3.4 Development of the Zygote

3B — Investigation

Examining Seeds

To perform this investigation, turn to page 100.

In this investigation you will dissect corn and bean seeds to identify the embryo and other seed structures.

LEARNING TIP

As you read about seed and fruit formation in a tomato plant, use the labels, lines, and arrows in Figure 1 to follow the explanation.

Once sperm and egg have fused to form a zygote, the zygote divides and becomes an **embryo**. The embryo is the developing organism. The embryos of sexually reproducing organisms are protected when they develop inside seeds, eggs, or the mother. **3B — Investigation**

Seeds

In plants, the ovary becomes the fruit. Figure 1 shows how seeds and fruit are formed in a tomato plant. Once the egg has been fertilized in the ovary of the flower, it is called a **seed**. The seed contains the embryo, as well as stored food. This food nourishes the developing plant until it is able to produce its own food using photosynthesis. The food in the seed is in the form of starch or sugar. Much of the world's food comes from the seeds of three plants: corn, rice, and wheat (Figure 2). Sometimes the fruit that surrounds the seeds contains sugar and tastes sweet. Apples and tomatoes are fruits we eat because of their sweet taste.

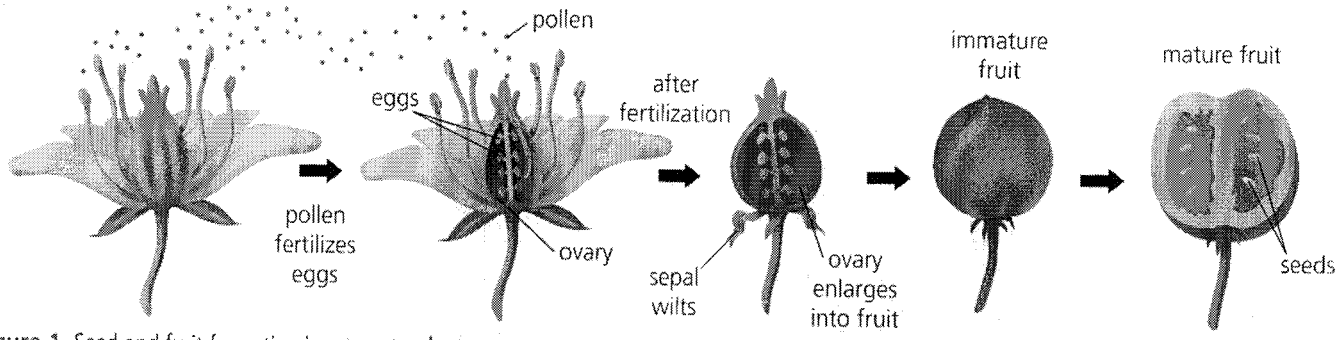


Figure 1 Seed and fruit formation in a tomato plant

Figure 2 Plant seeds, such as these corn seeds, are a source of food.

Seed Anatomy

Flowering plants produce two different types of seeds. Seeds contain seed leaves, called **cotyledons**. Bean plants are called dicotyledons because they produce seeds with two seed leaves. Corn plants are called monocotyledons, because they produce seeds with only one cotyledon.

Bean and corn embryos both contain structures that will develop into the main structures of a plant (Figure 3). Once the seeds **germinate**, or start to grow, they will use the food in the cotyledons. In a corn seed, the endosperm supplies food. The **radicle** is a part of the embryo that will develop into the roots. The **epicotyl** becomes the stem and the leaves. In beans, the **hypocotyl** pushes up through the soil and protects the epicotyl. The cotyledons get smaller as the embryo grows and the food is used up. Once the first leaves develop, the cotyledons will drop off (Figure 4). In corn, epicotyl grows straight up through a tube.

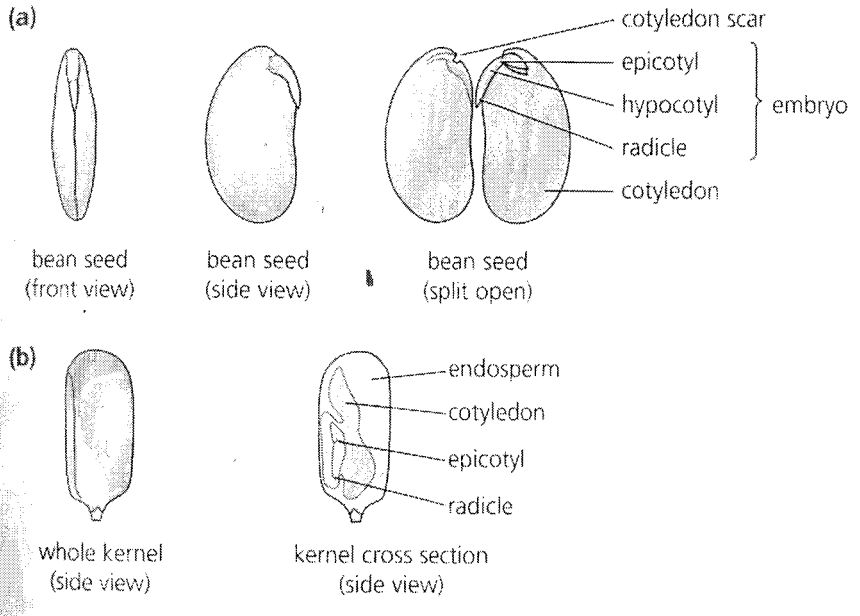
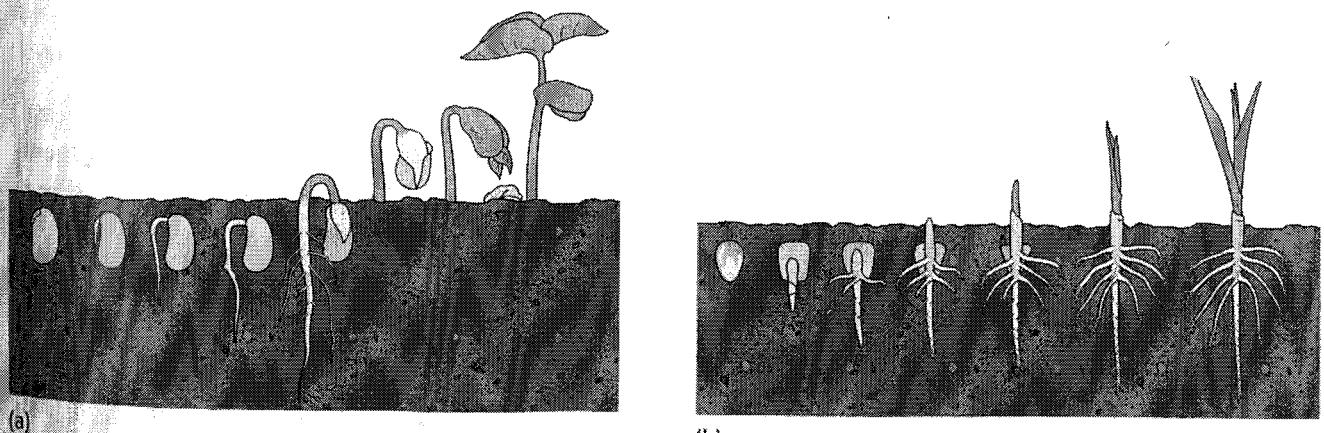


Figure 3 Anatomy of a bean seed (a) and a corn seed (b).

Did You KNOW?

It Doesn't Float

The world's heaviest seed comes from the fruit of the coco de mer palm tree, which grows in the Seychelles Islands. A mature seed can reach a mass of 17.6 kg. The fruit takes six to seven years to ripen and the seed takes two years to germinate.

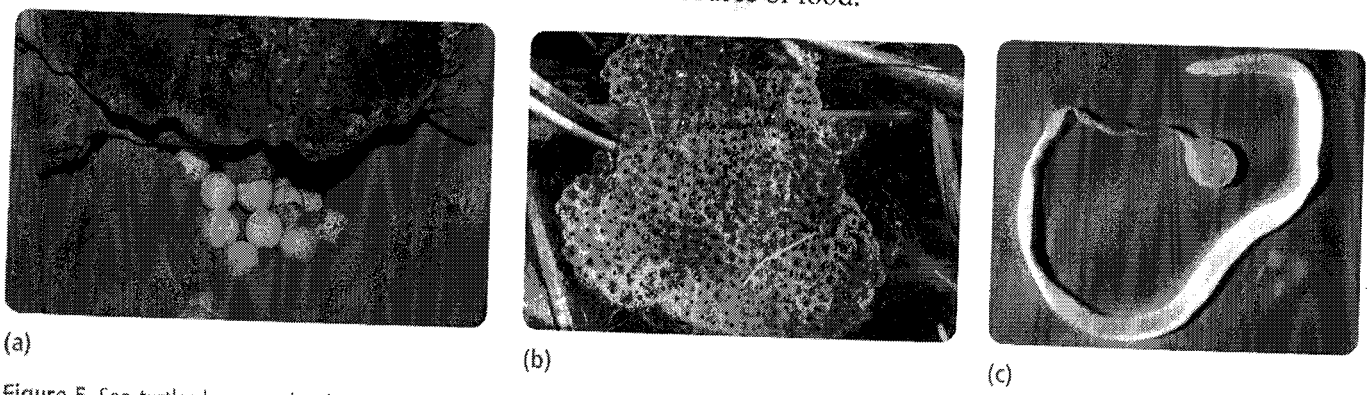


(a) (b)

Figure 4 Germinating bean (a) and corn (b) seeds

Eggs

The vast majority of animals lay eggs. Eggs that are laid contain the zygote, some nutrients, and a mechanism for protection, such as a shell, a jelly-like substance, or an egg case (Figure 5). Some animals, such as tapeworms, produce a single egg case that contains thousands of embryos. The eggs of reptiles and birds contain a single embryo surrounded by a shell. This type of egg is called an amniotic egg. Figure 6 shows the structures in an amniotic egg. The embryo is cushioned by the amnion, which is a fluid-filled sac. The yolk sac stores food for the embryo. The allantois holds wastes produced by the embryo. The chorion, along with the allantois, controls the movement of gases and wastes in and out of the egg. Albumen also cushions the embryo and is an additional source of food.



(a) (b) (c)

Figure 5 Sea turtles lay eggs that have soft shells (a). Each frog's egg (b) is surrounded by a jelly-like substance. A tapeworm produces an egg case (c), the circle at the end of the worm. Each egg case contains thousands of eggs.

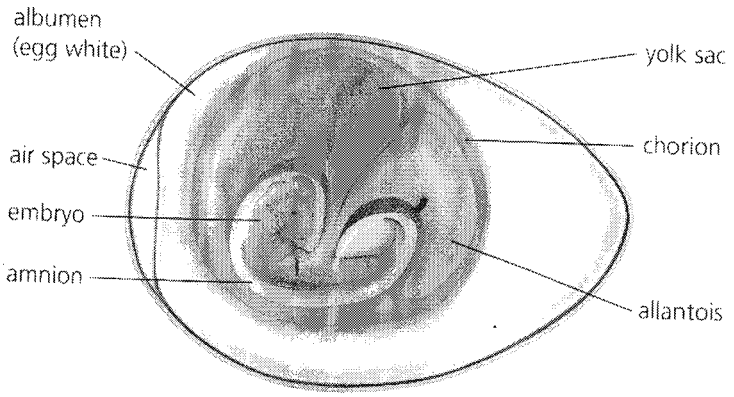


Figure 6 This amniotic egg is a self-contained environment in which the embryo develops.

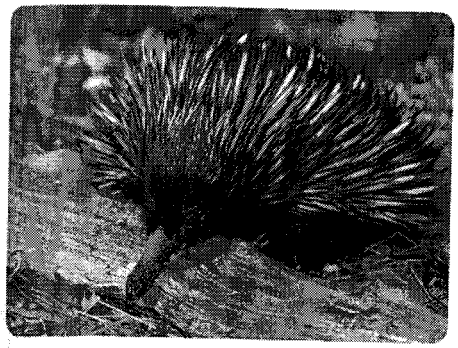
Just as there are many types of eggs, there are many levels of parental care of the eggs. Birds keep their eggs warm by sitting on them or insulating them with their feathers. Sea turtle mothers dig a hole in the sand, lay the eggs, bury them, and leave. When the eggs hatch, the hatchlings must dig their way to the surface and then crawl down the beach to the ocean. Many do not survive. Adult parasitic tapeworms live in the intestines of animals (Figure 5(c)). They release egg cases that contain thousands of eggs. The egg cases break open, and the eggs are released into the grass in the feces of the animals. The eggs are protected from drying out, but may be eaten by other grazing animals. The eggs that are eaten will travel to the intestines, where they will develop into adults and feed on digested matter.

Did You KNOW?

All Eggs Are Not Equal

The largest egg is the ostrich egg. It has a mass of 1.5 kg. The smallest egg is about 3000 times smaller than the ostrich egg. It has a mass of half a gram and belongs to the bee hummingbird.

Mammals that lay eggs are known as monotremes (Figure 7). There are only three living species of monotremes: the duckbill platypus and two species of spiny anteater. All the species live either on the continent of Australia or on the island of New Guinea. Like birds, these mammals care for their eggs during incubation. The platypus lays its eggs in burrows and incubates them until they hatch. The spiny anteater lays its eggs in its pouch, where they are incubated.



(a)

(b)

Figure 7 The short-beaked spiny anteater (a) and the duckbill platypus (b) are egg-laying mammals.

Embryos Develop in the Mother

The embryos of all mammals, except the spiny anteaters and platypus, develop inside the mother.

Marsupials include kangaroos, koalas, and opossums. These animals' embryos do not develop for very long inside the mother's uterus, so the young are born very tiny and immature. The young actually climb from the birth canal through the mother's fur into a pouch, where they attach to a nipple of a mammary gland (Figure 8). Even after they are mature enough to leave the pouch, they return to it for feeding and security.

The embryos of placental mammals, such as humans, develop inside the mother for much longer than the embryos of marsupial mammals. The word placental comes from the word placenta (Figure 9), which is the organ that develops around the fetus (developing offspring) and connects to the mother. The fetus is attached to the placenta via the umbilical cord, which carries wastes out of the fetus and nutrients into the fetus. You will learn about the development of a human fetus in Chapter 4.

Figure 8 When marsupial mammals leave the womb and enter the pouch, they still resemble embryos.

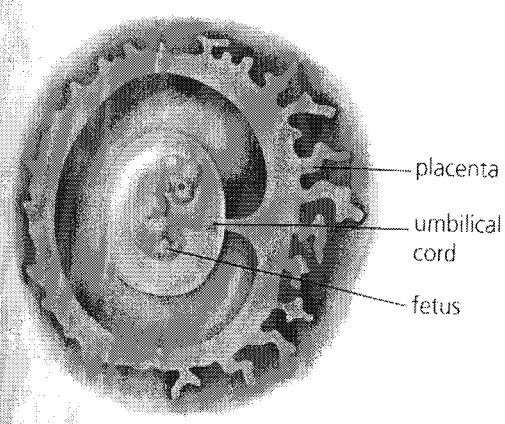


Figure 9 The umbilical cord connects the fetus to the placenta.

3.4 CHECK YOUR Understanding

1. Name three ways that embryos are protected in sexually reproducing organisms.
2. What are two forms of nutrition that are found in plant seeds?
3. Identify the seeds in Figure 10 as monocotyledons or dicotyledons.

(a)

(b)

(c)

(d)

Figure 10

4. What conditions are necessary for germination?
5. (a) What structure in a seed develops into a stem?
   (b) A seed can be a monocot or a dicot. Explain the difference between the two.
6. List three types of egg protection.
7. (a) List two species of egg-laying mammals.
   (b) In what parts of the world would you find these mammals in the wild?
8. Describe the path of the eggs of a parasitic tapeworm.
9. What are the similarities between the mammals in Figure 11?

(a)

(b)

Figure 11

10. List two structures associated with the placenta.
11. If plants can produce their own food during photosynthesis, why does a plant seed contain nutrients as well as the embryo?
12. Compare the three types of mammals in terms of where the embryo develops.
13. Compare the development of the zygotes of a bird, a tapeworm, and a horse by listing the advantages and disadvantages of each method of reproduction in a table.