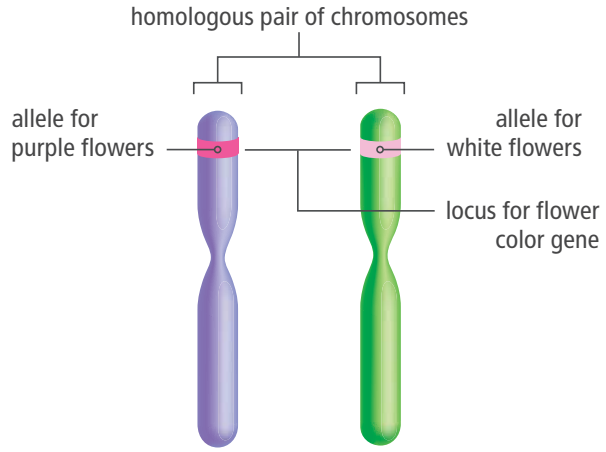
Traits, Genes, and Alleles

We know a lot about DNA and genes today, but this information was discovered long after Mendel's time. However, Mendel did correctly hypothesize that there was a hereditary factor that carried genetic information. We now call those factors genes.

Genes and Alleles

A gene is a piece of DNA that provides a set of instructions to a cell to make a certain protein. Each gene has a locus, which is a specific location on a pair of homologous chromosomes. You can think of the locus as the "address" that tells where a gene is located on a chromosome. In human cells, there are 23 pairs of homologous chromosomes, for a total of 46. Genes located on chromosomes, which get passed on to offspring during reproduction, are the basis for heredity. What Mendel essentially revealed is that it is not the traits that are passed from one generation to the next, but rather the genes that are responsible for those traits.

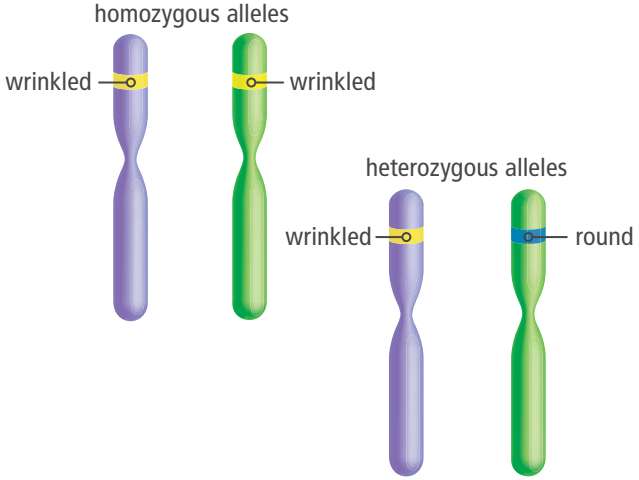
FIGURE 8: Alleles are different forms of a gene. They are located at the same position on homologous chromosomes.



Genes contain genetic information, but this information varies widely from one organism to another due to different alleles. An allele is any of the alternative forms or versions of a gene that may occur at a specific locus. Human cells have two alleles for each gene, which are found on homologous chromosomes. You receive one allele from one parent and one allele from your other parent. The same is true for almost all organisms that reproduce sexually, including pea plants. The traits observed in Mendel's experiments, such as flower color or plant height, resulted from varying alleles.

Explain How is an allele related to a gene?

FIGURE 9: Heterozygous and Homozygous Alleles



Combinations of Alleles

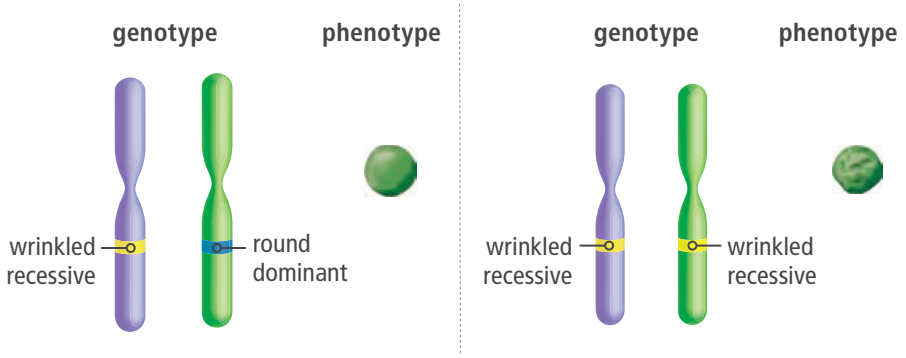
Your body cells contain two alleles for each gene. These alleles may be the same, or they may be different. The term homozygous describes two of the same alleles at a specific locus. The term heterozygous describes two different alleles at the same locus. For example, you may inherit an allele for freckles from one parent and another allele for no freckles from your other parent. The same holds true for pea plants. A pea plant may have a purple flower allele and a white flower allele, making it heterozygous for that trait.

Gather Evidence What is one question you could ask about how traits are expressed when an organism has heterozygous alleles for a trait?

Traits

When describing homozygous or heterozygous pairs of alleles, we are referring to an organism's actual genetic makeup. This is known as its genotype. If a pea plant has one allele for round seeds and one allele for wrinkled seeds, it is said to be heterozygous. Both of these alleles make up its genotype even though one trait will be masked. The actual physical characteristics, or traits, of an individual make up its phenotype. The plant might have an allele for wrinkled seeds, but the phenotype expressed is for round seeds.

FIGURE 10: Only the dominant allele is expressed when two different alleles for a gene are present.



Sometimes only one allele in the pair will affect the trait. As Mendel's results demonstrated, in some cases one allele may be dominant over another allele. A dominant allele is the allele that is expressed when two different alleles or two dominant alleles are present. A recessive allele is the allele that is only expressed when two recessive copies occur together.

The allele combination, or genotype, of an organism is often represented by a set of letters. Because each body cell contains two alleles per gene, two letters are needed to represent each allele in the pair. Uppercase letters represent dominant alleles, and lowercase letters represent recessive alleles.

In the chromosomes shown in Figure 10, the dominant allele, *R*, codes for round peas. The recessive allele, *r*, codes for wrinkled peas. The round phenotype will occur if one or two copies of the dominant allele is present. So plants that are homozygous dominant (*RR*) or heterozygous (*Rr*) will have round peas. The wrinkled phenotype, on the other hand, occurs only when two copies of the recessive allele are present. Only plants with the homozygous recessive (*rr*) genotype will have wrinkled peas.

Gather Evidence Based on what you know about Mendel's studies on purple and white flowers, why can genotype be different from phenotype?

Analyze In pea plants, *T* represents the allele for a tall plant, which is a dominant trait, and *t* represents the allele for a dwarf, or short plant, which is the recessive trait. Identify whether the genotypes *Tt*, *tt*, and *TT* are homozygous dominant, homozygous recessive, or heterozygous. Then identify the phenotype for each.

Explain Use what you have learned about Mendel's contributions to genetics to answer the following questions.

1. When Mendel crossed two purple-flowered plants from the F_1 generation, he found that out of every four flowers, three were purple and one was white. Which of these traits, purple or white, is most likely to be the dominant trait? Explain your reasoning.
2. Write two questions you could ask to learn more about how food preferences, such as distaste for broccoli, are passed from parents to offspring.