Section 12.4
Meiosis
I Can...

- **LS 3.1** I can model chromosome progression through meiosis and fertilization.

- **LS 3.1** I can argue that the process of sexual reproduction leads to both genetic similarities and variation in diploid organisms.
Key Questions

1. How many sets of genes are found in most adult organisms?
2. What events occur during each phase of meiosis?
3. How is meiosis different from mitosis?
4. How can two alleles from different genes be inherited together?
Vocabulary

- Homologous
- Diploid
- Haploid
- Meiosis
- Tetrad
- Crossing-over
Chromosome Number

• An organism with two parents must inherit a single copy of every gene from each parent.
• When that organism produces gametes (egg or sperm), those two sets of genes must be separated so that the gamete contains just one set of genes.
• Genes are located on chromosomes.
Diploid Cells

- Humans have 46 chromosomes
  - 23 of these came from the male parent
  - 23 of these came from the female parent
- These two sets of chromosomes are **homologous**
  - Each of the 23 chromosomes from the male parents has a corresponding chromosome from the female parent
Diploid Cells vs. Haploid Cells

**Diploid**
- A cell with two sets of homologous chromosomes
- "double"
- Two complete sets of inherited chromosomes (two complete sets of genes)
- Represented by 2N
- In humans, 2N = 46

**Haploid**
- A cell with a single set of chromosomes (a single set of genes)
- The gametes of sexually reproducing organisms
- Represented by N
- In humans, N = 23
Phases of Meiosis

• **Meiosis** - the process in which the number of chromosomes per cell is cut in half through the separation of homologous chromosomes in a diploid cell

• Involves two divisions, meiosis I and meiosis II

• Meiosis produces four haploid cells from one diploid cell
Phase of Meiosis

1. Interphase
   One diploid cell replicates its DNA

2. Meiosis I (PMAT) and Cytokinesis
   One diploid cell divides into two haploid cells

3. Meiosis II (PMAT) and Cytokinesis
   Those two haploid cells divide into four haploid cells
MEIOSIS I
- Interphase
- Prophase I
- Crossing-Over
- Metaphase I
- Anaphase I
- Telophase I and Cytokinesis

MEIOSIS II
- Two Cells With Two Replicated Chromosomes
- Prophase II
- Metaphase II
- Anaphase II
- Telophase II and Cytokinesis
- Four Haploid Daughter Cells
Meiosis I

• After interphase, where DNA is replicated, the diploid cell is ready to enter meiosis I.
• Meiosis I will produce two haploid cells.
Prophase I

- Each replicated chromosome pairs with its corresponding homologous chromosome
- Forms a tetrad, which contains four chromatids
- **Crossing-over** – bits and pieces of the homologous chromosomes are exchanged
  - Produces new combinations of alleles on each chromosome
Metaphase I

• Paired homologous chromosomes line up across the center of the cell
Anaphase I

- Spindle fibers pull each homologous chromosome pair toward opposite ends of the cell
Telophase I and Cytokinesis

• Nuclear membrane forms around each cluster of chromosomes
• Cytokinesis follows, forming two new cells
Meiosis II

• The two cells now enter a second meiotic division
• Unlike meiosis I, neither cell goes through DNA replication
• Meiosis II will produce four haploid cells
Prophase II

- Chromosomes do NOT form tetrads (homologous pairs already separated during meiosis I)
Metaphase II and Anaphase II

• Metaphase II
  • Chromosomes line up in the center of each cell

• Anaphase II
  • Sister chromatids separate
Telophase II and Cytokinesis

• The final result is four haploid daughter cells
Gametes (egg and sperm)
Comparing Meiosis and Mitosis

**Mitosis**
- Can be a form of asexual reproduction
- Each daughter cell receives a complete **diploid** set of chromosomes
- Produces two genetically **identical** cells

**Meiosis**
- Produces gametes for sexual reproduction
- Each daughter cell receives only a **haploid** set of chromosomes
- Produces four genetically **different** cells
- Increases genetic variation
Gene Linkage

• Genes that are located on different chromosomes assort independently
• But what about genes that are located on the same chromosome?

• Each chromosome is actually a group of linked genes
• Alleles of different genes tend to be inherited together from one generation to the next when those genes are located on the same chromosome
Gene Mapping

• Using crossing-over to figure out gene locations on a chromosome
  • If two genes are close together on a chromosome, crossing-over between them should be rare
  • If two genes are far apart on a chromosome, crossing-over between them should be more common
    • This would reduce the frequency with which they are linked

• Scientists can use the frequency of crossing-over between genes to determine their distances from each other

• Called a gene map
Gene Map for a fruit fly

Location | Chromosome 2
---|---
0.0 | 0 | Aristaless (no bristles on antenna)
1.3 | 10 | Star eye
13.0 | 20 | Dumpy wing
31.0 | 30 | Dachs (short legs)
48.5 | 40 | Black body
51.0 | 50 | Reduced bristles
54.5 | 60 | Purple eye
55.0 | 70 | Light eye
57.5 | | Cinnabar eye
67.0 | 80 | Vestigial (small) wing
75.5 | 90 | Curved wing
99.2 | 100 | Arc (bent wings)
104.5 | 110 | Brown eye
107.0 | | Speck body
Section 12.4 Exit Ticket

1. What are the key cellular events that occur during prophase I, metaphase I, anaphase I, telophase I, and cytokinesis?

2. What are the key cellular events that occur during prophase II, metaphase II, anaphase II, telophase II, and cytokinesis?

3. How is meiosis different from mitosis?
The End 😊