UNIT 8 Preparation

Prerequisite Concepts

This unit draws and builds upon your understanding of genetics (from Unit 7), factors that affect populations (from Unit 4, Chapter 3), and the theory of evolution by natural selection (from Unit 4, Chapter 4).

Heredity and Evolution

In the theory of evolution by natural selection, new variants of species arise continually in populations. Some variants thrive and produce more offspring, thus slowly leading to change in a population, which may even lead to the development of new species over time. Other variants die off because they cannot thrive in their environment.

As scientists in the 1930s began to broaden their understanding of genetics, they demonstrated that there is substantial genetic variation within populations. These variations can arise in populations through mutations—permanent changes in the genetic material of an organism. Evolution, therefore, depends on both random genetic mutation (with provides variation) and mechanisms such as natural selection.

Reviewing the Language of Genetics

To understand and discuss genetic variation, it is helpful to review certain terms. Alleles are alternate forms of a gene. In humans, for example, there are three alleles—I^A, I^B, and i—that determine whether an individual has A, B, AB, or O blood type. Since individuals generally have two sets of chromosomes, one received from the male parent and one from the female parent, there are two alleles for each gene at each locus. A locus (plural loci) is the location of a gene on a chromosome. So humans could be I^AI^A, I^AI^B, I^Ai, I^BI^B, I^Bi, or ii at the locus for blood group. If the two alleles at a locus are identical (for example, I^AI^A or ii), the individual is called homozygous for that characteristic. An individual with two different alleles at the locus (for example, I^AI^B) is called heterozygous. The three blood type alleles, I^A, I^B, or i,

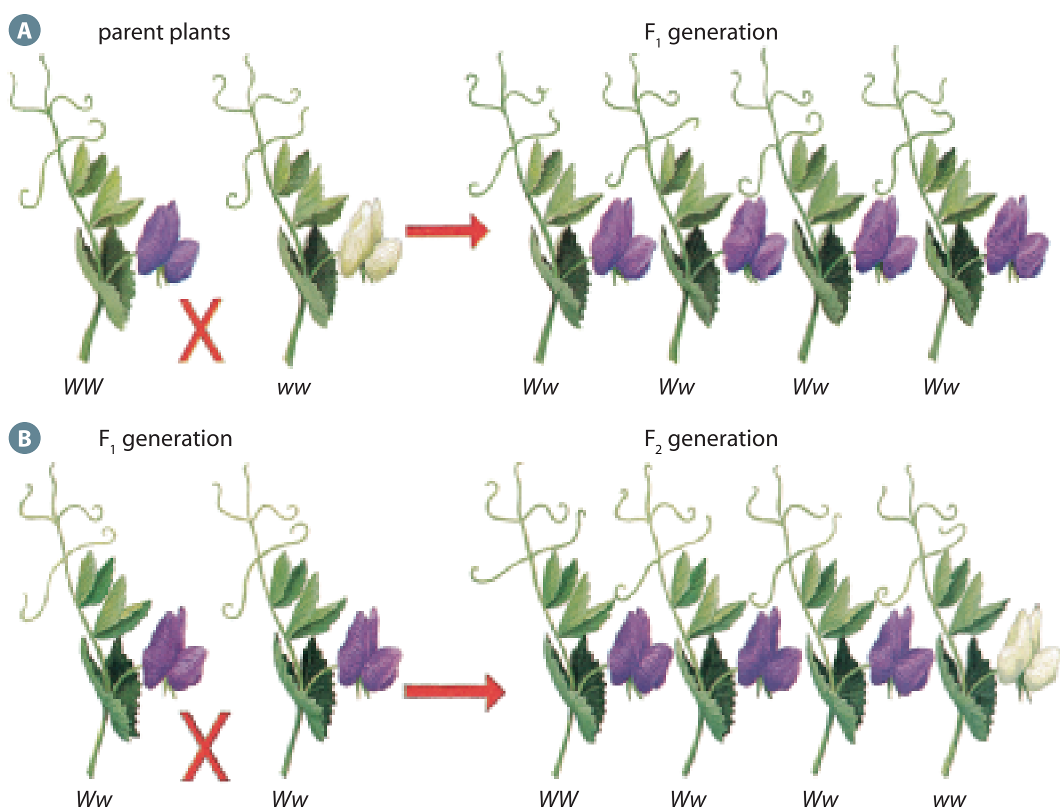

Figure P8.1 Two generations (**A** and **B**) resulting from the cross of a purple-flowered pea plant and a white-flowered pea plant.

exist in the population, but no single person can have all three. In some populations, the allele possibilities are even greater, and they far exceed the two possible alleles any human can have.

If the two alleles inherited from parents are different, one of them—the dominant allele—will be fully expressed in the individual's appearance and therefore will become the phenotype. The other allele, the recessive allele, has no noticeable effect on the organism's appearance, but it remains as part of the genotype of the organism. Figure P8.1 shows a cross between a pure purple-flowered pea plant and a pure white-flowered pea plant. The alleles for colour are represented by the letters *W* (for the dominant allele) and *w* (for the recessive allele). Since *W* is the dominant allele, the flowers can only be white when the two alleles are both recessive (that is, *ww*).

The genotype, or genetic makeup, of an individual remains constant throughout its life. However, over time, the alleles within a population may change. New alleles may arise and may be recombined, thus producing individuals with novel phenotypes. Phenotypes are the physical and physiological traits of an organism. A phenotype of an individual can be the product of both the environment and heredity. For example, environmental factors such as disease, crowding, injury, or the availability of food can all affect the appearance of an individual. But these acquired characteristics are not heritable; that is, they are not passed on to the next generation. Because of dominant and recessive alleles, an organism's appearance does not always reflect its genetic makeup. For example, Figure P8.2 shows a cross between two pea plants that have the alleles *W* or *w* at the locus for colour. The genotypes *WW* and *Ww* both result in a purple flower, while the genotype *ww* results in a white flower. Table P8.1 summarizes how genotype is related to phenotype.

Table P8.1 Genotype versus Phenotype

Genotype	Genotype	Phenotype
WW	homozygous dominant	purple flowers
Ww	heterozygous	purple flowers
ww	homozygous recessive	white flowers

Not all traits are totally dominant or totally recessive. Sometimes neither allele controlling a trait is dominant. In this case, blending of the two traits can occur—a situation called incomplete dominance. Occasionally both alleles for a trait may be dominant. These alleles are said to be co-dominant, and both alleles are expressed in the heterozygous individual. In some varieties of chickens, for example, two alleles for a trait may be expressed equally. A black rooster crossed with a white hen produces offspring that have some black feathers and some white feathers.

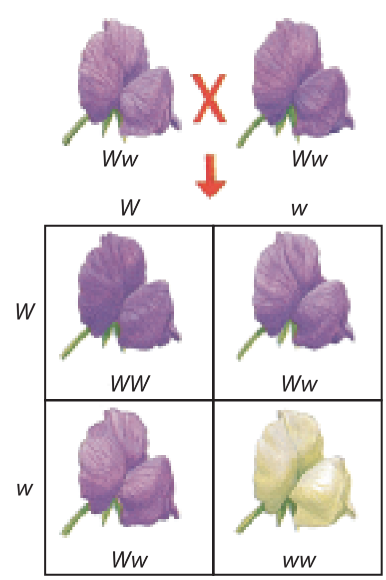

Figure P8.2 This cross between heterozygous pea plants (the same as the $F_1 \times F_1$ cross in Figure P8.1) is shown in a Punnett square.