15.1 Selective Breeding

Key Questions

- ***What is selective breeding used for?***
- ***How do people increase genetic variation?***

Vocabulary

selective breeding
hybridization
inbreeding
biotechnology

Taking Notes

Outline Before you read this lesson, start an outline. Use the green headings in the lesson as first-level entries. Use the blue headings as second-level entries, leaving space after each entry. As you read, summarize the key ideas below your entries.

THINK ABOUT IT You've enjoyed popcorn at the movies, you've probably made it at home, and you've certainly seen it in stores. Where does it come from? Would you be surprised to learn that popcorn is one of the earliest examples of human efforts to select and improve living organisms for our benefit? Corn as we know it was domesticated at least 6000 years ago by Native Americans living in Mexico. A tiny kernel of popped corn found in a cave in New Mexico is more than 5000 years old!

Selective Breeding

What is selective breeding used for?

Visit a dog show, and what do you see? Striking contrasts are everywhere—from a tiny Chihuahua to a massive Great Dane, from the short coat of a Labrador retriever to the curly fur of a poodle, from the long muzzle of a wolfhound to the pug nose of a bulldog. The differences among breeds of dogs, like the ones in **Figure 15–1,** are so great that someone might think they are different species. They're not, of course, but where did these obvious differences come from?

The answer is that we did it. Humans have kept and bred dogs for thousands of years, always looking to produce animals that are better hunters, better retrievers, or better companions. We've done so by **selective breeding,** allowing only those animals with wanted characteristics to produce the next generation. **Humans use selective breeding, which takes advantage of naturally occurring genetic variation, to pass wanted traits on to the next generation of organisms.**

FIGURE 15–1 Dog Breeds There are more than 150 dog breeds, and many new breeds are still being developed.

For thousands of years, we've produced new varieties of cultivated plants and nearly all domestic animals—including horses, cats, and cows—by selectively breeding for particular traits. Long before Europeans came to the New World, Native Americans had selectively bred teosinte (tee oh SIN tee), a wild grass native to central Mexico, to produce corn, a far more productive and nutritious plant. Figure 15–2 shows both plants. Corn is now one of the world's most important crops. There are two common methods of selective breeding—hybridization and inbreeding.

Hybridization American botanist Luther Burbank may have been the greatest selective breeder of all time. During his lifetime (1849–1926), he developed more than 800 varieties of plants. As one of his tools, Burbank used **hybridization,** crossing dissimilar individuals to bring together the best of both organisms. Hybrids—the individuals produced by such crosses—are often hardier than either of the parents. Many of Burbank's hybrid crosses combined the disease resistance of one plant with the food-producing capacity of another. The result was a new line of plants that had the traits farmers needed to increase food production. Figure 15–3 shows a type of peach developed using Burbank's methods.

Inbreeding To maintain desirable characteristics in a line of organisms, breeders often use a technique known as inbreeding. **Inbreeding** is the continued breeding of individuals with similar characteristics. The many breeds of dogs—from beagles to poodles—are maintained using this practice. Inbreeding helps ensure that the characteristics that make each breed unique are preserved. Although inbreeding is useful in preserving certain traits, it can be risky. Most of the members of a breed are genetically similar, which increases the chance that a cross between two individuals will bring together two recessive alleles for a genetic defect.

In Your Notebook *Compare and contrast hybridization and inbreeding.*

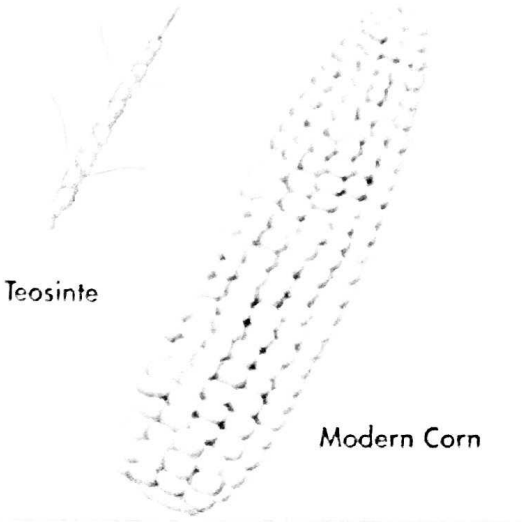


FIGURE 15–2 Corn From Teosinte
Modern corn was selectively bred from teosinte at least 6000 years ago. During its domestication, corn lost the ability to survive in the wild but gained valuable agricultural traits. For example, the hard case around the kernel disappeared over time, leaving the rows of soft corn kernels we enjoy today. Observe *What other differences can you see between the two plants?*

FIGURE 15–3 Selectively Bred Fruit
Luther Burbank used hybridization—a form of selective breeding—to develop a variety of plants. These July Elberta peaches, *Prunus persica*, are among his most successful varieties.

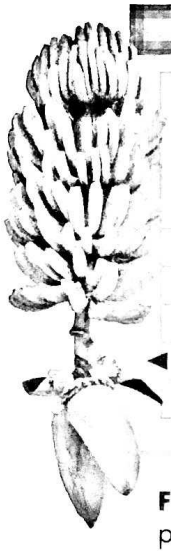
Increasing Variation

How do people increase genetic variation?

Selective breeding would be nearly impossible without the wide variation found in natural populations of plants and animals. But sometimes breeders want more variation than exists in nature.

Breeders can increase the genetic variation in a population by introducing mutations, which are the ultimate source of biological diversity.

When scientists manipulate the genetic makeup of an organism, they are using biotechnology. **Biotechnology** is the application of a technological process, invention, or method to living organisms. Selective breeding is one form of biotechnology important in agriculture and medicine, but there are many others.



Polyploid Crops

Plant	Probable Ancestral Haploid Number	Chromosome Number	Ploidy Level
Domestic oat	7	42	6N
Peanut	10	40	4N
Sugar cane	10	80	8N
Banana	11	22, 33	2N, 3N
Cotton	13	52	4N

FIGURE 15–4 Ploidy Numbers Because polyploid plants are often larger than other plants, many farmers deliberately grow polyploid varieties of crops like those listed above. **Interpret Tables** ***Which plant has undergone the most dramatic changes in chromosome number?***

Bacterial Mutations Mutations—heritable changes in DNA—occur spontaneously, but breeders can increase the mutation rate of an organism by using radiation or chemicals. Many mutations are harmful to the organism. With luck and perseverance, however, breeders can often produce a few mutants—individuals with mutations—with useful characteristics that are not found in the original population. This technique has been particularly useful with bacteria. Because they are small, millions of bacteria can be treated with radiation or chemicals at the same time, which increases the chances of producing a useful mutant. This technique has allowed scientists to develop hundreds of useful bacterial strains. For instance, we have known for decades that certain strains of oil-digesting bacteria are effective for cleaning up oil spills. Today scientists are working to produce bacteria that can clean up radioactive substances and metal pollution in the environment.

Polyploid Plants Drugs that prevent the separation of chromosomes during meiosis are very useful in plant breeding. These drugs can produce cells that have many times the normal number of chromosomes. Plants grown from these cells are called polyploid because they have many sets of chromosomes. Polyploidy is usually fatal in animals. But, for reasons that are not clear, plants are much better at tolerating extra sets of chromosomes. Polyploidy can quickly produce new species of plants that are larger and stronger than their diploid relatives. A number of important crop plants, including bananas and many varieties of citrus fruits, have been produced in this way. **Figure 15–4** lists several examples of polyploid plants.

15.1 Assessment

Review Key Concepts

1. a. Review Give an example of selective breeding.

b. Compare and Contrast Suppose you are a geneticist trying to develop a sunflower with red petals and a short stem. As you compare the sunflowers you have on hand, what genetic variations would you look for? What kinds of plants would you select for crossing?

2. a. Review What is the relationship between genetic variations and mutations?

b. Explain How can breeders introduce mutations?

c. Draw Conclusions How is selective breeding a form of biotechnology?

WRITE ABOUT SCIENCE

Explanation

3. Write a paragraph in which you suggest ways that plants could be genetically altered to improve the world's food supply. (*Hint*: The first sentence in your paragraph should express the paragraph's main idea.)