

Meiosis and Sexual Reproduction

Impacts, Issues: **Why Sex?**

- An adaptive trait tends to spread more quickly through a sexually reproducing population than through an asexually reproducing one



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Introducing Alleles

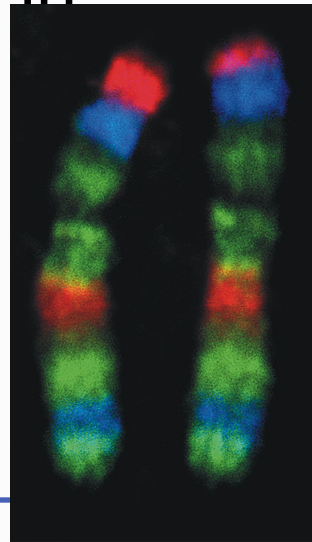
- **Asexual reproduction** produces genetically identical copies of a parent (**clones**)
 - **Sexual reproduction** introduces variation in the combinations of traits among offspring
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Genes and Alleles

- **Genes** are regions in an organism's DNA that encode information about heritable traits
 - In sexual reproduction, pairs of genes are inherited on pairs of chromosomes, one maternal and one paternal
 - **Alleles** are different forms of the same gene
 - Offspring of sexual reproducers inherit new combinations of alleles, the basis of traits
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Sexual Reproduction Shuffles Alleles

- Through sexual reproduction, offspring inherit new combinations of alleles (a unique molecular form of the same gene), which leads to variations in traits
 - For example, the “eye color gene” may say blue or brown!
- This variation in traits is the basis for evolutionary change – you can get different kinds of alleles in sexual reproduction!!!



Key Concepts

Sexual vs Asexual Reproduction

- *In asexual reproduction, one parent transmits its genetic information to offspring*
 - *In sexual reproduction, offspring typically inherit information from two parents who differ in their alleles*
 - *Alleles are different forms of the same gene; they specify different versions of a trait*
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What Meiosis Does

- **Meiosis**

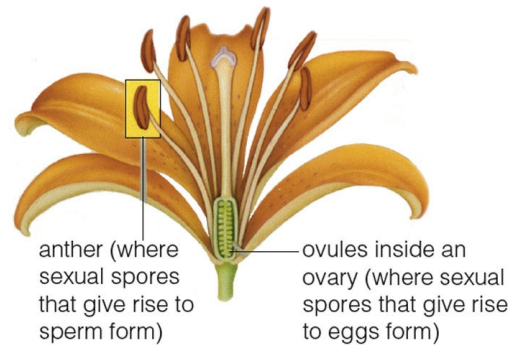
- A nuclear division mechanism that precedes cytoplasmic division of immature reproductive cells in sexually-reproducing eukaryotic species

Halving the Diploid Number

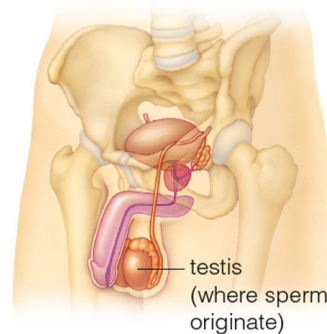
- A diploid cell has two nonidentical copies of every chromosome (except XY sex chromosomes)
 - Humans have 23 pairs of **homologous chromosomes**
 - Meiosis in **germ cells** halves the **diploid** number of chromosomes ($2n$) to the **haploid** number (n), producing haploid **gametes**
 - Eggs and sperm have 23 unpaired chromosomes
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Gamete Production

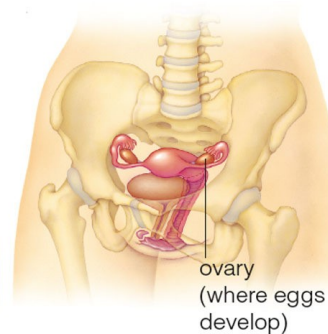
- Gametes are produced in specialized reproductive structures or organs



a Flowering plant



b Human male

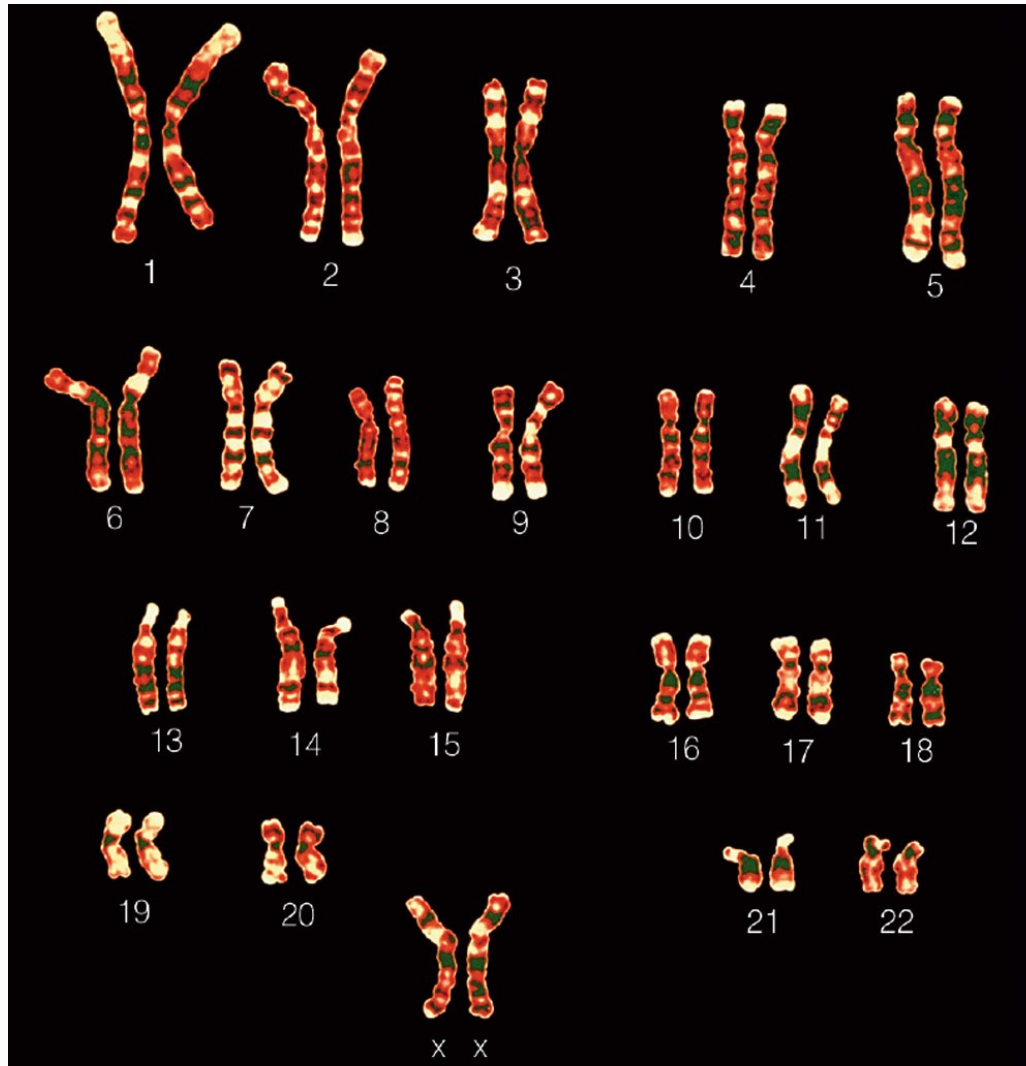


c Human female

Restoring the Diploid Number

- Human gametes (eggs and sperm) have 23 chromosomes – one of each homologous pair
 - The diploid number (23 pairs) is restored at fertilization, when two haploid gametes fuse and form a diploid **zygote**, the first cell of a new individual
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Human Chromosomes: Homologous Pairs

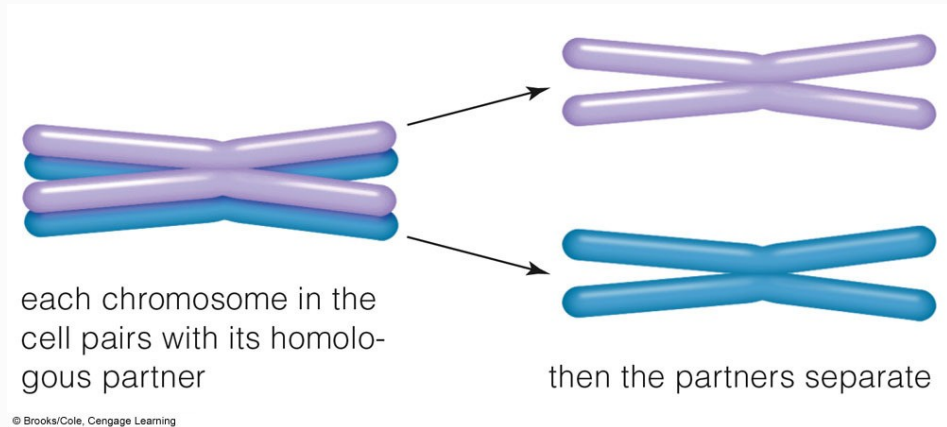


Two Divisions, Not One

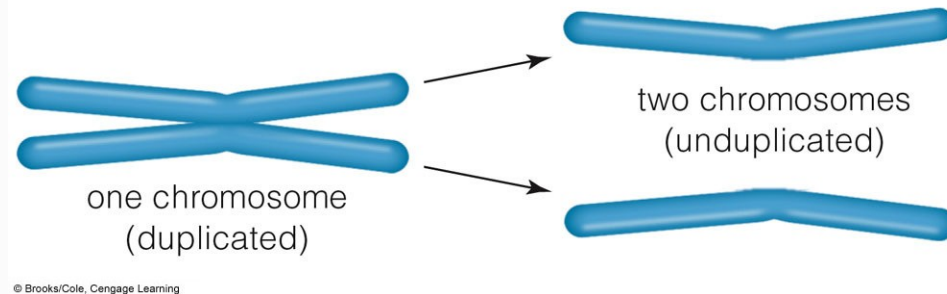
- In meiosis, DNA is replicated once and divided twice (meiosis I and meiosis II), forming four haploid nuclei
 - In meiosis I, each duplicated homologous chromosome is separated from its partner
 - In meiosis II, sister chromatids are separated
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Two Divisions, Not One

■ Meiosis I

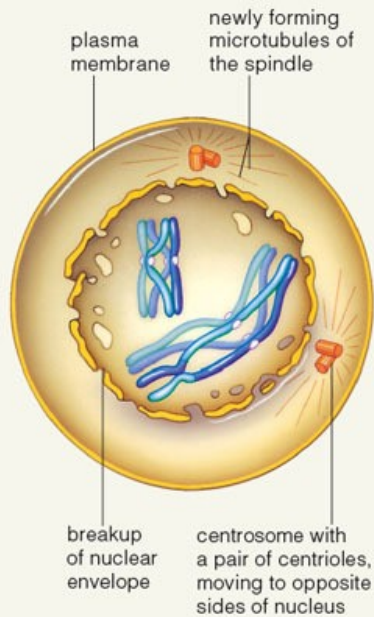
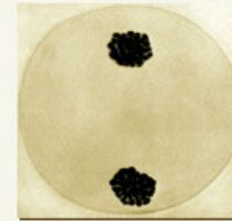
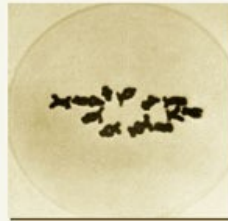


■ Meiosis II

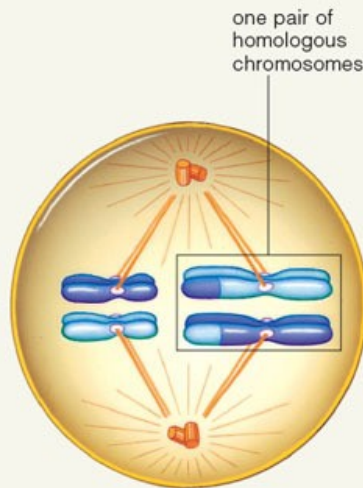


Visual Tour of Meiosis

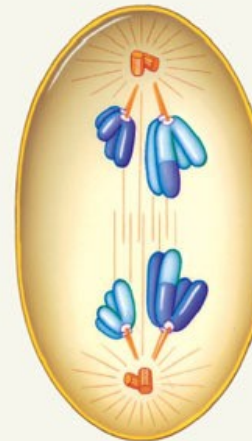
Meiosis I



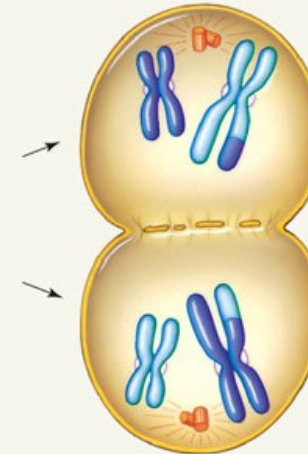
A Prophase I



B Metaphase I

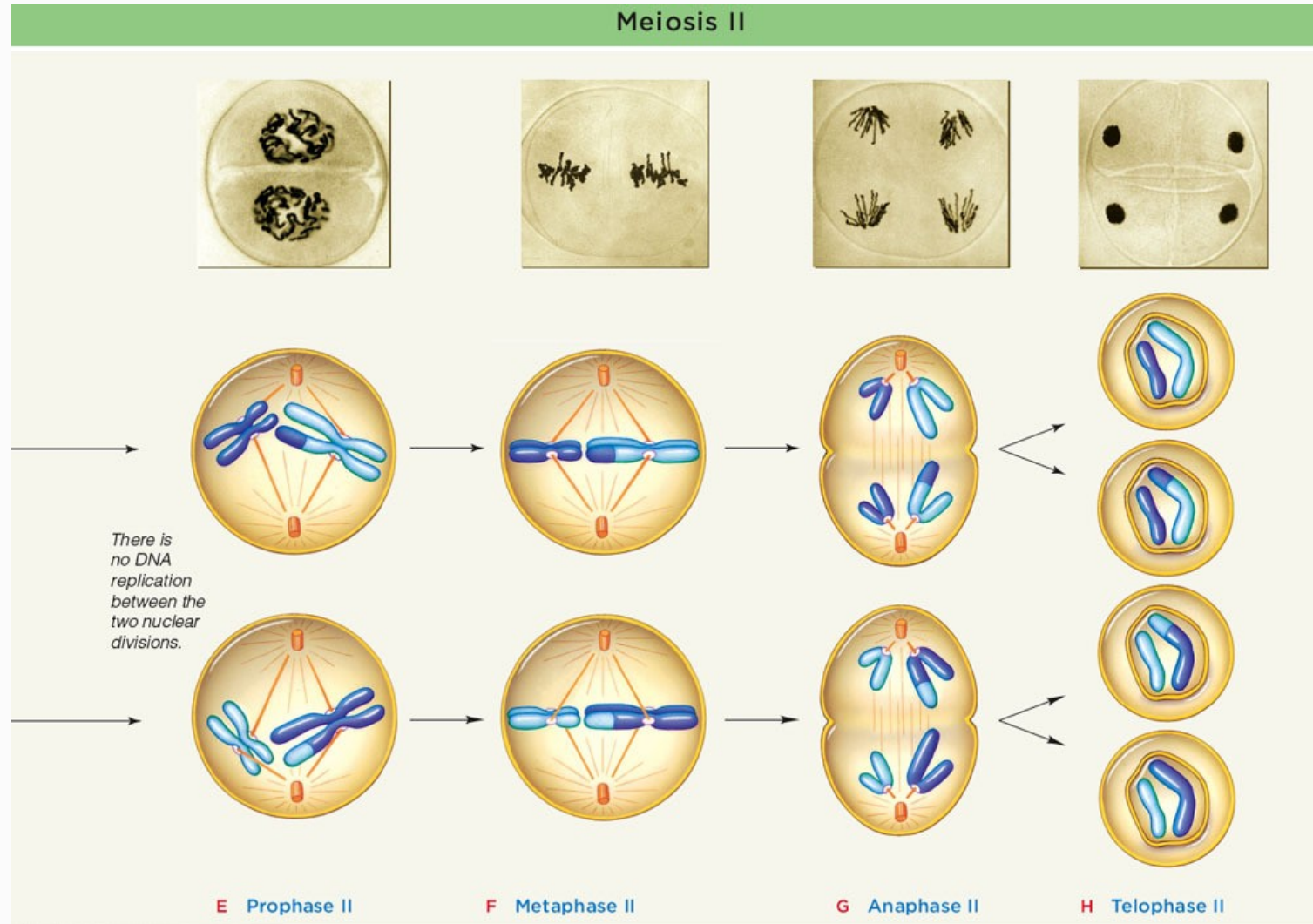


C Anaphase I



D Telophase I

Visual Tour of Meiosis



Animation: Meiosis step-by-step

<http://www.youtube.com/v/u7c8YbYGqo>

Key Concepts

Stages of Meiosis

- *Meiosis reduces the chromosome number*
 - *Meiosis occurs only in cells set aside for sexual reproduction*
 - *Meiosis sorts a reproductive cell's chromosomes into four haploid nuclei, which are distributed to descendent cells by cytoplasmic division*
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How Meiosis Introduces Variation in Traits

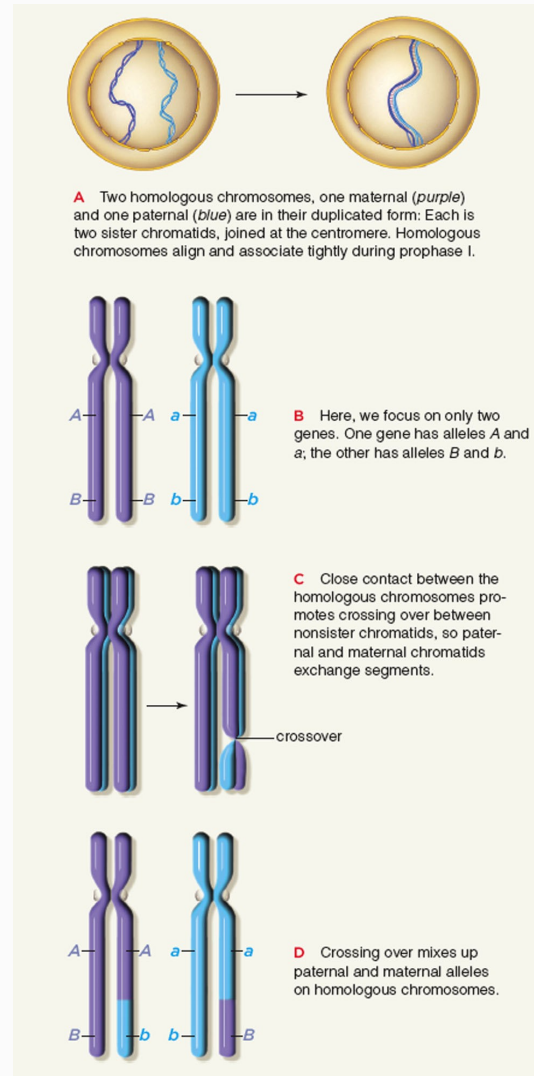
- Crossovers and the random sorting of chromosomes in meiosis introduce novel combinations of alleles into gametes, resulting in new combinations of traits among offspring
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Crossing Over in Prophase I

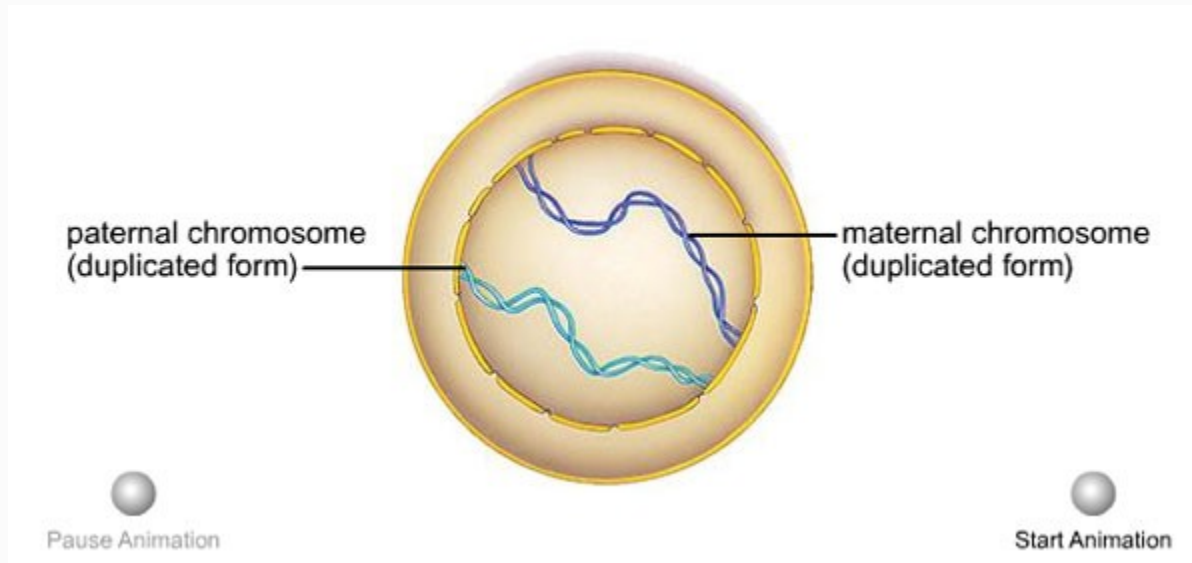
- **Crossing over**

- The process by which a chromosome and its homologous partner exchange heritable information in corresponding segments
 - Occurs during condensation in prophase I
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Crossing Over Between Homologous Chromosomes



Animation: Crossing over

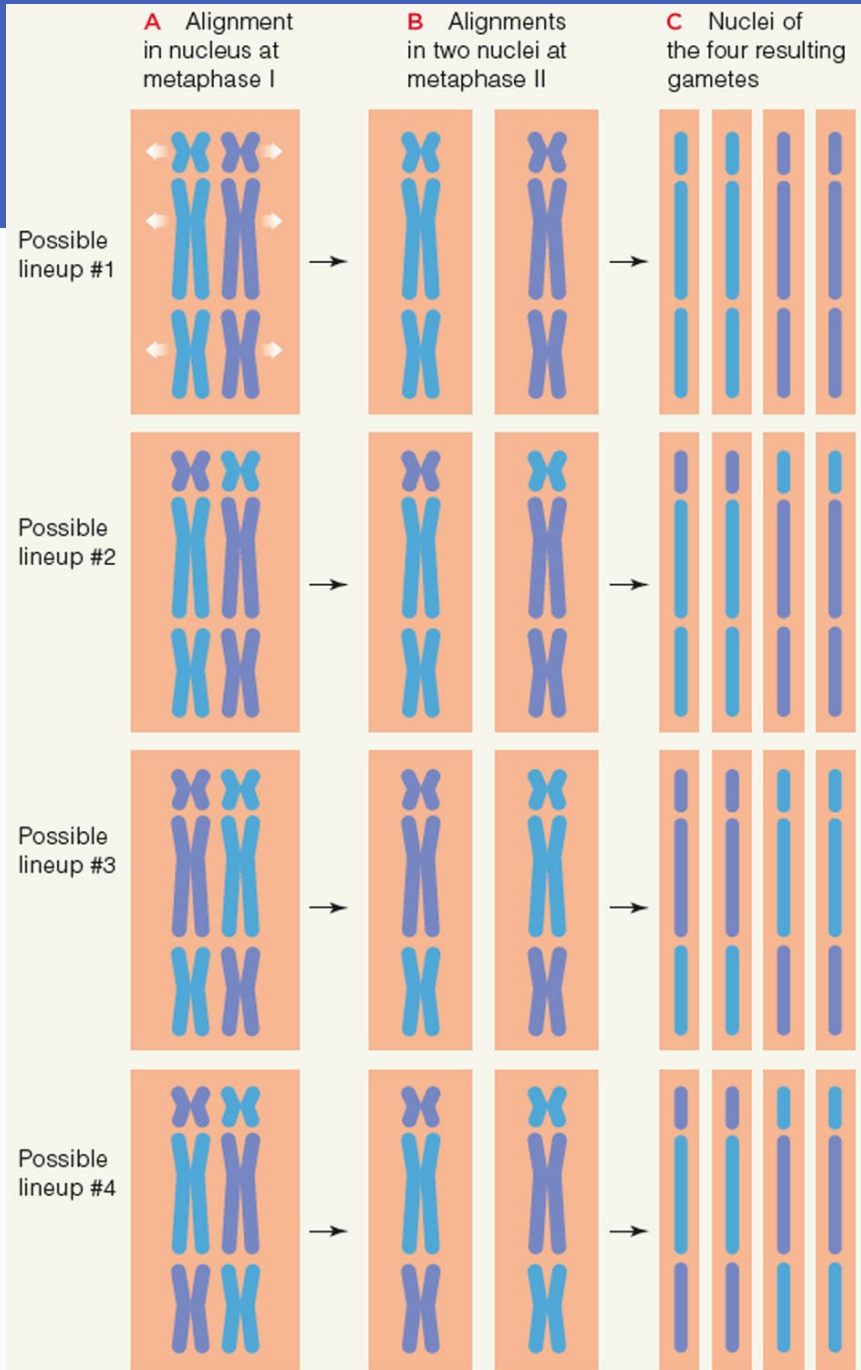


<http://www.youtube.com/v/op7Z1Px8oO4>

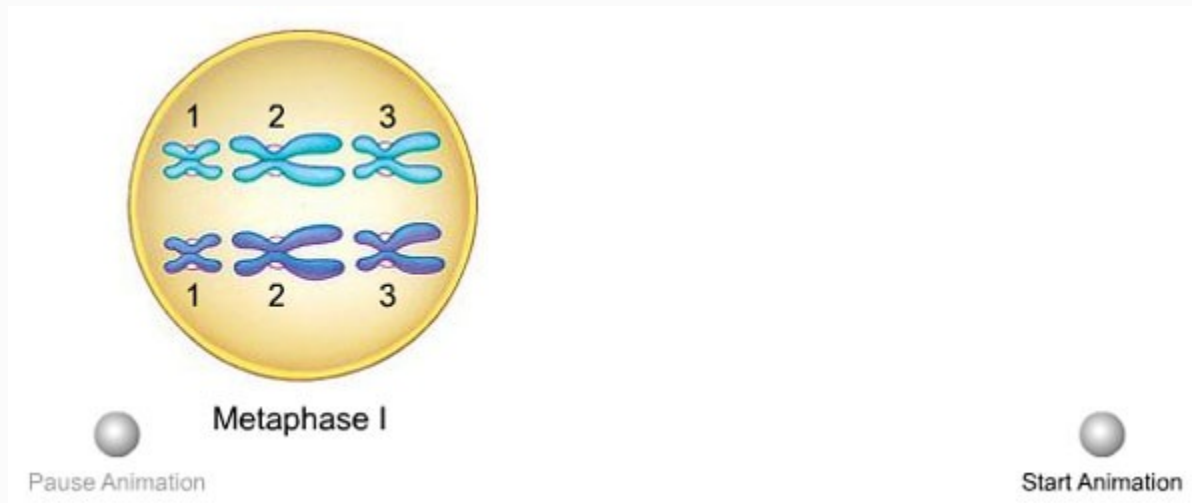
Segregation of Chromosomes into Gametes

- Homologous chromosomes can be attached to either spindle pole in prophase I, so each homologue can be packaged into either one of the two new nuclei
 - Random assortment produces 10^{23} (8,388,608) possible combinations of homologous chromosomes
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Random Assortment



Animation: Random alignment (assortment)



<http://www.youtube.com/v/u-jbIS3EPnY>

Key Concepts: Chromosome Recombinations and Shufflings

- *During meiosis, each pair of maternal and paternal chromosomes swaps segments*
 - *Then, each chromosome is randomly segregated into one of the new nuclei*
 - *Both processes lead to novel combinations of alleles – and traits – among offspring*
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Summary video

http://www.youtube.com/v/D1_-mQS_FZ0
