

Core Concept

Biodiversity

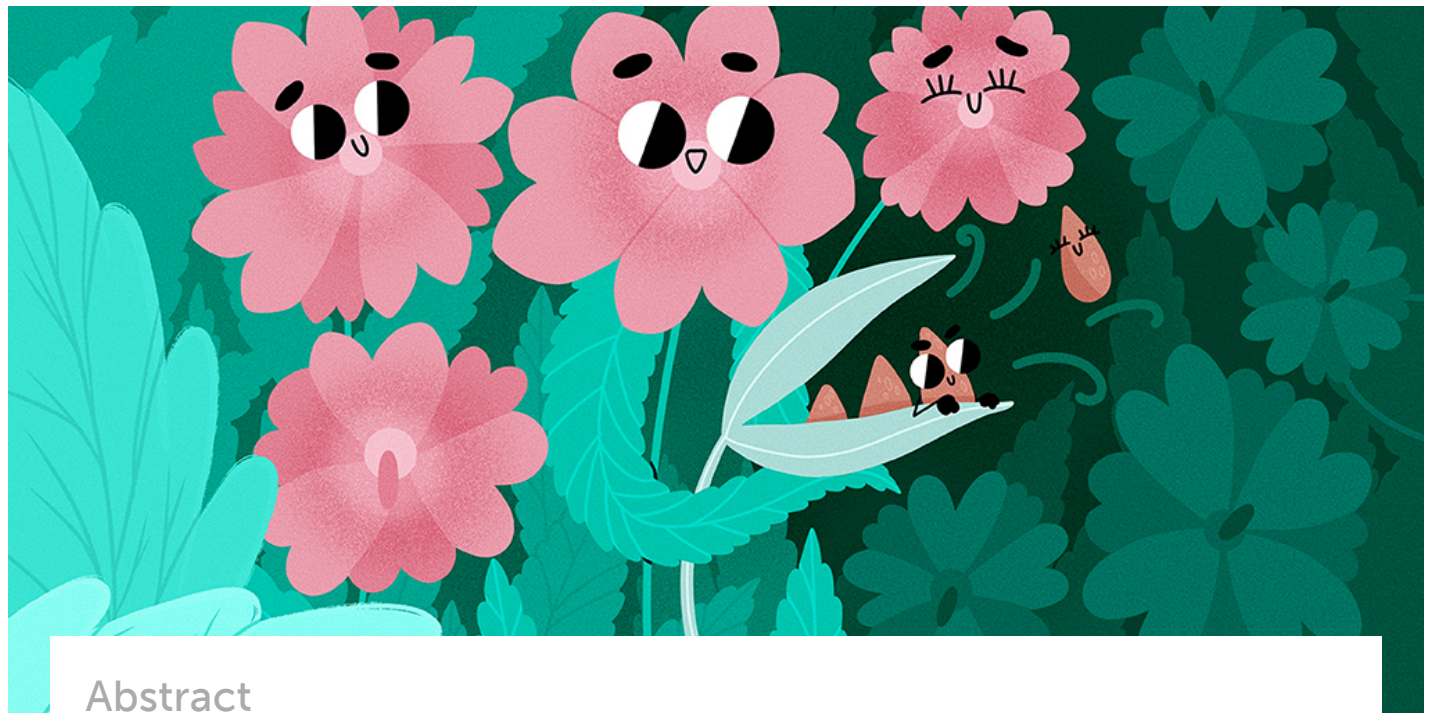
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How Seeds Shape Our World

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Abstract

Have you eaten bread or rice recently? Or maybe something with oil in it? If you said yes, then you were likely eating foods made from seeds. Seeds are an

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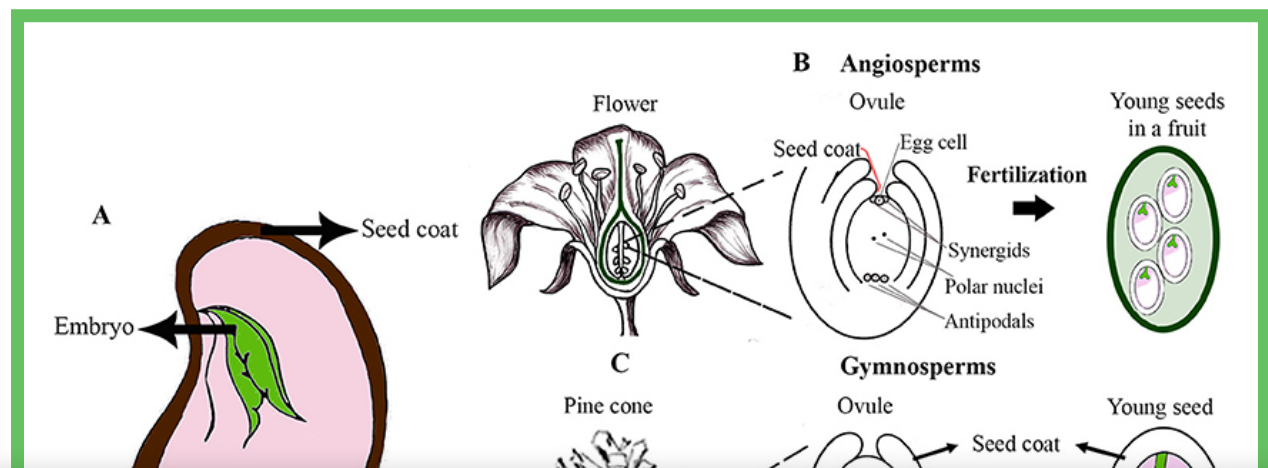
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they make new plants? Why do seeds grow when you plant them and not in seed packets in the store? Keep reading and you will find these answers, and learn how fascinating, complex, and extraordinarily diverse seeds can be.

The World Of Seed Plants

From the cereals you eat for breakfast, the coffee your parents drink, to your cotton clothes, seeds surround us and have a direct impact in our lives. Plants that make seeds (called seed plants) are all around us and they come in all shapes and sizes. In fact, seed plants are the most abundant group of plants on Earth and they can be found in all kinds of environments. It is important to know that seeds themselves have played a key role in the amazing diversity and abundance of seed plants.

A seed has three main parts: the **embryo**, a nutrient-providing tissue (often called the **endosperm**), and the **seed coat** (Figure 1). The embryo is the “baby plant”, meaning it is the new generation that will come from the parent plant. In general, the majority of the seed is made of the endosperm, which provides the embryo with all the nutrients it needs to survive until it **germinates** and grows into a new plant. The seed coat forms a protective layer over the endosperm and the embryo, providing a safe environment for the embryo to develop. It acts as a barrier against environmental dangers (bacteria, viruses, or fungi) that can hurt the embryo, which helps the embryo to survive for long periods of time. The seed coat can also play a role in determining when the embryo will germinate [1, 2].



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(B) Inside the flowers of angiosperms, the ovules begin to develop. If we remove an ovule and cut it in half, we can see the seed coat has two layers and has eight cells inside. Once the ovule is fertilized by the pollen, it becomes the seed. In angiosperms, the seeds are always covered by a fruit (C) Seed development in gymnosperms, as illustrated with a pinecone. You can see that the seed coat has only one layer. Development of the ovule into a seed takes longer in these plants.

There are two main groups of seed plants: flowering plants, called angiosperms, and plants without flowers, called gymnosperms (Figures 1B, C). Angiosperms include all plants that produce flowers and fruits. The female part of the flower develops into the fruit, which protects the seeds and helps spread them to new places [1]. Fruits can do this by making themselves tasty to animals or by flying with the wind. What about gymnosperms? The name comes from the Greek phrase for “naked seed”. This refers to the fact that this group of plants does not produce a fruit, so the seeds are directly visible. Conifers (like pine trees) and ginkgo are two examples from this plant group (Figure 1C). Even though gymnosperms do not have fruits, they have developed strategies to spread their seeds. For example, many gymnosperms house their seeds inside seed cones until they are ready to be spread, at which point the cones open up.

Where Does A Seed Come From?

The earliest stage of the seed is known as the **ovule**. Ovules begin to develop into seeds through the process of fertilization. As in animals, fertilization occurs when a male reproductive cell, which in plants is the **pollen**, fuses with a female reproductive cell, which comes from the ovule, to give rise to a new plant—the embryo (Figure 1).

Interestingly, not all plants have seeds! Mosses and ferns are two examples of these. Before the emergence of seed plants around 400 million years ago, Earth was dominated by plants like mosses and ferns whose embryos are not protected by a seed coat; therefore, these species are more sensitive to harsh conditions in the environment. The origin of the seed remains unclear, and scientists are still trying to find answers. But we know that thanks to the seed coat, seeds can survive many adversities, and seed coats have given seed plants an extraordinary advantage.

What Causes A Seed To Start Growing?

If you have ever tried to grow plants from seeds, you may have noticed that seeds do

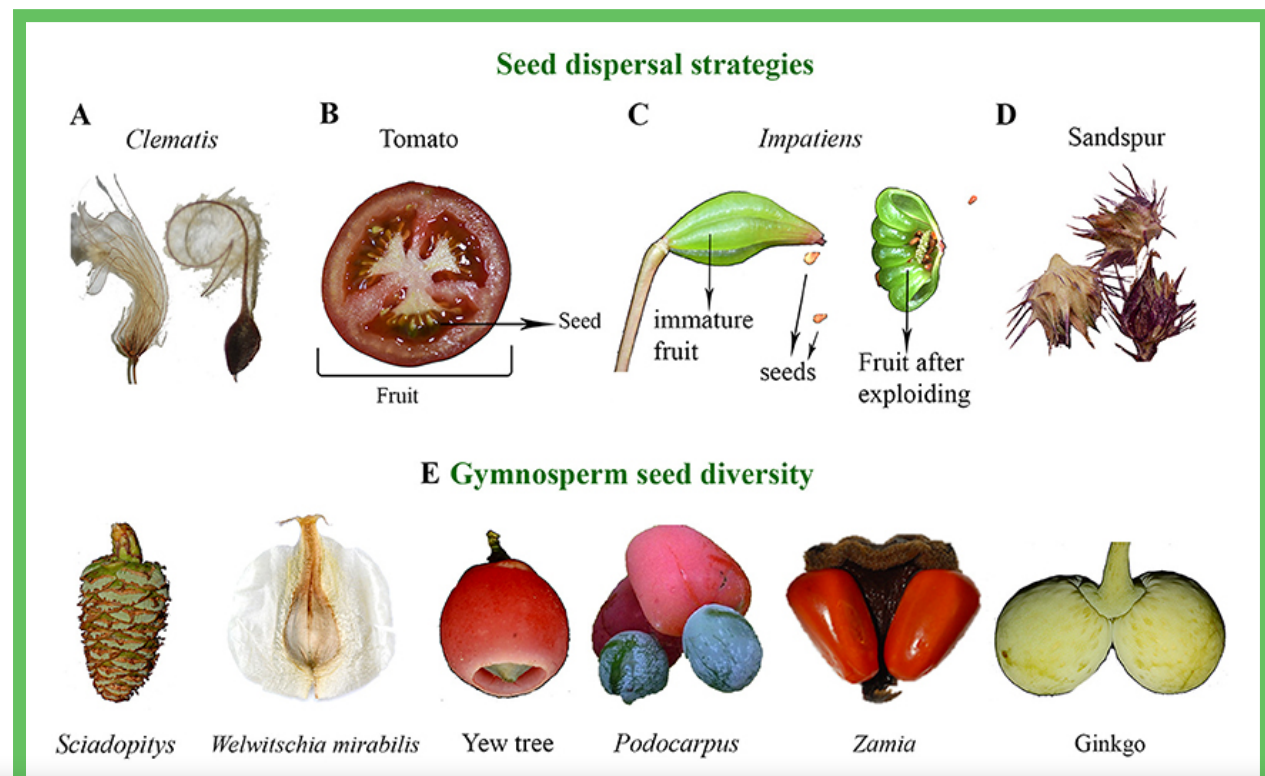
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most seeds will not start growing until they have received the right amounts of sunlight and water. Some plants have more extreme requirements to “break” dormancy. In cold climates, seeds that are produced in the fall often require exposure to extreme cold before they can break dormancy, to prevent the embryos from germinating too early during the winter and freezing. Seeds from environments that experience regular fires, such as prairies, often require heat or smoke exposure to break dormancy [2]. Because fires clear out much of the existing plant competition, when these seeds come out of dormancy, the new plants have lots of space and nutrients to grow. Scientists can manipulate dormancy signals to cause seeds to germinate, or to keep seeds dormant for a long time in order to store them.

How Do Plants Spread Their Seeds?

Seeds come in many shapes and forms, from those as large as your head to those that can only be seen with a microscope. All these seeds need ways to spread from the parent plant, which is called **dispersal** (Figure 2). There are four main types of seed-dispersal strategies [4].



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First, seeds can be dispersed by the wind. If you have ever blown on a dandelion puff, you were helping disperse its seeds! Those white tufts carry the seeds, and they can fly as far as the wind takes them. Other examples of plants with seeds dispersed by wind are orchids, swan plants, maples, cottonwoods, and *Clematis* (Figure 2A).

Second, seeds can be dispersed when animals eat them. This method is often found among plants with fruits or berries around their seeds. These structures are usually tasty or attractive, to entice animals to eat them. The animal swallows the seeds as well, which then pass through the animal's digestive tract and are spread to new locations through the animal's droppings. Some animals eat the fruit (like cherries and peaches) and throw the seeds away. Humans also spread seeds this way (Figure 2B)! This dispersal method does not work for all plants though—some plants produce highly toxic seeds to prevent animals from eating them.

Third, some plants use a fun and dramatic way to disperse their seeds, called ballistic release. In these plants, the fruit splits open and explosively catapults the seeds with great force, so the seeds fall to the ground some distance away from the parent plant. This ensures that the new plants will not compete with the parents. One example is a plant called impatiens or Busy Lizzies, which you might see decorating gardens (Figure 2C).

Finally, some seeds have special thorns or barbs that stick to feathers, animal fur, or a person's clothing as they pass by, until they eventually fall off in a new location. Examples of plants that use this "hitchhiking" method include burdock and sandspur, commonly called "stickers", which are abundant in the southern United States (Figure 2D).

Gymnosperms have also found unique ways to protect and disperse their seeds, and their seeds also come in an enormous diversity of shapes and colors (Figure 2E). The typical cones found in pine trees are difficult to break, protecting the seeds inside. There are also winged seeds from plants like *Welwitschia* that use wind dispersal, and colorful and fleshy seeds that are dispersed by animals.

Seeds We Eat

It is easy to think of eating sesame or sunflower seeds, but there are many other common foods that also come from seeds! Grains such as rice, wheat, and corn can be

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pine nuts and ginkgo nuts (**Figure 2**). Seeds can make good foods because the endosperm holds lots of nutrients. However, these nutrients vary from plant to plant, and some species produce seeds that are not edible (like avocado) or are poisonous to eat (like castor bean). The next time you are outside or at the grocery store, see how many kinds of seeds you can identify, and remember the wonderful diversity of seeds that exist and how important they are to the lives of plants, too.



Figure 3 - Examples of seeds that are important food sources.

It is important to note that the seeds in this image have been treated so that they are edible and will last a long time—this is not what the seeds look like on the plant.

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Germinate: ↑ When the new plant breaks out of the seed because the conditions are good for the plant to grow.

Ovule: ↑ Young stage of the seed, which includes the female reproductive cell.

Pollen: ↑ The male reproductive cell.

Dormant: ↑ When a seed is “waiting” for the proper conditions to germinate and grow.

Dispersal: ↑ The spreading of seeds to new locations away from the parent plant.

Edible Seeds: ↑ Seeds that can be safely eaten by humans.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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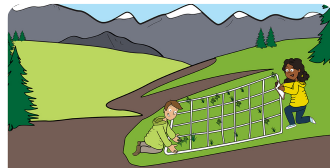
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