6.1 Natural and artificial clones of plants

Plant clones in nature and agriculture

Plant clones in nature

A **clone** is an exact genetic copy of an organism. It can be used to describe genes, cells or whole organisms which carry the same genetic material because they are derived from the same piece of DNA. Dizygotic twins (identical twins) are formed when the **zygote** splits into two, and so such twins are **natural clones**. When plants reproduce **asexually** by producing *runners*, the offspring are all natural clones of the parent plant: the genetic material comes from one place. The table below shows the main advantages and disadvantages of asexual reproduction:

- ✓ it is quick, allowing organisms to reproduce rapidly and so take advantage of resources in their environment
- ✓ it can also be completed where sexual reproduction fails or is not possible
- ✓ all offspring have the same genetic information which enables them to survive in their environment

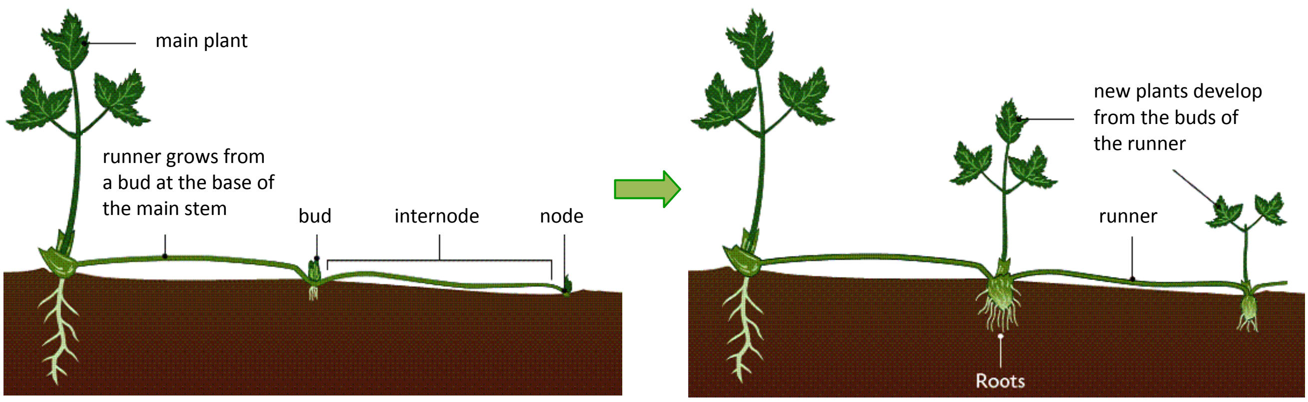
- ✗ it does not produce any genetic variation, so any genetic parental weaknesses will be passed on, and all members of the species will be susceptible to the same selection pressures
- ✗ likewise, with no genetic variety, this means that adaptations are reduced

Natural vegetative propagation

Vegetative propagation refers to the production of structures in an organism that can grow into new individual organisms. These offspring contain the same genetic information (and so are clones of) the parent.

A number of plant species, including the English elm tree, have adapted to reproduce asexually following damage to the parent plant, allowing the species as a whole to survive catastrophes, such as disease. New growth in the form of **root suckers** (or **basal sprouts**) appears within two months of the destruction of the main trunk. These suckers grow from meristem tissue in the trunk close to the ground, where the least damage is likely to have occurred.

Another method of vegetative propagation used by some plants is to use **runners**, small shoots which run along the ground and cause buds to grow which develop roots. The diagram shows how runners can produce offspring.



Other natural methods of vegetative propagation include specialised underground stems forming **tubers** – stems which become swollen full of nutrient molecules – from which new plants can grow. Potatoes grow in this way.

Artificial vegetative propagation

For a very long time now, farmers have been able to use **artificial** vegetative propagation methods to allow valuable plants to reproduce asexually, keeping their successful traits There are two main methods:

- taking **cuttings** – a section of stem is cut between leaf joints (**nodes**) and the cut end of the stem is then treated with plant hormones to encourage root growth, and planted – the cutting forms a new plant which is a clone of the original parent plant – this allows large numbers of genetic clones to be produced quickly
- **grafting** – a shoot section of a woody plant, such as a fruit tree or rosebush, is joined to an already growing root and stem (known collectively as a **rootstock**) and the graft will grow, being genetically identical to the parent plant, despite the fact that the rootstock is genetically different

Artificial propagation using tissue culture

Although these two methods are useful for producing clones, neither grafting nor taking cuttings can produce very large numbers of cloned plants with ease. Some plants don't even reproduce well under these methods. More modern techniques involve the use of **tissue culture** to produce huge numbers of genetically identical daughter plants from a small piece of starting plant material. This can be useful for generating large stocks of beneficial and advantageous plants, such as those which are immune from a particular disease.

The most common technique is **micropropagation**:

- a small piece of tissue, called an **explant**, is taken from the plant to be cloned, usually from the shoot tip
- the explant is placed inside a nutrient growth medium
- cells in the tissue divide, but do not differentiate, instead forming a large mass of undifferentiated cells, called a **callus**
- after a few weeks, single callus cells can be removed from the mass and placed on a growing medium containing plant hormones that encourage shoot growth
- after a further few weeks, the growing shoots are transferred onto a different growth medium containing different hormone concentrations, that stimulate root growth
- the growing plants will then be transferred to a greenhouse to be acclimatised and grown before they are planted

Evaluation of artificial vegetative propagation

For thousands of years, agriculture has sought to provide high quality crops, in terms of yield and resistance to environmental conditions such as disease, pests, weed and weather. Selective breeding over time has reduced the amount of genetic variation, as farmers have identified what they consider to be the favourable characteristics. Using methods such as a callus tissue culture in agriculture means that farmers know what their outcome crop will be like, as it is genetically identical and shares the features of the original plant, and also from a commercial side the farming costs are decreased as the entire crop will be ready at the same time.

Micropropagation is much faster than selective breeding, because huge numbers of genetically identical plants can be generated from a single valuable plant: but the disadvantage of using cloned plants is that genetic uniformity means that all individuals are going to be equally susceptible to the same diseases, pests or environmental conditions. This can cause a serious problem is these selective pressures arise. Farmers still grow crops to have genetic uniformity, but as a result, the distance between areas of specific crops are carefully controlled to limit the effects of a new pathogen to the farm.