **haploid**



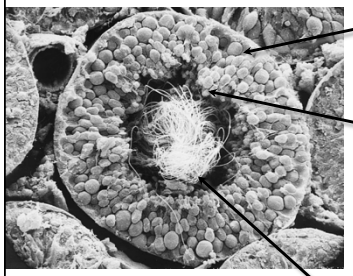
Seminiferous tubules

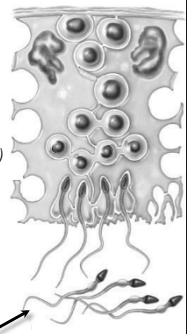




The seminiferous tubules contain the cells that undergo meiosis and create sperm

Spermatogenesis



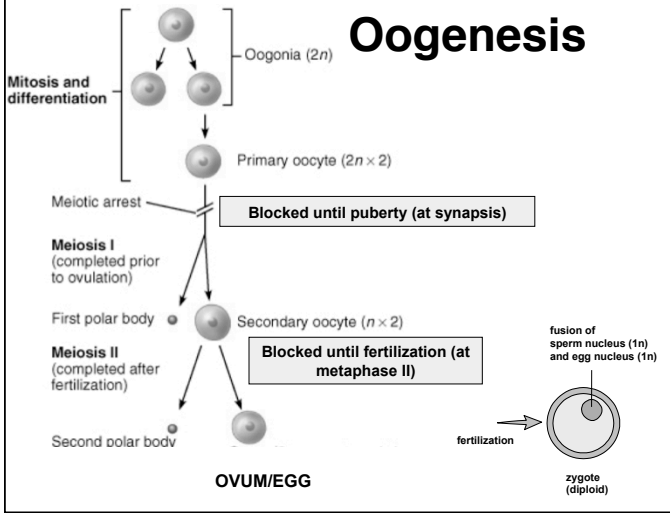


Spermatogonia (diploid)

Spermatids (haploid)

Spermatozoa (haploid)

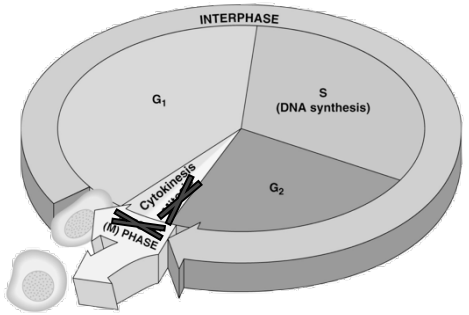
Oogenesis

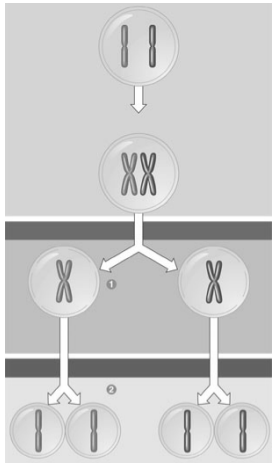


Meiosis and the Production of Gametes

- Meiosis **only** occurs in the reproductive cells of the **testes** and **ovaries**
- It halves the genetic material in the cell

- The **interphase** stage of these specialized cells is the same
- M-phase differs



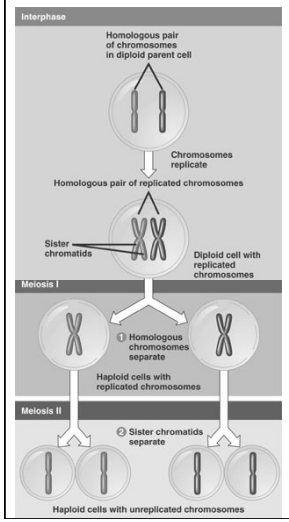


Purpose of Meiosis

To reduce the chromosome number from diploid to haploid

To ensure each haploid product has a complete set of chromosomes

To generate genetic diversity



Meiosis Overview

Chromosomes are duplicated but line up side-by-side (in series) with their **homolog**

Anaphase results in a **haploid** cell - one which has either the parental or maternal chromosome, but not both.

Meiosis has a **second** round of nuclear division that further separates the sister chromatids, and results in **four 1n cells**

Nucleus divides twice, DNA replicated only once

Meiosis and the Production of Gametes

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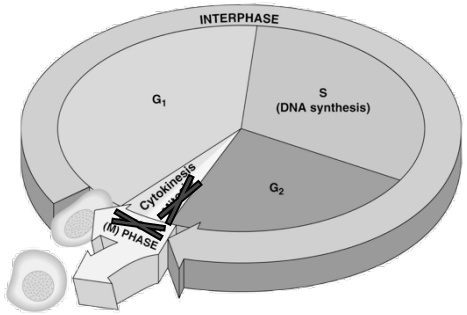
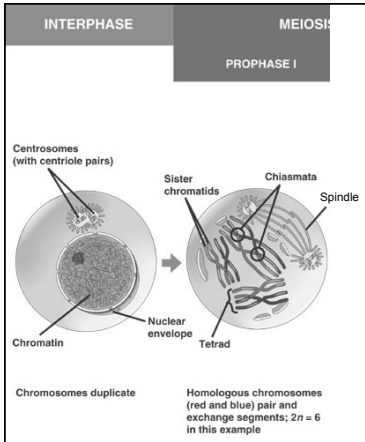


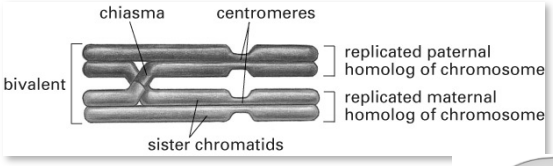


INTERPHASE
- Chromosomes condense
- Centrosomes divide

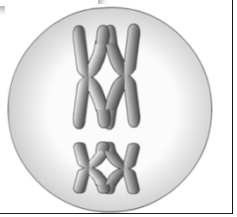
PROPHASE I
- Nuclear membrane/nucleolus break down
- **Synapsis** occurs

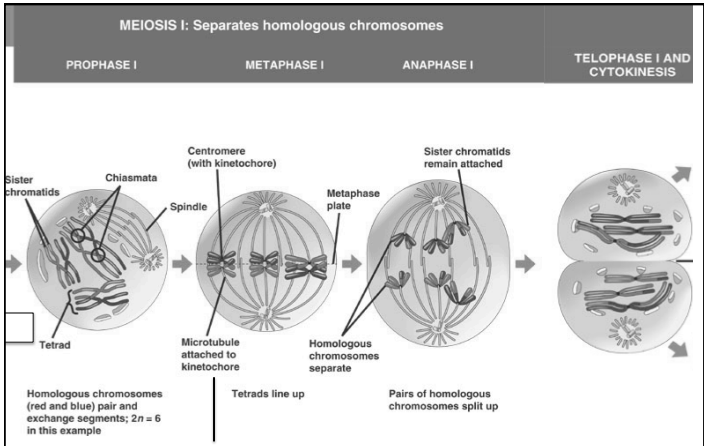
Synapsis/ Crossing-Over

- **Synapsis** is the alignment of the **tetrad**, the two homologous chromosomes and sister chromatids.



- Genetic rearrangements between **nonsister** chromatids, known as **crossing over**, occurs during **prophase I.**
Chiasma form where a cross-over has occurred.





Microtubule spindles connected to **one of the two sisters** at either end.

A Huge Difference - Metaphase 1

Mitosis Metaphase

Meiosis Metaphase 1

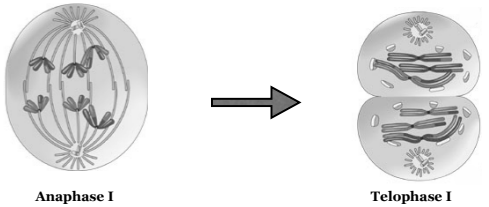
Homologous chromosomes line up in <u>parallel in Mitosis</u>, but in <u>series in Meiosis I</u>

Meiosis I

(Anaphase I and Telophase I)

Homologous chromosomes are separated from each other

Chromosomes still in the form of attached sister chromatids.

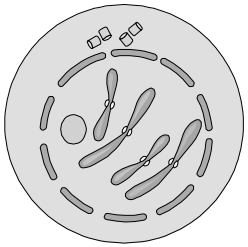


Anaphase I **Telophase I**

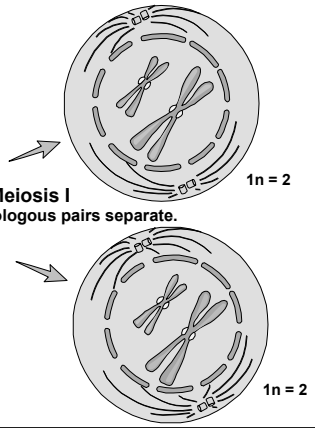
Meiosis I

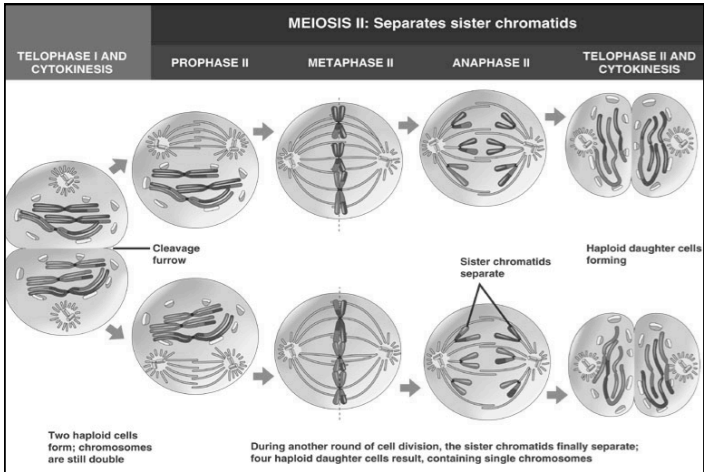
(Prophase I to Telophase I)

• The cells are now **haploid!**

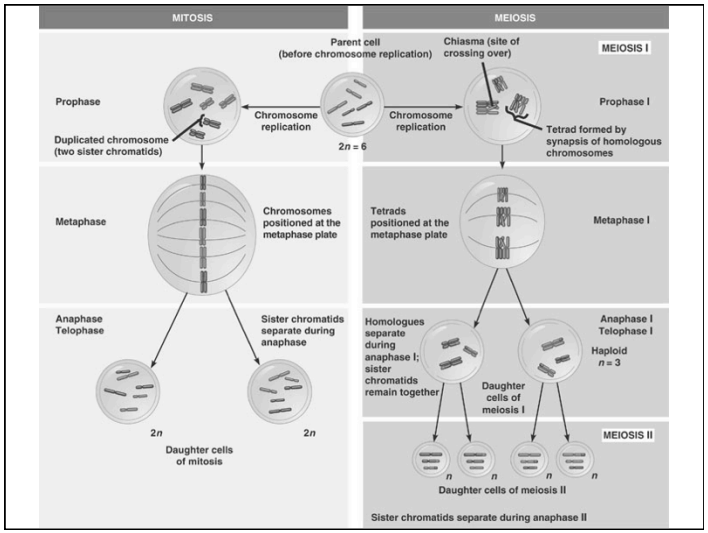


2n = 4
(note that this picture of the cell is *before* S-phase)





• **Meiosis II** is essentially the same as **mitosis**, except with haploid daughter cells



SUMMARY

Property	Mitosis	Meiosis
DNA replication	Occurs during interphase before mitosis begins	Occurs during interphase before meiosis I begins
# of divisions	One, including prophase, metaphase, anaphase, and telophase	Two, each including prophase, metaphase, anaphase, and telophase
Synapsis of homologous chromosomes	Does not occur	Occurs during prophase I along with crossing over between nonsister chromatids; resulting chiasmata hold pairs together due to sister chromatid cohesion
# of daughter cells/ genetic composition	Two, each diploid (2*n*) and genetically identical to the parent cell	Four, each haploid (*n*), with half as many chromosomes as the parent cell; genetically different from the parent cell and from each other
Role in the animal body	Enables multicellular adult to arise from zygote; produces cells for growth, repair, (in some species, asexual reproduction	Produces gametes; reduces number of chromosomes by half and introduces genetic variability among the gametes

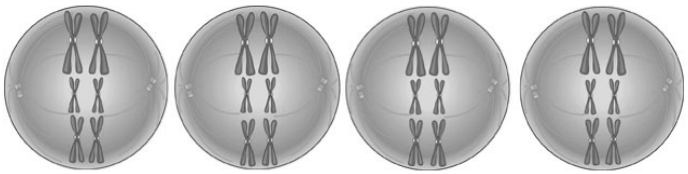
Fig. 13-9b

Sources of Variation

Meiosis results in genetic variation as the result of **three** events

1. **Independent Assortment**

   The alignment of homologous chromosomes at metaphase I is **random**

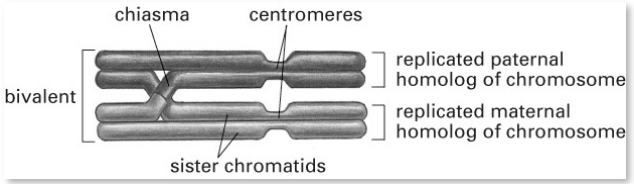


Alignment of homologous chromosomes in metaphase I of meiosis

Sources of Variation

Meiosis results in genetic variation as the result of **three** events

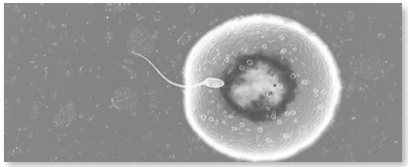
1. **Independent Assortment**
2. **Recombination** at Synapsis (i.e. "crossing over")



Sources of Variation

Meiosis results in genetic variation as the result of **three** events

1. **Independent Assortment**
2. **Recombination** at Synapsis (i.e. "crossing over")
3. Random **Fertilization**



Fertilization of egg by sperm is random chance (mostly)

Fertilization is Random