What is Pollination?

The transfer of pollen by wind, water or insects is essential to the production of seeds (illustration by Cara Dawson)

Pollination is the first step in the process of sexual reproduction in plants.

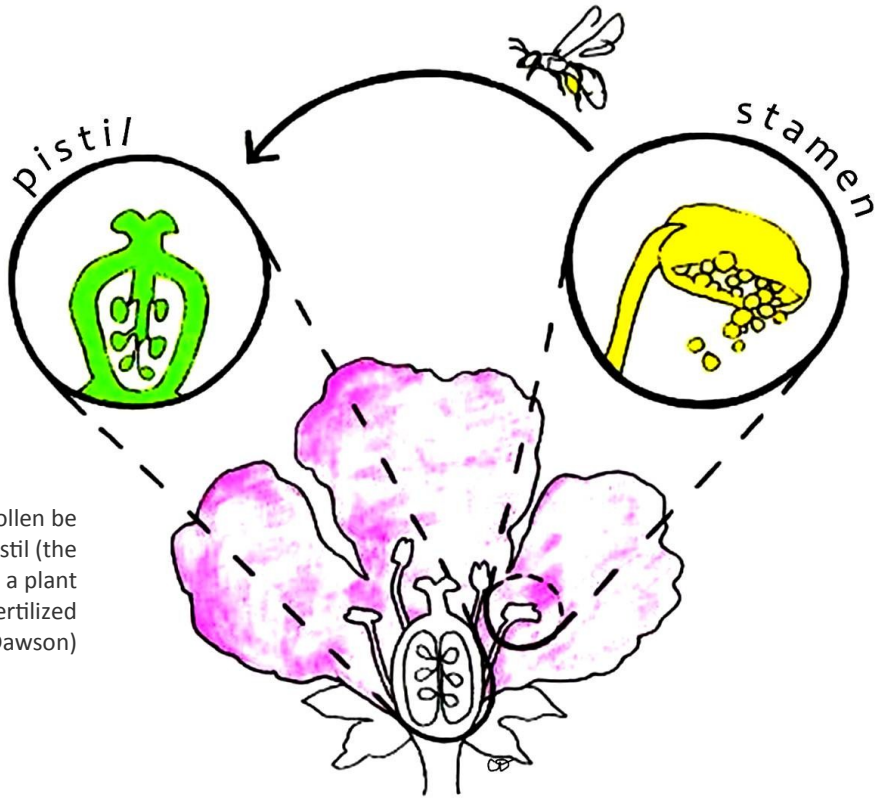
In pollination, a male pollen grain is transferred to the female part of a flower, germinates and fertilizes the ovule. All of these steps must occur for a seed to develop. Without pollination, the production of many of the seeds and fruits that we eat would not be possible.

As in all sexually reproducing organisms, mating in plants results in offspring that contain genes from both parents. Unlike animals, plants cannot seek each other out. They must rely on wind, water, or animals to move pollen between plants. Wind is responsible for pollinating many staple crops such as wheat and corn, but many Ontario crops rely heavily or completely on insects for pollination. Bees are the most commonly discussed pollinators, but many other insects and even vertebrates can play a role (see **Pollinators**).

Insects that visit flowers are in search of **pollen** and **nectar**. Most flowers produce nectar just to attract pollinators. The higher the concentration of sugar in the nectar, the more attractive it is to pollinators. Nectar can also contain other useful compounds such as lipids, amino acids, vitamins, and minerals. Pollen is high in protein, carbohydrate, lipids, and vitamins. It is valuable to some adult insects as a food source, and especially to bees looking for food for their young (larvae). A **nectary** (nectar-producing organ) is usually positioned within the flower so that visitors to the flower have to contact the reproductive organs to access the nectar.

Plants that can self-fertilize (i.e., are self-compatible) can still benefit from cross-pollination because it can lead to more fruit or higher quality fruit. In these plants, self-pollination is often an emergency back-up mechanism in case cross-pollination does not occur. Because plants prefer to invest their resources in cross-pollinated offspring, self-pollination often produces fewer fruit, or fruit that is smaller or misshapen.

Flower Anatomy & Function



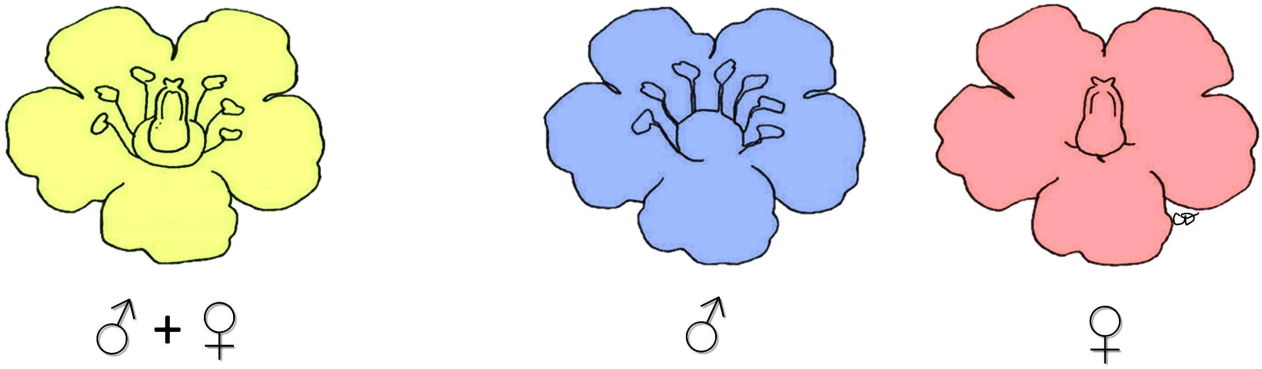
All plant reproduction requires that pollen be transmitted to the female organ, or pistil (the exception is *agamospermy*, in which a plant produces viable seed without being fertilized (illustration by Cara Dawson)

There is an incredible variety of floral shapes in nature, but they are all derived from the same basic structures.

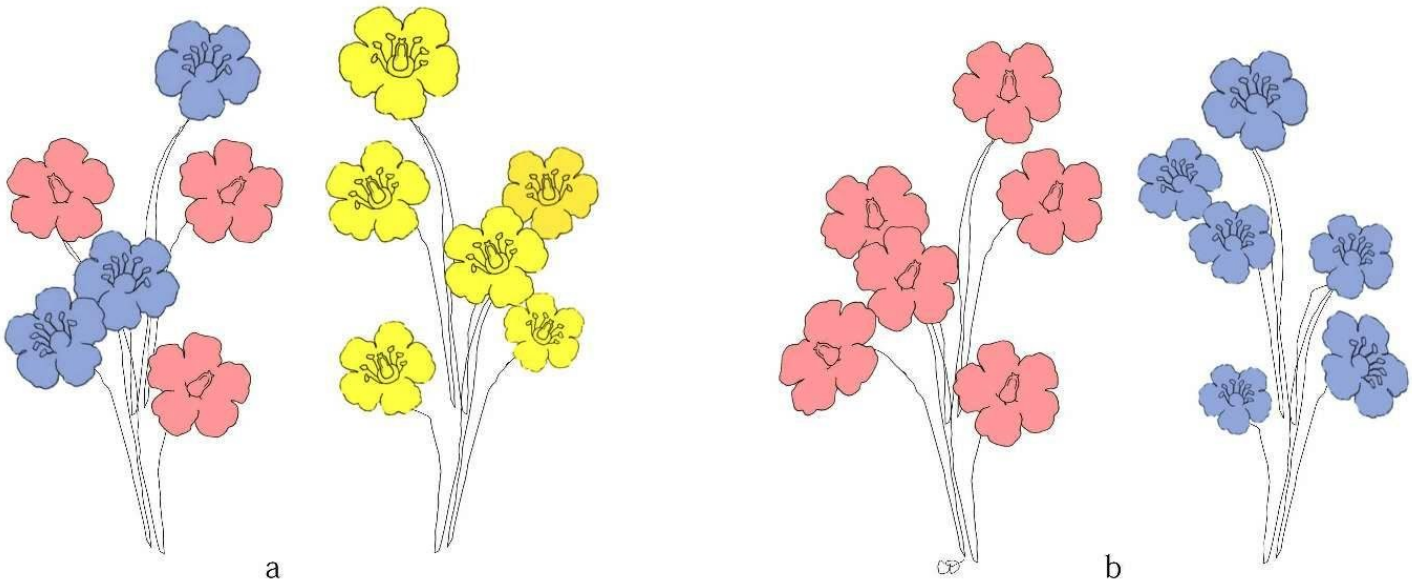
Pollen is produced by the male organ, called the **stamen**. The stamen consists of an **anther** atop a long **filament**. Pollen grains released by the anther are picked up by visiting insects or the wind. When a pollen grain reaches the female pistil (which may be on the same or a different flower), it germinates on the **stigma**, forming a pollen tube that grows through the **style** and into the **ovary**. The fertilized **ovules** then develop into seeds.

Flowers may have male or female organs (called *imperfect flowers*), or both (referred to as *perfect flowers*). Examples of crops with perfect flowers include apples, cherries and legumes; crops with imperfect flowers include squash, cucumber and corn.

These terms should not be confused with those that describe the plant as whole. A species may have individual plants that produce either male or female flowers (*dioecious*, from the Greek for 'two houses'), or plants that produce both (e.g., hermaphrodite or *monoecious*, 'one house'). In those species that are monoecious, individual plants may have their male and female functions in separate (imperfect) flowers, in perfect flowers, or they may have two or even all three of the flower types. Monoecious plants may also have sexual functions separated in time. This means that the pollen production and stigma receptivity to the pollen occur at different times. All of the crops covered in this website are monoecious, but may have perfect or imperfect flowers.



A *perfect* flower has both male and female parts (left) while *imperfect* flowers have either male or female parts (illustration by Cara Dawson)



(a) Example of a *monoecious* plant species with separate male and female flowers (left) or perfect flowers (right) on the same plant. (b) Example of a *dioecious* species, in which male and female flowers are located on separate plants (illustration by Cara Dawson)

Inbreeding (self-fertilization or fertilization by close relatives) can reduce the vigour and health of living things. An inbred plant may perform poorly and leave fewer offspring. In a crop plant, this may mean lower yields. While plants do not suffer as rapidly or severely from inbreeding as animals do, most have ways to reduce or eliminate the possibility of self-fertilization. Self-fertilization is usually only a back-up mechanism in case cross-pollination does not occur. The most effective way to ensure cross-fertilization is for plants to be dioecious, but these plants have no alternative in the event that cross pollination does not occur.

There are many different ways that plants avoid self-fertilization. These include physical separation of male and female flower parts on the plant, or staggering the fertility of male and female flowers over time. Some plants may prevent self-fertilization by chemically preventing germination of their own pollen on the stigma.

There is great structural diversity among flowers in the plant kingdom. From left to right: crab apple, *perfect* flower; legume, *perfect* flower; squash, *imperfect* flower (female); squash, *imperfect* flower (male)

Wind Pollination

When pollen is transported by wind, this is called anemophily.

Pollen release in a conifer

Many of the world's most important crop plants are wind-pollinated. These include wheat, rice, corn, rye, barley, and oats. Many economically important trees are also wind-pollinated. These include pines, spruces, firs and many hardwood trees, including several species cultivated for nut production. Wind-pollinated plants do not invest in resources that attract pollinating organisms, such as showy flowers, nectar, and scent. Instead, they produce larger quantities of light, dry pollen from small, plain flowers that can be carried on the wind. Female structures on wind pollinated plants are adapted to capture the passing pollen from the air, but the majority of the pollen goes to waste.

While this website focuses on crop plants that rely on insect pollination, the physics of pollen release and transport on the wind, and subsequent capture by the female floral structures, is no less complex or worthy a topic than insect-mediated pollination.

Animal Pollination

When a plant relies on animals (including insects and vertebrates) to transfer its pollen, it is zoophilic.

Zoophilic plants use their flowers to advertise the presence of resources, including nectar and pollen to attract an animal pollinator. When the pollinator visits the flower to collect resources, it deliberately or accidentally picks up pollen on its body. As it goes on to forage, an effective pollinator will deliver some of that pollen to the receptive stigma of another flower of the same plant species.

For animal pollination to be successful, several things must occur. First, the pollinator must have viable pollen adhering to its body. Second, as it visits other flowers of the same plant species, the body parts that have the pollen on them must come in contact with a receptive stigma. Finally, enough of the pollen must be left behind on the stigma to fertilize the ovules in the flower. Often sufficient pollen is not left behind on the stigma during a single pollinator visit, so multiple visits are necessary.

Honey bee foraging on a flower