To illustrate the Hardy-Weinberg theorem, consider a hypothetical population that meets all of the assumptions listed on p. 65. In this population, a particular autosomal locus has two alleles: allele A has a frequency of 0.8 [$f(A) = 0.8$], and allele a has a frequency of 0.2 [$f(a) = 0.2$]. Stated another way, in this population, 80% of the genes for this locus are allele A, and 20% are allele a. For the purpose of the example, assume dominance; however, it is irrelevant to the Hardy-Weinberg theorem.

Because random mating is assumed, the genotypic and phenotypic frequencies of the next generation can be determined using a Punnett square type of analysis (figure 1). Since dominance is assumed, the phenotypic frequencies of the F_1 generation are:
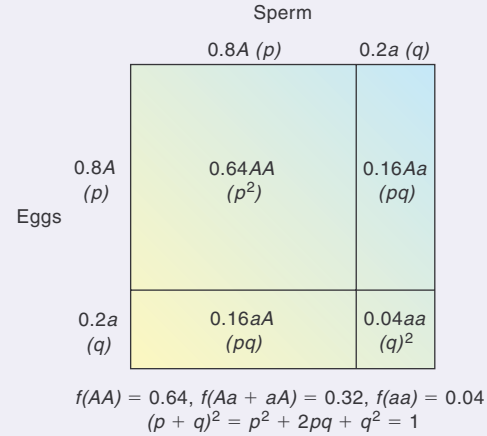
$$f(\text{phenotype A}) = 0.64 + 0.32 = 0.96$$
$$f(\text{phenotype a}) = 0.04$$

Gene frequencies of the F_1 generation are determined by adding the frequency of each homozygote to half the frequency of the heterozygote. (The frequency of an allele in the heterozygote is reduced by half because heterozygotes contain only a single copy of each allele.)

	f(allele A)	f(allele a)
AA individuals	0.64	0
Aa individuals	½(0.32) = 0.16	½(0.32) = 0.16
aa individuals	0	0.04
Overall frequency	0.80	0.20

Note that the overall frequency of each allele in the F_1 generation has not changed from that assumed for the parental generation. This example illustrates that, if the assumptions of the Hardy-Weinberg theorem are met, gene frequency does not change from generation to generation. In other words, **Hardy-Weinberg equilibrium** is achieved, and evolution does NOT occur!

Sperm

0.8A (p)   0.2a (q)

Eggs

0.8A (p)   0.64AA (p²)   0.16Aa (pq)

0.2a (q)   0.16aA (pq)   0.04aa (q²)

$f(AA) = 0.64$, $f(Aa + aA) = 0.32$, $f(aa) = 0.04$
$(p + q)^2 = p^2 + 2pq + q^2 = 1$

FIGURE 1   **Genotypic Frequencies.** Determining the genotypic frequencies of offspring from allelic frequencies in a parental generation. This analysis assumes random mating and that each allele is equally likely to be incorporated into a viable gamete. The frequency of each allele in a sperm or egg is simply the frequency of that allele in the parental population. Allelic frequencies are often represented by p and q, and genotypic frequencies can be found by expanding the binomial $(p + q)^2$. Miller/Harley: Zoology, 5th ed. © The McGraw-Hill Companies.

The Hardy-Weinberg theorem can be stated in general mathematical terms. Given a locus with two interacting alleles, if p = the frequency of one allele, and q = the frequency of a second allele, then $p + q = 1$. The frequency of genotypes in the next generation is found by algebraically expanding the binomial equation $(p + q)^2 = p^2 + 2pq + q^2 = 1$.