Why Sample *with* Replacement? All of the examples in this section involved sampling *with replacement*. Sampling *without replacement* would have the very practical advantage of avoiding wasteful duplication whenever the same item is selected more than once. However, we are particularly interested in sampling *with replacement* for these two very important reasons:

1. When selecting a relatively small sample from a large population, it makes no significant difference whether we sample with replacement or without replacement.
2. Sampling with replacement results in independent events that are unaffected by previous outcomes, and independent events are easier to analyze and result in simpler calculations and formulas.

For the reasons above, we focus on the behavior of samples that are randomly selected *with replacement*. Many of the statistical procedures discussed in the following chapters are based on the assumption that sampling is conducted with replacement.

The key point of this section is to introduce the concept of a sampling distribution of a statistic. Consider the goal of trying to find the mean body temperature of all adults. Because that population is so large, it is not practical to measure the temperature of every adult. Instead, we obtain a sample of body temperatures and use it to estimate the population mean. Data Set 3 in Appendix B includes a sample of 106 such body temperatures. The mean for that sample is $\bar{x} = 98.20°F$. Conclusions that we make about the population mean temperature of all adults require that we understand the behavior of the sampling distribution of all such sample means. Even though it is not practical to obtain every possible sample and we are stuck with just one sample, we can form some very meaningful conclusions about the population of all body temperatures. A major goal of the following sections and chapters is to learn how we can effectively use a sample to form inferences or conclusions about a population. In Section 6-5 we consider more details about the sampling distribution of sample means, and in Section 6-7 we consider more details about the sampling distribution of sample proportions.

CAUTION Many methods of statistics require a *simple random sample*. Some samples, such as voluntary response samples or convenience samples, could easily result in very wrong results.

6-4 Basic Skills and Concepts

Statistical Literacy and Critical Thinking

1. Minting Quarters In a recent year, the U.S. Mint in Denver manufactured 270 million quarters. Assume that on each day of production, a sample of 50 quarters is randomly selected, and the mean weight is obtained.

a. Given that the population of quarters has a mean weight of 5.67 g, what do you know about the mean of the sample means?

b. What do you know about the shape of the distribution of the sample means?

c. The population of quarters has a mean of 5.67 g, but the weights of individual quarters vary. For each sample of 50 quarters, consider the proportion of quarters that weigh less than 5.67 g. What do you know about the shape of the distribution of the sample proportions?

2. Sampling with Replacement In a recent year, the U.S. Mint in Denver manufactured 270 million quarters. As part of the mint's quality control program, samples of quarters are