

Meiosis

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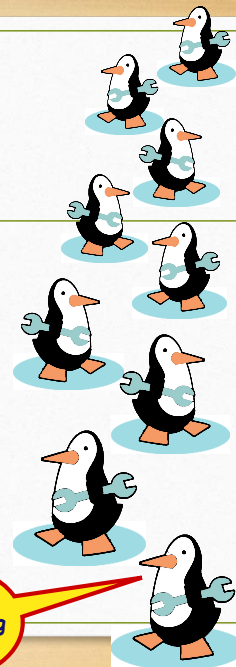
How is meiosis different from
mitosis?

3 Types of Cell Division

- 1. Binary fission- cell division in prokaryotes
- 2. Cell Cycle (with Mitosis)- cell division in eukaryotes to form new somatic cells
- 3. Meiosis- cell division in eukaryotes to form gametes/sex cells (egg and sperm)

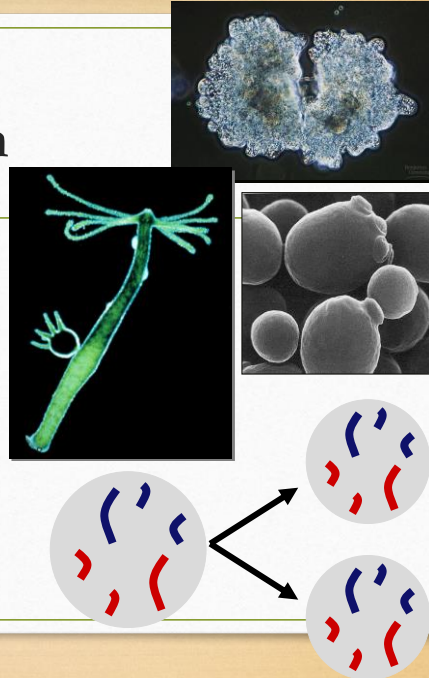
Cell division Asexual reproduction

- Mitosis
 - produce cells with same information
 - identical daughter cells
 - exact copies
 - clones
 - same number of chromosomes
 - same genetic information



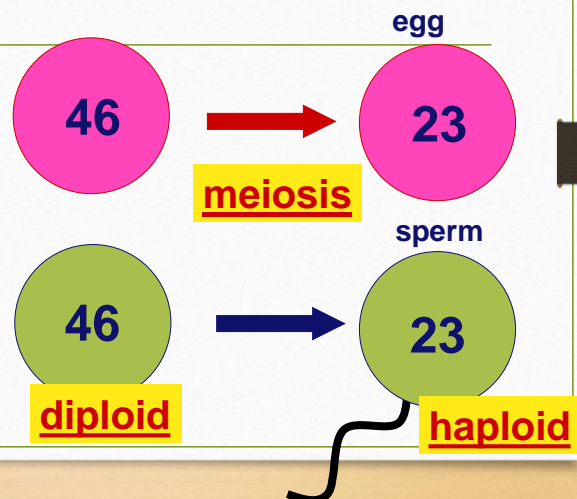
Asexual reproduction

- Single-celled eukaryotes
 - yeast
 - *Paramecium*
 - *Amoeba*
- Simple multicellular eukaryotes
 - *Hydra*
 - budding



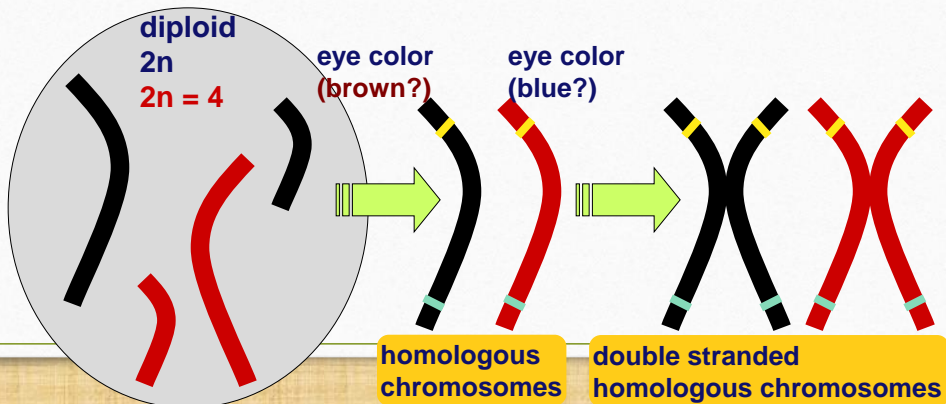
Meiosis makes sperm & eggs

- 46 chromosomes to 23 chromosomes
 - half the number of chromosomes



Paired chromosomes

- Homologous chromosomes
 - both chromosomes of a pair carry “matching” genes
 - control same inherited characters
 - homologous = same information



Lesson Overview

Meiosis

Haploid Cells

Some cells contain only a single set of chromosomes, and therefore a single set of genes.

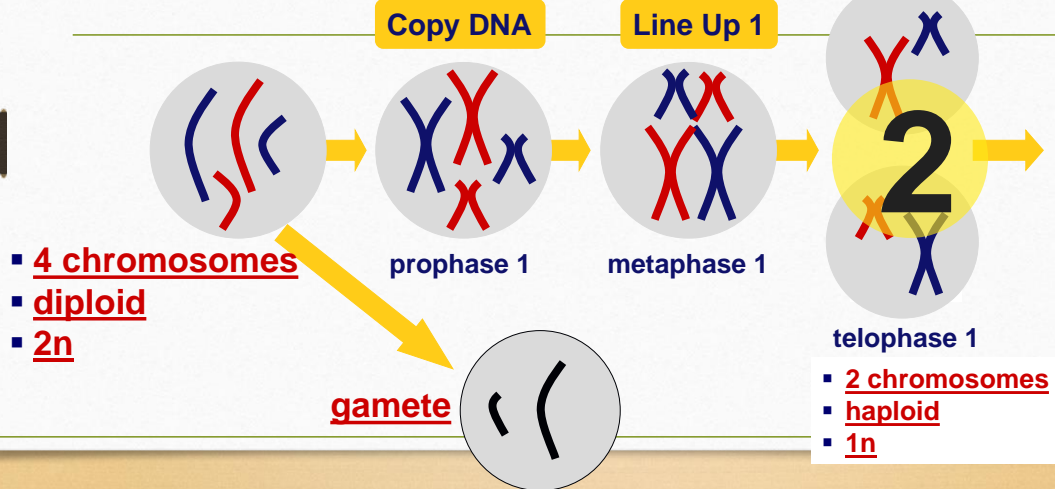
Such cells are **haploid**, meaning “one set.”

The gametes of sexually reproducing organisms are haploid.

For fruit fly gametes, the haploid number is 4, which can be written as **N = 4**.

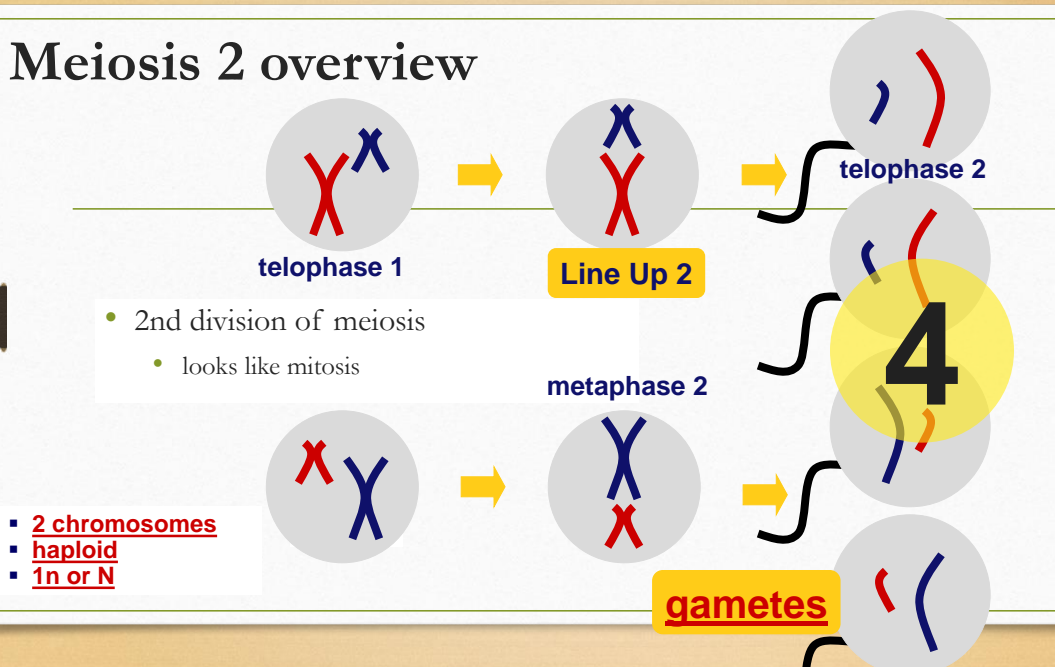
Meiosis 1 overview

- 1st division of meiosis



Meiosis 2 overview

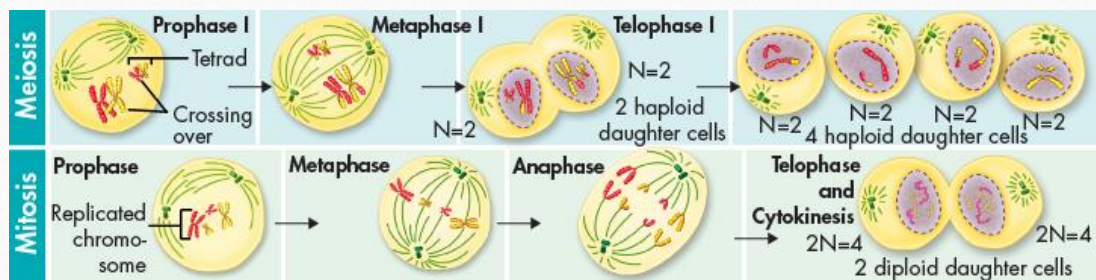
- 2nd division of meiosis
- looks like mitosis



Mitosis v. Meiosis

	Mitosis	Meiosis
Results in	2 Diploid Cells (2N)	4 Haploid Cells (N)
Cells are	Genetically Identical	Genetically Different
Occurs in	Somatic or body cells	Gamete or sex cells

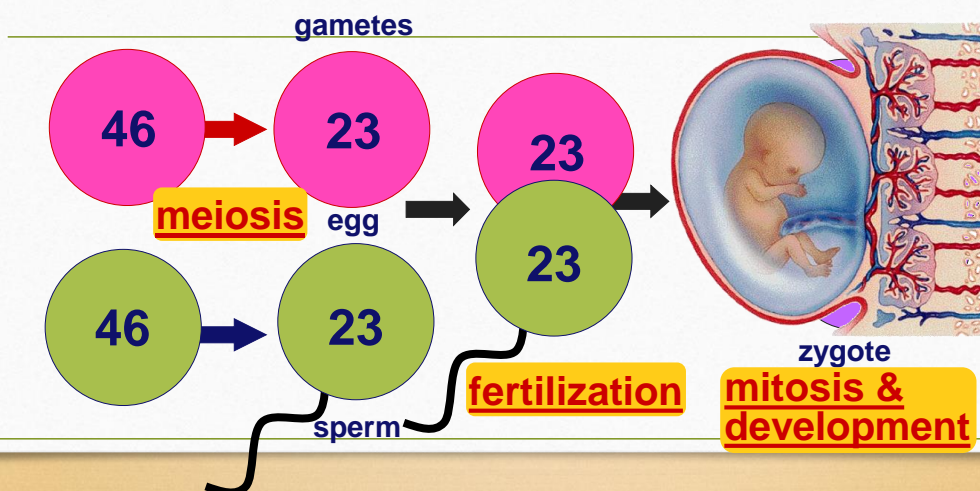
Mitosis v. Meiosis



What events occur during each phase of meiosis?

Putting it all together...

meiosis → fertilization → mitosis + development



How are reproductive cells formed? MEIOSIS

- **Meiosis**--cell division that produces reproductive cells called gametes (egg and sperm)
 - 1 REPLICATION AND *2* DIVISIONS
 - 46 chromosomes -----→ 23 chromosomes
- | | | |
|-----------------------|----------------|-----------------------|
| diploid (2 sets) | MEIOSIS | haploid (1 set) |
| 1 somatic (body) cell | | 4 gametes (sex cells) |
| START | | END |
- Only one set of chromosomes in gametes—no longer in pairs
 - Mutations in gametes can be passed on to offspring
 - **Nondisjunction** is the failure of chromosomes to separate properly and may result in genetic diseases, such as Down Syndrome

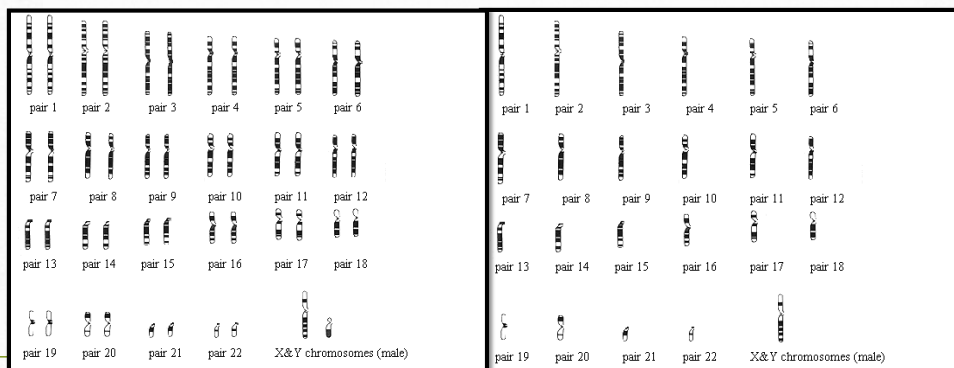
Body Cells vs. Reproductive Cells

SOMATIC CELLS

GAMETES (sperm, eggs)

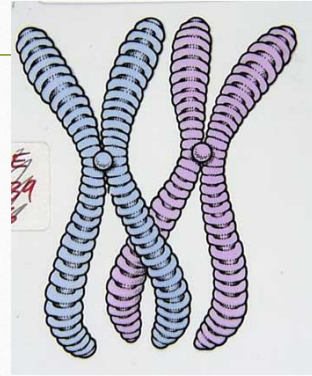
*non-sex **DIPLOID**

* sex cells **HAPLOID**



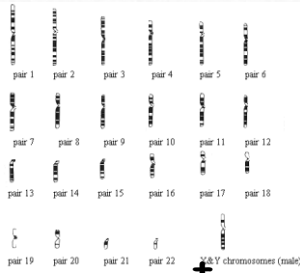
Chromosome number

- The fruit fly, *Drosophila*, has 8 chromosomes
 - 4 chromosomes came from the male and the other 4 from the female
- These 2 sets of chromosomes are **homologous** which refers to chromosomes that each have a corresponding chromosome from the opposite sex parent

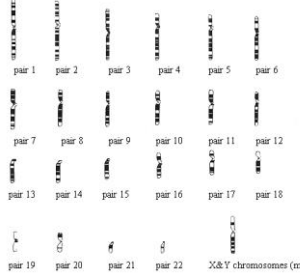


- A cell that contains both sets of homologous chromosomes is said to be **diploid**
 - The number of chromosomes in a diploid cell is represented by $2N$
 - Therefore the fruit fly, *Drosophila* the diploid number is 8 or $2N= 8$
- The gametes of organisms however contain only 1 set of chromosomes and thus a single set of genes and are considered to be **haploid**

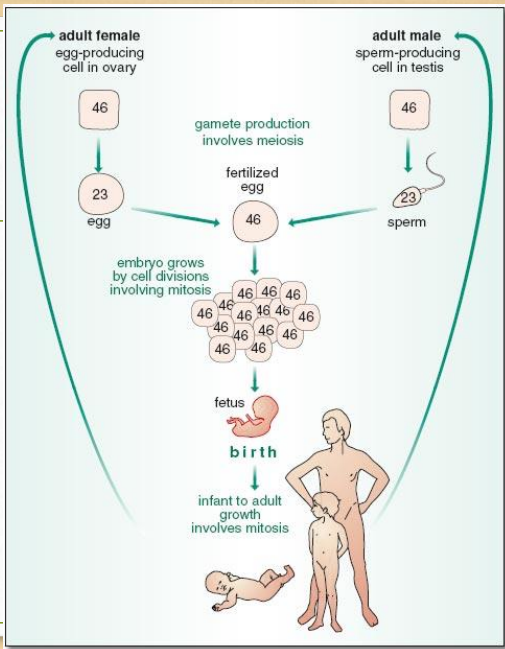
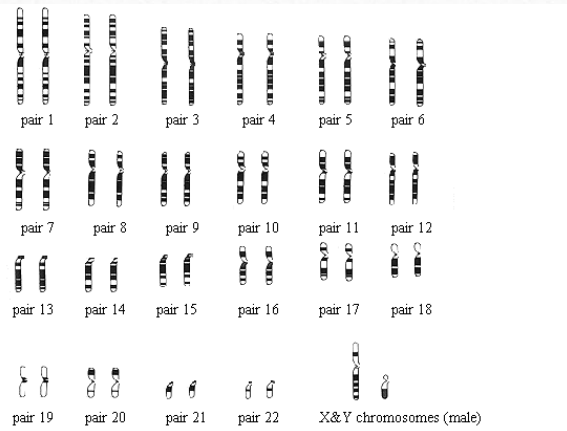
**HAPLOID GAMETE (EGG)
23 CHROMOSOMES**



**HAPLOID GAMETE (SPERM)
23 CHROMOSOMES**



**FIRST DIPLOID CELL OF BABY
46 CHROMOSOMES IN PAIRS!!!!**

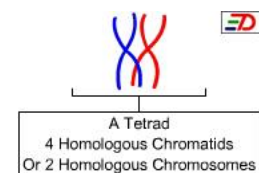
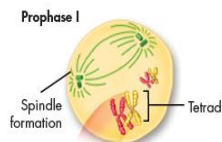


Phases of Meiosis

- Meiosis usually involves **2** distinct stages
 - Meiosis I
 - Meiosis II
- Meiosis is a process of reduction division in which the number of chromosomes per cell is cut in half through the separation of homologous chromosomes in a diploid cell
- At the end of meiosis II, **4 haploid** cells are produced

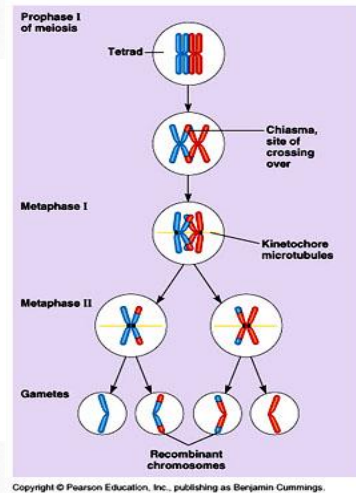
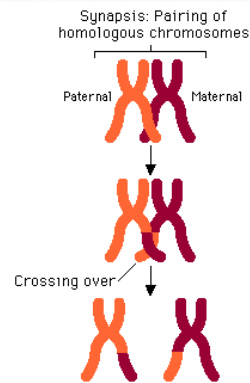
Prophase I

- Each chromosome pairs with its corresponding homologous chromosome to form a **tetrad**. A **Tetrad** pertains to the structure formed by the synapsis of homologous chromosomes during the prophase I of meiosis
 - There are 4 chromatids in a tetrad.
- **Synapsis** is the pairing of two homologous chromosomes that occurs during meiosis. *The pairing of homologous chromosomes is the key to understanding meiosis.*
- Crossing-over may occur here. **Crossing-over** is when chromosomes overlap and exchange portions of their chromatids.



Crossing-Over

- Crossing-over during meiosis results in pieces of chromosomes being exchanged.
- This leads to great genetic diversity of the egg and sperm that are produced.



Metaphase I

- Spindle fibers attach to the chromosomes



Anaphase I

- The fibers pull the homologous chromosomes toward opposite ends of the cell.

Anaphase I



Telophase I & Cytokinesis

- Nuclear membranes form.
- The cell separates into 2 cells.

Telophase I
and Cytokinesis



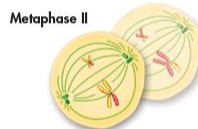
Prophase II

- Meiosis I results in two haploid (N) cells.
- Each cell has half the number of chromosomes as the original cell.



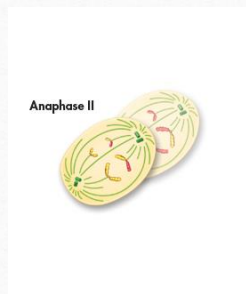
Metaphase II

- The chromosomes line up similar to metaphase in mitosis.



Anaphase II

- Sister chromatids separate and move to opposite ends of the cell.



Telophase II

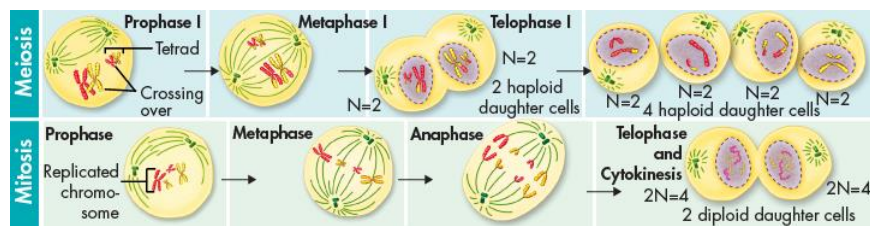
- Meiosis II results in 4 haploid cells.

Telophase II
and Cytokinesis



Gamete Formation

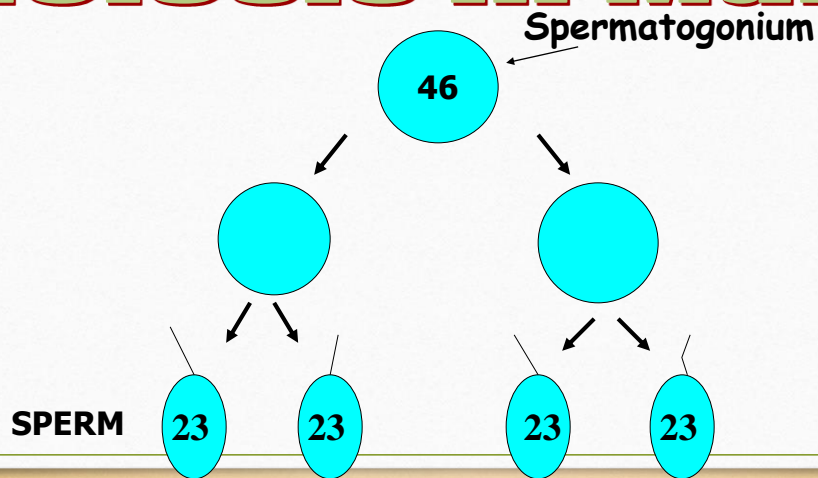
- In males, meiosis results in 4 sperm cells
- In females, meiosis results in 1 egg cell (ovum) and three polar bodies, which are not used in reproduction.
- Each ovum and sperm cell contains one copy of the sex chromosomes and one set of autosomes



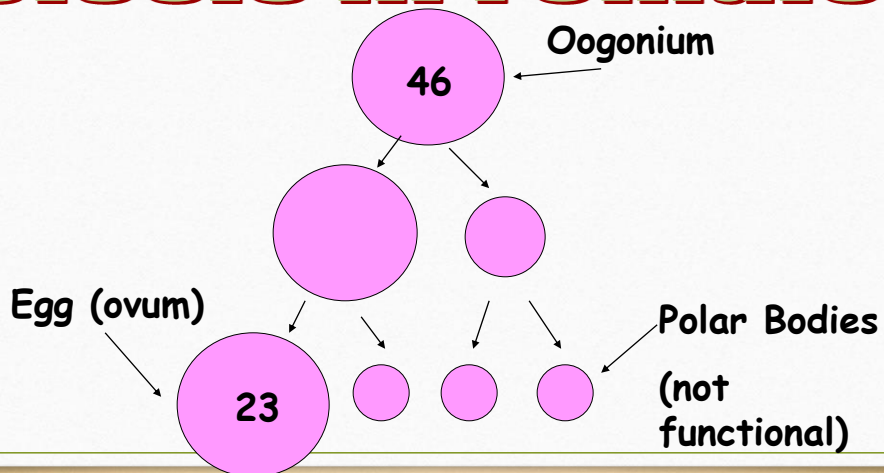
What are reproductive cells?

- EGGS--In females, body cells in the ovaries called **oogonium** undergo meiosis to form eggs (ova singular- ovum plural)
- SPERM--In males, body cells in the testicles called **spermatogonium** undergo meiosis to form sperm.

Spermatogenesis (Meiosis in Males)

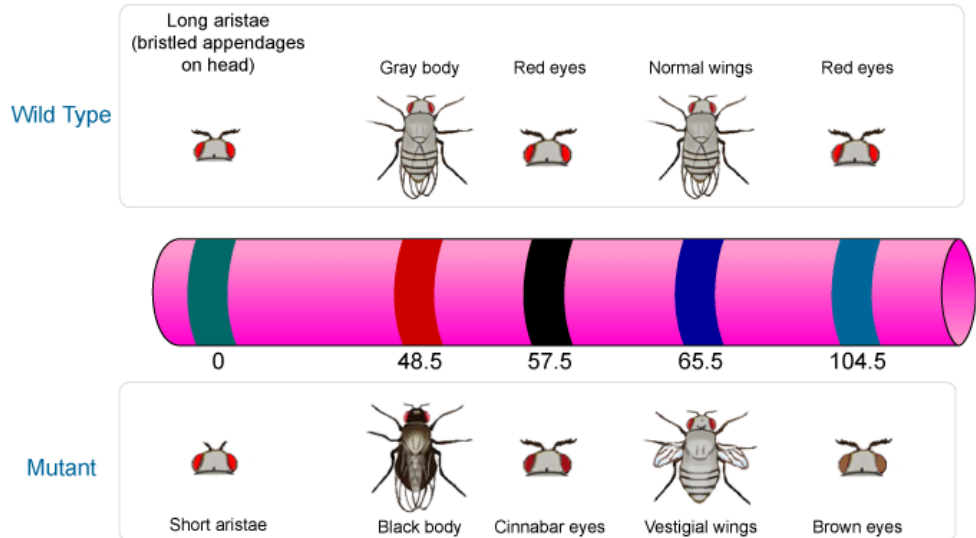


Oogenesis (Meiosis in Females)



Linkage and gene maps

- Chromosomes are sorted independently, NOT genes
- Crossing over accounts for the genetic variety in organisms
- The farther apart 2 genes were, the more likely they were to be separated by crossover during meiosis
- **A gene map** is a diagram showing the relative locations of each known gene in a particular chromosome

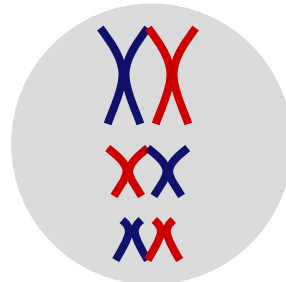


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What are some problems that may occur during meiosis?

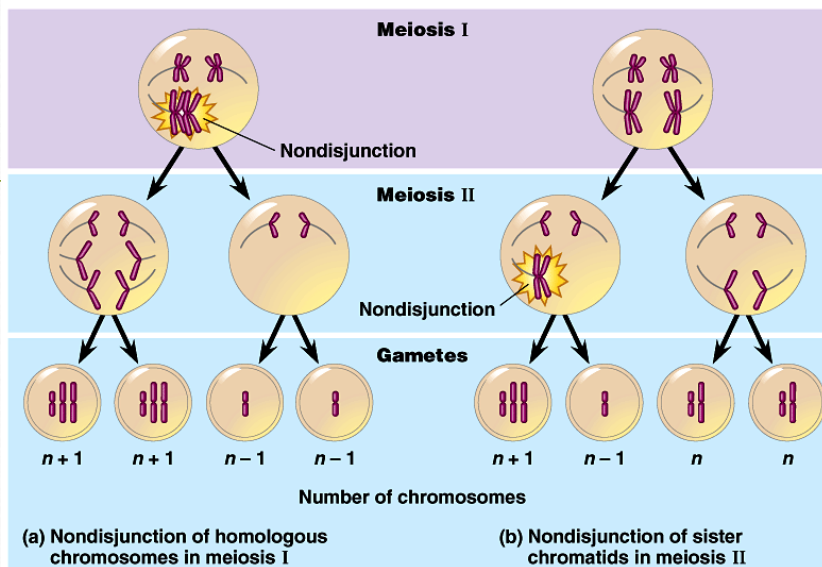
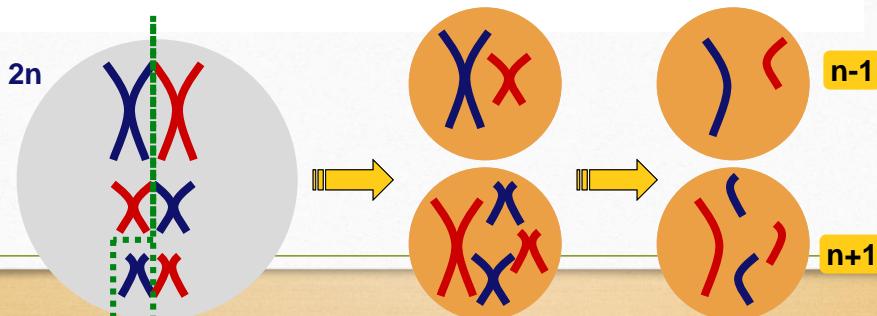
Chromosomal abnormalities

- Incorrect number of chromosomes
 - nondisjunction
 - chromosomes don't separate properly during meiosis
 - breakage of chromosomes
 - deletion
 - duplication
 - inversion
 - translocation



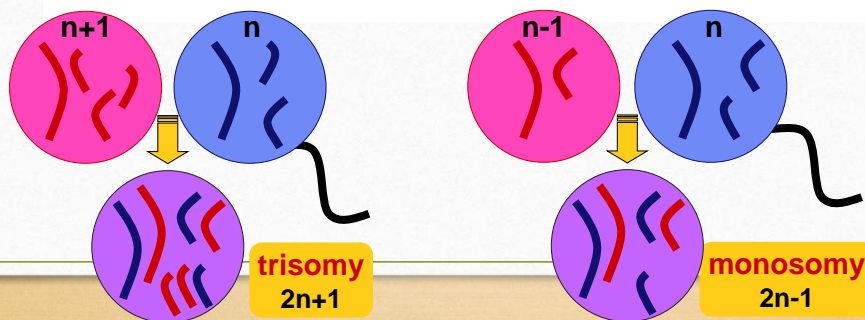
Nondisjunction

- Problems in meiosis cause errors in daughter cells
 - chromosome pairs do not separate properly during Meiosis 1
 - sister chromatids fail to separate during Meiosis 2
 - too many or too few chromosomes



Nondisjunction

- Baby has wrong chromosome number
 - trisomy
 - cells have 3 copies of a chromosome
 - monosomy
 - cells have only 1 copy of a chromosome



Human chromosome disorders

- High frequency in humans
 - most embryos are lost to miscarriage
 - alterations are too disastrous
 - developmental problems result from biochemical problems
- Certain conditions are tolerated
 - upset the balance less = **survivable**
 - characteristic set of symptoms = syndrome

Down syndrome

- Trisomy 21
 - 3 copies of chromosome 21
 - 1 in 700 children born in U.S.
- Chromosome 21 is the smallest human chromosome
 - but still severe effects
- Frequency of Down syndrome is related to the age of the mother

