Chapter 13 Meiosis
Chapter 13  Meiosis

• Terms
  – Heredity
    • Transmission of traits to offspring
  – Variation
    • Genetic variation in population
  – Genetics
    • Study of heredity
  – Genes
    • DNA coded information for protein
  – Gametes
    • Sperm and egg (and spores)
sexual reproduction

• 2 parents give rise to genetically unique offspring
Sexual Life Cycles

• Life cycle – from conception to production of offspring
• Some organisms can also reproduce asexually
• Other animals and plants reproduce sexually

Male sea star releasing sperm into water, some sea stars are hermaphrodites and release both sperm and egg
Example: humans

- **Somatic cells** (body cells)
  - 46 chromosomes
  - 23 pairs \(2n\) (diploid) = 46
Human chromosomes
Arranged in homologous pairs

**Autosomes** = pairs 1 – 22

**Sex chromosomes** = pair 23

**XX** = female

**XY** = male
• Germ line cells (gametes)—ovary/testes
  — $1n$ (haploid) = 23

Fertilization $1n + 1n = 2n$

Ex. Fruit fly egg has 4 chromosomes ($1n$). How many chromosomes in a sperm? A fly larval cell? An adult somatic cell?
Sperm + egg $\rightarrow$ zygote

fertilization

Haploid $\rightarrow$ diploid $\rightarrow$ haploid $\rightarrow$ diploid etc............
Humans: \[ 2n = n = \]
what makes chromosomes homologous?

**Homologous chromosomes**
- Same length
- Same genes at same locations
When meiosis is complete:

4 new haploid cells

genetically unique
Interphase

- Same as in mitosis
- Chromosomes replicate
- Centrioles replicate

Sister chromatids identical
Key

- Maternal set of chromosomes ($n = 3$)
- Paternal set of chromosomes ($n = 3$)

$2n = 6$

Two sister chromatids of one replicated chromosome

Centromere

Pair of homologous chromosomes (one from each set)

Two nonsister chromatids in a homologous pair
Stages of Meiosis

• Prophase I
  1. Nuclear envelope breaks down
  2. Chromosomes (sister chromatids) condense

The diploid number of this cell is?

The number of pairs of homologous chromosomes is?
3. Centrioles to poles
4. Spindle forms
• Mitotic spindle
  – directs the movement of chromosomes

Describe the anatomy of the mitotic spindle
5. Synapsis
replicated **homologous chromosomes** line up to form a tetrad

What is happening here??
Which is prophase of mitosis? Prophase I of meiosis?
6. Crossing over

- Non-sister chromatids exchange
- Creates diversity!
Prophase I

- Crossing over – note **chiasmata**

How many sister chromatids participate in each **tetrad**?
Chiasma – the $\mathbf{X}$ observed after crossing over
• **Metaphase I**
  – Tetrads line up along metaphase plate
Which is metaphase of mitosis?
Metaphase I of meiosis?
• **Anaphase I**
  
  Homologs separate and move towards opposite poles
  
  Note: sister chromatids connected
• **Telophase I**
  – Nuclear membranes form around chromosomes
→ **cytokinesis**
  • Division of cytoplasm

→ 2 haploid daughter cells
Overview of Meiosis 1

• **Bioflix meiosis animation**

• **Meiosis I is** = **reduction division**
  → Each cell has 1 set of chromosomes
    (replicated and recombined)
Meiosis II

• Prophase II
• Metaphase II
• Anaphase II
Telophase II

→ 4 genetically unique haploid cells
Meiosis and genetic variation

1. crossing over (prophase I) $\rightarrow$ recombinant chromosomes

2. independent assortment
   random orientation of homologous chromosomes are metaphase I
• 3. random fertilization

Humans:

\[ 2^{23} \times 2^{23} = \]
### Compare mitosis and meiosis

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