Genes and Alleles

Plant and animal cells contain many thousands of different genes and typically have two copies of every gene.

The two copies (or alleles) of the gene may or may not be identical, and one may be dominant in determining the phenotype while the other is recessive.

When Mendel published his work in the 1800s, he did not use the word “gene” to describe his units of heredity.

- He also wasn’t sure where his units might be found or how to identify them.
- His work went unnoticed for almost thirty years.

In 1902, American scientist Walter Sutton (1877 to 1916) examined the nuclei of grasshopper cells under a microscope.

- He observed that chromosomes occurred in homologous pairs that separated during meiosis.

A year later, Sutton found that chromosomes contained genes!

- He had discovered Mendel’s units of heredity!

The laws stated on the next slide combine the work of Mendel and Sutton.

These laws are taken from Mendel’s basic laws of how traits are passed on to offspring and what Sutton knew about genes, chromosomes, DNA, and meiosis.

1. Individual units called genes determine an organism’s traits.
2. A gene is a segment of DNA, located on the chromosomes, that carries hereditary instructions from parent to offspring.
3. For each gene, an organism typically receives one allele from each parent.
4. If an organism inherits different alleles for a trait, one allele may be dominant over the other.

5. The alleles of a gene separate from each other when sex cells are formed during meiosis.

Homologous pairs of chromosomes separate during meiosis.
- Since alleles of a gene are found in corresponding locations on homologous pairs of chromosomes, they also separate during meiosis.

How do alleles separate?
- To illustrate how alleles separate, let’s follow the alleles for the flower color trait in a pea plant with the genotype $Pp$.
- The plant in this example has a dominant allele ($P$) and a recessive allele ($p$).
- What is the phenotype of the plant?
- You are correct if you said purple!

The next slide shows the fertilization in peas.
- To keep it simple, only one pair of chromosomes is shown.
- A real pea plant has 14 chromosomes (7 pairs).
When fertilization occurs, offspring inherit one homologous chromosome in a pair from each parent.

- As a result, one allele for a gene also comes from each parent.
- When Mendel crossed pure breeding, purple-flowered plants with pure-breeding, white-flowered plants, the first generation offspring were purple with the genotype $Pp$.

### Predicting genotype and phenotype using Punnett Squares

You can predict the genotypes and phenotypes of offspring if you know the genotypes of the parents.

- A punnett square shows all of the possible combinations of alleles from the parents.

#### First Generation Punnett

As you can see, all of the offspring in Mendel’s first cross had a genotype of $Pp$.

- That’s why all of the plants in the first generation had purple flowers.
Using a punnett square, you can predict the possible genotypes and phenotypes of the offspring.

**Probability**

- When you flip a coin, there is a 50 percent chance you’ll get heads and a 50 percent chance you’ll get tails.
- The way the coin lands is completely random.
- Like flipping a coin, the chance of inheriting a certain genotype and phenotype is random.

**Probability is the mathematical chance that an event will occur.**

- Probability can be expressed as a fraction or a percentage.

<table>
<thead>
<tr>
<th>Offspring</th>
<th>Probability Calculation</th>
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<tbody>
<tr>
<td>3 purple and 1 white</td>
<td>( \frac{3}{4} \times 100 = 75% )</td>
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<tr>
<td></td>
<td>( \frac{1}{4} \times 100 = 25% )</td>
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