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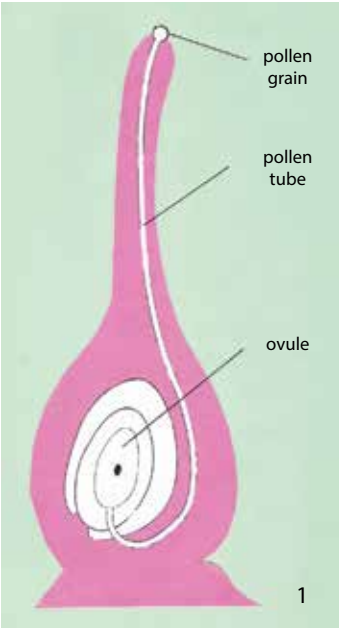
How plants work – seeds and fruits

Gail Summerfield

The one bright spark in the cold winter months of January and February is the arrival of the seed catalogues and the chance to look forward to the gardening year ahead. There's a huge temptation to have a go with any seed we fancy, often with little consideration of the form or requirements of the final plant. We may order seeds of whose hardiness we are not sure, seeds which require far more attention than we are prepared to give, and those which we may never sow.

Seed is the result of fertilisation, which is the fusing of the sperm from the pollen grain with the ovum from the ovary to produce an embryo. When the pollen lands on the stigma it takes up water from the air and is often said to have germinated. This involves the growth of the pollen tube from the pollen grain down the style to the ovary in order to deliver two male gametes to the female gamete in the ovule (fig. 1). One of the male gametes will fuse with the ovum to produce an embryo while the other will form the endosperm, a source of food for the developing embryo.

In flowering plants, the Angiosperms, the embryo develops into a seed complete with food reserves and a protective seed coat, the testa. The seeds are within the ovary wall, the pericarp, and together they form the fruit. In conifers or Gymnosperms, the seed is naked and sits on the seed-leaves of the cone, so if you prize open a pine cone you will find a winged seed on each leaf of the cone. In evolutionary terms, Angiosperms are considered to be the most advanced type of plants as the seeds are protected within the fruit, giving them a greater chance of survival until environmental conditions are favourable. For the botanist, the terms seed and fruit are specific: for example, in the poppy or *Papaver* family the seeds are enclosed within the ovary wall of the capsule, which is the fruit.



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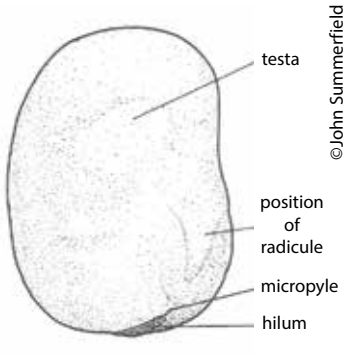

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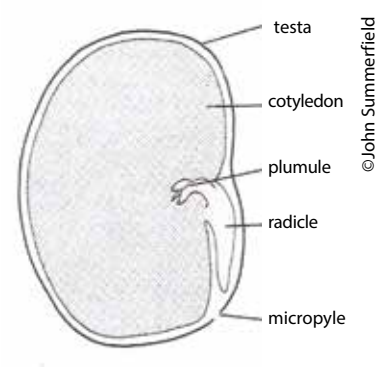

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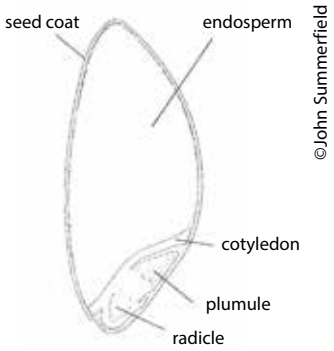

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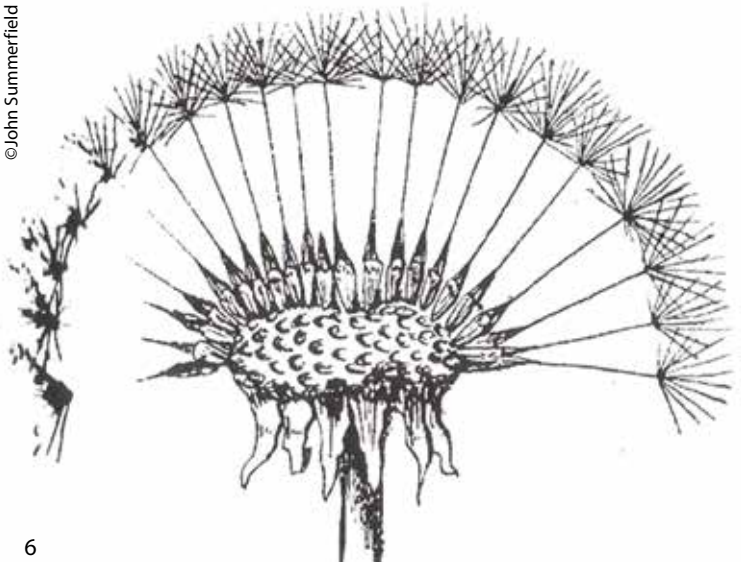
So tomatoes are fruits because they contain seeds, as are nuts and courgettes, and lettuce 'seeds' are really one-seeded fruits.

When fertilisation takes place, the DNA from the male and female gametes combines to make a genetically distinct plant. It follows that there should be no such thing as a plant coming true from seed; indeed, Fig. 2 shows the variation in young plants grown from the same batch of seed from one seedhead of *Miscanthus transmorissonensis*. So what we really mean is that the offspring closely resemble the parent plants although they are genetically different. If we want truly identical plants, we must propagate them vegetatively. However, in the horticultural production of some citrus fruits and mangos, the grower is able to exploit a natural phenomenon whereby more than one embryo is produced within the seed. In this case, one embryo is produced by sexual fusion but others develop from additional nuclei in the ovule and are identical with the mother plant (fig. 3). Rootstocks for these crops are produced this way.

Flowering plants are grouped into monocotyledons – grasses, bulbs and related genera – and dicotyledons, which are the majority of plants in our gardens. The distinction is in the number of cotyledons in the seed. A typical dicotyledon seed is shown in Figs 4a & 4b: it consists of two large cotyledons which contain the food reserves for the germinating seed and an embryo in which the first root – the radicle, and the first shoot – the plumule, can be clearly seen. The structure is protected by the seed coat or testa and the only direct access for air and water is through the micropyle, a tiny hole through which the radicle will emerge. In the monocotyledon seed shown in Fig. 5, the plumule, radicle and testa are present but the cotyledon is greatly reduced, its function of food storage taken over by the endosperm.

Germination is the onset of growth of the embryo and usually takes place after a period of dormancy, and it will occur at some point after fertilisation has taken place and the seeds have formed. We know that when we sow seeds, germination can take place at different times or not at all, depending on whether the seed is viable. Initially the seed will imbibe water through the micropyle and testa. Within the seed, proteins, starch and cell-wall materials swell with the intake of water and burst the testa to allow the radicle to emerge. There is usually a temperature range outside which the seed will not germinate, a range which may vary from 5– 40°C depending on the environmental conditions where the species originates. Oxygen is also necessary and, in most cases, light.

Seeds contain chemicals which inhibit germination and the moment the seed is released from the plant their effect begins to decline.



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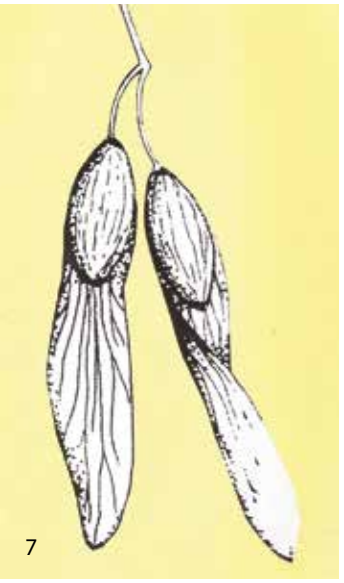

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Seed viability varies from species to species: willow seeds lose their viability within three days but most tree seeds will germinate after several years providing they have the right storage conditions. Undoubtedly the fresher the seed, the greater the viability, and in some cases it is wise to buy fresh seed every year: parsnips, *Cleome* and *Verbena bonariensis* are best grown from the previous year's seed. A packet of seeds bought at the end of the season will still be viable, but to a lesser extent. The germination of tree seeds is spasmodic, so sow them in a seed bed and prick them out into pots as they germinate. Sometimes we're advised to sow seeds in the green before the testa has hardened and the radicle cannot penetrate it. Another problem you may have encountered is the failure of lettuce and winter pansy seeds to germinate when sown in July and August. This is because the higher temperatures induce a secondary dormancy which is very hard to break. To prevent such a dormancy, place your seed trays in a cool place where temperatures do not exceed 26°C.

The conditions required for germination are specific to the plant and often seeds may need a combination of temperature cycles. In the garden these conditions are provided by the seasons, with often a week of warmth in winter followed by a cold snap. It's not uncommon for seeds to appear reluctant to germinate in the seed tray but, when you despair and empty the contents on to a border, a forest of seedlings appear. Not all plants are so fussy about the conditions needed for germination, and annuals very rarely fail to perform; of course, the expert germinators are the weed seeds which have adapted to germinate immediately the soil temperature is right, or when the soil is disturbed and they're exposed to light.

A viable seed is considered dormant if it fails to germinate when given appropriate water, temperature, oxygen and light. Obviously a dead seed will not germinate, but other factors come into play. Water is necessary to prime the chemical reactions which take place in the germinating seed – substances in solution are much more mobile and accessible to the plant. An increase in temperature speeds up plant processes, which also require oxygen.

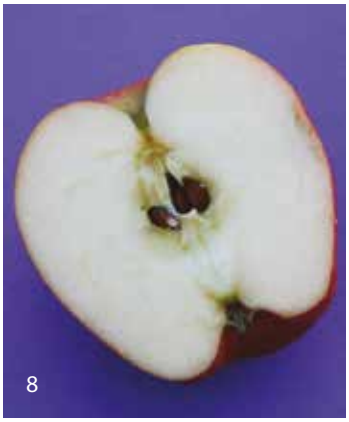
Light plays a role in germination, especially in woodland plants whose seeds are prevented from germinating when the leaf cover is dense. If the tree canopy is removed, the light reaches the seeds and triggers a change in the balance of chemical receptors within the seed, triggering germination.

Most of the seeds we sow will have developed within the ovary, protected by the wall or pericarp. In commercial production growers often use artificial hormones to stimulate the development of the fruit without fertilisation taking place. This explains the availability of seedless grapes, which are said to be parthenocarpic fruits.

Sources of seeds for the gardener are various. Most professionally packeted seeds are enclosed in a small vacuum-packed packet within a larger picture packet, which reduces the amount of oxygen available to the seeds, keeping them in a dormant state. Seeds from the larger seed companies tell you when they were packed and have a sow-by date. If you buy seeds offered at reduced prices they will probably have a lower percentage viability, so sow more of them for greater success. Seeds from small companies such as Plant World Seeds or internet sites often have a higher germination rate, and some unusual varieties of both ornamentals and edibles are available. Bearing in mind the variation which comes from open-pollinated seeds, select seedlings which closely resemble the parent plant. Unfortunately, accurate identification is not always achieved and plant-naming leaves something to be desired with all packeted seeds. This is also true of seed exchanges: we've all had surprises, pleasant or otherwise.

Most of our seeds are now collected in Europe where environmental conditions are more favourable. Seeds of many of the bedding and vegetable varieties are F1, which is the first filial generation, the result of a cross made between two pure strains. F1 seeds show a uniformity in germination and growth which is desirable for mass bedding or commercial vegetable production. The cross can be made only once so they are expensive to produce; if you're prepared to accept a degree of variation then F2 seeds are a cheaper option. F1 seeds are not genetically identical to one another, although they look the same; when the next cross is made between F1 seeds, the plants produced from this F2 seed will display greater variation.

Of course, it's possible to collect and save seed from our own plants, and often the germination rates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are high. Collection should be made in a paper bag when the seedheads are dry and almost ready to leave the plant. Store them in a cool, dry place until the seeds have fallen out of the fruits into the bottom of the bag. It's advisable to sow some of the seed immediately and retain the remainder until spring for a second sowing. Identifying seed is difficult in some families: for example, the daisy family produces a lot of material which is not seed. Most seeds have a hard testa and feel hard to the touch; it's important to remove as much of the chaff as possible because it is this material which will carry any fungal disease – seed-borne diseases are rare.

It can be fun to grow plants from your own seed, but the results are likely to be unpredictable. Good hygiene, accurate labelling, effective cleaning of the seed, and consistent and even watering and temperature regimes are necessary.

9a

9b

Once the seedlings have germinated, handle them by their leaves as damage can easily occur if their stems are touched and fungal infection may follow. Often planting seedlings deeper, so that most of the young stem is underground, will encourage roots to develop and improve stability.

The identification of garden plants is based on flower structure, and includes a description of the fruit. After the seeds have developed, either the entire fruit or the individual seeds are dispersed. If the ovary wall, the pericarp, becomes hard and dry it is referred to as a dry fruit, or if it's fleshy, a succulent fruit. Dry fruits may be dehiscent – releasing seeds by splitting, for example aquilegias, or indehiscent – intact like acers. Often the structure is governed by the method of dispersal so the fruits of the dandelion, a cypsela (fig. 6), have small parachutes attached; ash has a single winged samara (fig. 7); and the poppy a capsule from which seeds are shaken out by the wind and animals. Fruit which is dispersed by animals must offer a reward to the vector. All our fleshy fruits – apples (fig. 8) and pears (pomes), plums and blackberries (drupes), tomatoes and gooseberries (berries) and strawberries (achenes) (figs 9a & 9b) where the fruits are on the outside of the swollen receptacle – offer fruit to the animals which disperse them. They may have hard testas which need to pass through the animal or bird's digestive tract before the radicle can emerge. Self-dispersal is also practised to great effect by plants such as hairy bittercress (*Cardamine hirsuta*) and Himalayan balsam (*Impatiens glandulifera*).

Collecting seed from fleshy fruits is a little more time consuming as removal of the fleshy pericarp is necessary to ensure clean, dry seed. Seeds should be extracted either manually or by breaking up the flesh and mixing it with water: the pericarp and any non-viable seeds will float and can be removed, leaving viable seeds at the bottom of the container.

In this series of articles I have covered basic botany as it relates to gardening. Hopefully readers will be more informed when practising various gardening techniques; the best strategy is always to think 'plant first, gardener second!' I will leave you in the hands of my six-year-old grandson, who asked his class whether a tomato was a fruit or a vegetable, following up with what about a courgette? At this point his teacher admitted to googling under her desk. Perhaps you'll be more botanically confident when passing on your knowledge to the next generation of gardeners.

Gail Summerfield is a botanist and former lecturer in horticulture. In 1985 she started Westshores Nurseries, which has specialised in ornamental grasses for the past 23 years.