ASEXUAL AND SEXUAL REPRODUCTION

Learning Objective

1. Compare the benefits of asexual and sexual reproduction, and describe each mode of reproduction, giving specific examples.

Most animals carry on *sexual reproduction*, and some carry on *asexual reproduction*. Some animals reproduce asexually under some conditions and sexually at other times. As we will discuss, many variations of both asexual and sexual reproduction have evolved.

Asexual reproduction is an efficient strategy

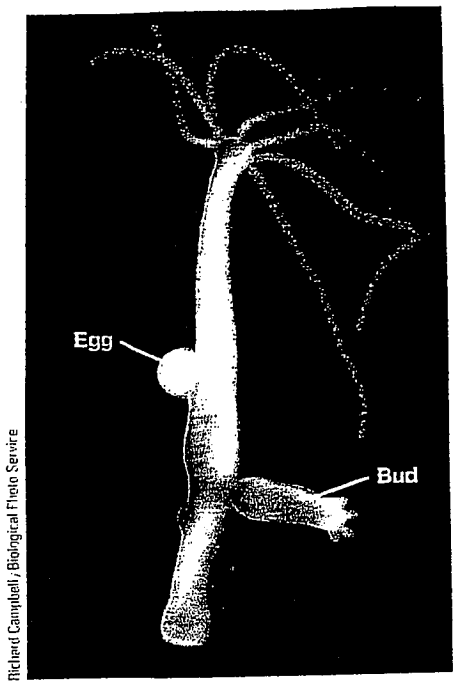
In **asexual reproduction**, a single parent gives rise to offspring that are genetically identical to the parent (unless there are mutations). Many invertebrates, including sponges, cnidarians, and some rotifers, flatworms, and annelids, can reproduce asexually. Some vertebrates also reproduce asexually under certain conditions. Asexual reproduction is an adaptation of some sessile animals that cannot move about to search for mates. For animals that do move about, asexual reproduction can be advantageous when the population density is low and mates are not readily available.

In asexual reproduction, a single parent may split, bud, or fragment to give rise to two or more offspring. Sponges and cnidarians are among the animals that can reproduce by **budding**. A small part of the parent's body separates from the rest and develops into a new individual (↓ Fig. 49-1). Sometimes the buds remain attached and become more or less independent members of a colony.

Oyster farmers learned long ago that when they tried to kill sea stars by chopping them in half and throwing the pieces back into the sea, the number of sea stars preying on the oyster bed doubled! In some flatworms, nemerteans, and annelids, this ability to regenerate is part of a method of reproduction known as **fragmentation**. The body of the parent breaks into several pieces; each piece regenerates the missing parts and develops into a whole animal.

Parthenogenesis ("virgin development") is a form of asexual reproduction in which an unfertilized egg develops into an adult animal. The adult is typically haploid. Parthenogenesis is common among insects (especially honeybees and wasps) and crustaceans; it also occurs among some other invertebrate and vertebrate groups, including some species of nematodes, gastropods, fishes, amphibians, and reptiles.

Although a few species appear to reproduce solely by parthenogenesis, in most species episodes of parthenogenesis alternate with periods of sexual reproduction. Parthenogenesis may occur for several generations, followed at some point by sexual reproduction in which males develop, produce sperm, and mate with the females to fertilize their eggs. In some species, parthenogenesis is a means of rapidly producing individuals when conditions are favorable.



Richard Campbell, Biological Photo Service

Figure 49-1 Asexual reproduction by budding

A part of *Hydra*'s body grows outward, then separates and develops into a new individual. The region of the parent body that buds is not specialized exclusively for reproduction. The *Hydra* shown here is also reproducing sexually, as evidenced by the egg (*left*).

Most animals reproduce sexually

Sexual reproduction in animals involves the production and fusion of two types of **gametes**—sperm and eggs. Typically, two different individuals are required. A male parent contributes **sperm**, and a female parent contributes an egg, or **ovum** (pl., *ova*). The sperm provides genes coding for some of the male parent's traits, and the egg contributes genes coding for some of the female parent's traits. The egg is typically large and nonmotile, with a store of nutrients that supports the development of the embryo. The sperm is usually small and motile and adapted to propel itself by beating its long, whiplike flagellum.

When sperm and egg unite, a **zygote**, or fertilized egg, is produced. The zygote develops into a new animal, similar to both parents but not identical to either. Sexual reproduction typically involves remarkably complex structural, functional, and behavioral processes. In vertebrates, hormones secreted by the hypothalamus, pituitary gland, and gonads regulate these processes.

Many aquatic animals practice **external fertilization** in which the gametes meet outside the body (↓ Fig. 49-2a). Mating partners usually release eggs and sperm into the water simultaneously. Gametes live for only a short time, and many are lost in the water; some are eaten by predators. However, so many gametes are released that sufficient numbers of sperm and egg cells meet to perpetuate the species.

In **internal fertilization**, matters are left less to chance. The male generally delivers sperm cells directly into the body of the

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(a) **External fertilization.** Like many aquatic animals, these spawning frogs (*Rana temporaria*) release their gametes into the water. The female lays a mass of eggs, while the male mounts her and simultaneously deposits his sperm in the water.

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(b) **Internal fertilization.** In most terrestrial animals, such as these lions (*Panthera leo*), the male deposits sperm inside the female body. Internal fertilization is also practiced by some fishes and some aquatic reptiles and mammals.

Figure 49-2 ***Animated*** External and internal fertilization

female. Her moist tissues provide the watery medium required for the movement of sperm, and the gametes fuse inside the body. Most terrestrial animals, sharks, and aquatic reptiles, birds, and mammals practice internal fertilization (Fig. 49-2b).

Hermaphroditism is a form of sexual reproduction in which a single individual produces both eggs and sperm. A few hermaphrodites, such as the tapeworm, are capable of self-fertilization. More typically, two animals come together and fertilize one another's eggs (see photograph of mating nudibranchs at beginning of chapter). The common earthworm is also a hermaphrodite. Two animals copulate, and mutual cross-fertilization occurs, with each inseminating the other. In some hermaphroditic species, self-fertilization is prevented by the development of testes and ovaries at different times.

Sexual reproduction increases genetic variability

Asexual reproduction is actually the fastest and most efficient way to reproduce. Compared to asexual reproduction, sexual reproduction is more expensive in terms of energy, because the animal must produce gametes and find mates. It is also less efficient, because two cells, rather than just one, are required to make a new organism. Why, then, do most animals reproduce sexually?

Many biologists hold that a major benefit of sexual reproduction is that it increases the *fitness* (reproductive success) of offspring. In contrast to asexual reproduction, in which an animal passes all of its genes to its offspring, sexual reproduction has the biological advantage of promoting genetic variety among the members of a species. Each offspring is the product of a particular combination of genes contributed by both parents rather than a genetic copy of a single individual. By combining inherited traits of two parents, sexual reproduction gives rise to at least some offspring that may be better able to survive than either parent. Also, because the offspring are diploid, they have a backup copy of their genes in case one copy gets damaged by mutation.

Although they generally agree that sexual reproduction has some selective advantage, biologists do not agree on the details. They are exploring several hypotheses, including the following. Sexual reproduction is advantageous because it permits beneficial mutations from each parent to come together in offspring that can reproduce and spread these mutations through the population. For example, certain beneficial mutations may permit animals to protect themselves from predators or resist parasites. Sexual reproduction provides a mechanism for such mutations to spread through the population.

Sexual reproduction also removes harmful mutations from a population. Mutations occur constantly, and most mutations are harmful. When animals reproduce asexually, all the offspring inherit all the harmful mutations. As mutations accumulate in a population, individuals carry a bigger and bigger load of harmful genes. In contrast, when animals with different mutations mate,

1. How would you distinguish between budding, Fragmentation, and parthenogenesis?
2. What are the advantages + disadvantages of asexual Reproduction compared to sexual Reproduction?