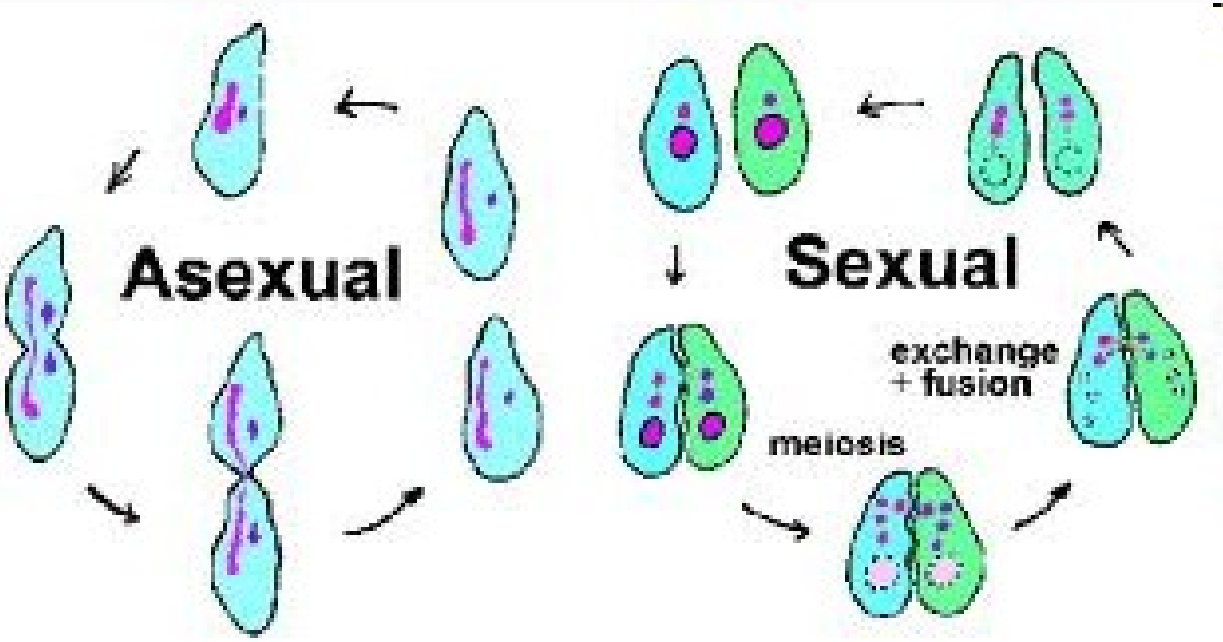
Meiosis and Sexual Reproduction

Some reproductive review

- **Asexual reproduction** produces genetically identical copies of a parent (**clones**)

- **Sexual reproduction** introduces variation in the combinations of traits among offspring

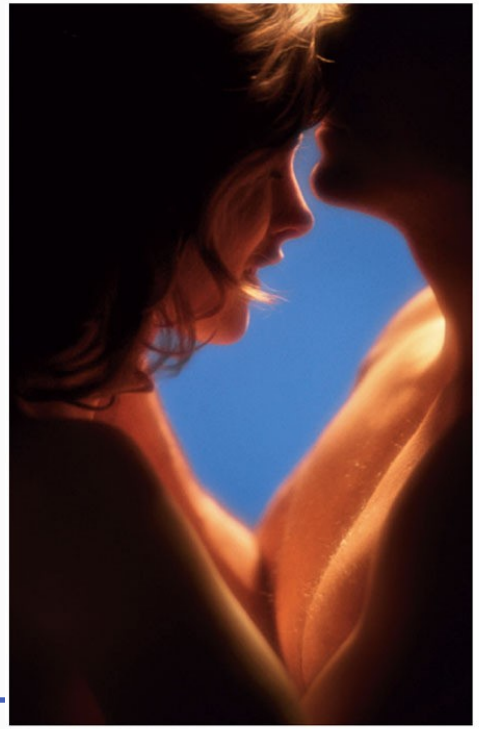
Why sex???



So much more complicated, right???

- An adaptive trait tends to spread more quickly in sexual reproduction
- Leads to more variation in traits
  - is the basis for evolutionary change

Meiosis makes sexual reproduction work!

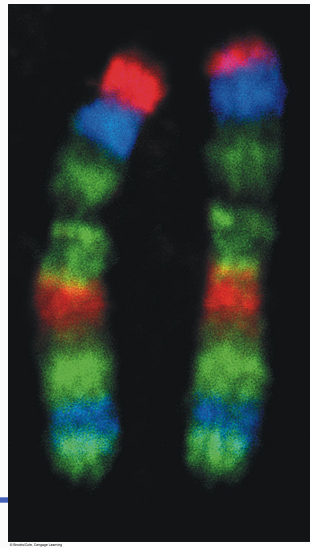


Functions of Meiosis

- Reducing chromosome number by nuclear division
- **Shuffling chromosomes in the cell**
  - Creates variety!!!

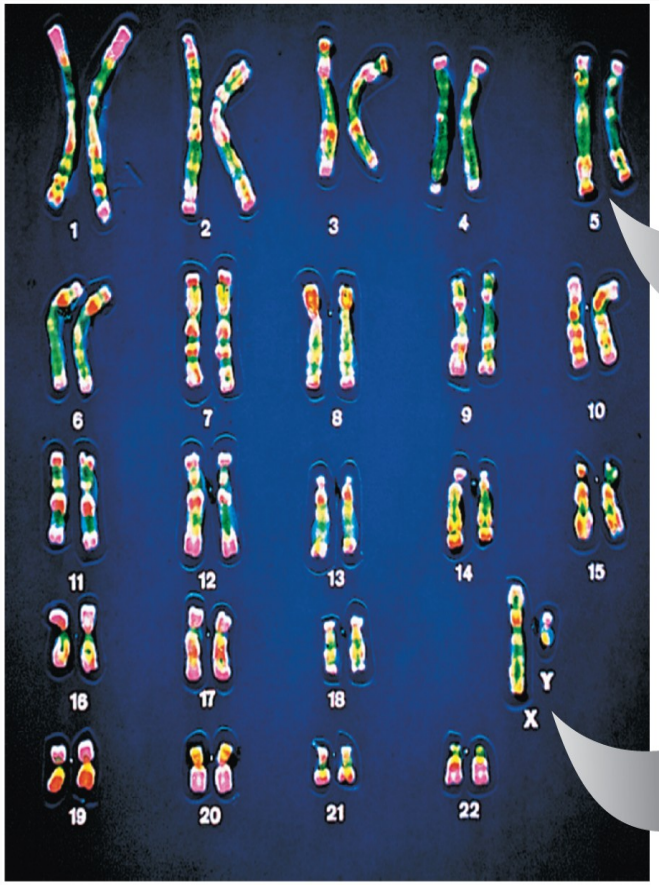
How does meiosis reduce the chromosome number???

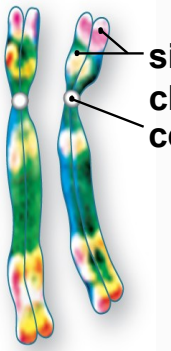
It separates homologous chromosomes



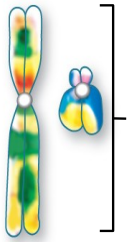
Homologous chromosomes

Figure 9.1 Homologous chromosomes
22 autosomal pairs, 1 sex pair XX, XY





homologous autosome pair



Sex chromosomes are different lengths in males.

The 46 chromosomes of a male

We have 23 pairs of homologous chromosomes (diploid)

- Contain same genes for same traits
- Same size, shape
- 1 goes in sperm, 1 goes to egg in meiosis! (haploid)

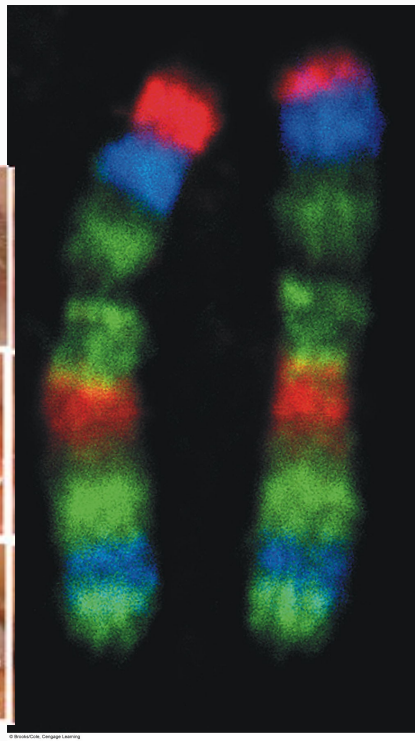
Same genes don't mean same genes exactly!!!

Genes and Alleles

- **Genes** are regions in an organism's DNA that encode information about heritable traits

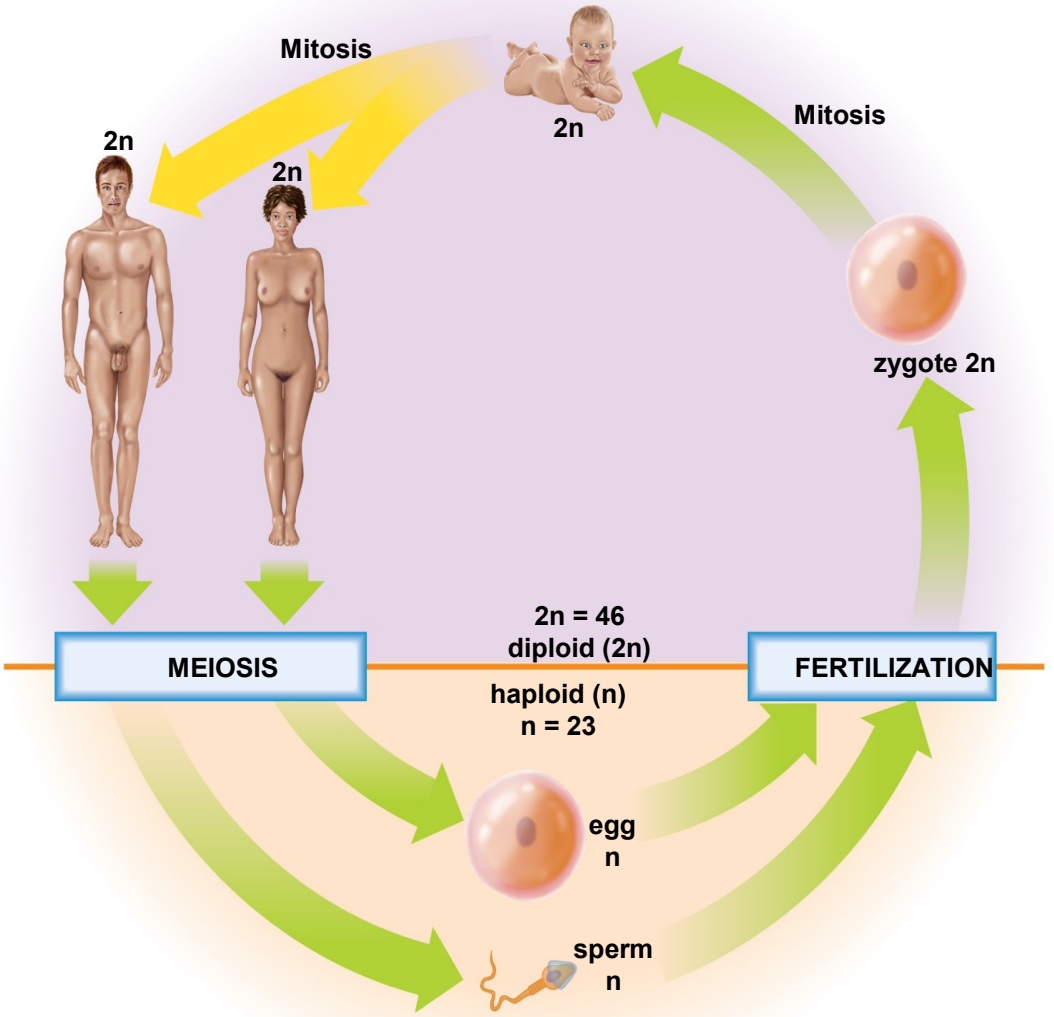
- **Alleles** are different forms of the same gene
  - Offspring of sexual reproducers inherit new combinations of alleles, the basis of traits

Same car, different gene, different alleles!!!



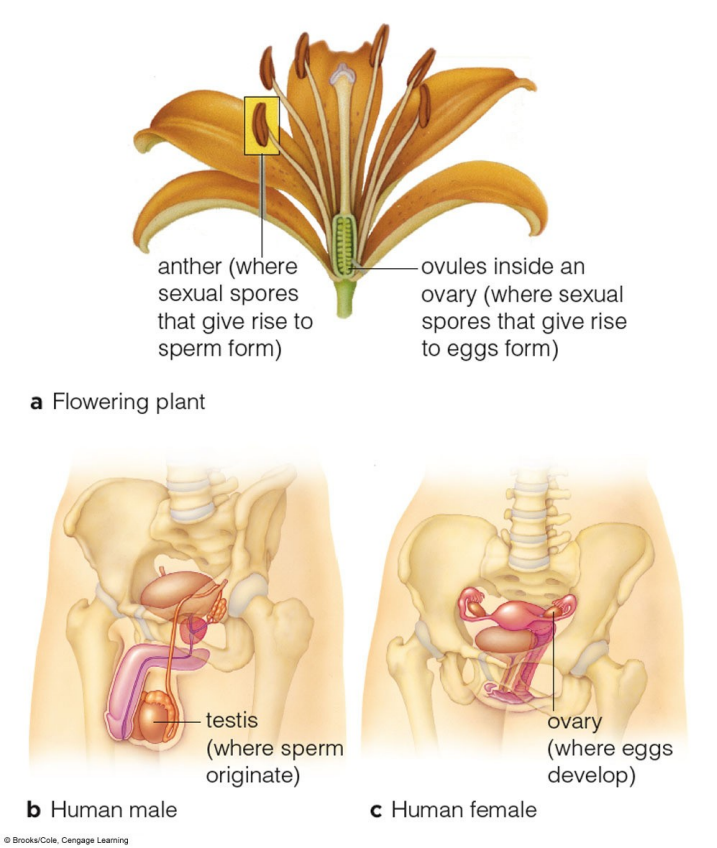
Human Life Cycle

- Involves both mitosis and meiosis
- Mitosis – growth & development
  - Somatic (body) cells are diploid
- Meiosis: diploid (2n) to haploid (n)
  - Gametes (egg and sperm) have only 1 member of each homologous pair.
- Egg and sperm join to form diploid zygote.
  - Fertilization restores chromosome number

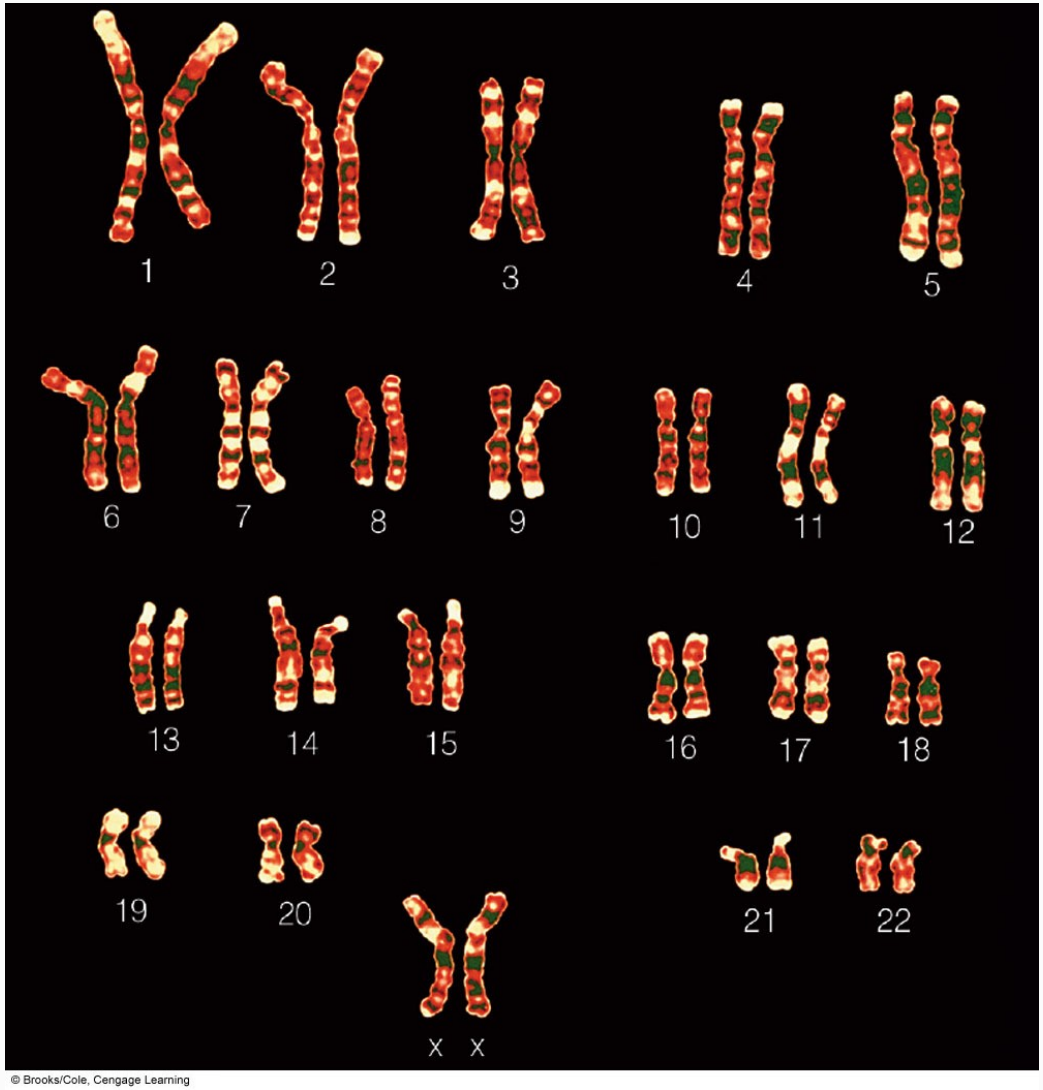


Gamete Production

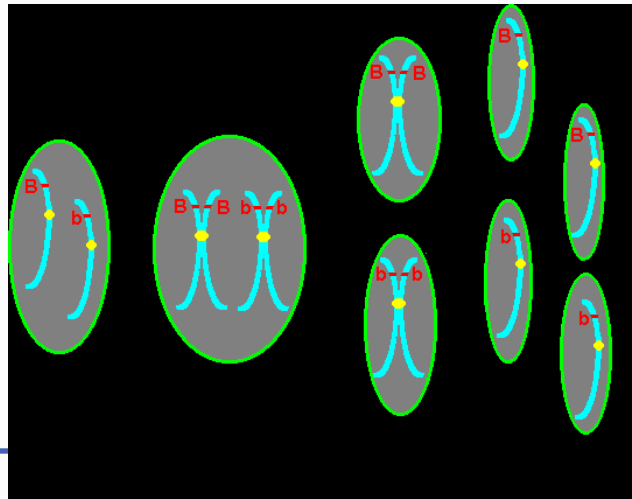
- Gametes are produced in specialized reproductive structures or organs



Human Chromosomes: Homologous Pairs

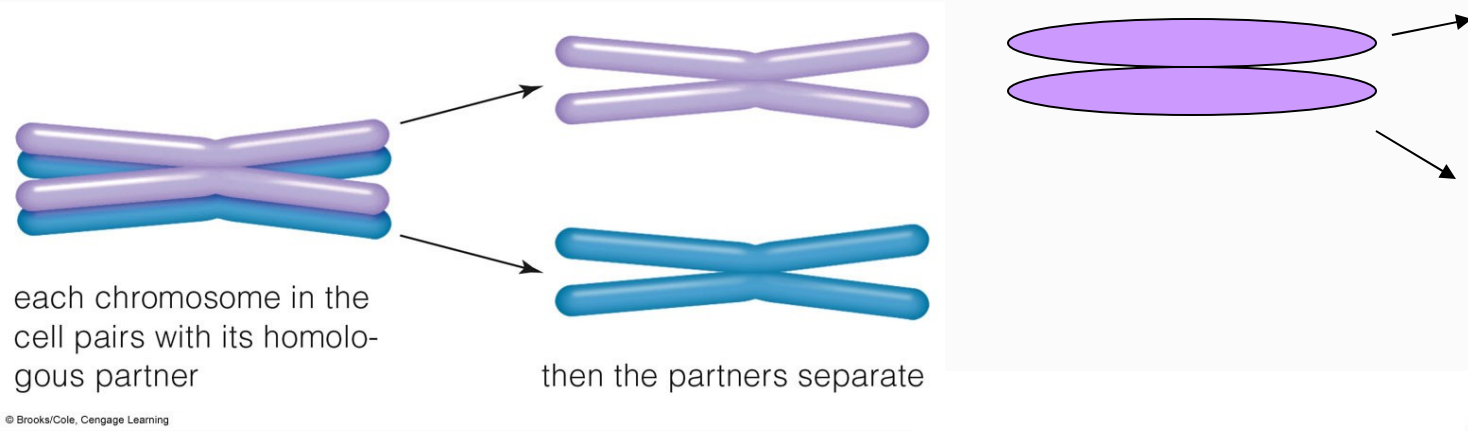


What happens to these homologous pairs of chromosomes in meiosis?

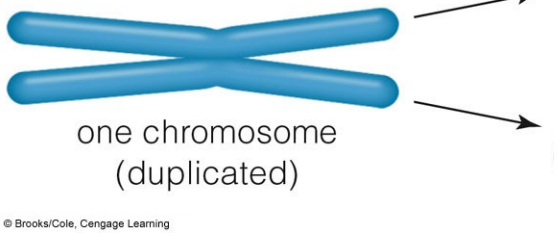


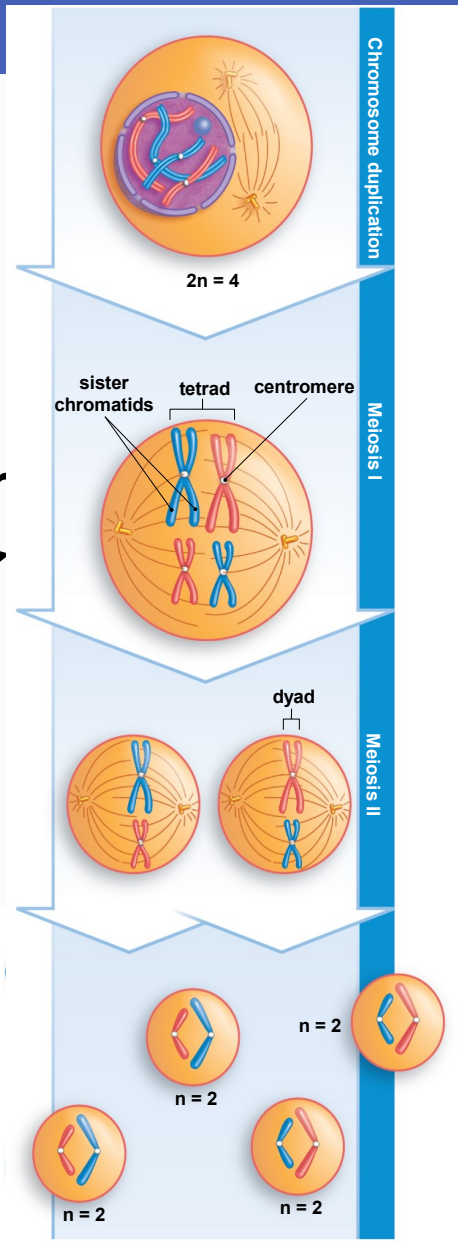
Overview of Meiosis: Two Divisions, Not One

- 4 daughter cells result
- 2 nuclear divisions
- In meiosis I, each duplicated homologous chromosome is separated from its partner

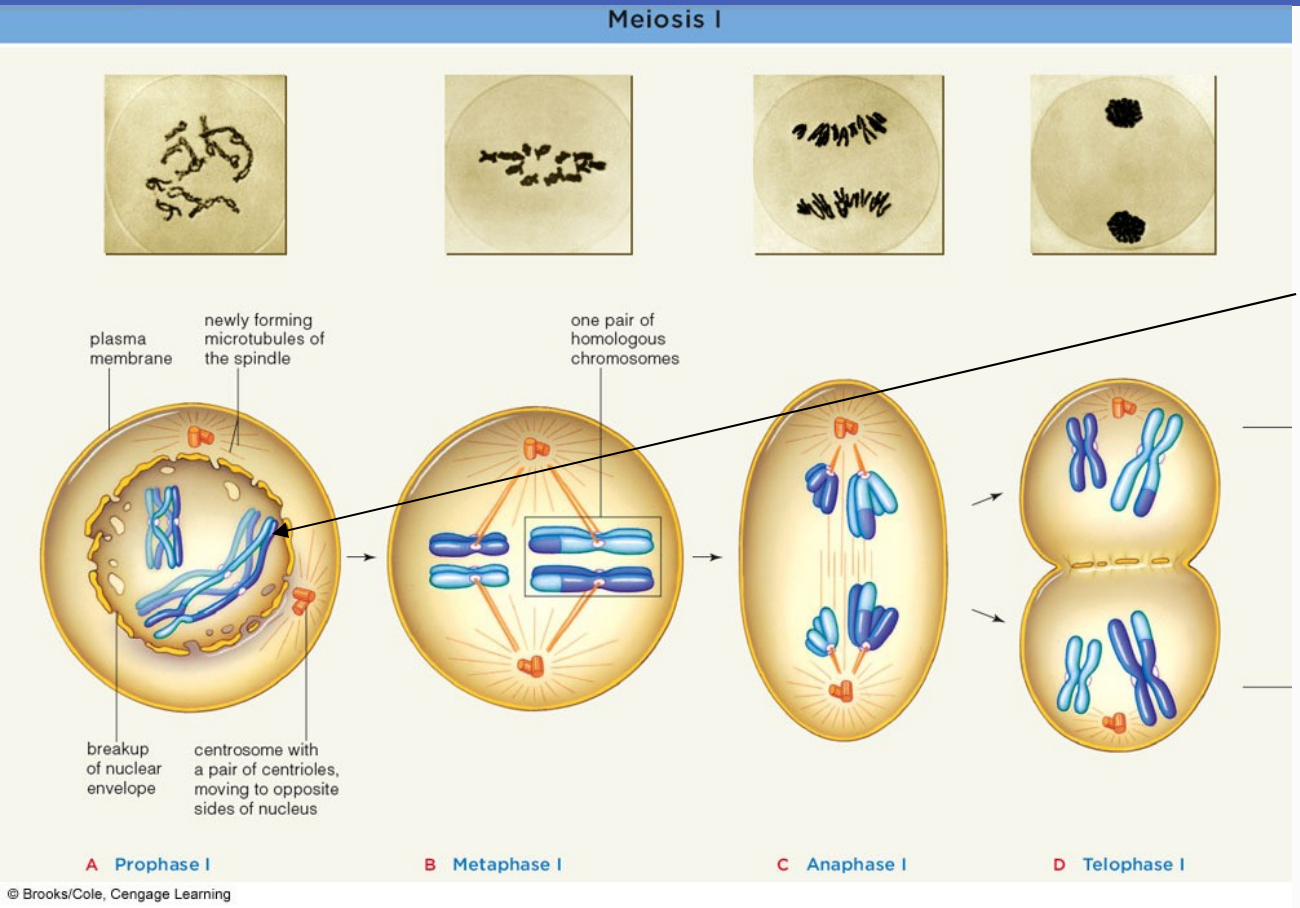


- In meiosis II, sister chromatids are separated





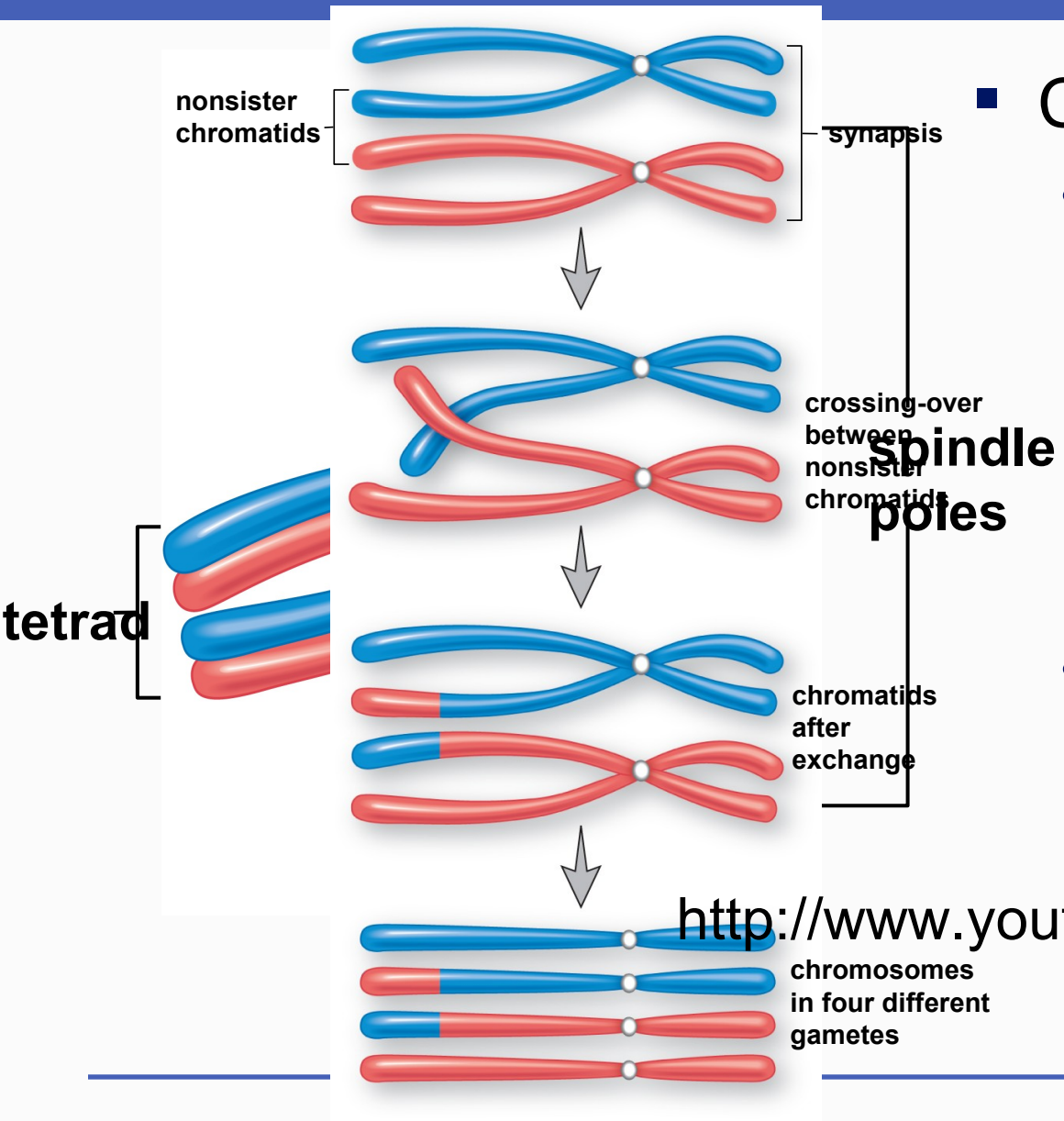
Visual Tour of Meiosis



During prophase I, homologous chromosomes pair up, forming a tetrad - synapsis

2 chromosomes = 4 chromatids

Synapsis and crossing-over

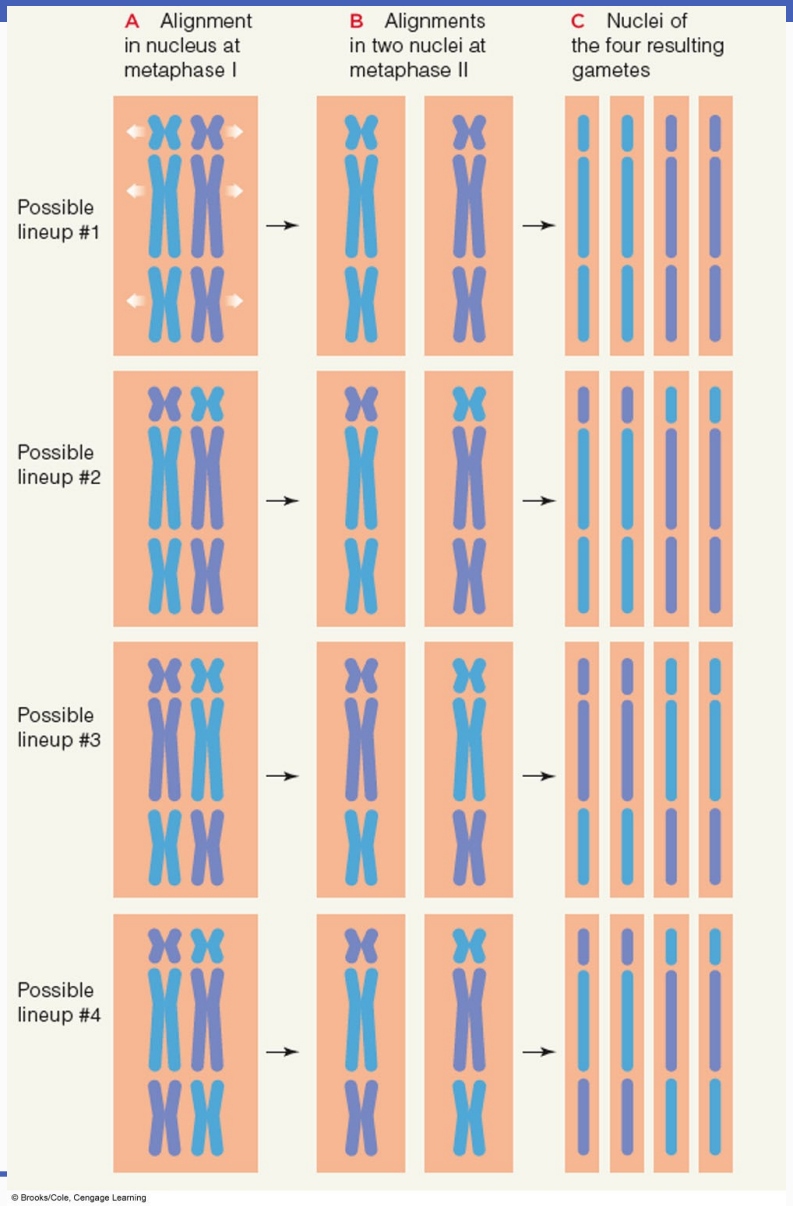


- Crossing-over
  - During synapsis, chromatids from homologous chromosomes may exchange genetic material.
  - Increases variability of the gametes

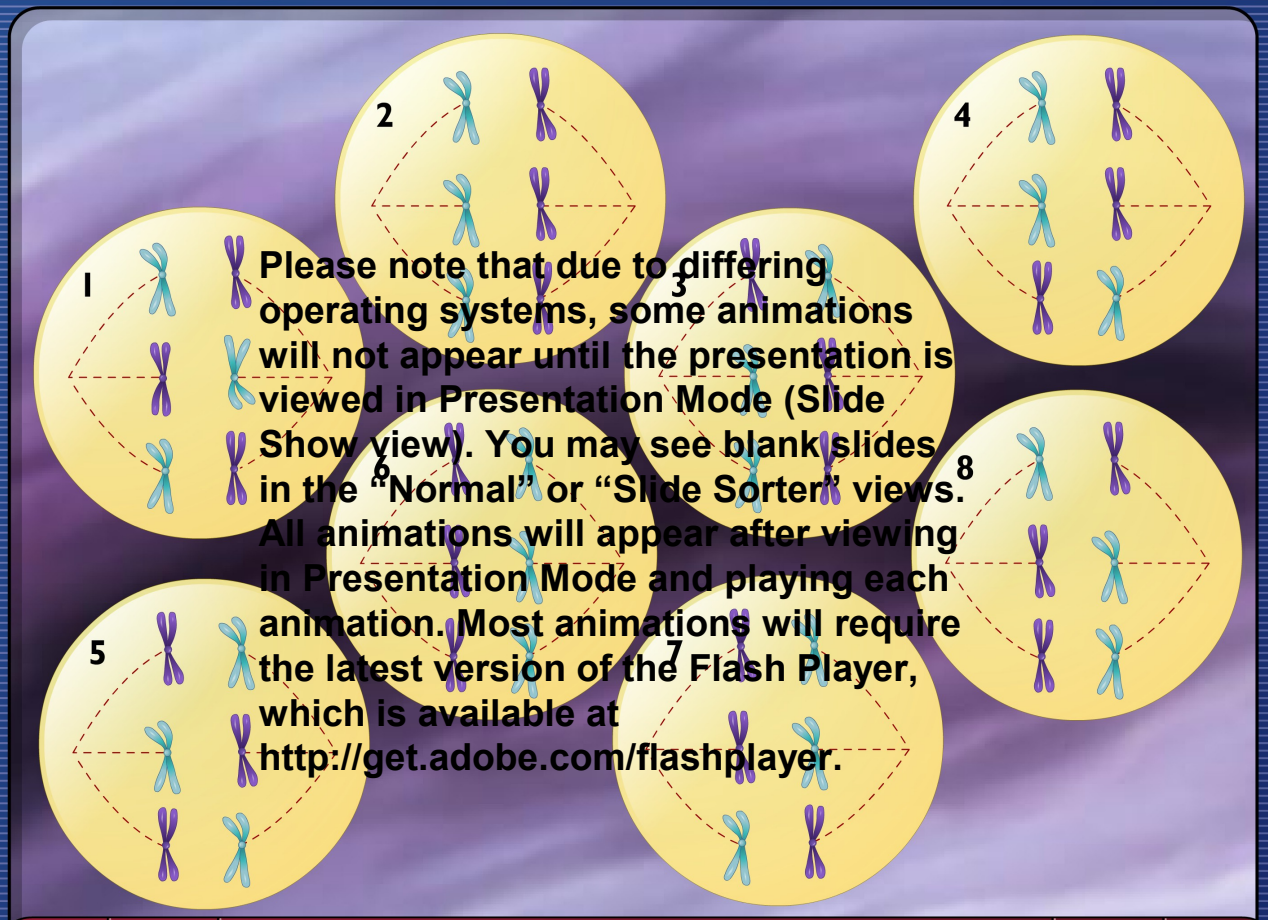
http://www.youtube.com/v/op7Z1Px8oO4

The importance of meiosis

- Chromosome number stays constant
- Generates diversity
  - Crossing-over
  - All possible combinations of haploid chromosomes (random assortment – during Metaphase I)
    - $(2_{23})^2$ or 70,368,744,000,000 different combinations in zygotes assuming no crossing-over!



Random Orientation of Chromosomes During Meiosis



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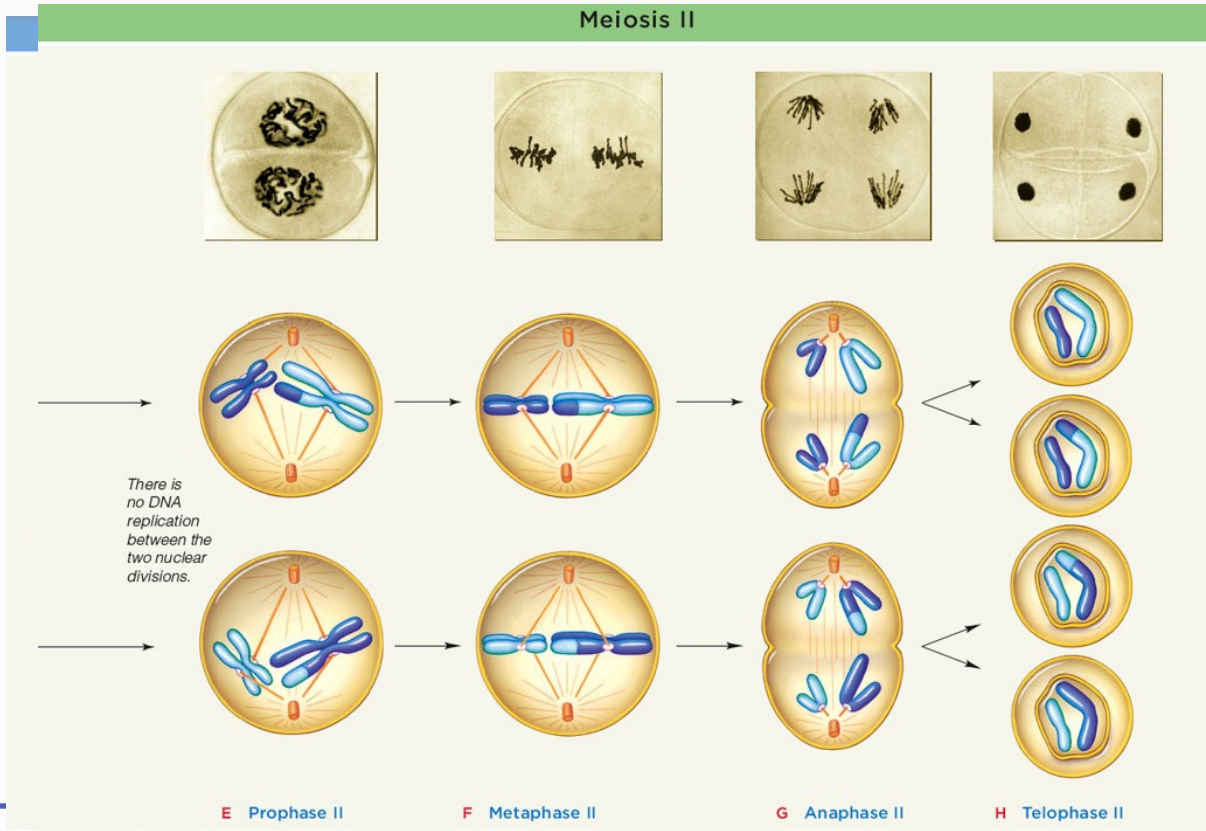
Each orientation produces gametes with different combinations of parental chromosomes.

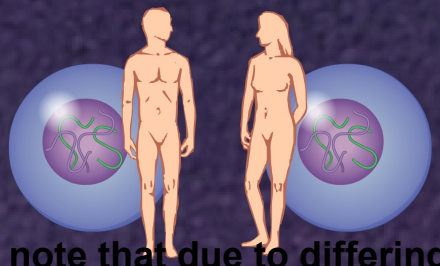
Meiosis – A closer look!

- Meiosis involves two divisions: meiosis I & meiosis II – Each division has 4 phases
  - Prophase (I & II)
  - Metaphase (I & II)
  - Anaphase (I & II)
  - Telophase (I & II)



How Meiosis Works

Male
germ-line cell
Diploid (2*n*)



Female
germ-line cell
Diploid (2*n*)

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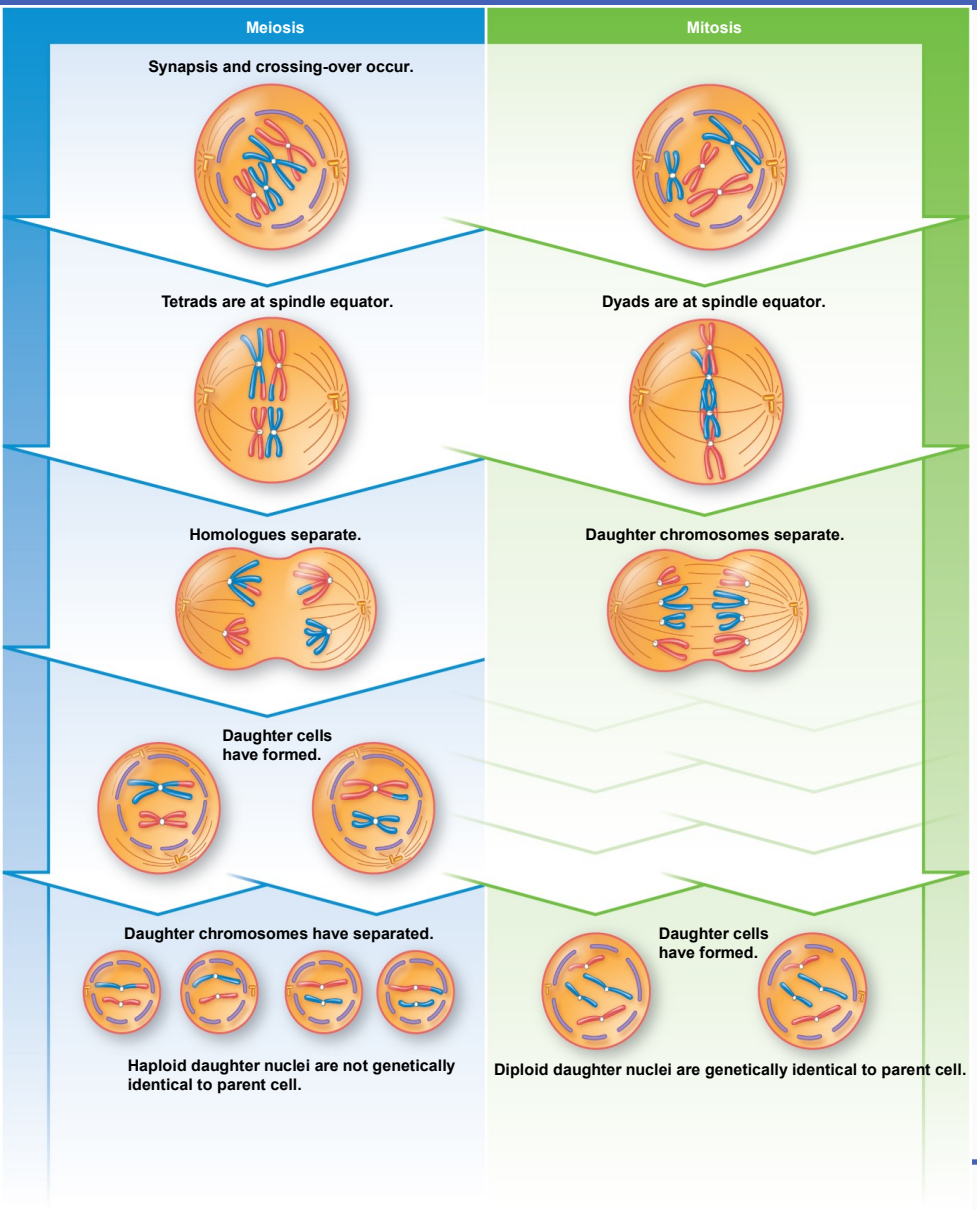
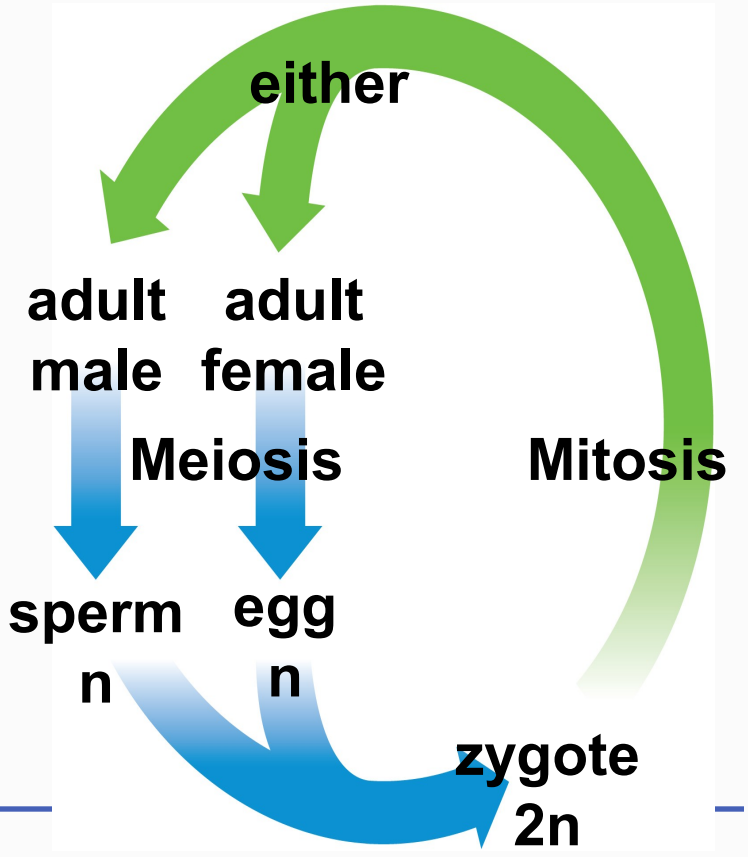
Meiosis is the process that results in the formation of sperm cells and egg cells. The cells that will undergo meiosis are typically found in the testes and ovaries of males and females respectively.

Meiosis vs. Mitosis

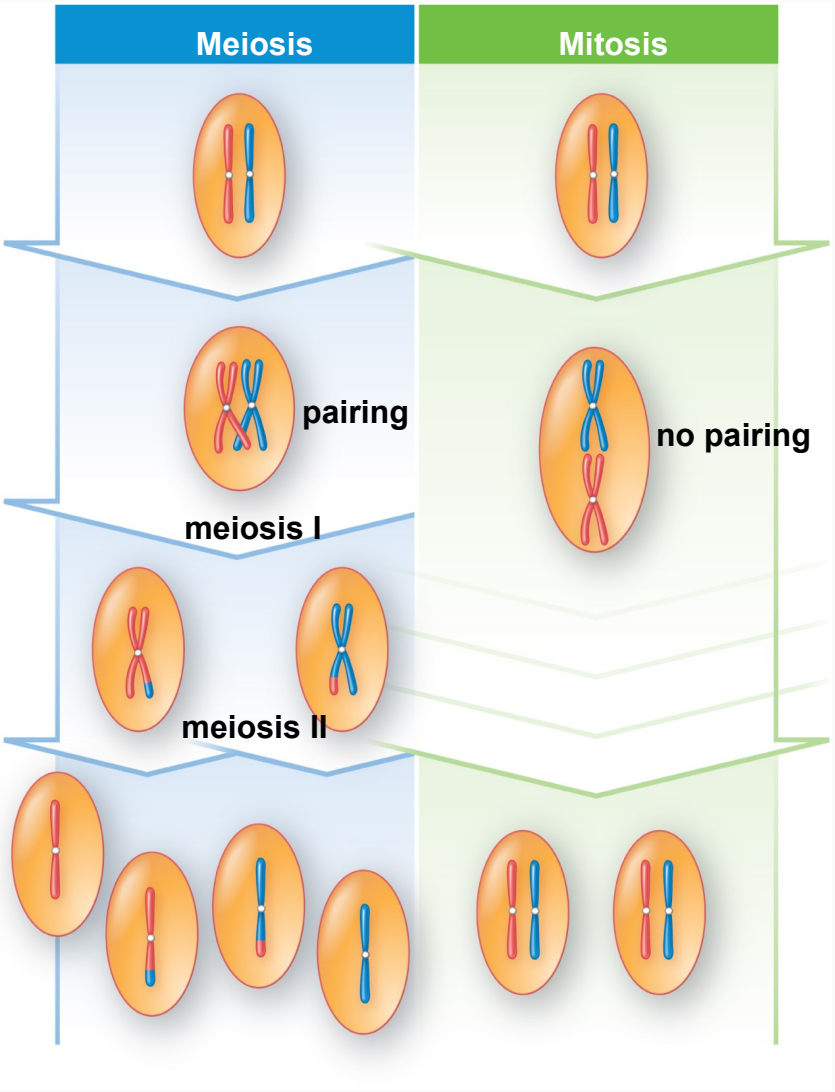


- Number of nuclear divisions
- Number of daughter cells
- Number of chromosomes
- Genetics of parents vs. daughters

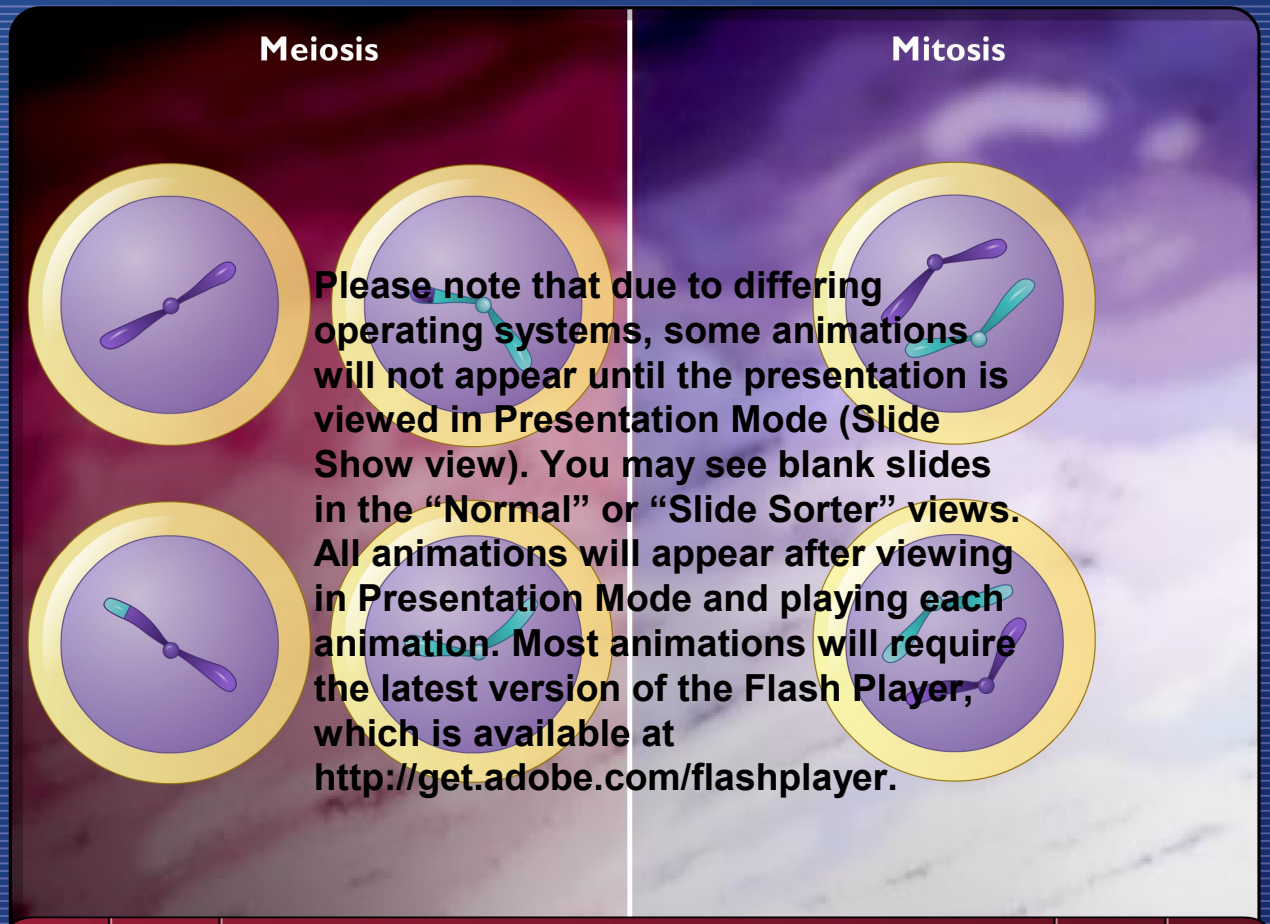


Meiosis vs. Mitosis Round 2

- Meiosis I compared to Mitosis I
  - Chromatids separating vs. chromosomes separating
  - Synapsis in meiosis
  - Dyads (mitosis) vs. tetrads (meiosis)
  - Crossing over & independent assortment
- Meiosis II compared to Mitosis II
  - THE SAME (CHROMATIDS SEPARATING)!!!
  - HAPLOID VS. DIPLOID



Comparison of Meiosis & Mitosis



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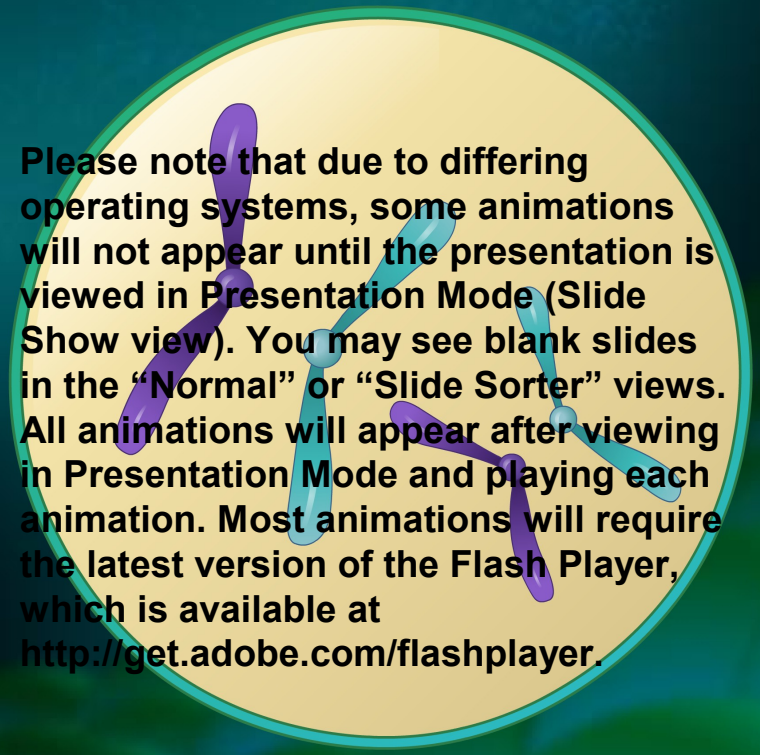
In meiosis, a second division sequence occurs, resulting in four cells with half the number of chromosomes. Mitosis involves a single division sequence, resulting in two cells with no net change in the number of chromosomes.

Unique Features of Meiosis



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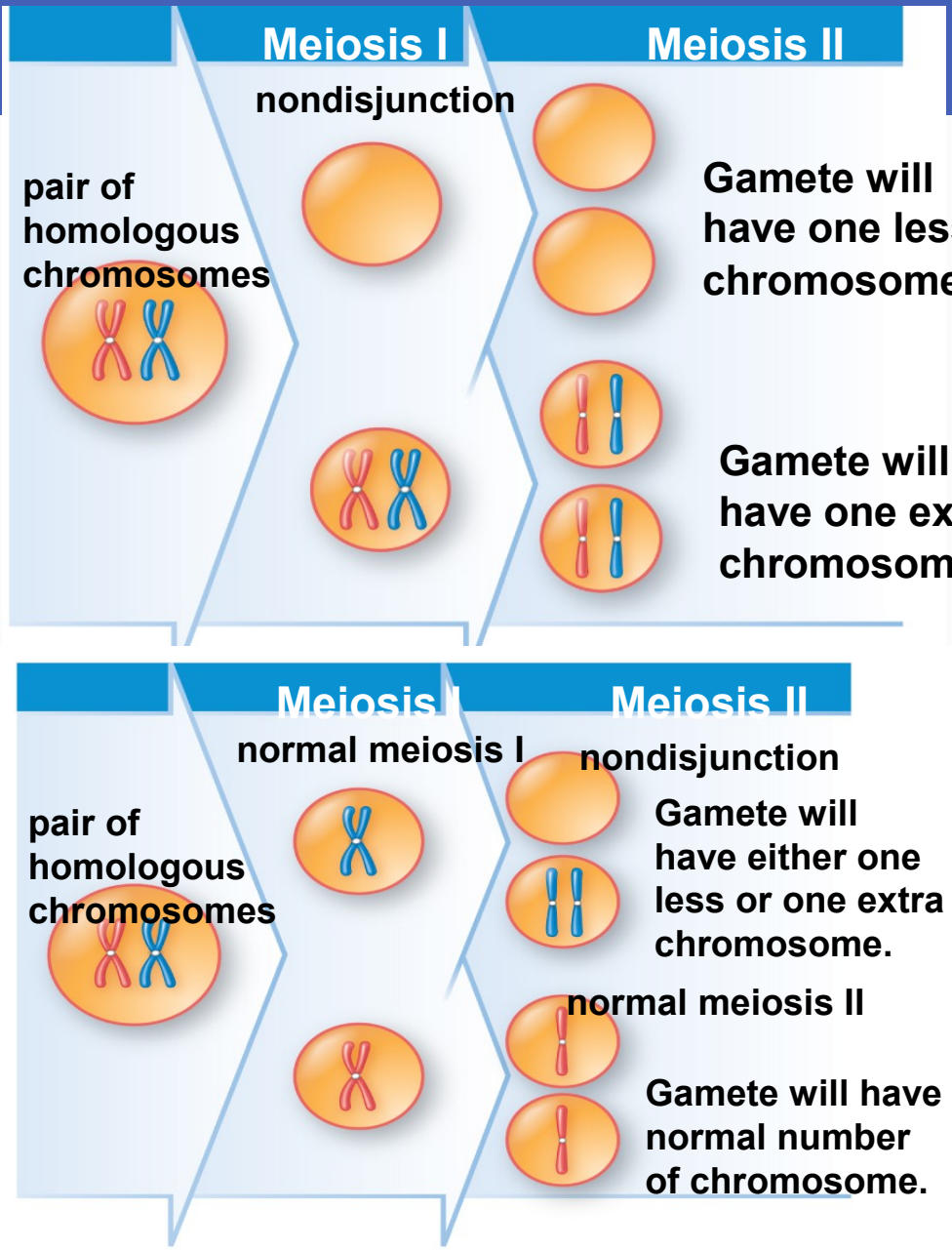
Although mitosis and meiosis have much in common, meiosis has three unique features: synapsis, homologous recombination and reduction division.

One more big difference – Mitosis happens pretty much always!!!

- Meiosis only occurs in “sex” cells in sexually reproducing organisms
- Mitosis occurs in body (somatic) cells

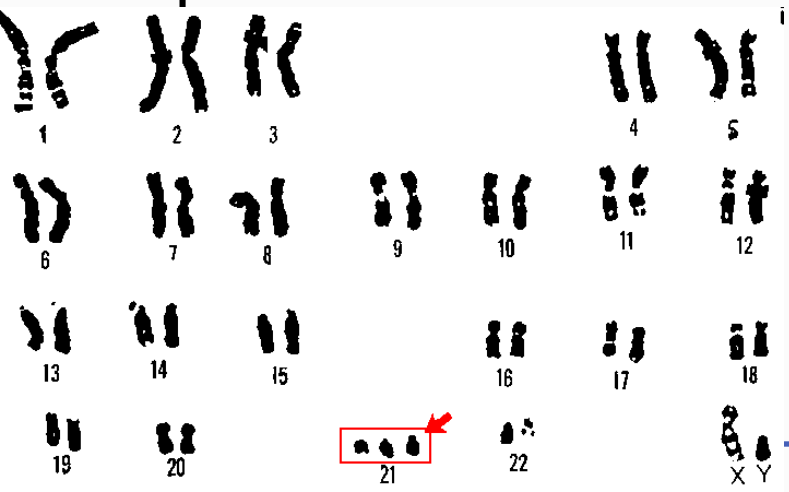
Abnormal Chromosome Inheritance

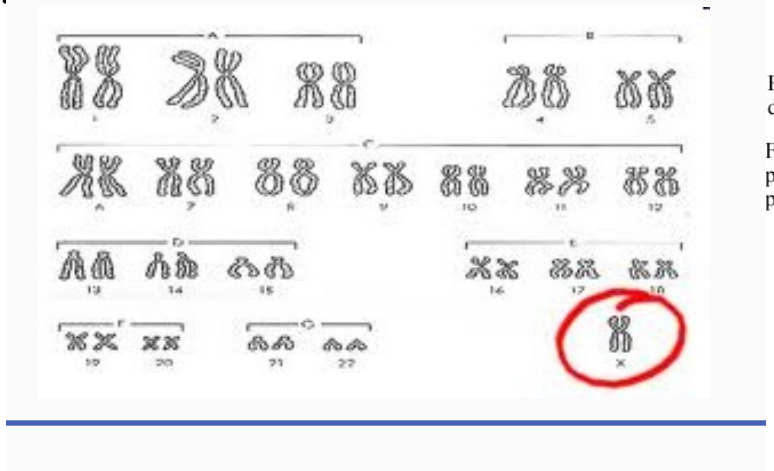
- Nondisjunction
  - Meiosis I when both members of a pair go into the same daughter cell
  - Meiosis II when sister chromatids fail to separate

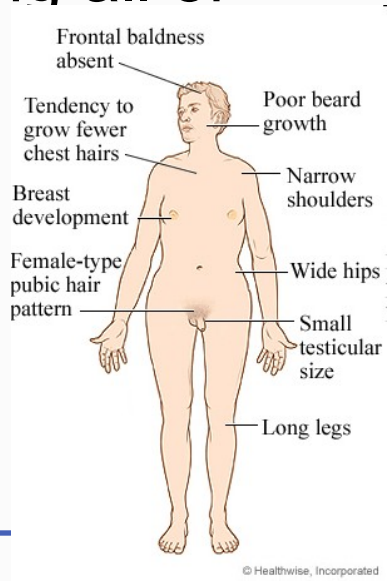


Chromosomal Abnormalities – some examples

- Errors sometimes occur during meiosis
  - Down Syndrome – extra copy of Chromosome #21
  - Klinefelter Syndrome (XXY male) – sterile male with female characteristics and diminished mental capacity (extra X). Normally XX and XY
  - Turner Syndrome (XO female) – sterile female with webbed neck and diminished stature. Missing all or part of 2nd X chromosome





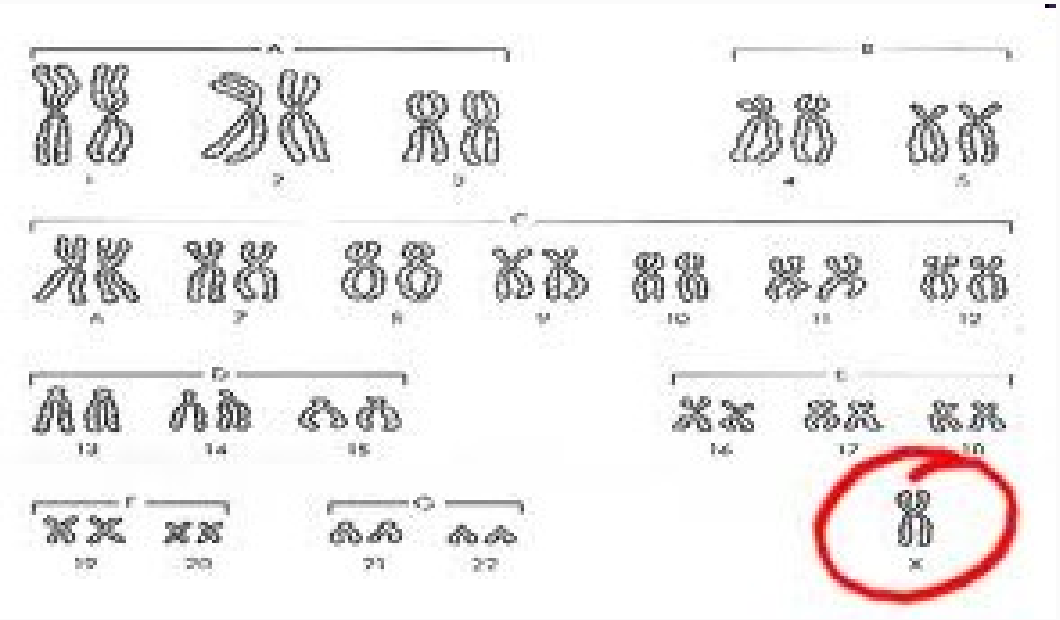


Abnormal Chromosome Inheritance

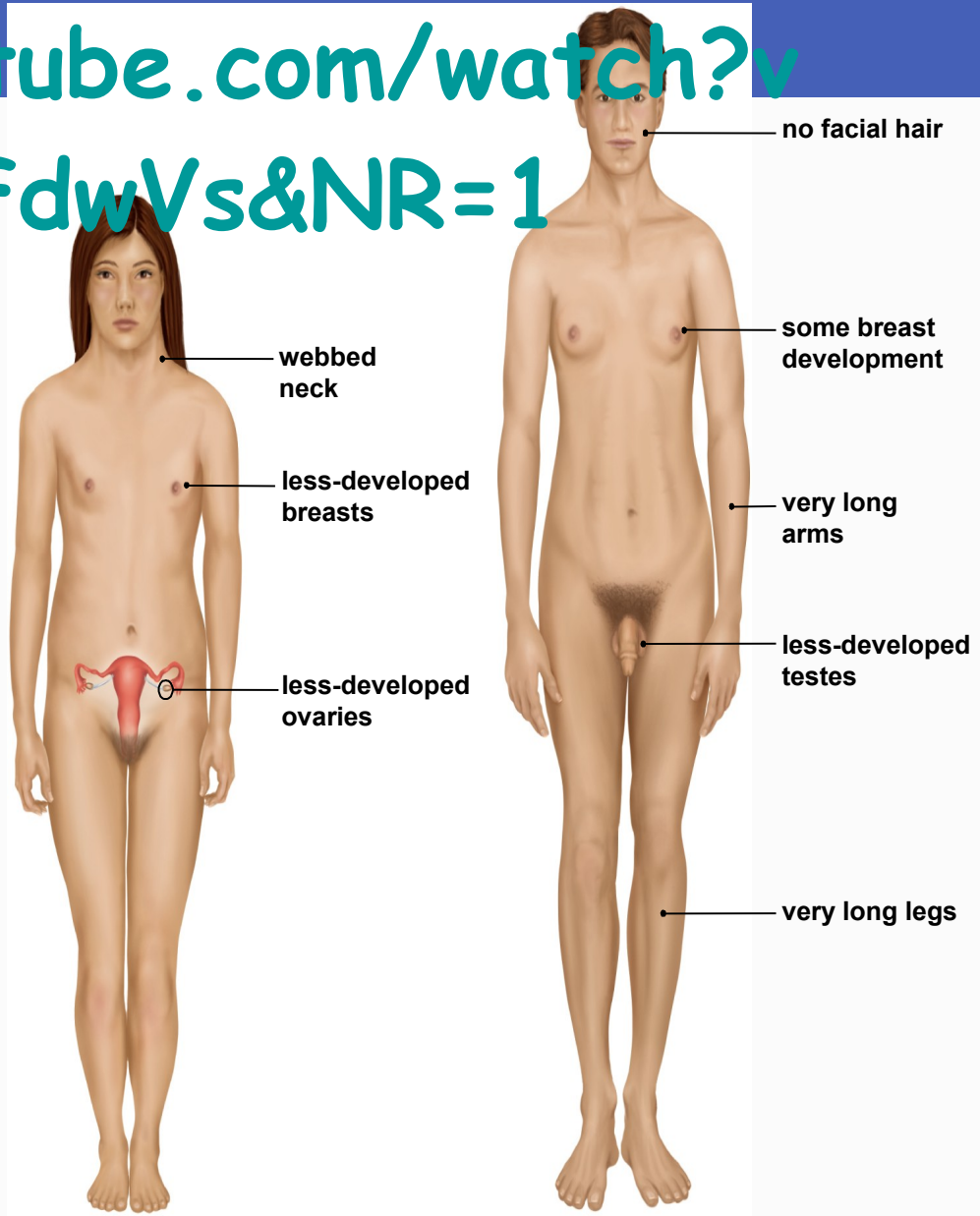
- Trisomy – 3 copies of a chromosome
- Monosomy – single copy of a chromosome
  - Only occurs in sex chromosomes in humans
  - Down Syndrome is Trisomy 21

Abnormal Sex Chromosome Numbers

- Normal is XX or XY
- Klinefelter Syndrome (XXY male) – sterile male with female characteristics and diminished mental capacity
- Turner Syndrome (XO female) – sterile female with webbed neck and diminished stature.



http://www.youtube.com/watch?v=fTp6vqFdwVs&NR=1



a. A female with Turner (XO) syndrome

b. A male with Klinefelter (XXY) syndrome