ÁGNES SZEPESI – LÁSZLÓ BAKACSY

PLANTS UNDER THE MICROSCOPE

Collection of plant specimens from Department of Plant Biology, University of Szeged, Hungary

SZTE | UNIVERSITY OF SZEGED

National Research, Development and Innovation Office
Hungary

PROJECT FINANCED FROM THE NRDI FUND

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Popular Science

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CONTENTS

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INTRODUCTION, PROLOGUE

In the 100-year history of the Department of Plant Biology at the University of Szeged, plant anatomy and plant organization have played and still play an important role not only in teaching but also in research. Over the past 100 years, a valuable collection of microscopic slides has been collected, which is still of inestimable value for today's biology students. Based on our experience in education, it is necessary to share the knowledge of plant biology in a scientific educational format, taking into account the objectives of the European Union, in accordance with the efforts of Open Science and Open Access. Using today's digital technological solutions, we have set ourselves the goal, within the framework of the Mecenatura call for proposals, of making this valuable collection, which even includes an engraving dating from 1954, freely available to everyone. For those who are interested, the book has been prepared with the most important and spectacular sections of plants that the reader may be familiar with, but whose internal structure they may not yet know. The illustrations in the book have been produced with the help of students, and an online database is being developed to present additional sections from the Department's collection. We believe that this publication can play an important role in stimulating public interest in plants and in helping people to develop their living conditions in a sustainable way by getting to know nature and putting biodiversity first. We hope that this publication will inspire many more people to take an interest in plants in the future.

Ágnes Szepesi
László Bakacsy

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The sections of the SZTE Department of Plant Biology have been serving students for decades

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MANUAL FOR USING THIS BOOK

This book has been created to introduce the reader to a special world. A world that is not always visible to the naked eye, although we sometimes hold, feel, eat, but still do not fully know the basic structure of plants. The digital developments of recent years include initiatives that bring us closer to this mysterious world. At the Department of Plant Biology of the University of Szeged, more than 200 types of cuttings await interested students. Microscopic sections of plants, which were previously only available to students and their instructors, have now been digitized thanks to the Mecenatura grant, and it is now possible to get to know the wonderful world of plants better by looking at the sections of the organs of the most interesting and well-known plants in the pages of this book.

STRUCTURE OF THIS BOOK:

- 5 types of plant category based on their application
- 21 plant species
- 49 different specimens

Abbreviations:

C.S. – cross-section
L.S. – longitudinal section
R.S. – radial section

In addition to the images of the plants, we see not only digitally produced cross-sectional images, but also a short description of what parts can be separated in the image.
We have also included many interesting facts about the plants that may be of interest to the reader.

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SZTE
Növénybiológia
Növény
Metszet
Sejttan
Sejt
Oktatás
Tudomány
Élet
Mikroszkóp
Botanika
Növényanatómia
Szövettan
Biodiverzitás
Növényvilág

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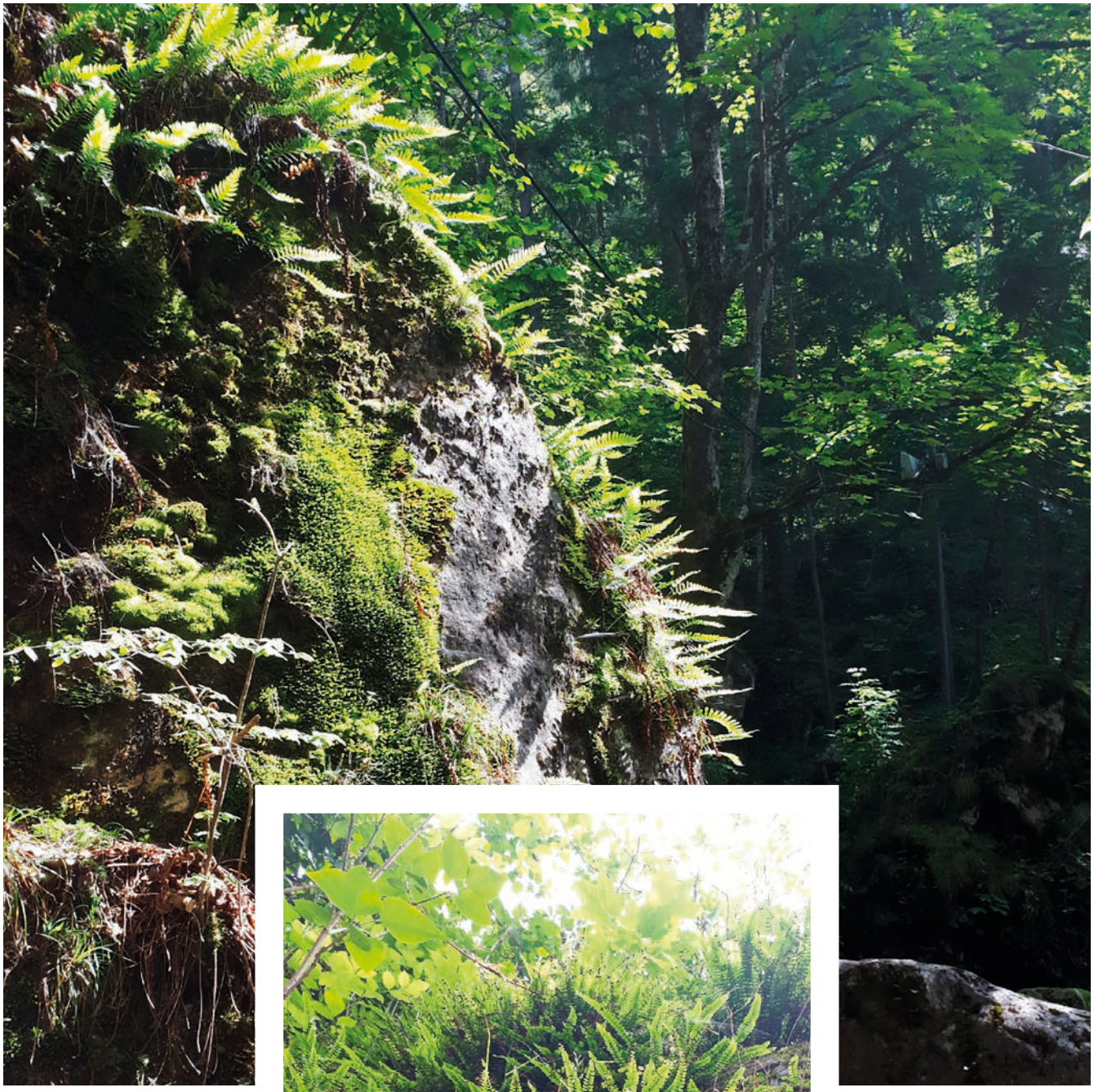
FERNS



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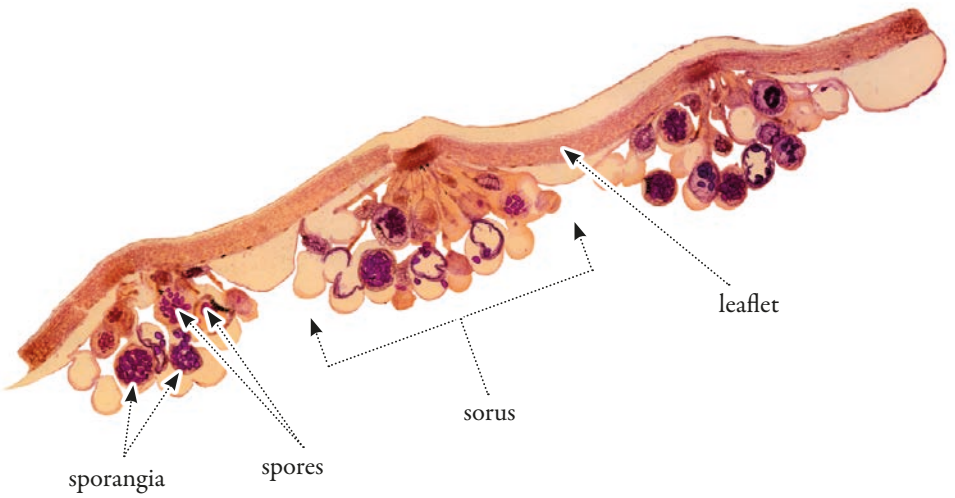
Polypodiaceae
Polypodium vulgare
COMMON POLYPODY

sorus L.S.

On the underside (back) of the leaf there are spore holders (sporangia) with a handle and a head, the groups of which form vertical lines (3 of them are visible in the section).
Together these tissues provide a suitable development environment and protection for the spores of the fern plant. The spores develop in them until they mature.

DO YOU KNOW?

- Unlike most ferns, which prefer humid conditions, the liquorice fern can live in dry conditions and can be found on old trees, rock faces and building walls.



Longitudinal section of sorus of common polypody

Polypodiaceae
Polypodium vulgare
COMMON POLYPODY

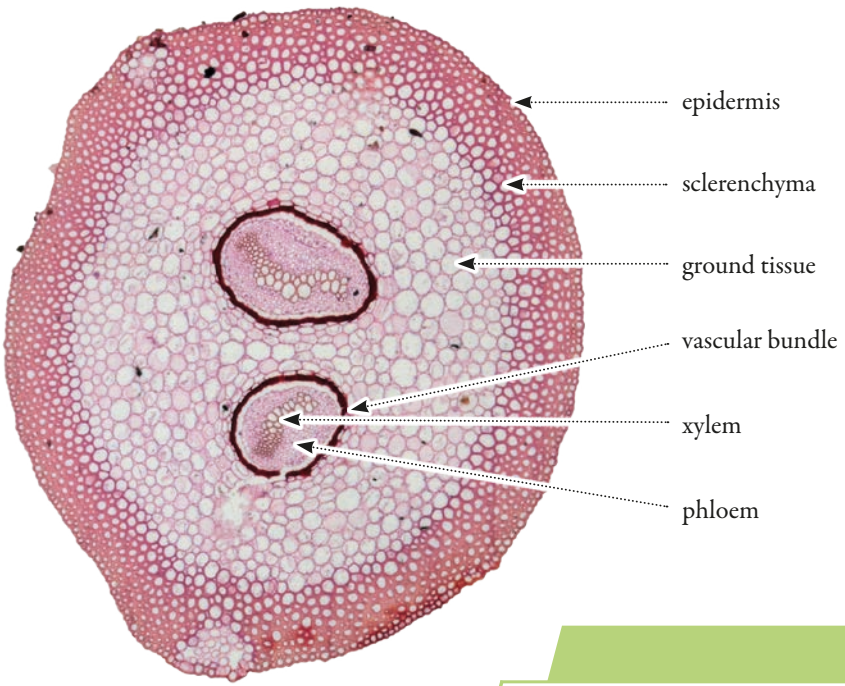
leaf stalk C.S.

The walls of the cells of the support tissue beneath the skin tissue are very thick, helping the leaf to stay in place and transport nutrients.
The wood and bark tissues in the stems transport water and nutrients.

DO YOU KNOW?

- Liquorice fern is an evergreen species, which means that it retains its green foliage throughout the year.

Cross-section of leaf stalk of common polypody



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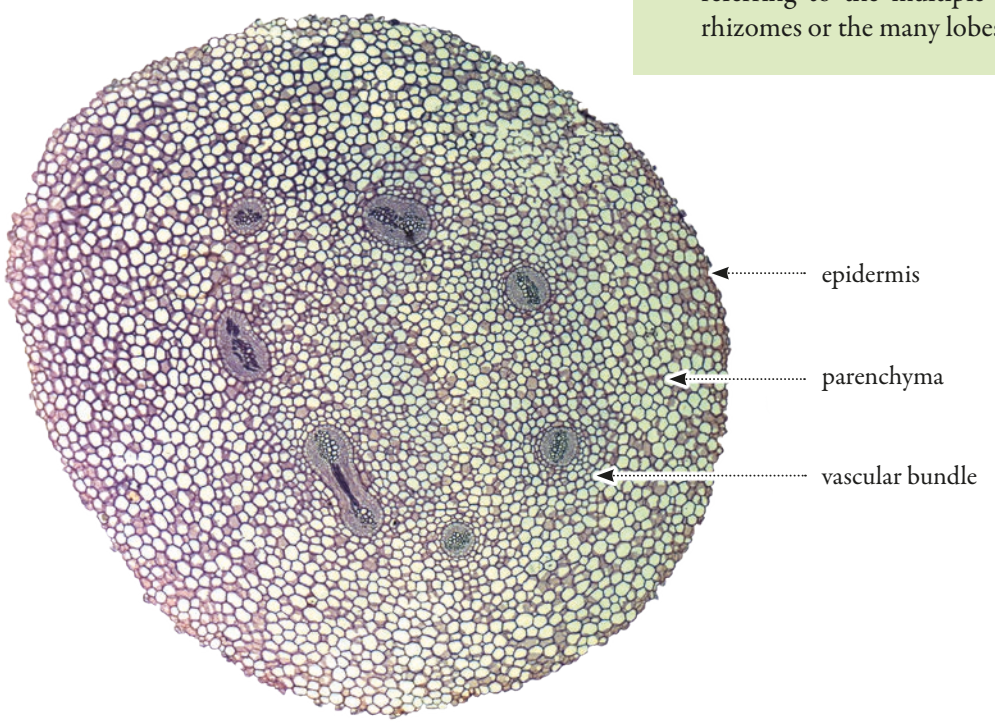
Polypodiaceae
Polypodium vulgare
COMMON POLYPODY

rhizome C.S.

The cortex, called the outer layer of the rhizome, is protected by an epidermis consisting of a single layer of narrow, thick-walled cells. Inside the bark is the stele, which contains vascular tissues arranged in a ring around the central cavity. This arrangement is called a dictyostele. The vascular tissues consist of xylem and phloem, which are responsible for the transport of water and nutrients in the plant, and much of the rhizome is filled with basal tissue.

DO YOU KNOW?

- Licorice fern has traditionally been used in cooking for its fragrance and sweet taste, and as a medicinal herb as a laxative and antiseptic.
- The name "Polypodium" is derived from the Greek word "podos" meaning foot, possibly referring to the multiple branching of the rhizomes or the many lobes on the leaves.



Cross-section of rhizome of common polypody

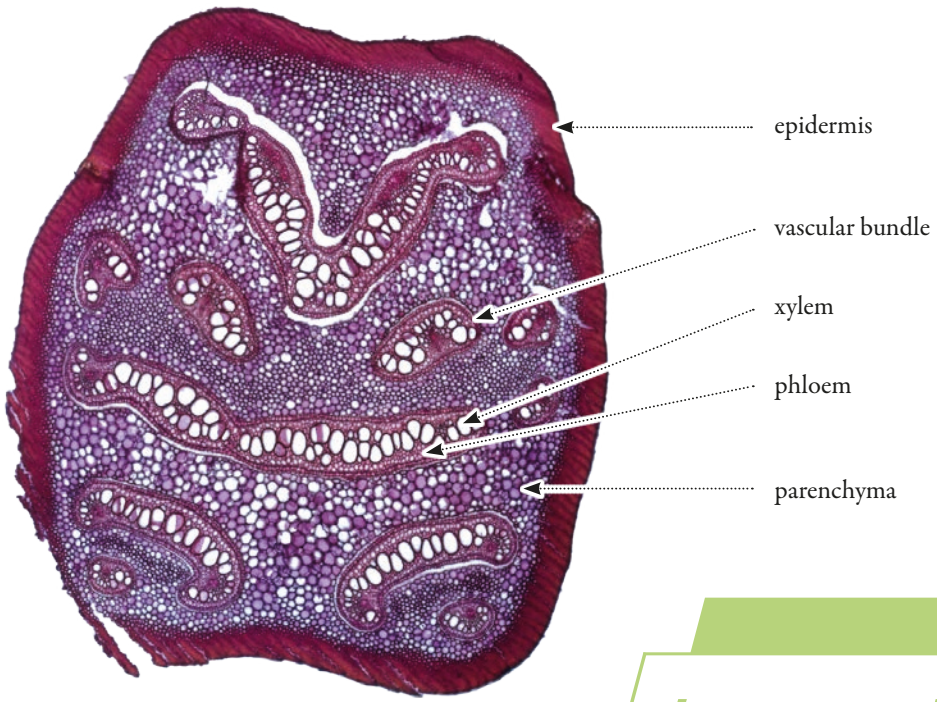
Dennstaedtiaceae
Pteridium aquilinum
BRACKEN, BRAKE,
COMMON BRACKEN, EAGLE FERN
leaf stalk C.S.

Similar to the liquorice fern mentioned above, several types of tissue can be seen in the cross section of the petiole of the eagle fern:
Transport tissues, xylem and phloem, which are responsible for transporting water and nutrients within the plant. Again, the xylem wraps around the phloem to form vascular bundles.
Parenchyma cells can be involved in many life processes (e.g. storage, photosynthesis and space filling).

DO YOU KNOW?

- The eagle fern is one of the most common ferns, which can be found on almost every continent in a variety of climates.
- It is well adapted to fire and is often one of the first plants to return after a forest fire.

Cross-section of leaf stalk of eagle fern



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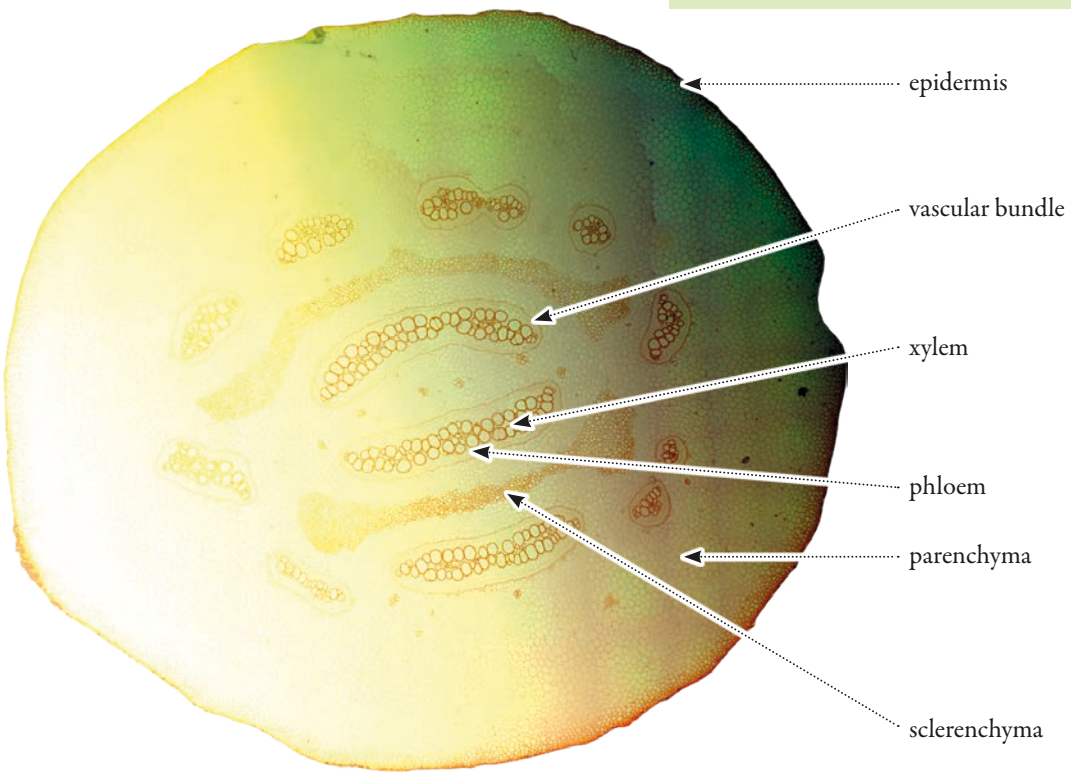
Dennstaedtiaceae
Pteridium aquilinum
BRACKEN, BRAKE, COMMON BRACKEN, EAGLE FERN
rhizome C.S.

The fern's rhizome, or underground stem, plays an important role in the plant's nutrition and vegetative reproduction.
The outer layer of the rhizome is the rhizodermis, which protects the plant and conserves water. The cells of the rhizodermis are thick and waxy to keep out water and protect against disease. Underneath is a thick layer that stores a lot of water and nutrients and often contains starch. This layer is very important because it helps the rhizome to grow and live.

DO YOU KNOW?

- The fern is able to extract nutrients from the soil from other plants. This allows it to dominate the undergrowth.



Cross-section of rhizome of eagle fern

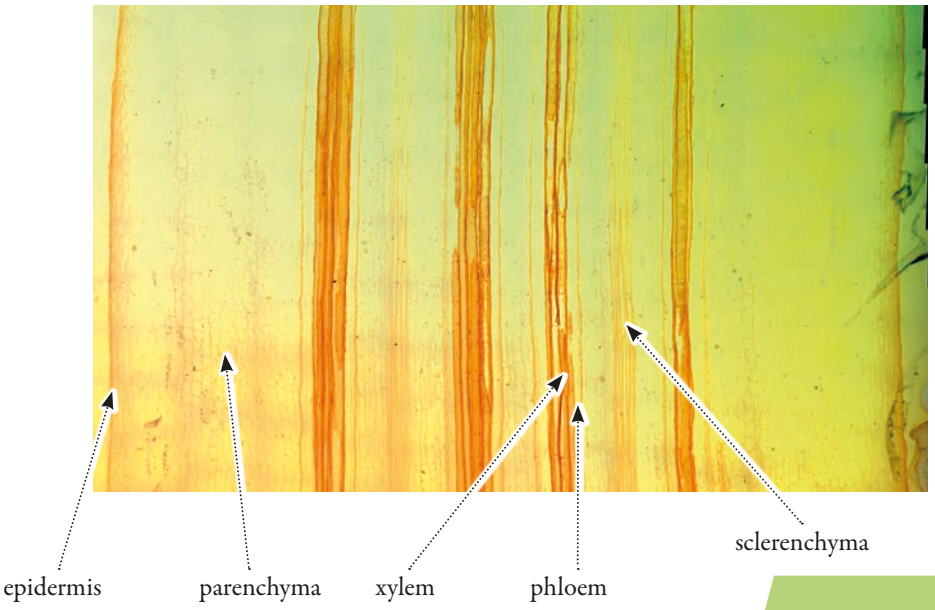
Dennstaedtiaceae
Pteridium aquilinum
BRACKEN, BRAKE,
COMMON BRACKEN, EAGLE FERN
rhizome L.S.

A longitudinal section of a fern rhizome helps to understand how the cells are arranged in relation to each other and how the different tissues work together.

DO YOU KNOW?

- Parts of the plant contain a compound called ptaquiloside, which is toxic to animals and humans.
- Despite its toxicity, the fern has been used for animal feed and medicinal purposes since ancient times. Its young shoots, called "fiddleheads", are eaten as a gourmet delicacy in many places, although proper preparation is required to remove the toxic substances.

Longitudinal section of rhizome of eagle fern



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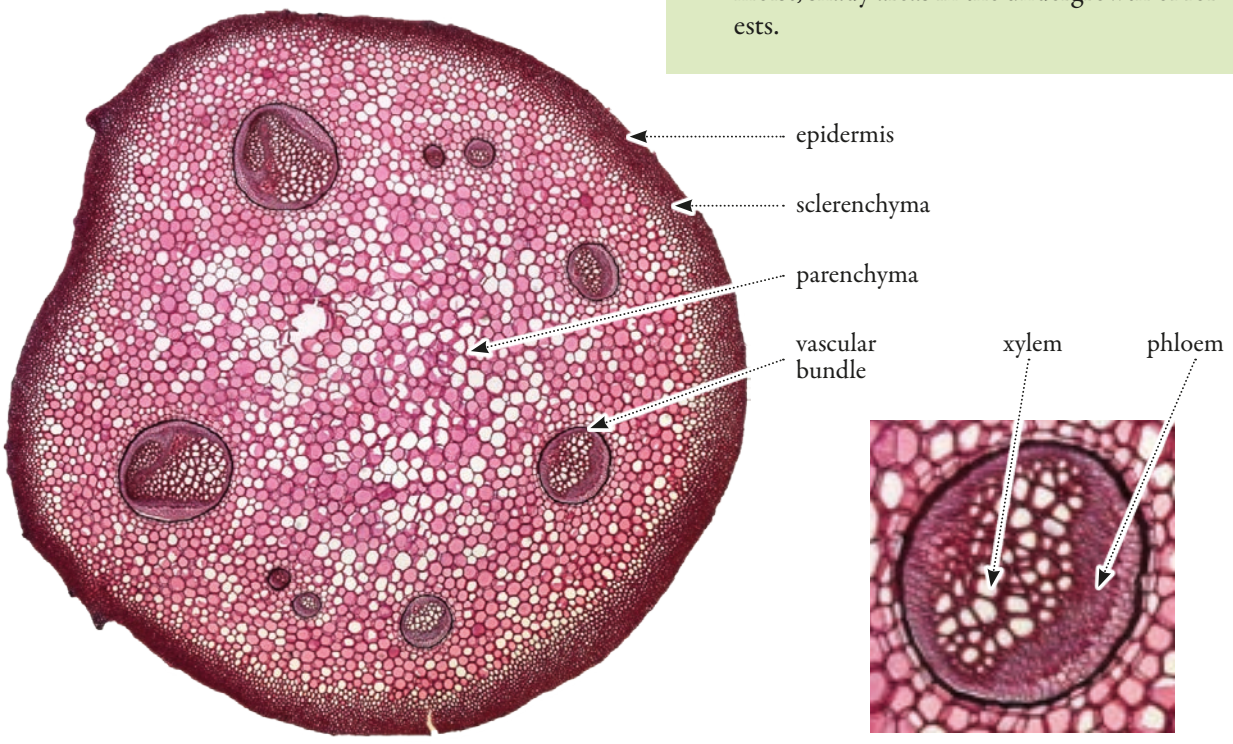
Dryopteridaceae
Dryopteris filix-mas
MALE FERN

leal stalk C.S.

Several types of tissue can be observed in the cross section of the petiole of the male fern. The darker pink layer visible at the outer edge of the section is the protective outer layer of the epidermis or petiole. The darker circular structures in the image are the vascular bundles that transport water and nutrients. The pink areas may be parenchyma cells involved in storage and metabolism. These tissues form a complex system, similar to that of animals, to help plants transport fluids and nutrients.

DO YOU KNOW?

- The male fern is a common plant in the temperate northern hemisphere, preferring moist, shady areas in the undergrowth of forests.



Cross-section of leaf stalk of male fern

Dryopteridaceae
Dryopteris filix-mas
MALE FERN

leaf C.S.

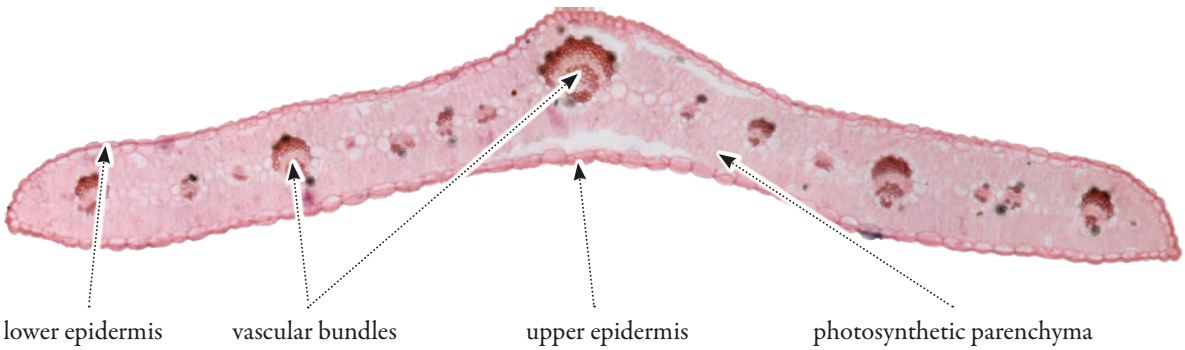
This cross section shows the internal structure of a fern leaf, which can help you understand plant anatomy and physiology. Again, the outer layer of the leaf is made up of epidermal cells, which provide protection from environmental factors. The cells of the basic food-producing tissue (mesophyll) make up most of the leaf and play an important role in photosynthesis, the process by which the plant uses light and water to produce organic nutrients. Nutrients produced in the mesophyll are transported by vascular tissues to the xylem and phloem as needed. The xylem mainly transports water, while the produced nutrients are transported in the phloem.

DO YOU KNOW?

- The male fern was known as a magical plant in the Middle Ages and was the subject of many superstitions. For example, it was believed that whoever found the fern's flower – which did not actually exist – could become invisible.
- It was used in traditional medicine as an anthelmintic because it contains filix acid.

Leaf full with sorii

Cross-section of leaf of male fern



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WEEDS

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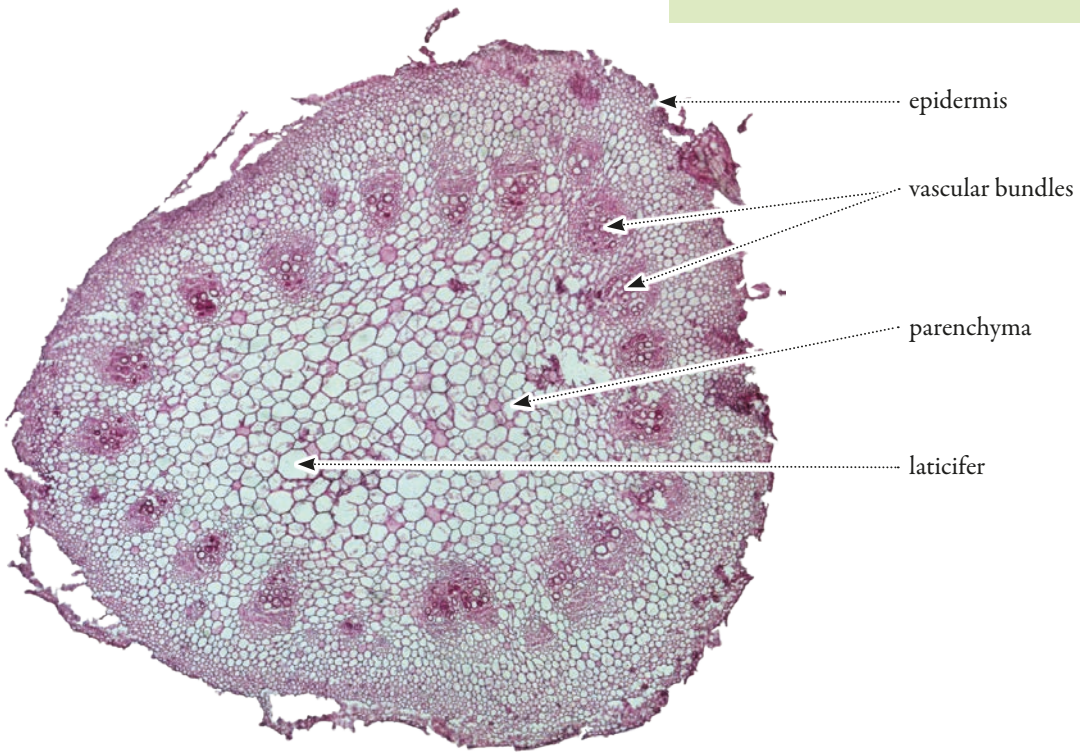
Papaveraceae
Papaver rhoeas
COMMON POPPY

shoot C.S.

The picture shows a microscopic section of a poppy stem. The bundles of vascular tissue, which contain xylem and phloem, are arranged in a circle at the edge of the section. They are responsible for transporting water, nutrients and sugars within the plant. The central area is densely packed with a layer of basal tissue cells, known as mesophyll tissue, which provides structural support. The outermost layer is the epidermal tissue, which protects the plant.

DO YOU KNOW?

- Poppy flower petals contain alkaloids which are used medicinally as mild tranquillisers and for coughs.



Cross-section of stem of common poppy

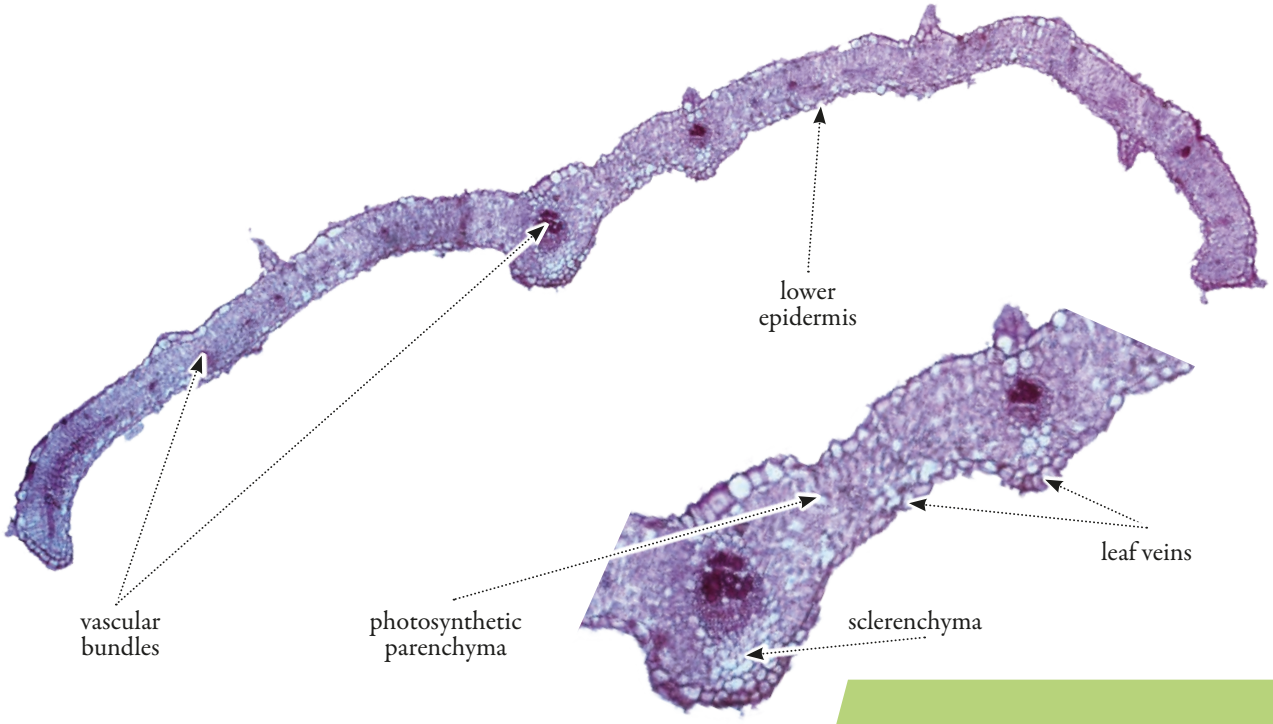
Papaveraceae
Papaver rhoeas
COMMON POPPY

leaf C.S.

The larger image shows a cross-section of the whole poppy leaf, which is less than 1 mm thick. The enlarged image shows the main vein and a side vein in detail, mainly the part of the vascular tissue and the associated supporting tissues. The main mass of the leaf consists of the basic food-producing tissue (in some cases elongated cells), which is also responsible for the production of nutrients.

DO YOU KNOW?

- Poppy is often found in agricultural fields and cereal crops, which can sometimes be a problem for farmers as it competes with crops for nutrients and space.



Cross-section of leaf of common poppy

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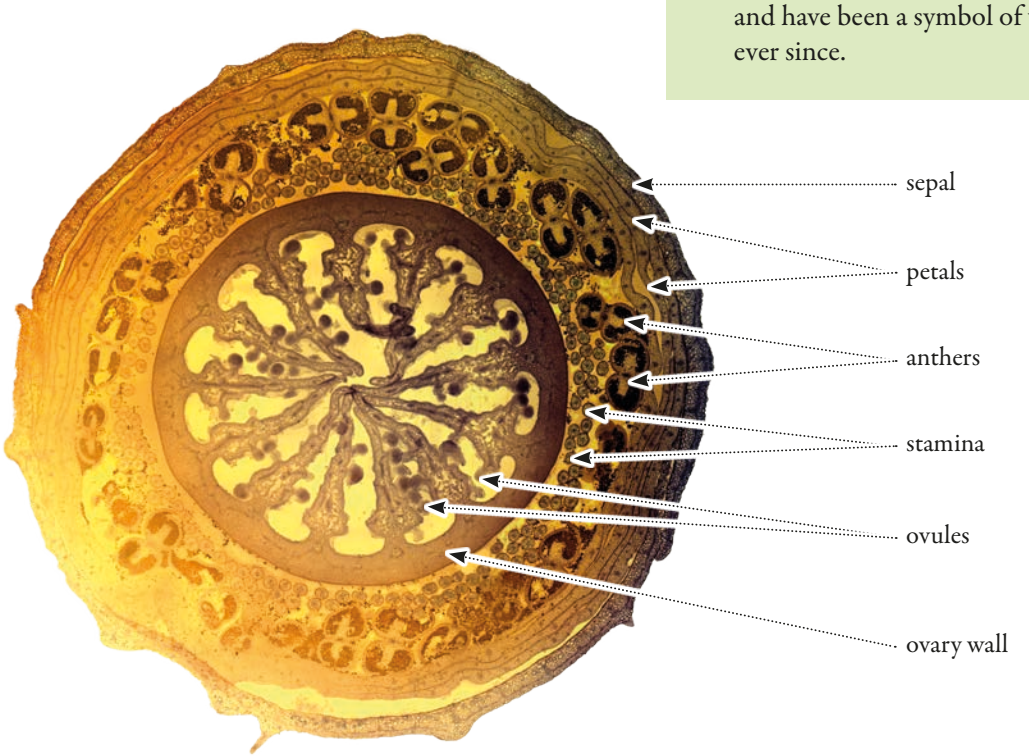
Papaveraceae
Papaver rhoeas
COMMON POPPY

flower bud C.S.

Moving inwards from the outside, there is the calyx and then the petals, which protect the cotyledons. The stamens are located at several levels, so that cross sections of the anthers and stamens are visible in many places, but the pistil is not, as it is still immature in the anthers. The gynoecium consists of several pericarps, the walls of which contain the ovules.

DO YOU KNOW?

- Poppies are an important food source for pollinators, such as bees and butterflies.
- After the First World War, the poppy was used to commemorate fallen soldiers, especially in the United Kingdom. Red poppies were the flower of the Flanders battlefields and have been a symbol of war remembrance ever since.



Cross-section of flower bud of common poppy

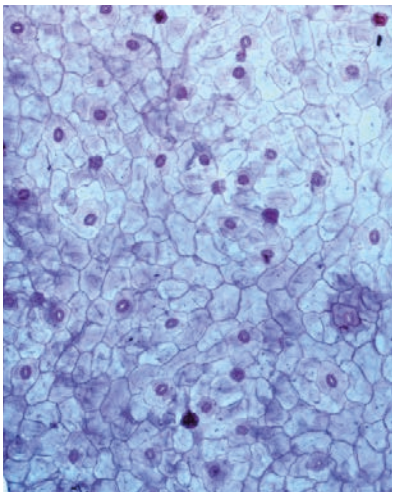
Polygonaceae
Rumex acetosa
COMMON SORREL

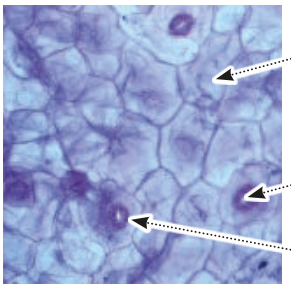
upper epidermis peel

The epidermal cells form the upper layer of the plant, the epidermis, and are usually polygonal in shape. They are close together and have a protective function. The outer walls of epidermal cells can be thicker and are usually more transparent than other cell types. The two bean-shaped guard cells surround the stomatal pore (stoma). Stomata are small pores on the surface of the plant through which gas exchange takes place.

DO YOU KNOW?

- Field sorrel is a perennial edible medicinal and weed plant that is native to Europe, but has now spread all over the world.
- "Rumex" means "spear", referringto the shape of the leaves, which are like spears.
- The name "acetosa" refers to its taste, which is bitter and astringent reminiscent of vinegar.





Epidermal peel from upper epidermis of leaf of common sorrel

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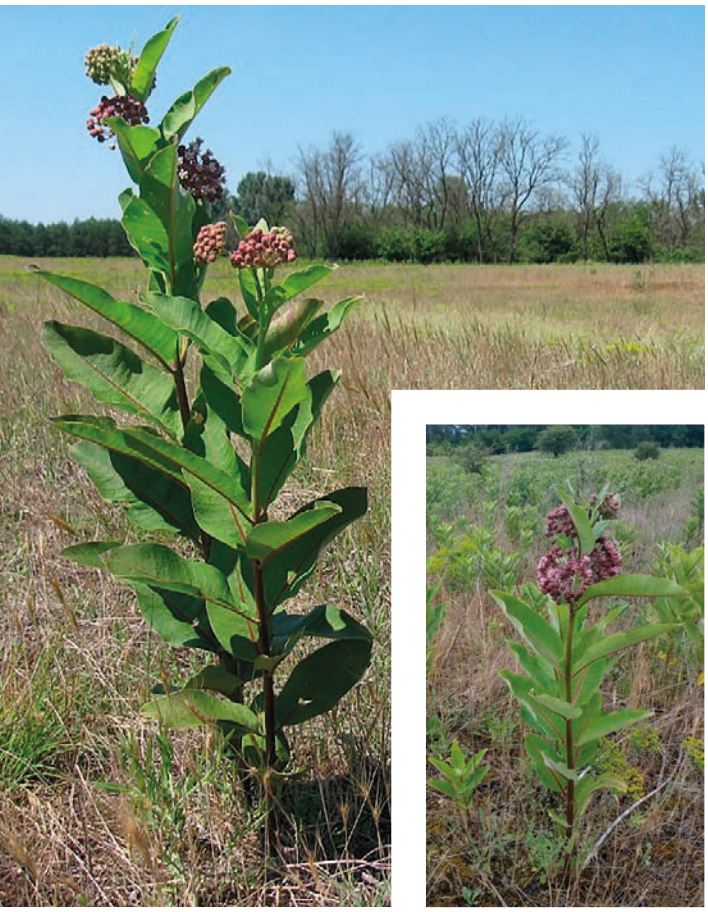


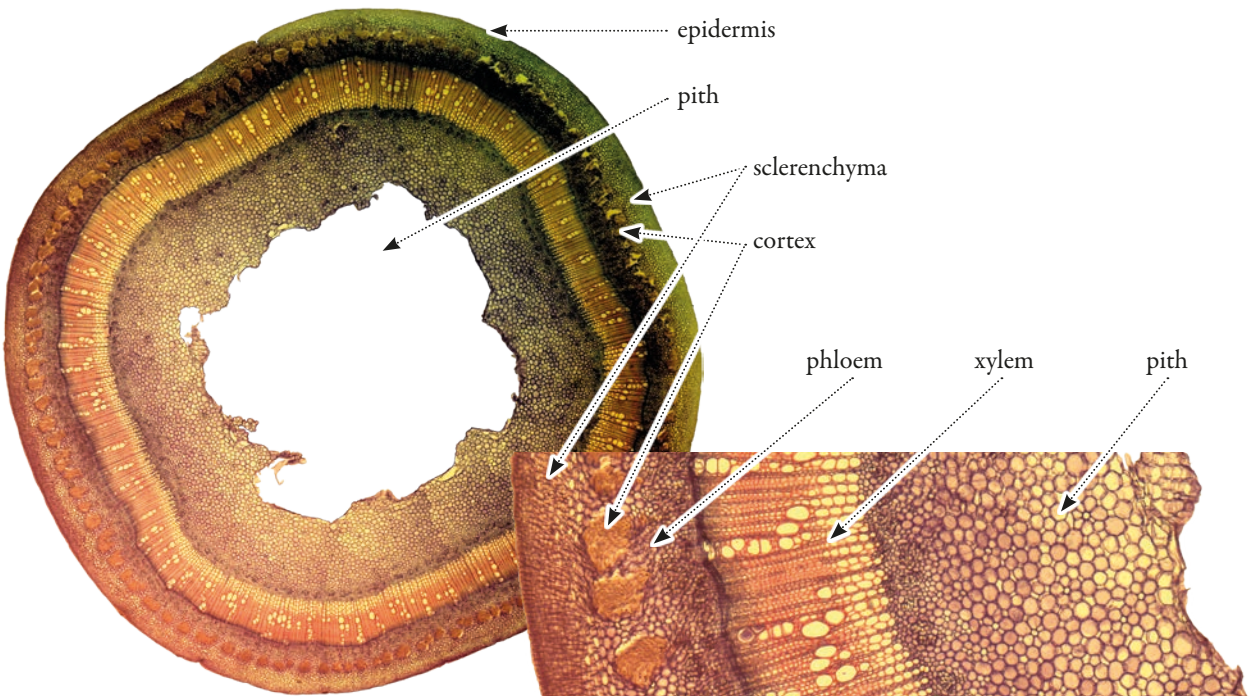
Asclepiadaceae
Asclepias syriaca
COMMON MILKWEED

shoot C.S.

Beneath the epidermis of the stem, there are several rows of cells, the cortex. In the bark, the supporting tissue (sclerenchyma) and the vascular bundles are visible. The vascular tissue is responsible for the transport of water, nutrients and sugars. The central part of the stem consists of pith tissue with larger cells. The pith makes the stem light and flexible.

DO YOU KNOW?

- Although its scientific suggests that it is native to Syria, it is actually native to North America. In Hungary, it can be found mainly in the sandy soil regions of the Great Plain, where it spreads aggressively and displaces our native plant species.



Cross-section of stem of common milkweed

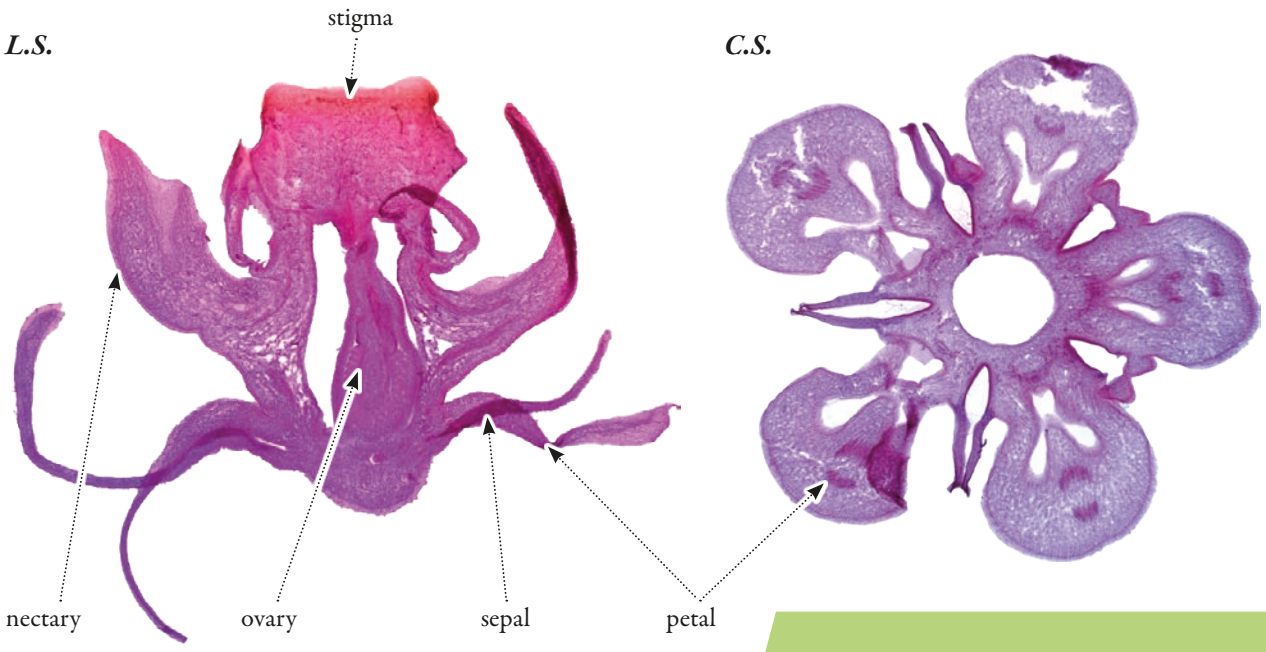
Asclepiadaceae
Asclepias syriaca
COMMON MILKWEED

flower C.S. and L.S.

Milkweed flowers have a rather complicated structure, which is mainly due to the nectaries and the stamens that grow on the side of the pistil. Milkweed honey is a much sought-after product.

DO YOU KNOW?

- The flowers of the common milkweed are pale pink or rust-coloured. They are real bee-eaters, and some butterflies also like to visit them too. The flowers produce beak-shaped pods that contain a variety of seeds that are dispersed by the wind.
- The North American Danaida moth feeds on the nectar of the milkweed to get to Mexico, which is why the plant is protected in the Americas.



Cross section and longitudinal section of flower of common milkweed

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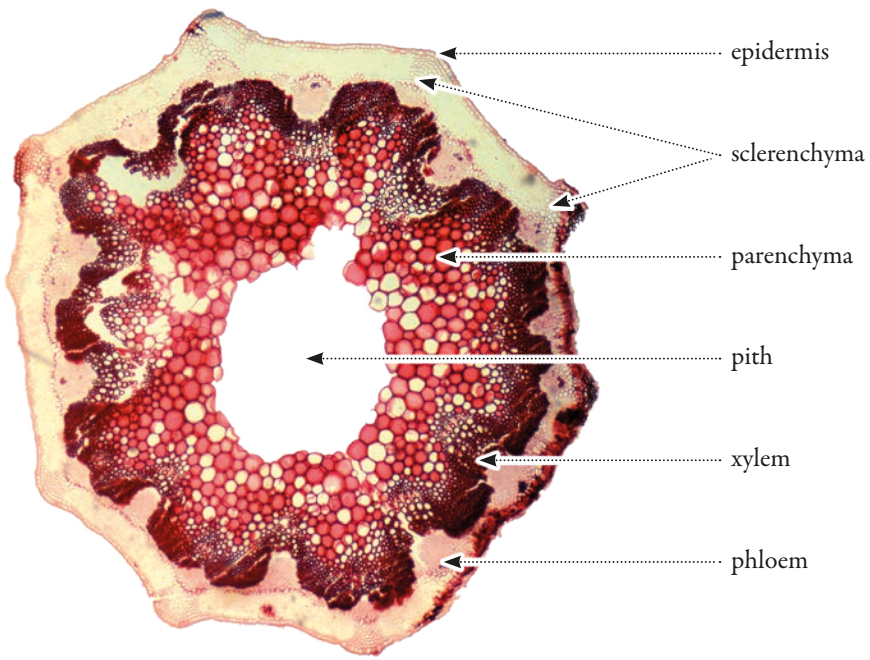
Asteraceae
Cichorium intybus
CHICORY

shoot C.S.

The stem is ribbed, and it is mainly in these areas that the reinforcing tissues are located under the epidermis. These cells support the stem and are flexible, making it easier for the plant towithstand wind and other external influences. Arranged in a circle in the stem are the vascular bundles, which contain the xylem (which carries water water and nutrients upwards) and the phloem (transporting sugars and other substances downwards).

DO YOU KNOW?

- Chicory produces beautiful, clear, sky-blue flowers on almost leafless, hollow stems. These flowers usually open in the morning and close during the day.



Cross-section of stem of chicory

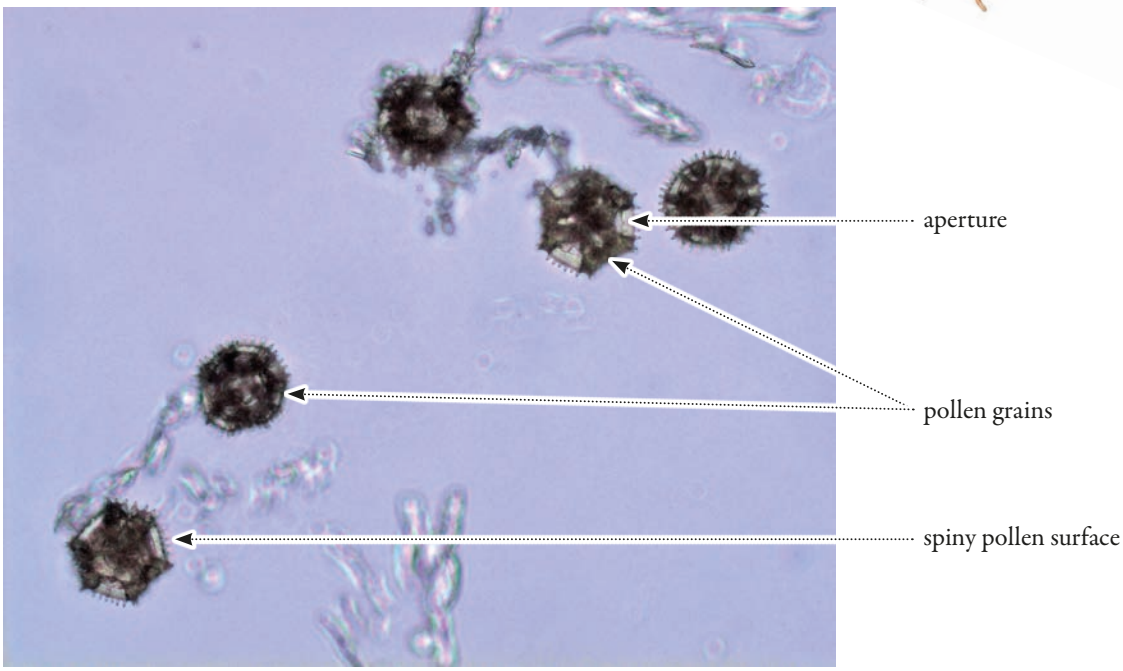
Asteraceae
Cichorium intybus
CHICORY

pollen

Chicory pollen is spherical and has a spiky surface to make easier for the pollinating insects to stick to it. The pollen wall is thinner in three places, this is called the aperture, where the pollen tube germinates after pollination.

DO YOU KNOW?

- The thick, fleshy root of chicory exudes a milky juice when cut. The root is used as a substitute for coffee, and the leaves are used to flavour soups, sauces and gravies.



Pollen grains of chicory

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TROPICAL AND MEDITERRANEAN PLANTS

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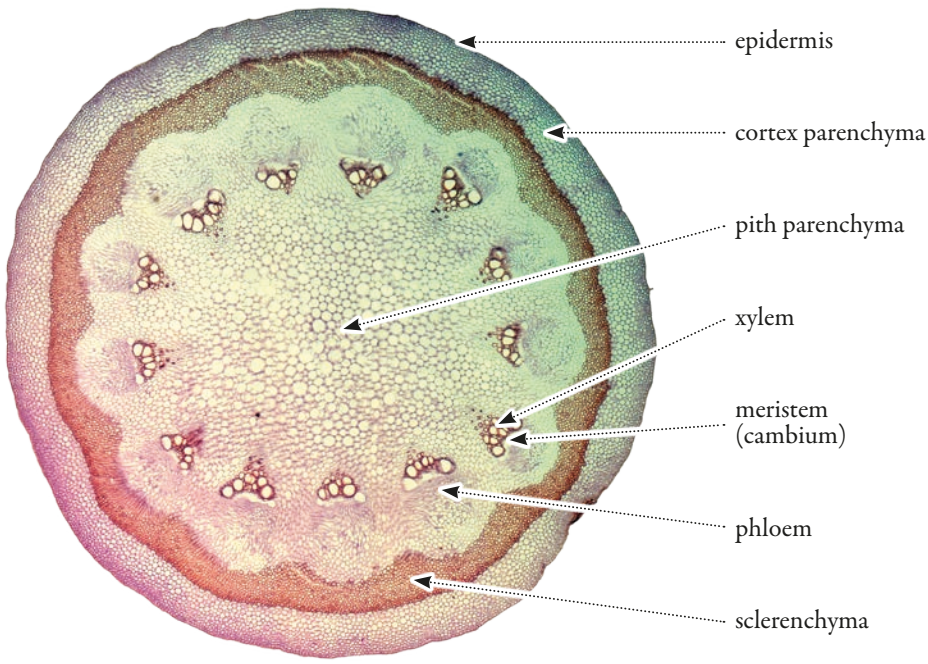
Aristolochiaceae
Aristolochia durior
DUTCHMAN'S PIPE

1-year-old stem C.S.

The Dutchman's pipe has a liana stem, which is a special woody stem capable of twisting. A cross section of a first year stem shows that the vascular bundles are arranged in a circle under the solidifying tissue (sclerenchyma), which forms a continuous ring. The vascular bundles also contain a tissue that divides the xylem from the phloem, called the cambium. This meristem is responsible for increasing the diameter of the plant.

DO YOU KNOW?

- The huge, 20-25 cm wide, heart-shaped leaves are dark green and have a rough surface.
- It's English name comes from the fact that the shape of its flower resembles the Dutch pipe.



Cross-section of one-year stem of Dutchman's pipe

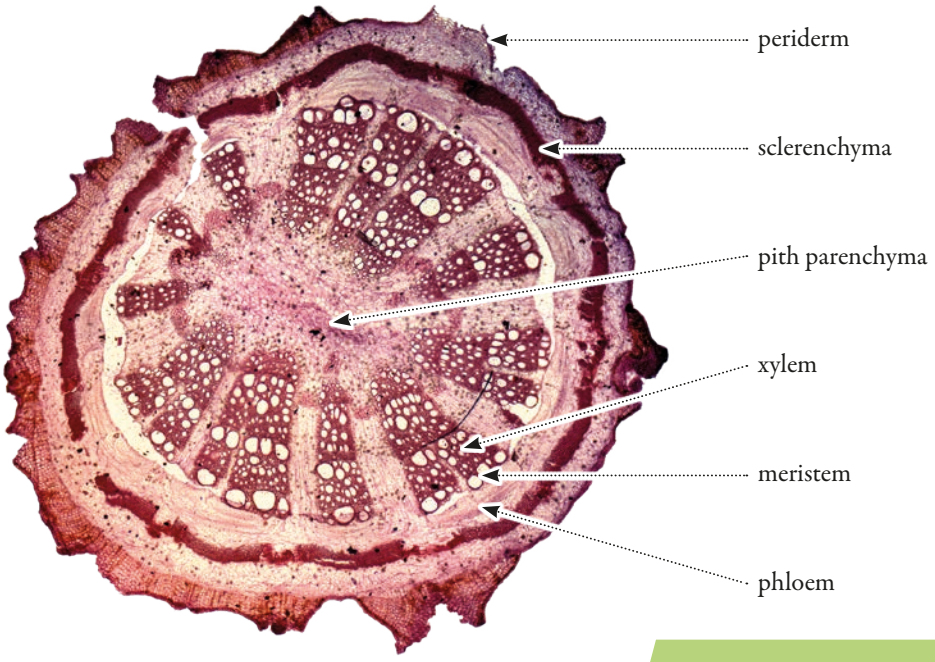
Aristolochiaceae
Aristolochia durior
DUTCHMAN'S PIPE

3-year-old stem C.S.

The diameter of the liana stem increases year by year due to the action of the Dutchman's pipe dividing tissue, this is also clearly visible in the structure of the vascular bundles, the xylem will have a banded pattern, and the previously connected ring of reinforcing tissue will also be fragmented to allow growth.

DO YOU KNOW?

- Dutchman 's pipe is native to the southeastern United States, but can also be found in the northeastern United States and Ontario, Canada.
- Tubular, mahogany and cream colored flowers appear in late spring, but despite their size they are not very showy.



Cross-section of three-year stem of Dutchman's pipe

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Rutaceae

Citrus × *limon*

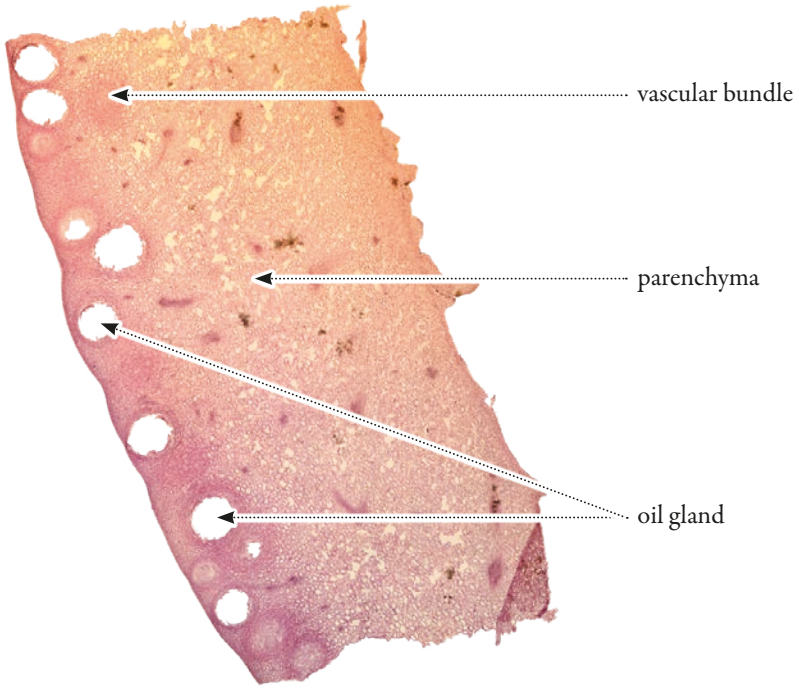
LEMON, EUREKA LEMON, IMPERIAL LEMON, SWEET LIME

pericarp C.S.

The following tissues can be found in the cross section of the fruit wall of an orange: The exocarp is the outer part of the fruit, we call it its "peel" or "skin". The mesocarp is the middle layer, which is often fleshy and contains essential oils, pectin and cellulose. Endocarp: the inner part which contains the edible and juicy segments called carpels.

DO YOU KNOW?

- Lemon flowers are edible.
- All citrus species have an orange fruit, i.e. a hesperidium.
- Finger of the Buddha is the name of one of the oranges.



Cross-section of pericarp of lemon

Rutaceae

Citrus × *limon*

LEMON, EUREKA LEMON, IMPERIAL LEMON, SWEET LIME

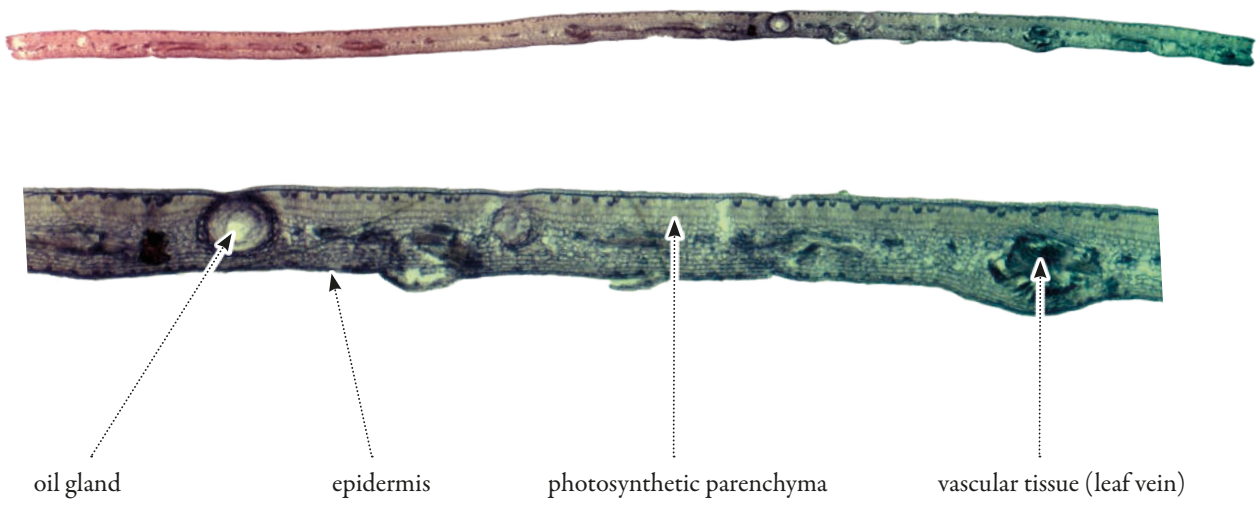
leaf C.S.

The epidermis of the leaves is multi-layered, allowing the plant to adapt to drier climates such as the Mediterranean. In addition to the basic food-producing tissues and veins (bundles) in citrus leaves, there are also essential oil cavities.

DO YOU KNOW?

- The French aristocracy maintained orange gardens, orangeries.

Cross-section of leaf of lemon



National Research, Development and Innovation Office
Hungary

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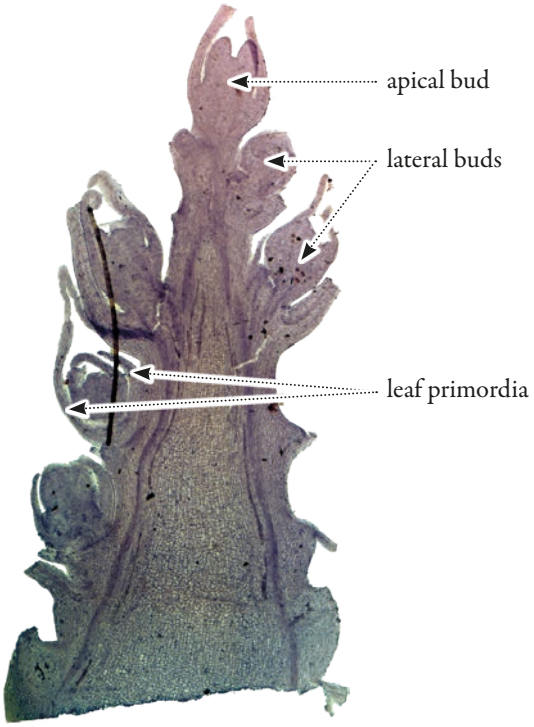
Euphorbiaceae
Ricinus communis
CASTOR BEAN

shoot apex L.S.

The epidermal cells form the upper layer of the plant, the skin tissue, and are usually polygonal in shape.

DO YOU KNOW?

- In its original tropical habitat, the castor plant is a perennial that can grow up to a height of 10-13 metres, while in temperate climates it is an annual that can reach a height of 1.5-2.5 metres.
- It is grown as an ornamental plant in Hungary, mainly because of its foliage color and the palmate shape of its leaves.
- Ricin, a toxin extracted from castor seeds is 12.000 times more potent than rattlesnake venom.



Longitudinal section of shoot apex of castor bean

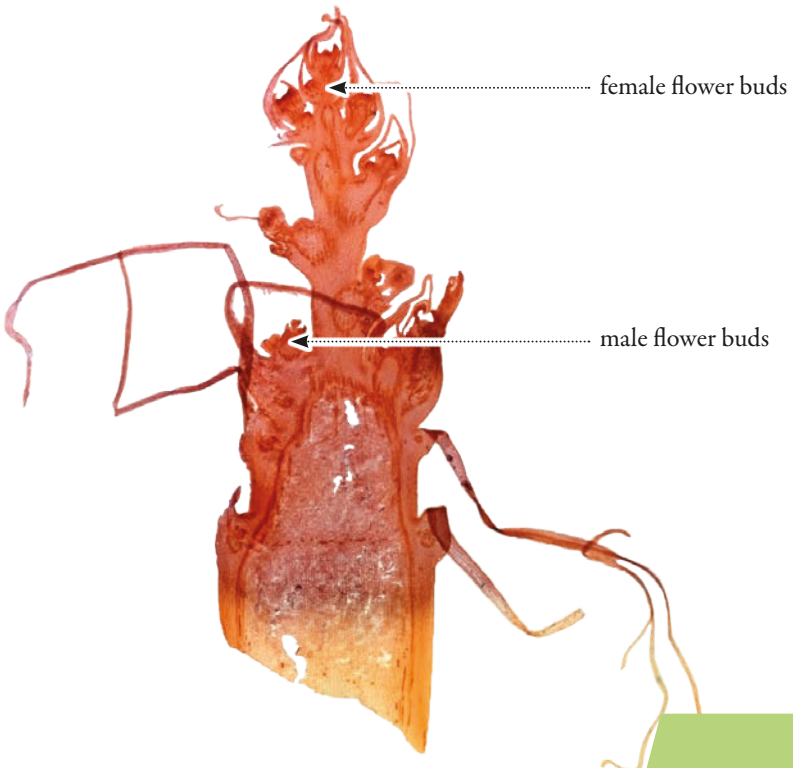
Euphorbiaceae
Ricinus communis
CASTOR BEAN

flower L.S.

Castor bean flowers have no petals and are not particularly decorative. The male flowers are located at the bottom of the inflorescence, are cream-coloured, have many stamens and shed large quantities of windborne pollen. Female flowers are usually located at the top of the inflorescence, are reddish in colour (especially the pistils) and hairy.

DO YOU KNOW?

- Castor oil is used for pharmaceutical and industrial purposes. It is also used in cosmetics, as an emollient in various medicines and is also suitable for abdominoplasty.
- It is also used in paints and as a lubricant due to its unique properties.



Longitudinal section of inflorescence of castor bean

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CROP PLANTS

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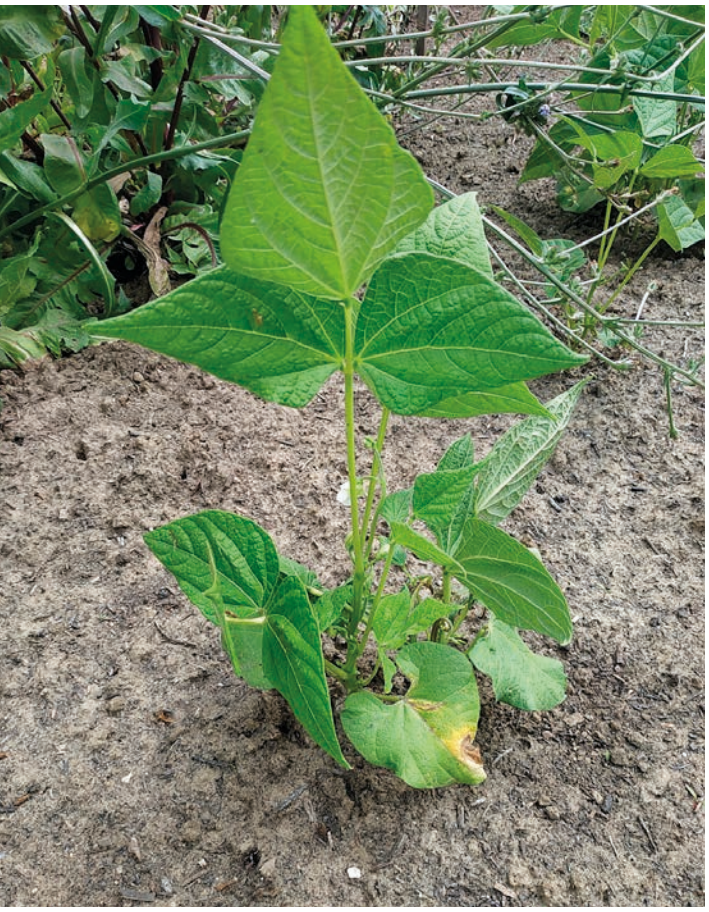


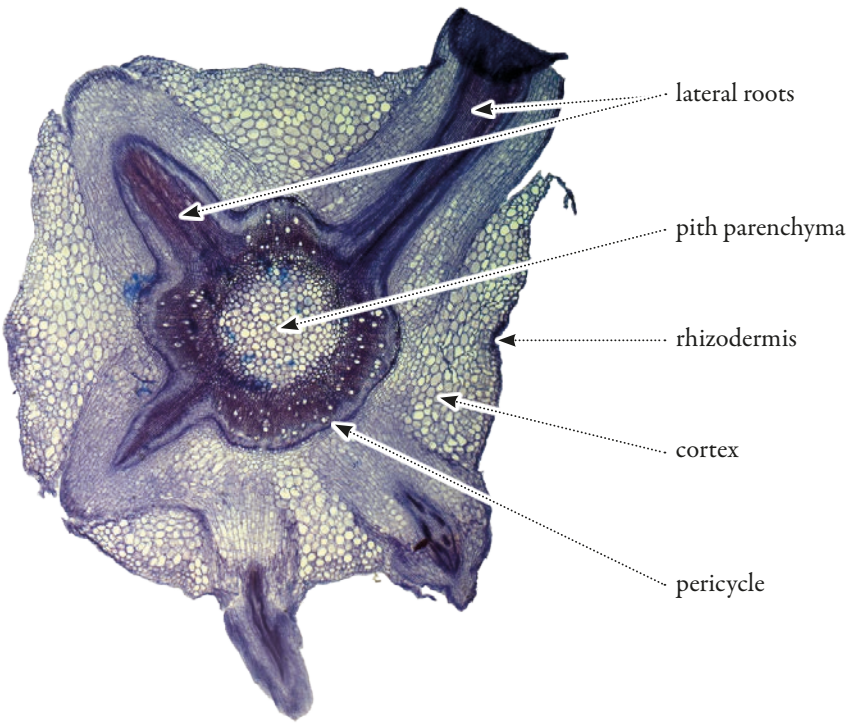
Fabaceae
Phaseolus vulgaris
COMMON BEAN

lateral root zone C.S.

The skin tissue on the root is called the rhizodermis and its function is similar to the skin tissue (epidermis) of the shoot. Beneath this epidermal tissue is the primary cortex, which is formed from the parenchyma. A thick layer of cells called the pericycle (meristematic tissue) is responsible for division, growth and the formation of lateral roots.

DO YOU KNOW?

- The common bean is native to Mexico and Central America and has been cultivated for over 7.000 years.
- It is a rich source of protein and contains all the essential amino acids, which is rare among plant foods. It is also rich in fibre, B vitamins, iron, phosphorus, potassium and magnesium.



Cross-section of root branching zone of common bean

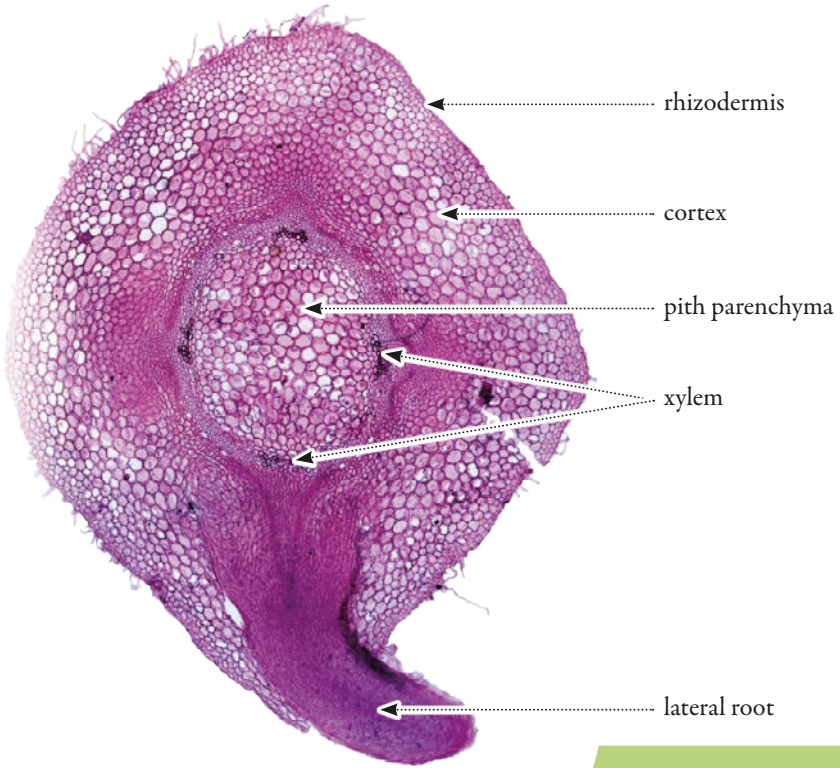
Fabaceae
Phaseolus vulgaris
COMMON BEAN

lateral root zone, C.S.

In the root, the vascular bundles are separated, consisting of separate xylem and phloem. In all cases, the lateral roots emerge from the pericycle in the direction of the xylem.

DO YOU KNOW?

- The common bean is a member of the legume family, also known as pulses. This family has a significant nitrogen-fixing capacity, which means that with the help of the bacteria living in the bean roots, they are able to fix nitrogen from the air and convert it into nutrients, thereby improving the quality of the soil.



Cross-section of lateral root zone of common bean

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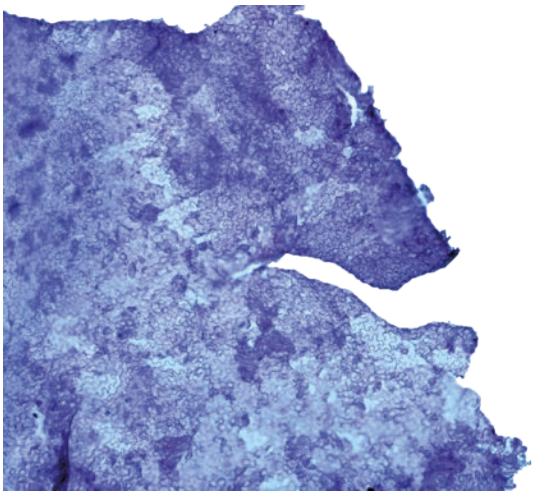
Asteraceae
Lactuca sativa
LETTUCE

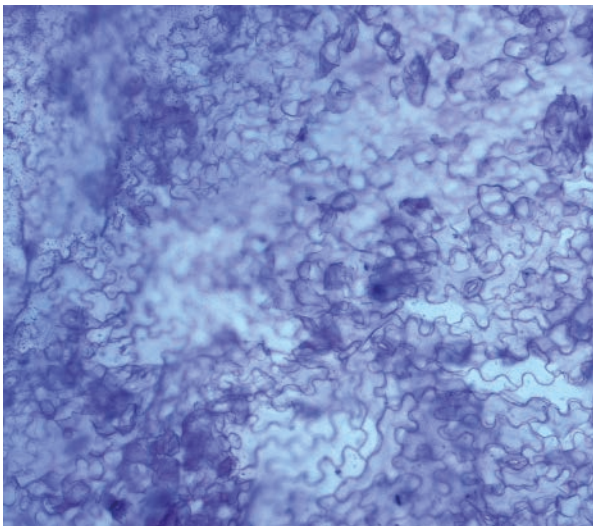
lower epidermis peel

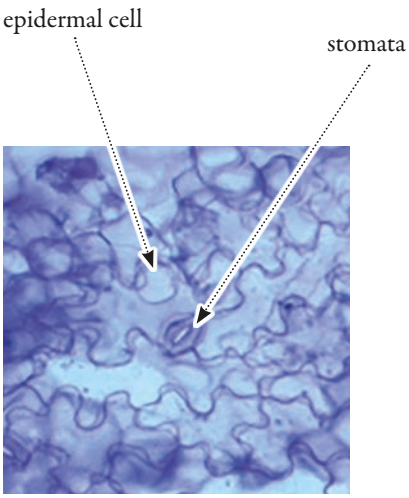
In the lower part of the lettuce leaf, i.e. on the back of the leaf, there are epidermal tissue cells with wavy walls, and between the epidermal cells there are gas exchange openings called stomata. The stomata are the site of air exchange, ensuring the supply of air to the plant. Two guard cells close the air gap. The opening and closing of the stomata helps the plant to grow optimally.



DO YOU KNOW?

- Lettuce is a good source ofions, such as sodium and potassium, as well as vitamins such as vitamin A.
- There are many types of lettuce, such as corn salad, butterhead lettuce and iceberg lettuce.
- Lettuce can germinate in the second year, i.e. it produces its flowers and seeds this year.
- Lettuce can be eaten not only in its mature form, but also in the so-called microgreen, i.e. the young form after germination.





Epidermal peel from lower epidermis of leaf of lettuce

Poaceae

Zea mays

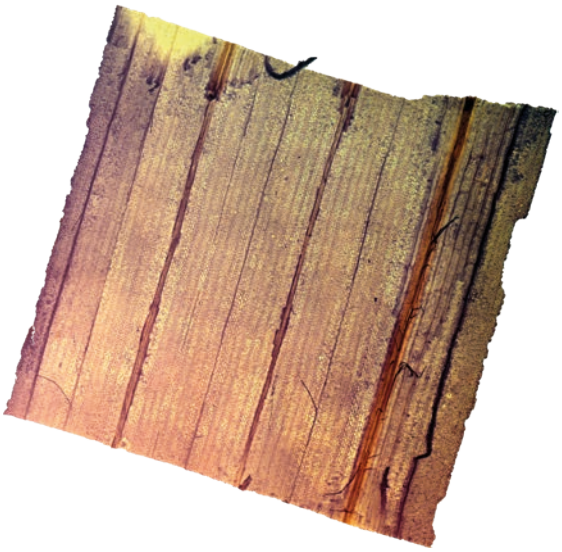
DENT CORN, FLINT CORN, FLINT MIX, FLOUR CORN, FLOUR MIX, HOPI SWEET CORN, KOKOMQAO, MAIZE, ORNAMENTAL CORN, POPCORN, PUEBLO RED, SWEET CORN

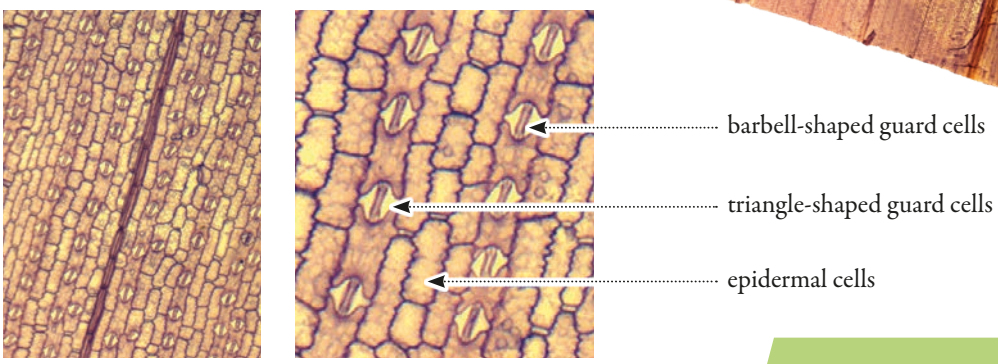
epidermal peel

The epidermis of the maize leaf is made up of several types of cells. The stomata, or gas exchange openings, characteristic of monocots, are found along a regular line between the rectangular skin tissue, or epidermal cells. In addition to the dumbbell-shaped guard cells, in the case of the maize leaf, we also find triangular-shaped lateral cells. In dry weather, maize is able to wrap its leaves around itself to prevent evaporation and retain the necessary moisture. In this case, the stomata are closed.

DO YOU KNOW?

- Another name for maize is sea maize, which refers to its South American origin.
- The modern form of corn comes from the ancient teosinte plant.
- Corn silk is rich in vitamins and antioxidants.
- The "hair" of the corn cob, the so called in Hungarian „csuhé", used to be a children's toy, as it was used to make hair dolls.





Epidermal peel of leaf of maize

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Poaceae

Zea mays

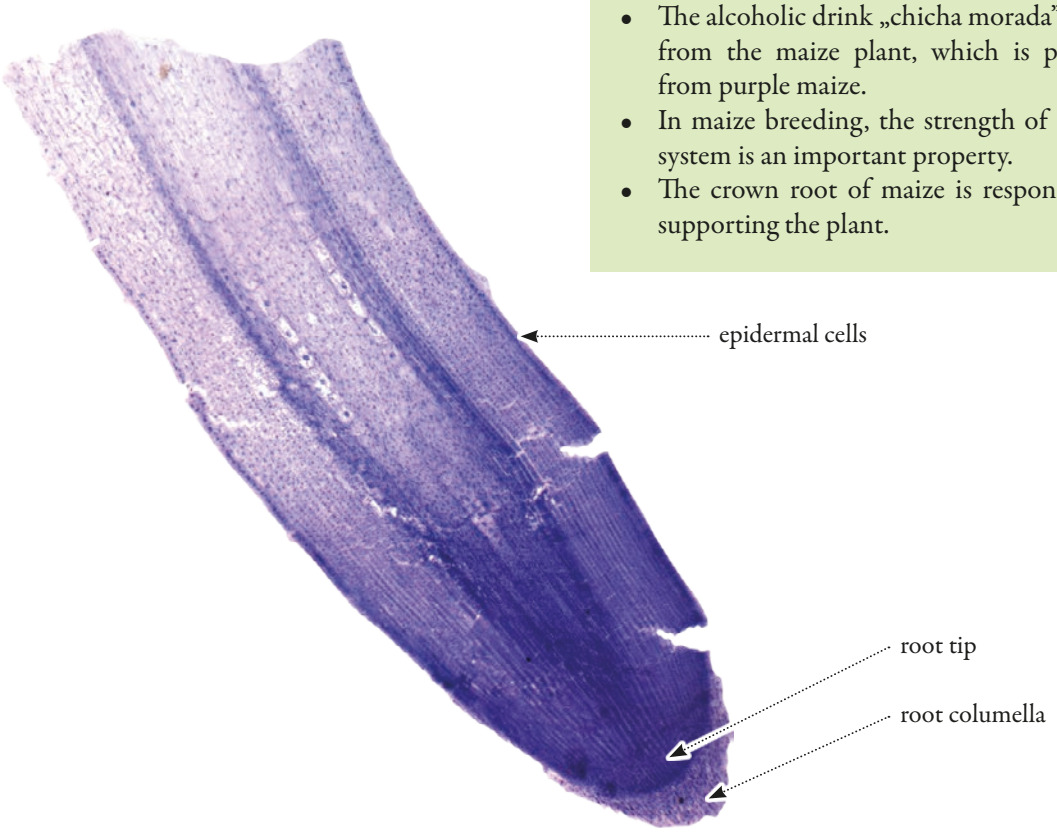
DENT CORN, FLINT CORN, FLINT MIX, FLOUR CORN, FLOUR MIX, HOPI SWEET CORN, KOKOMQAO, MAIZE, ORNAMENTAL CORN, POPCORN, PUEBLO RED, SWEET CORN

root apex L.S.

This longitudinal section of a maize root clearly shows that the root tip and root cap are sharply separated. The cells of the root cap control the position of the root growth, i.e. they point the way down in the soil, this is called positive geotropism. The root tip is undergoing constant division to ensure the continued development and growth of the root.

DO YOU KNOW?

- The alcoholic drink „chicha morada" is made from the maize plant, which is produced from purple maize.
- In maize breeding, the strength of the root system is an important property.
- The crown root of maize is responsible for supporting the plant.



Longitudinal section of root tip of maize

Poaceae

Zea mays

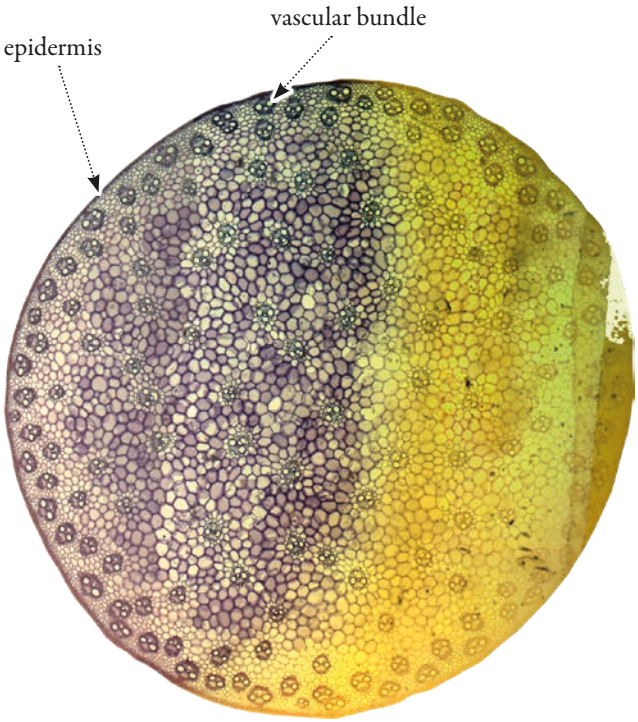
DENT CORN, FLINT CORN, FLINT MIX, FLOUR CORN, FLOUR MIX, HOPI SWEET CORN, KOKOMQAO, MAIZE, ORNAMENTAL CORN, POPCORN, PUEBLO RED, SWEET CORN

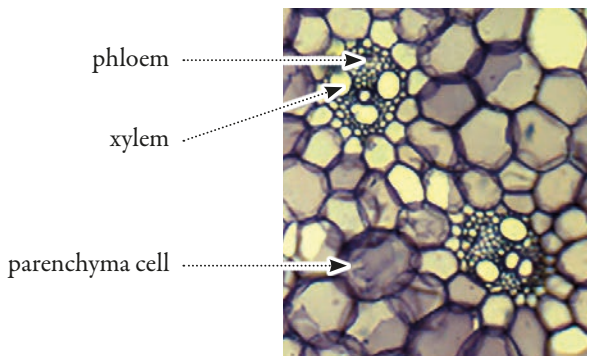
stem C.S.

We see vascular bundles scattered across the cross section of the maize stem. These are complex bundles, i.e. together we find the xylem, which is capable of transporting water and minerals, and the, which transports the organic matter produced. On closer inspection, the vascular bundles show a pattern reminiscent of a an ape's face or mask. A group of them ensures the optimal development of the maize plant and regulates the water balance, as well as the delivery of the nutrients produced to the place of use.

DO YOU KNOW?

- Maize is one of the world's top 6 agricultural crops.
- Breeding maize is not only about making the crop sweeter, but also about producing varieties that can adapt to extreme climate change.
- One of maize's most serious pests is the corn beetle.





Cross-section of stem of maize

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Solanaceae

Capsicum annuum

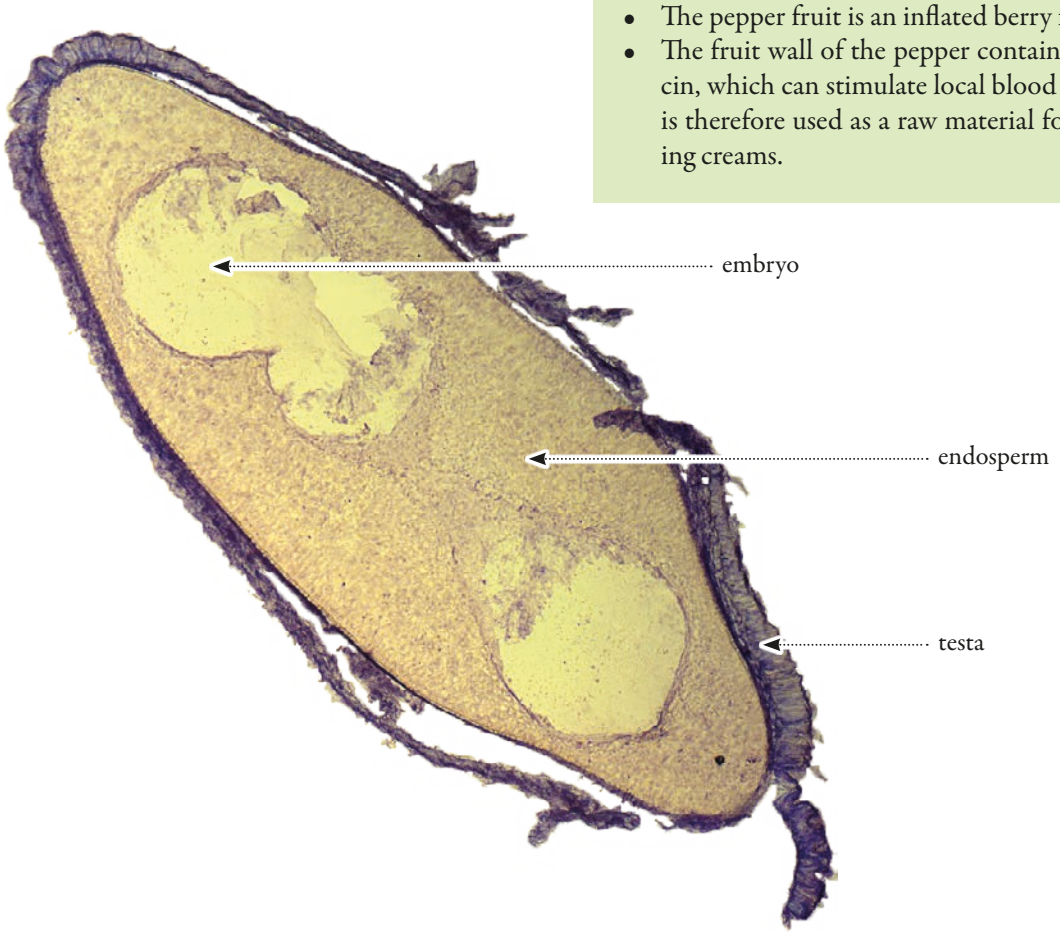
PEPPER, CHILLI, CHILLI PEPPER, HOT PEPPER, JAPANESE HOT PEPPER, SWEET PEPPER

seed C.S., cultivar: Cecei vörös

The cross section of a pepper seed shows the embryo cut in half in the centre, surrounded by the nutritious tissue known as the endosperm. The seed is covered on the outside by the seed coat.

TUDTAD?

- Peppers belong to the potato family and are related to tomatoes.
- The pepper fruit is an inflated berry fruit.
- The fruit wall of the pepper contains capsaicin, which can stimulate local blood flowand is therefore used as a raw material for warming creams.



Cross-section of seed of pepper

Solanaceae

Capsicum annuum

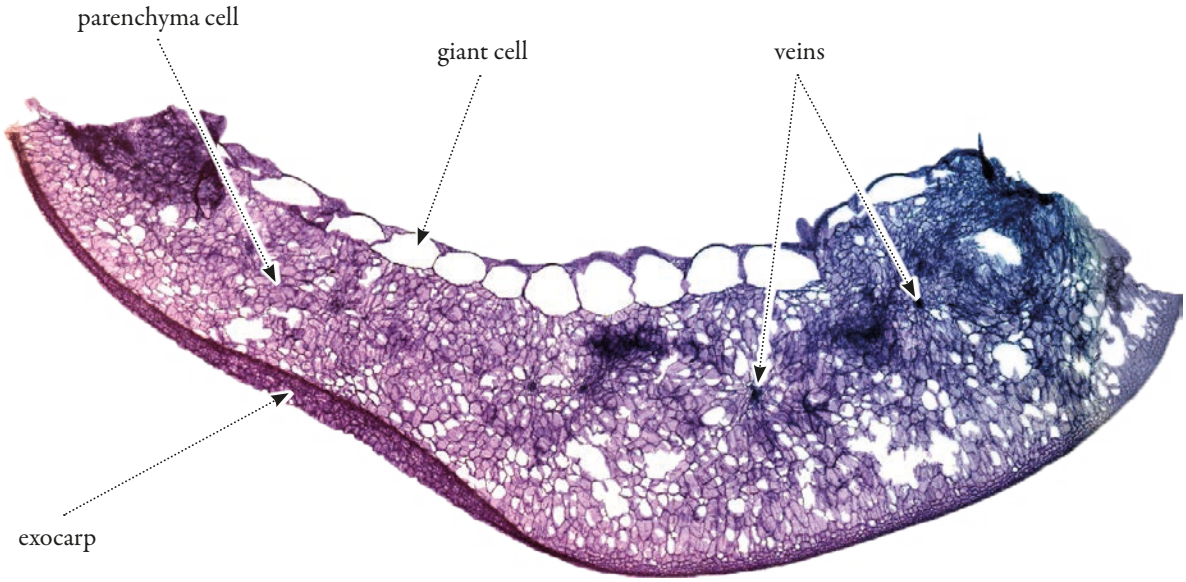
PEPPER, CHILLI, CHILLI PEPPER, HOT PEPPER, JAPANESE HOT PEPPER, SWEET PEPPER

pericarp C.S.

The pepper fruit is an inflated berry. The outer layer of the pericarp is the exocarp, while the middle part is the mesocarp and the inner part is the endocarp. We can see veins in the mesocarp. The endocarp layer contains giant cells that are visible to the naked eye.

DO YOU KNOW?

- The heat of chillies, caused by capsaicin, is measured in the Scoville hotness units (SHU).
- Jalapeno chilli has a SHU of 5,000, while the Dorset Naga variety has a SHU of 1 million!



Cross-section of pericarp of pepper

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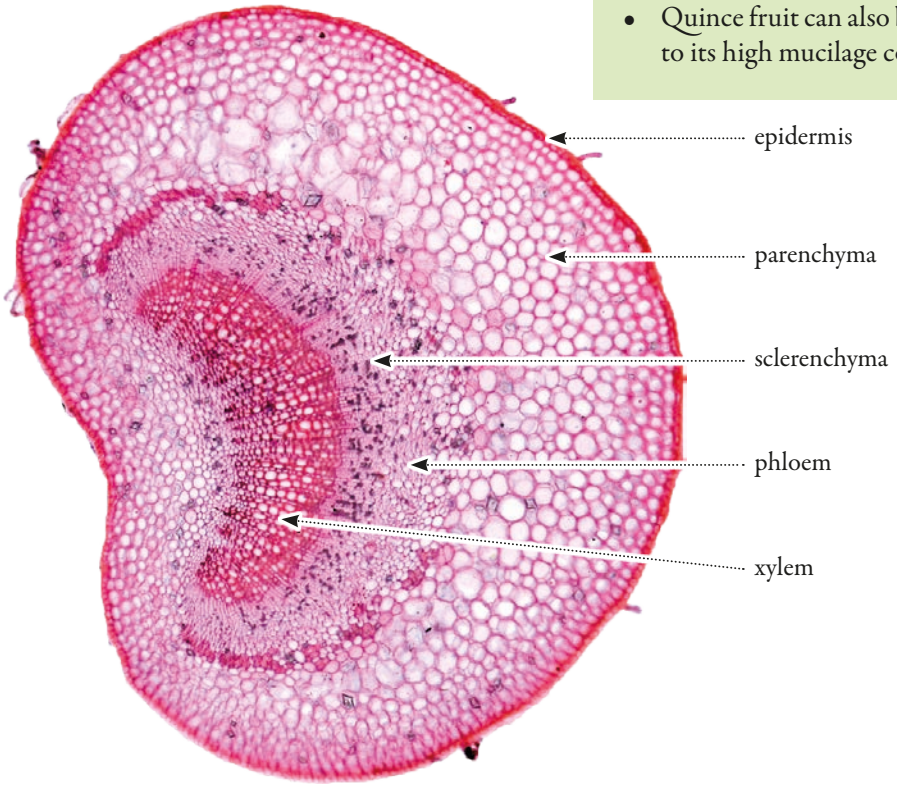
Rosaceae
Cydonia oblonga
QUINCE

leaf stalk C.S.

The cross section of a quince petiole clearly shows how epidermis is a single layer adjacent to the petiole. Beneaththe epidermis is the multi-layered parenchyma, which fills the space between the epidermis and the vascular bundle. The vascular bundle is surrounded by reinforcing elements. Water and ions are transported by the extensive xylem, while the adjacent phloem, made up of cells of smaller diameter, transports the finished organic materials.

DO YOU KNOW?

- The high pectin content of the quince fruit makes it ideal for making jam and quince cheese.
- Brandy and liqueur can also be made from quince fruit.
- Quince fruit can also be used as a laxative due to its high mucilage content.



Cross-section of leaf stalk of quince

Rosaceae
Cydonia oblonga
QUINCE

seed C.S.

The quince seed is surrounded by a mucilage on the outside. Beneath this is the seed coat. The seed coat protects and nourishes the embryo, or germ. The quince has two cotyledons.

DO YOU KNOW?

- Quince seeds contain antiseptic and anti-inflammatory substances.
- According to popular tradition, quince was also used as a perfume.

Cross-section of seed of quince

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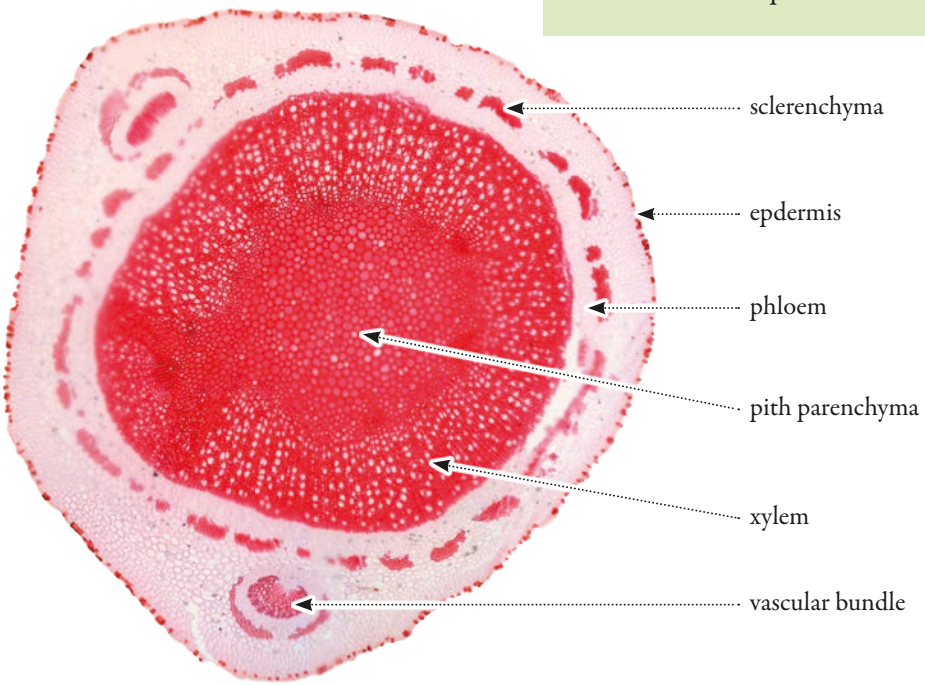
Rosaceae
Cydonia oblonga
QUINCE

shoot C.S.

If we look at the cross section of the quince stalk, we can see why it is so hard and stiff. On the outside, the quince stem is bounded by the epidermis, under which there are reinforcing elements in the soft parenchyma. Beneath this is the part of the phloem responsible for transporting organic matter, made up of cells of smaller diameter. The xylem shows strong staining, indicating that the wall of the xylem cells has thickened. In the innermost part we find the pith, made up of the parenchyma.

DO YOU KNOW?

- Quinces were grownby the ancient Greeks and Romans, and their name derives from the ancient name of the city of Chania on the island of Crete, i.e. Cydonia.
- Some varieties of quince are extremely frost tolerant. The "Aiva Servenaia" quince can withstand temperatures as low as -35°C.



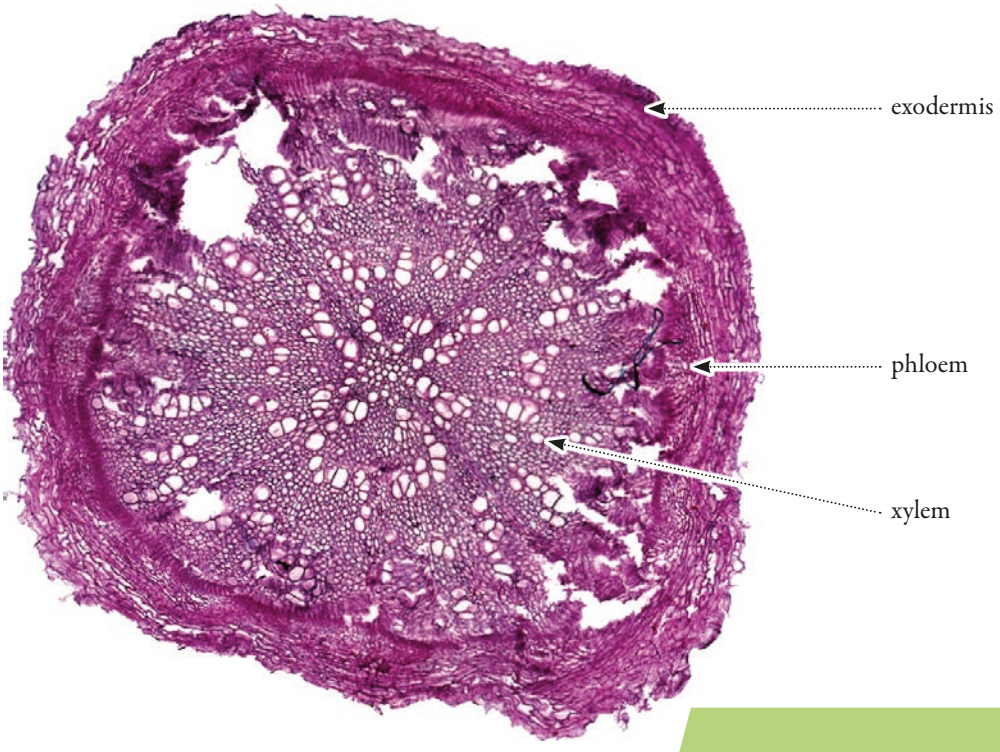
Cross-section of stem of quince

Asteraceae
Helianthus annuus
COMMON SUNFLOWER, SUNFLOWER
mature root C.S.

The cross section of an old sunflower root clearly shows the structure of the transport tissues that have formed in several layers over the years. As this is an older organ, we do not find a single layer epidermis, but a multi-layered, thick exodermis. The small cells of the phloem part are heavily stained, while the xylem makes up the majority of the root section.

TUDTAD?

- Archaeological evidence of the sunflower shows that the dye extracted from the plant was used for textile and body painting in and around Mexico.
- The painter Vincent Van Gogh painted sunflowers several times.



Cross-section of mature root of sunflower

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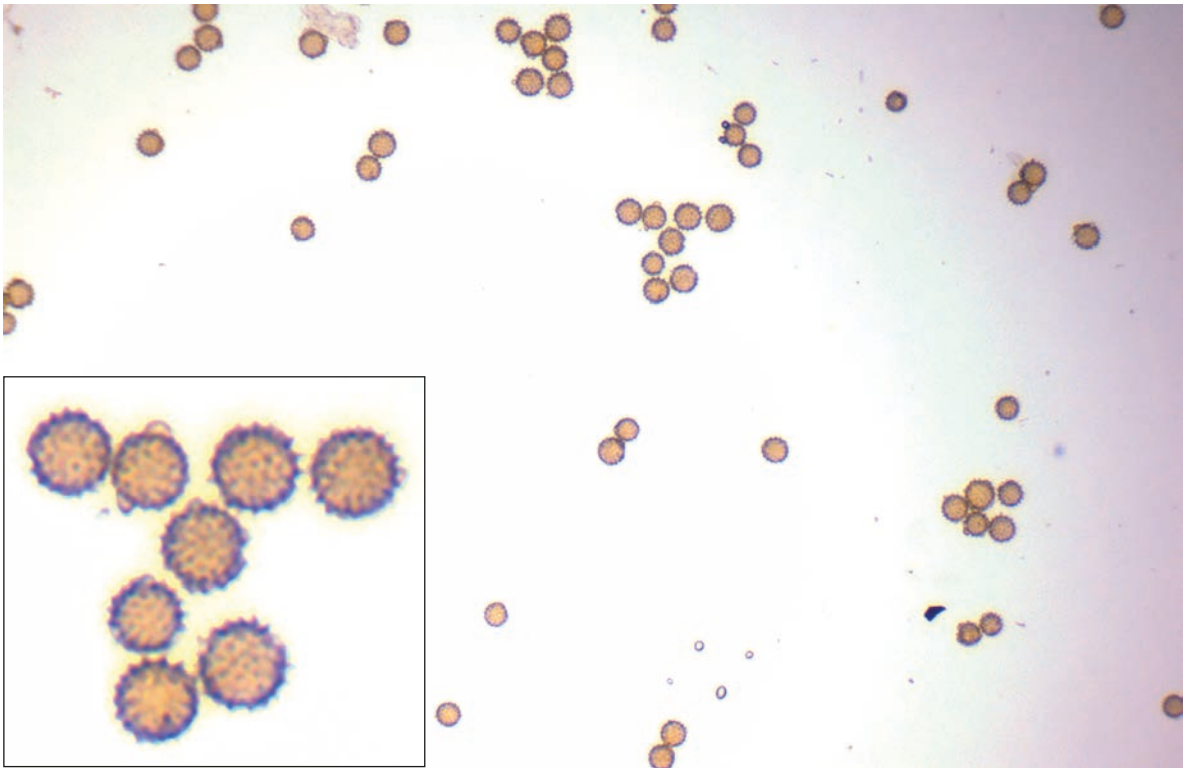
Asteraceae
Helianthus annuus
COMMON SUNFLOWER, SUNFLOWER
pollen

Sunflower pollen has a spiky structure that helps it to attach and adhere to the pollinating insects. On some pollen, we find a small, round bulge, which is a sign that these pollen have already started to move the pollen tube, which ensures that they reach the seed initiation. The pollen tube emerges from the pistil.

DO YOU KNOW?

- Sunflower pollen can protect pollinating insects from infection by stomach pathogens.



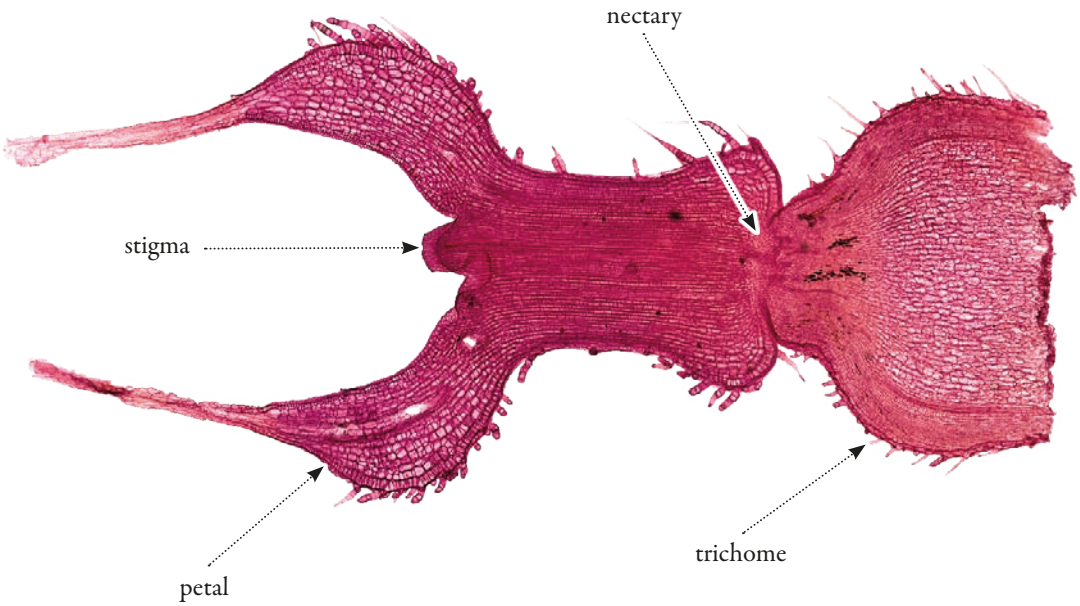
Pollen grains of sunflower

Asteraceae
Helianthus annuus
COMMON SUNFLOWER, SUNFLOWER
nectary gland L.S.

Nectaries, or nectar glands in other words, secrete nectar, which is a complex biochemical substance. Nectar is used as a food source by pollinating insects in return for their willingness to pollinate the flower and help transport the pollen. In the case of the sunflower, the petals surround the pistil, at the base of which is the nectar gland.

DO YOU KNOW?

- Sunflower nectar is a source of energy for many pollinating insects.
- The amount of nectar is affected by extreme weather conditions.
- The use of fertilizers affects the composition of sunflower nectar.



Longitudinal section of nectary gland of sunflower

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ORNAMENTAL PLANTS

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Araliaceae

Hedera helix

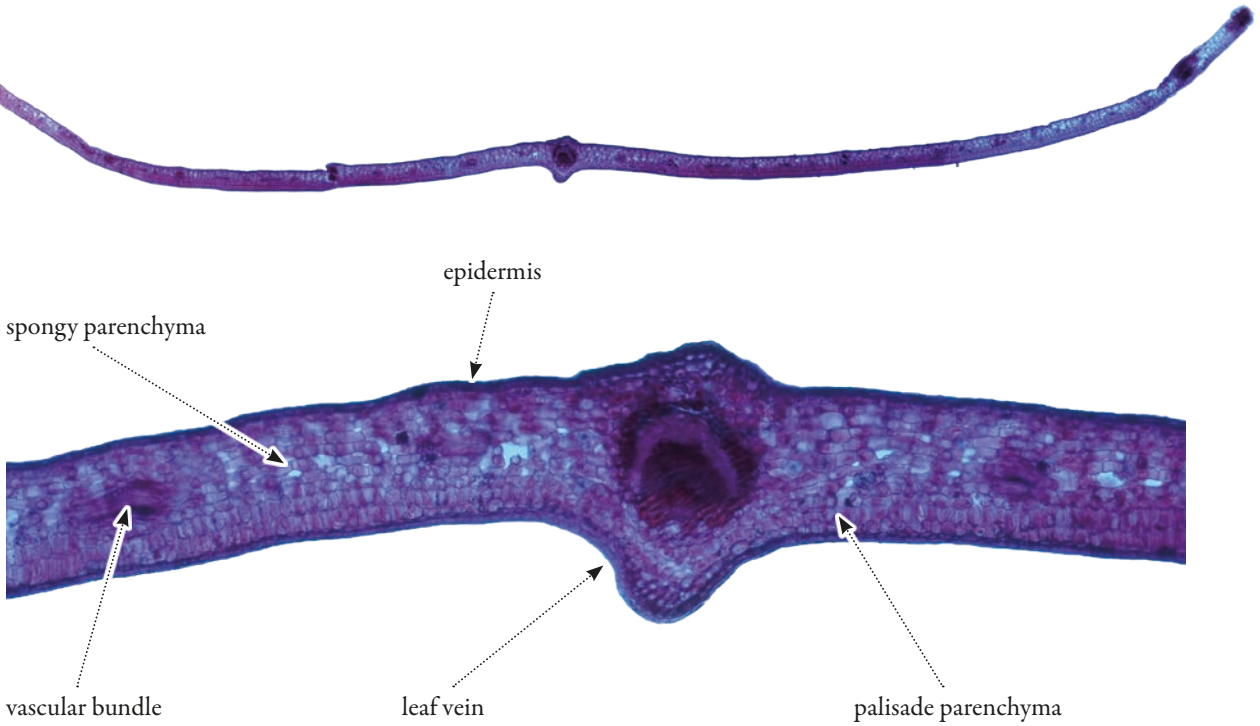
COMMON IVY, HELFORD RIVER IVY

lower leaf C.S.

The outside of the ivy leaf is covered by a waxy epidermis. The part of the leaf between the two layers of epidermis is called the midrib, or mesophyll. There are two types of cells in the mesophyll, both of which belong to the parenchyma, known as spongy parenchyma and palisade parenchyma. The vein has a thicker layer of cells called the collenchyma. The vascular bundles are located in the pith.

DO YOU KNOW?

- Ivy is an evergreen plant species.
- It grows in cool, damp places.



Cross-section of lower leaf of common ivy

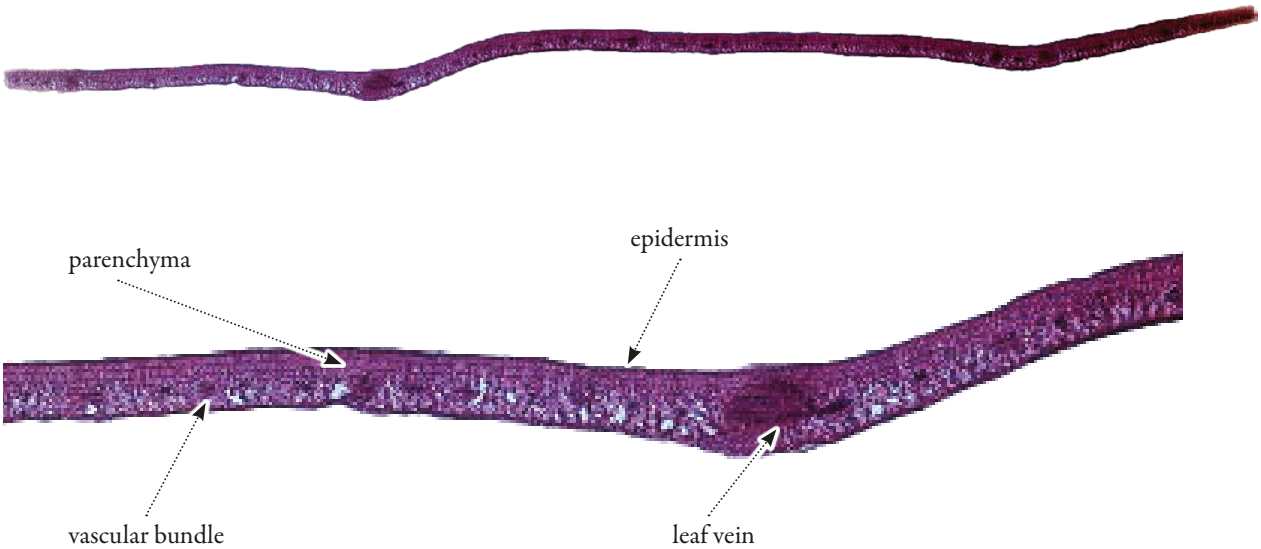
Araliaceae
Hedera helix
COMMON IVY, HELFORD RIVER IVY

upper leaf C.S.

The cross section of the upper leaf shows a similar structure to that of the lower leaf. You can clearly see that the leaf has a smaller cross-section because these leaves receive enough light and do not form a large surface area.

DO YOU KNOW?

- It is planted as an ornamental plant in gardens and parks.
- Its leaves are rich in active substances.
- In the Lord of the Rings films, it is an accessory to the elves' clothing.



Cross-section of upper leaf of common ivy

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Iridaceae

Iris × *germanica*

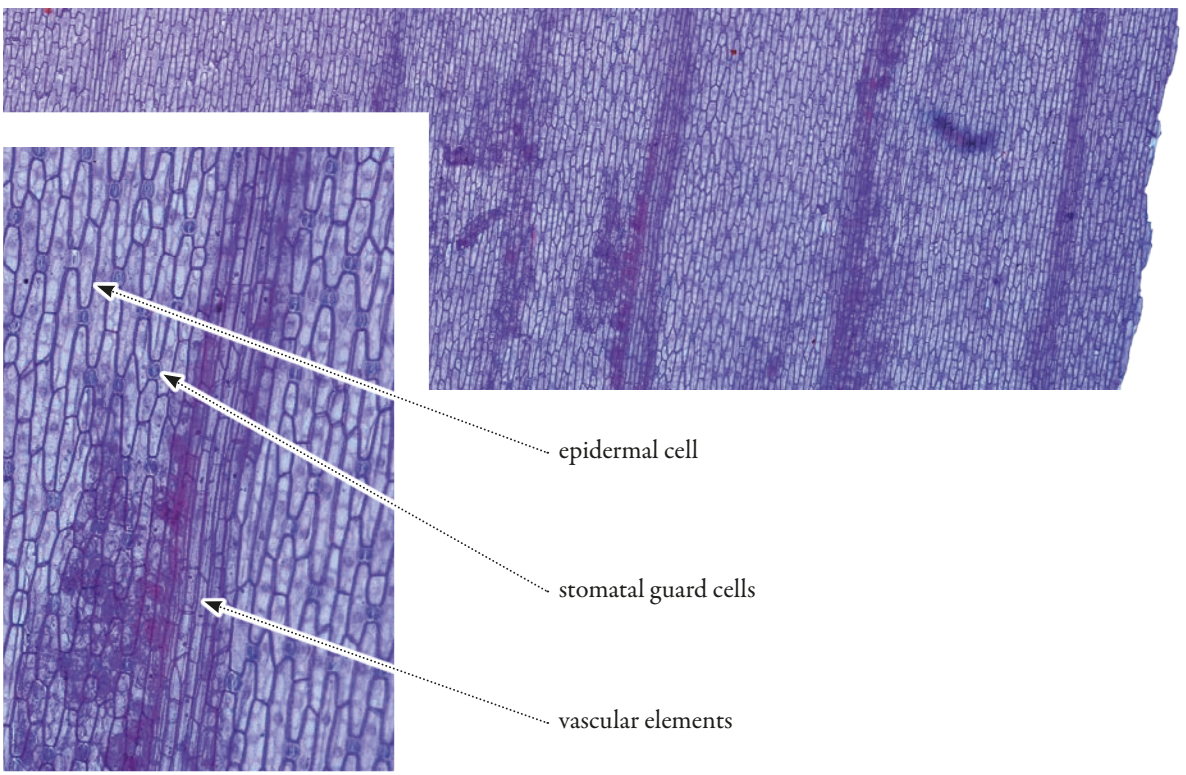
GERMAN BEARDED IRIS, BEARDED IRIS

epidermal peel

By removing the epidermis from the surface of the leaf of the bearded iris leaf, we make an epidermal peel. This epidermis allows us to see the composition of the epidermal tissue covering the leaf. The cells of the epidermal tissue are elongated, rhombic, and between them we see the smaller, round stomatal guard cells that surround the stomata. In the centre of the epidermis we see longitudinally elongated cells that are suitable for transport.

DO YOU KNOW?

- In Greek mythology, Iris was the goddess of the rainbow.
- Bearded iris tolerates drought well.



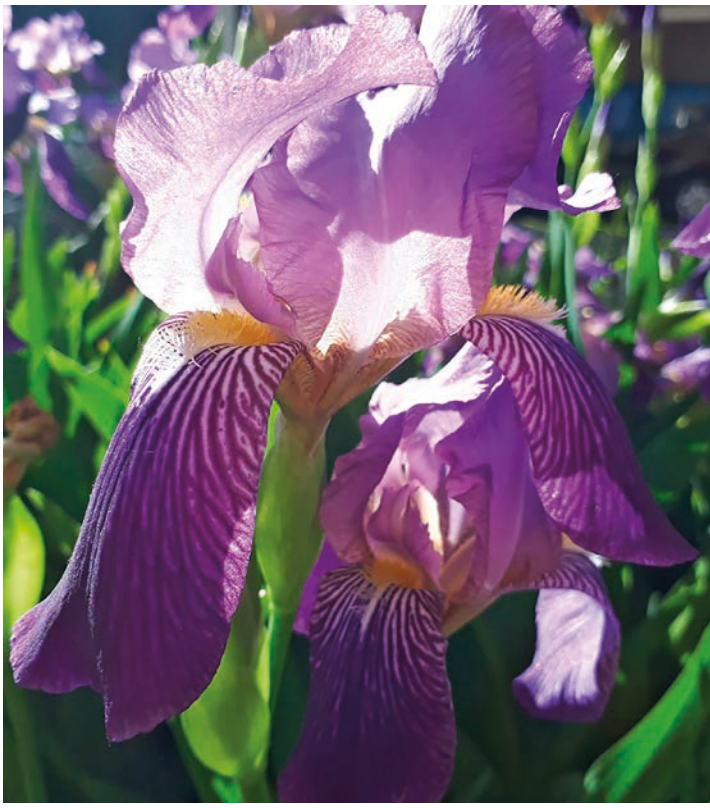
Epidermal peel of epidermis of bearded iris

Iridaceae

Iris × *germanica*

GERMAN BEARDED IRIS, BEARDED IRIS

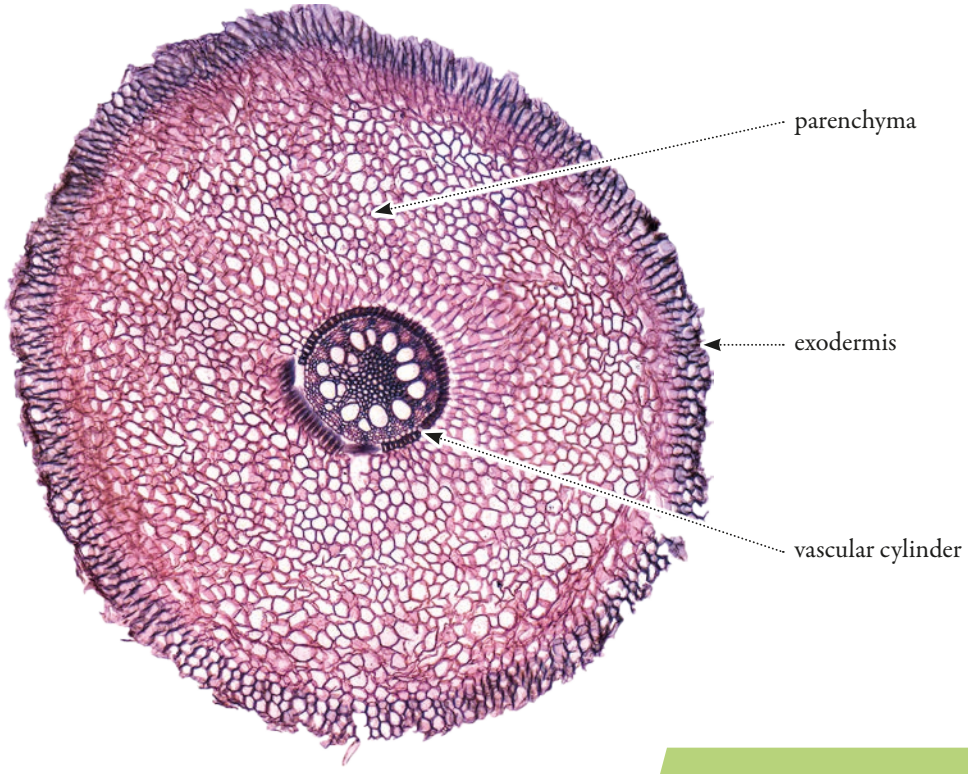
root C.S.



The cross section of the root of the bearded iris clearly shows that the multi-layered exodermis surrounds the root from the outside. Beneath the exodermis is an extensive parenchyma with loosely interconnected cells. The tyre-like structure in the centre of the section is the central part of the root, containing the vascular tissue. The large cells correspond to the elements of the xylem that are responsible for water transport.

DO YOU KNOW?

- The rhizomes of the bearded iris should not be completely covered by the soil, they should be kept at the same level as the soil or barely covered.



Cross-section of root of bearded iris

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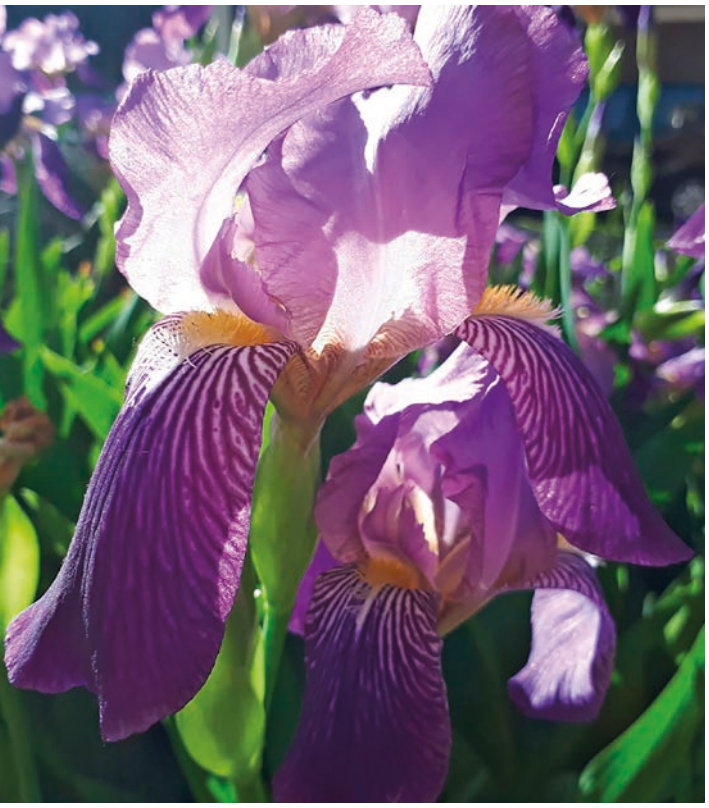


Iridaceae

Iris × *germanica*

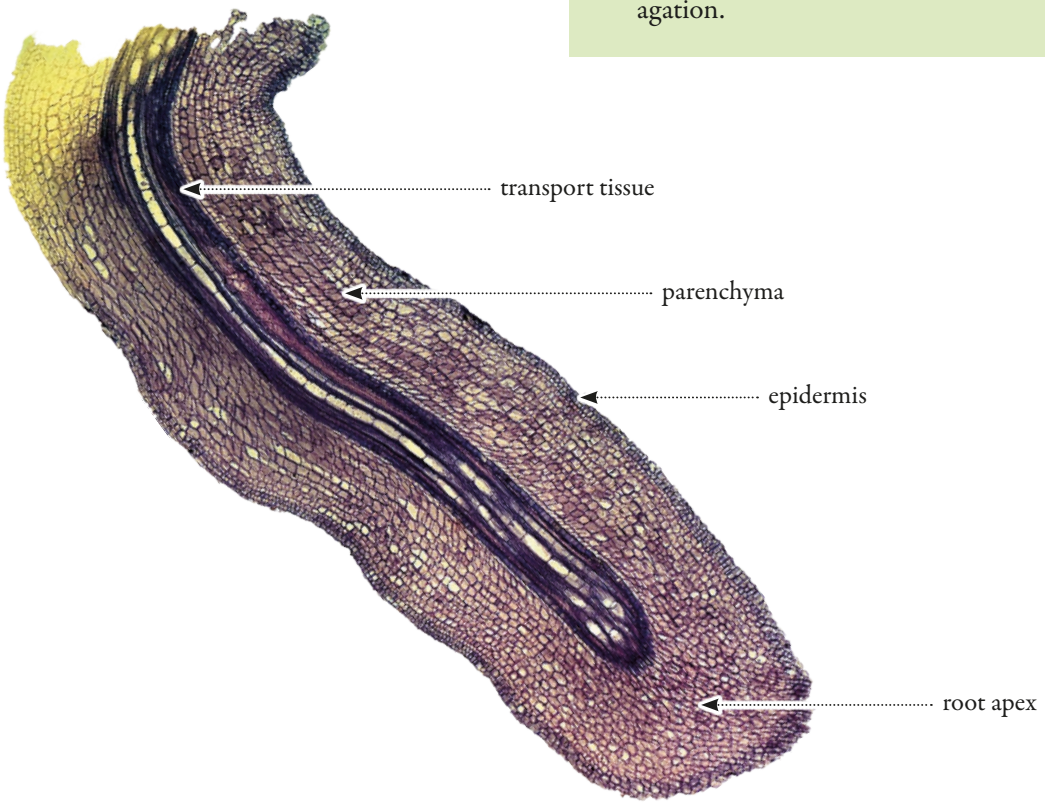
GERMAN BEARDED IRIS, BEARDED IRIS

contractile root L.S.

The longitudinal section of the contractile root of the bearded iris shows that the parenchyma is located beneath the epidermis. While small cells are closely spaced at the tip of the root, the parenchyma cells in the upper part are elongated in the direction of growth. The vascular tissue shows strong staining in the middle of the section, indicating that the walls of these cells are thickened to resist water flow.

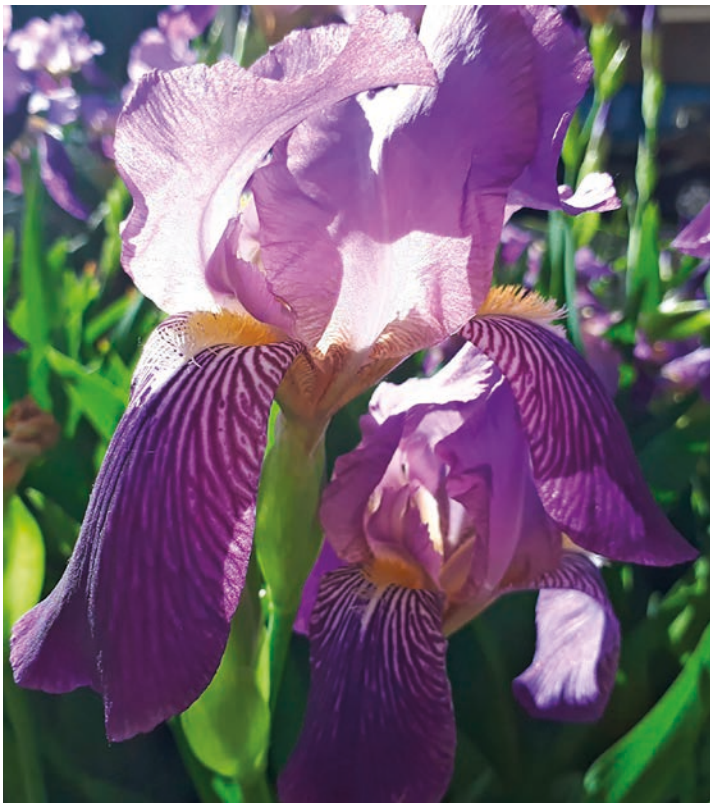
DO YOU KNOW?

- The contractile roots of the iris help the bulb to penetrate deeper into the soil as they are able to contract, promoting downward propagation.



Longitudinal section of contractile root of bearded iris

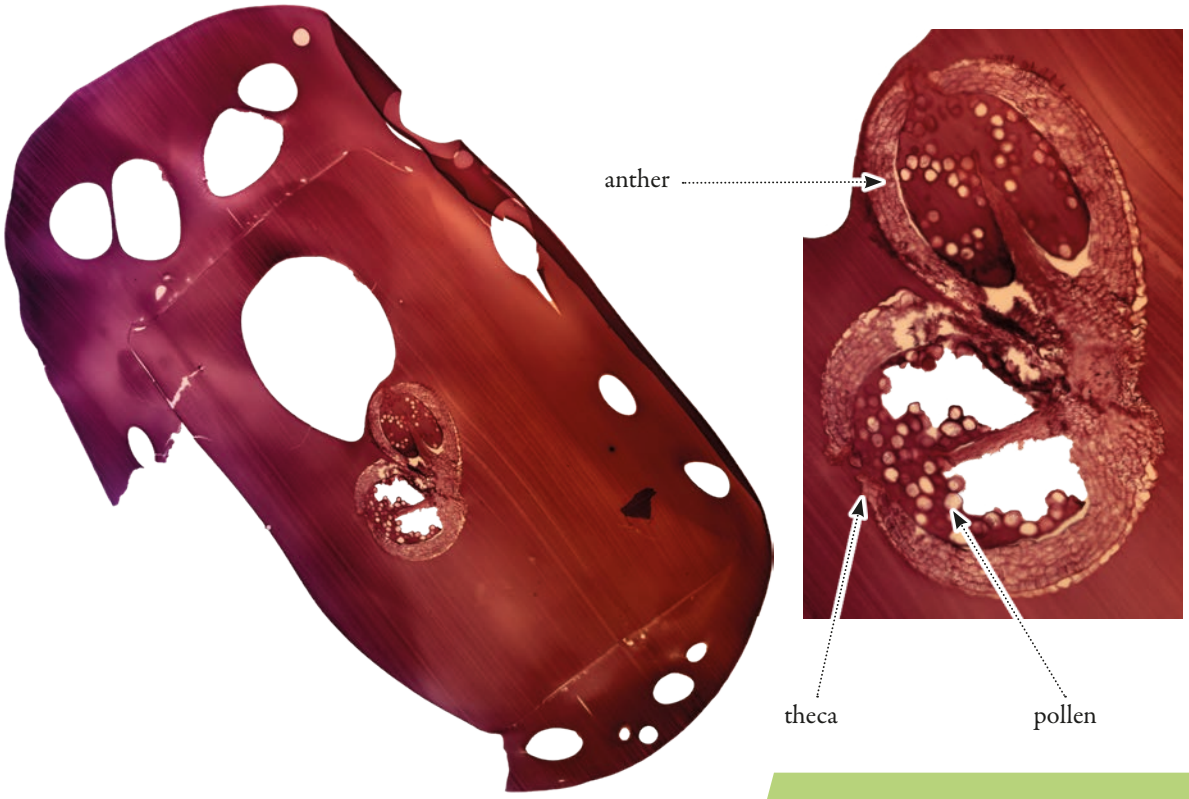
Iridaceae
Iris × *germanica*
GERMAN BEARDED IRIS, BEARDED IRIS
theca C.S.



In this specimen we can see a detail of the stamen area of the bearded iris. The anthers are made up of two thecas, in which we find the pollen scattered.

DO YOU KNOW?

- The rhizome of the bearded iris gives off a violet-like scent and is used as a raw material for cosmetic preparations.
- Bearded iris is one of our most popular garden ornamentals.



Cross-section of anther of bearded iris

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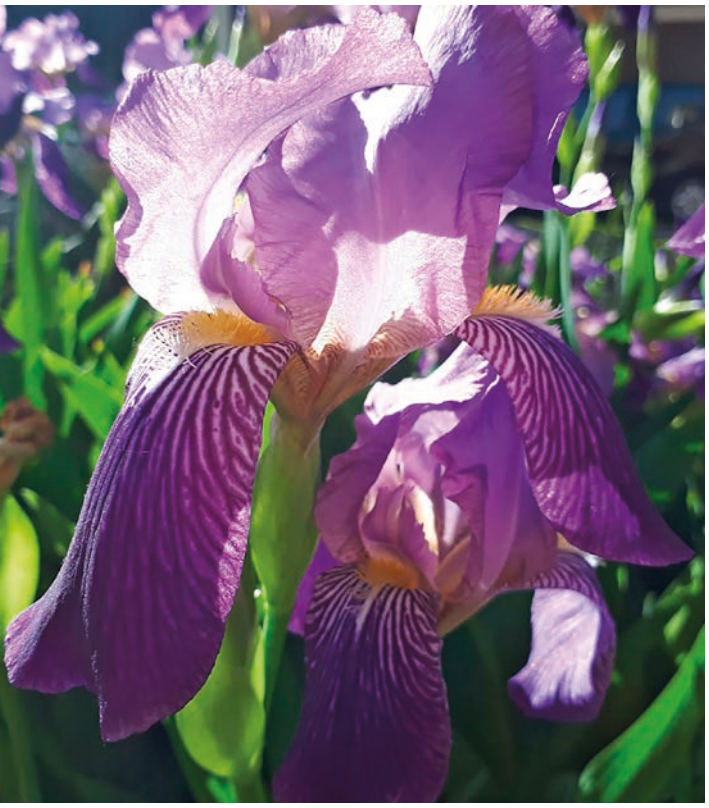


Iridaceae

Iris × *germanica*

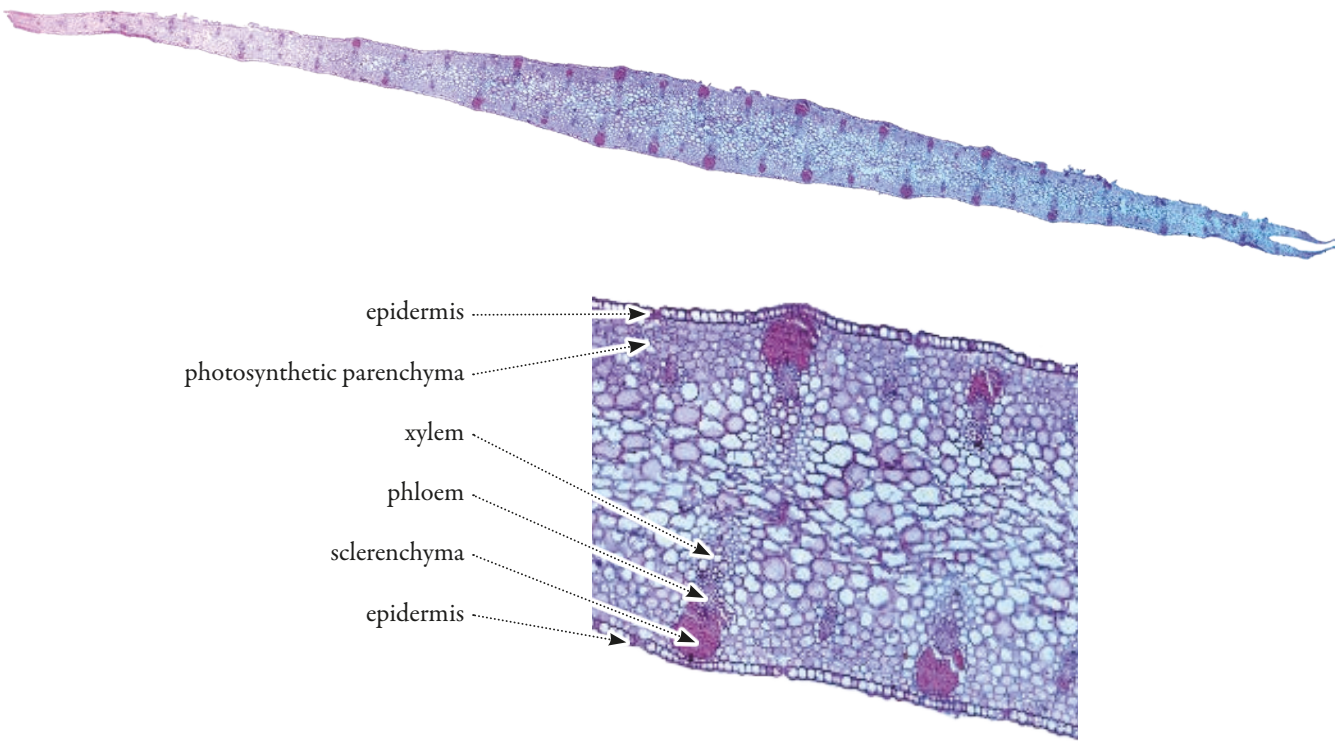
GERMAN BEARDED IRIS, BEARDED IRIS

leaf C.S.

In the cross section of a bearded iris leaf you can see the two epidermal tissues that surround the central part of the leaf. Two types of cells can be distinguished in the parenchyma, the spongy and the palisade tissue, also known as the parenchyma. The vascular bundles are covered by a reinforcing sclerenchyma, which stiffens the leaf.

DO YOU KNOW?

- Orris root powder is nothing more than a ground powder made from the dried rhizomes of garden yarrow plants. It is a valuable raw material for perfumers.



Cross-section of leaf of bearded iris

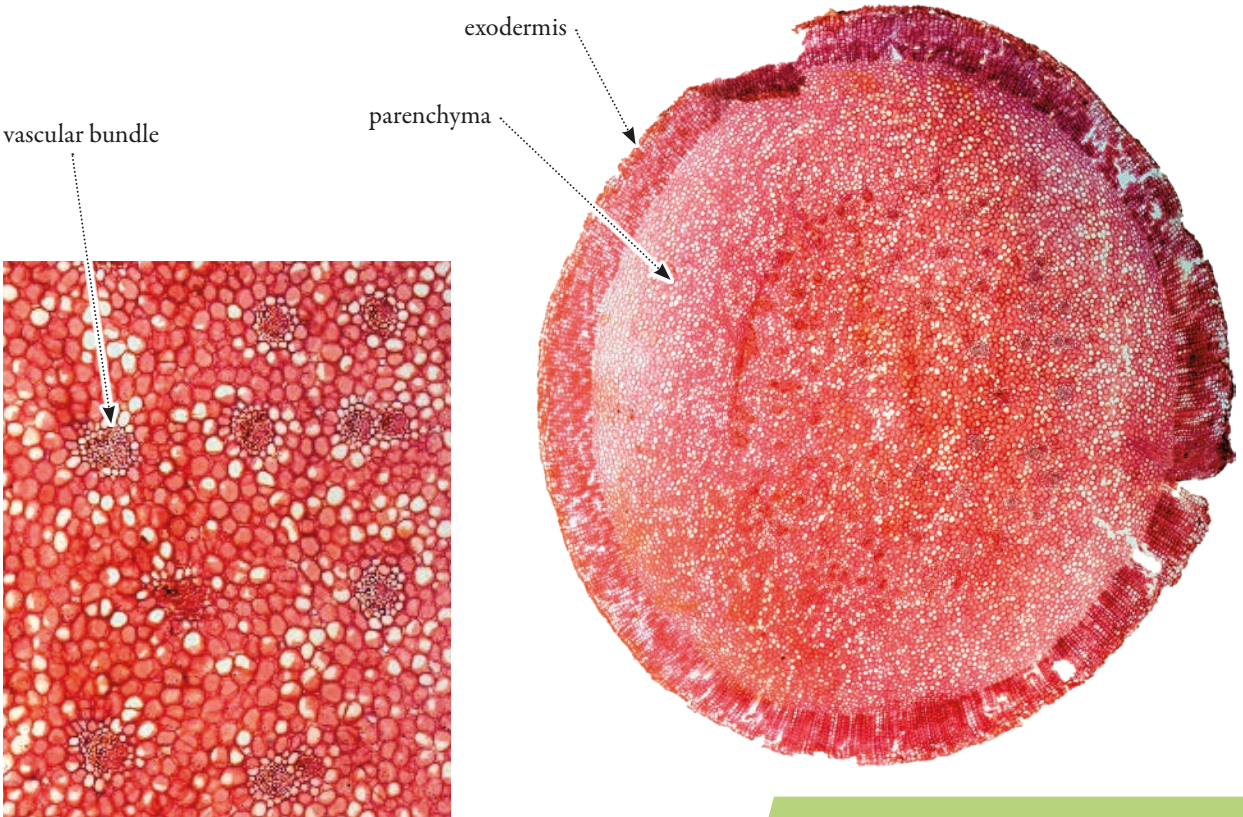
Iridaceae
Iris pumila
PYGMY IRIS, DWARF IRIS

rhizome C.S.

A cross section of the rhizome of the tiny dwarf iris clearly shows the exodermis, which runs in several layers along the outer part of the rhizome and performs the function of epidermal tissue, i.e. it encloses the organ from the outside. The loose parenchyma cells fill most of the rhizome, in the middle of which the vascular bundles are scattered. The small cells of the phloem are surrounded by the large water-carrying elements of the xylem.

DO YOU KNOW?

- The dwarf iris can be found in many colours: it can be white, yellow, or even purple.



Cross-section of rhizome of dwarf iris

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Iridaceae

Iris pumila

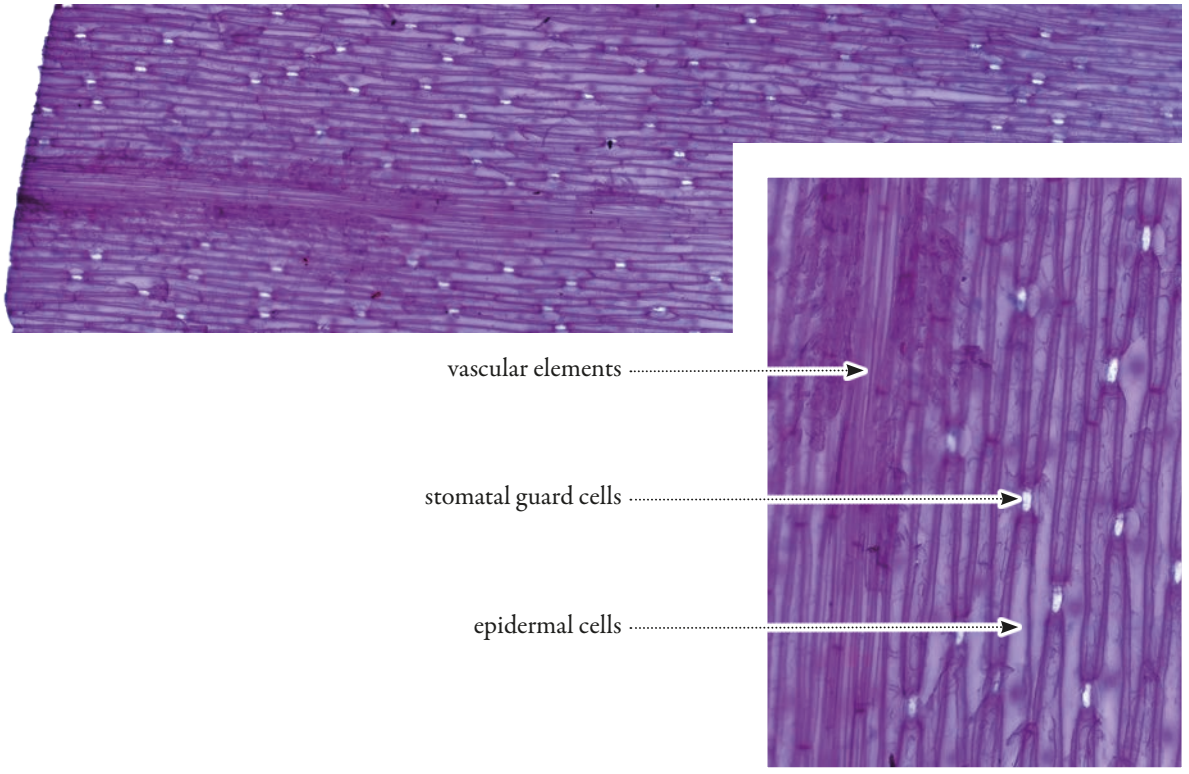
PYGMY IRIS, DWARF IRIS

epidermal peel

The epidermis of the dwarf iris has structures similar to those of the bearded iris. The epidermal cells are elongated, diamond-shaped, with round stomata or gas exchange openings between them. The guard cells in the stomata are round, as can be seen from the picture. The transport elements are elongated in the longitudinal direction.

DO YOU KNOW?

- The dwarf iris is not suitable for consumption, i.e. it is not edible.
- As its name suggests, it is small in stature, growing to a maximum of 0.5 m.



Epidermal peel of leaf of dwarf iris

Caprifoliaceae
Lonicera tatarica
TATARIAN HONEYSUCKLE

bud L.S.

In the longitudinal section of the honeysuckle bud, the leaf primordia can be seen at the tip of the shoot at the end of the stem, as well as the mature long leaves. At the base of the leaf tips, close to the tip, we find axillary buds, which will not be active until the hair tip is intact.

TUDTAD?

- Honeysuckle is a good soil binder.
- Tatarian honeysuckle has been shown to have an allelopathic effect on larch, i.e. it hinders its development.

Longitudinal section of bud of tatarian honeysuckle

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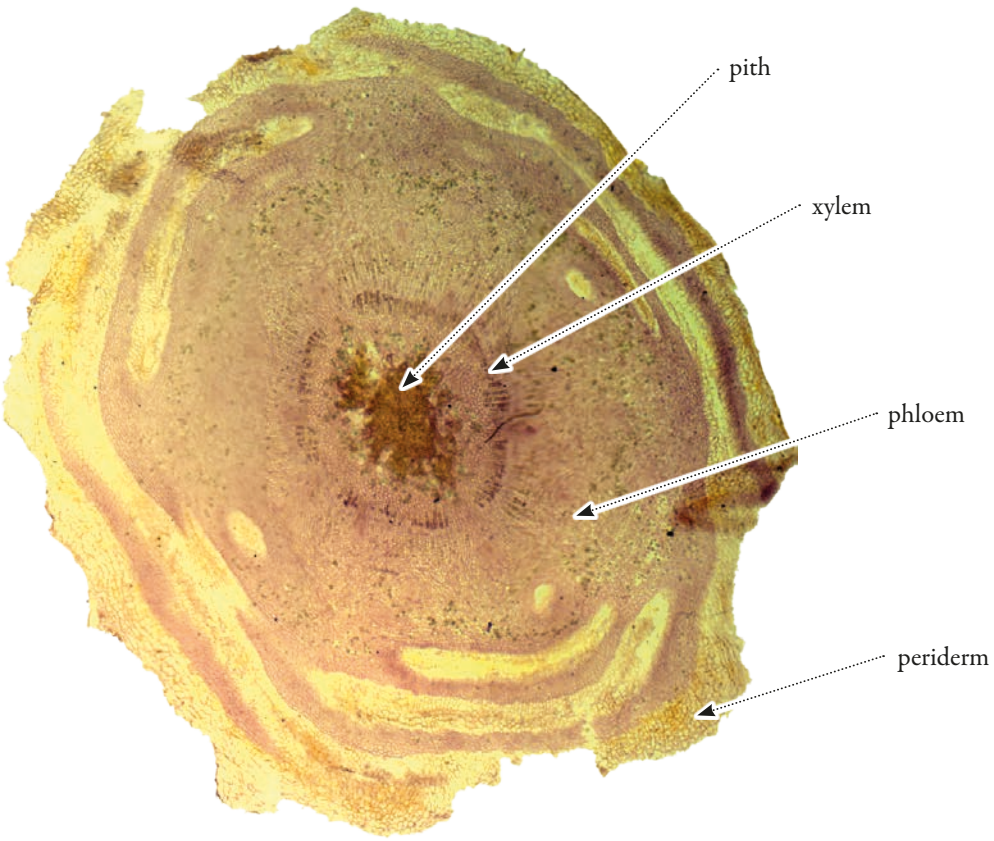
Caprifoliaceae
Lonicera tatarica
TATARIAN HONEYSUCKLE

bud C.S.

In the cross section of the honeysuckle bud we can see the overlapping leaves that cover the tip of the shoot. At the tip of the shoot you can see the phloem, which is made up of small cells that transport organic matter to where it is needed, and the wider, hollow xylem, which is responsible for transporting water and minerals.

DO YOU KNOW?

- The Tatarian honeysuckle is a frost tolerant plant that can withstand temperatures as low as -34 °C.



Cross-section of bud of tatarian honeysuckle

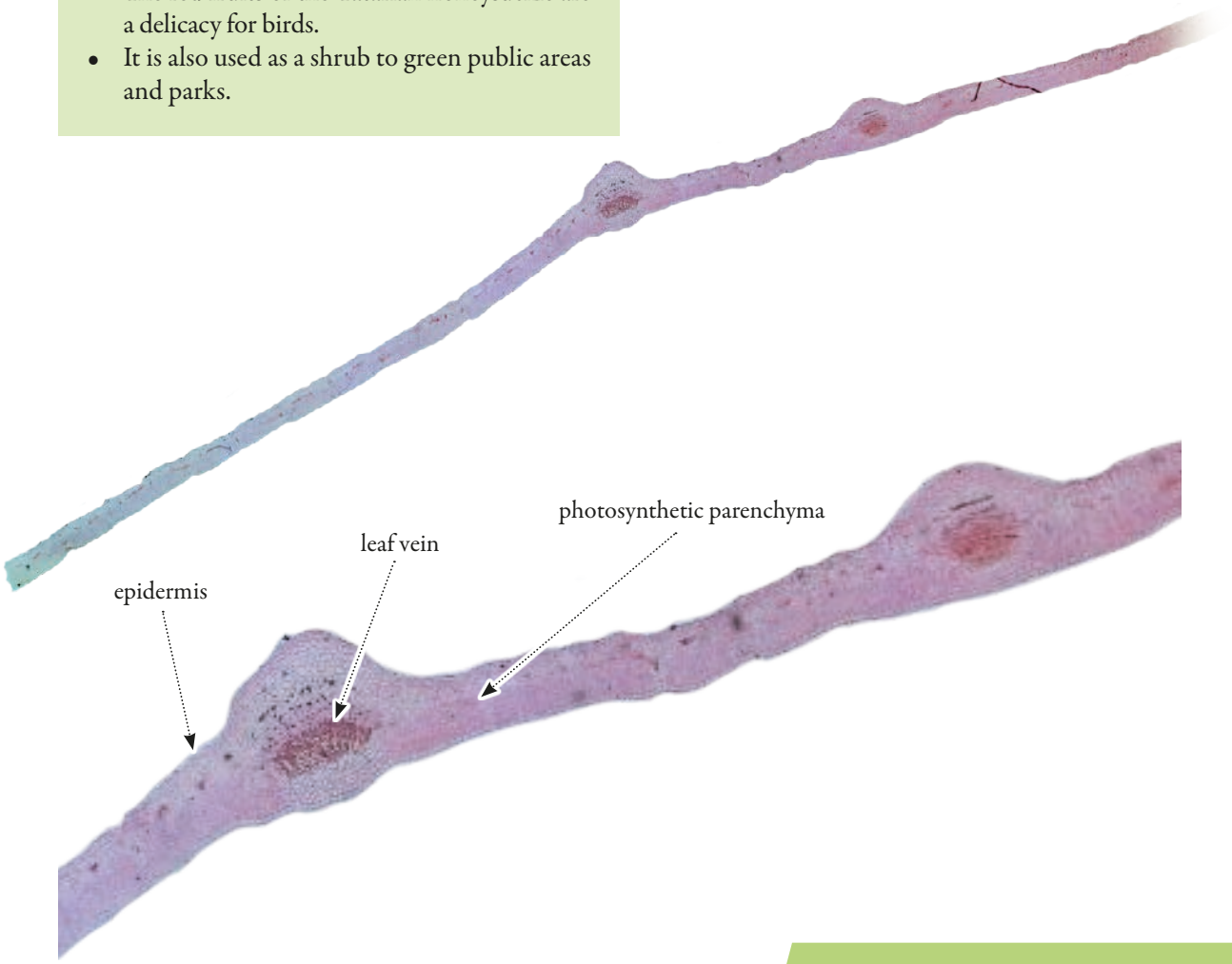
Caprifoliaceae
Lonicera tatarica
TATARIAN HONEYSUCKLE

leaf C.S.

The leaves of the Tatarian honeysuckle are covered on both sides with epidermal tissue. The central part of the leaf, known as the mesophyll, which is held together by the two epidermal tissues, consists of the largest mass of parenchyma cells. The vascular bundles are stiffened by a multi-layered sclerenchyma.

TUDTAD?

- The red fruits of the Tatarian honeysuckle are a delicacy for birds.
- It is also used as a shrub to green public areas and parks.



Cross-section of leaf of tatarian honeysuckle

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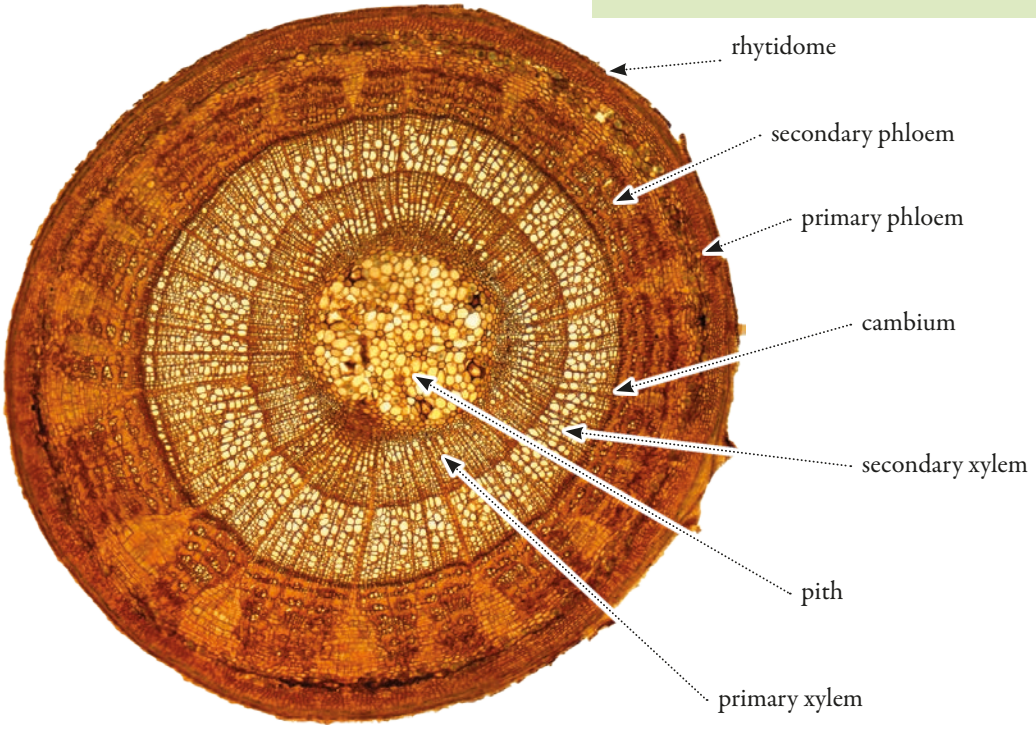
Malvaceae
Tilia cordata
SMALL-LEAVED LIME, LITTLELEAF LINDEN, PRY TREE
branch C.S.

In the cross section of a small-leaved lime branch, the tertiary rhytome, also known as the bark, can be seen from the outside. Below this it is the secondary phloem and the primary phloem. A thin layer of cambium separates the phloem from the xylem, which contains the larger diameter water-carrying elements. The age of the given tree can be easily calculated from the annual rings on the tree trunk. Inside we find soft pith tissue.

DO YOU KNOW?

- The linden blossom is used medicinally and has been used in folk medicine for a long time, its tea is good for colds and for calming the nerves.
- It is often planted in towns and cities as it is well adapted to urban conditions.

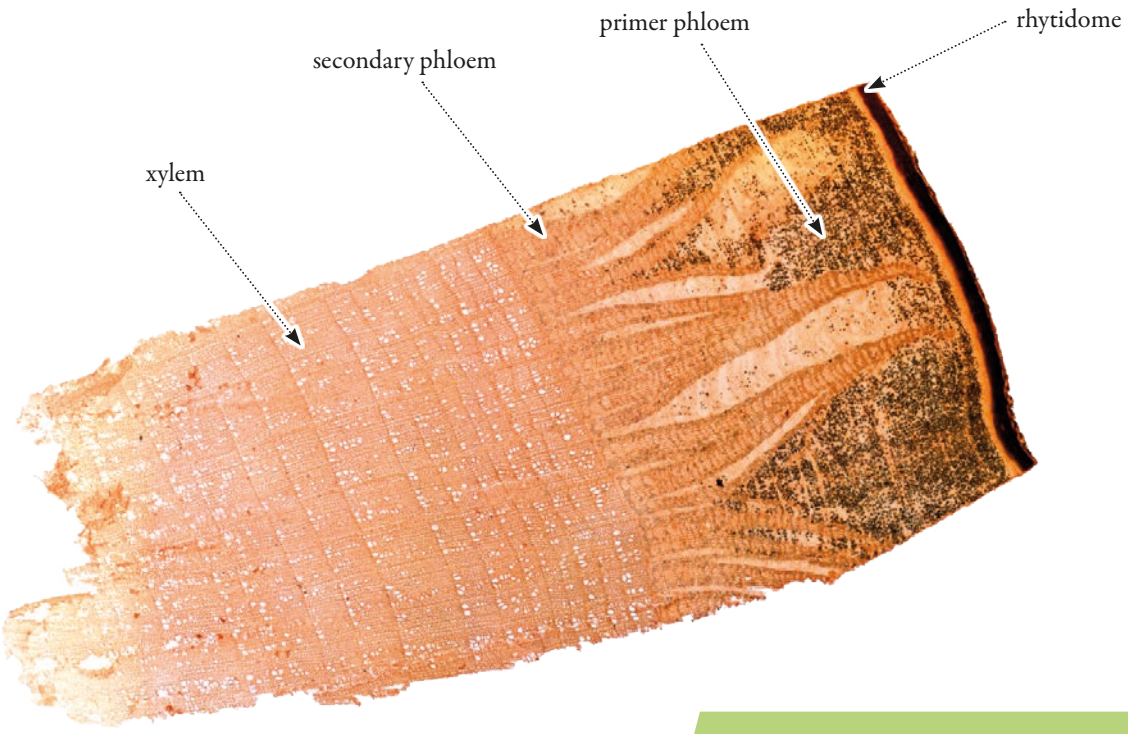


Cross-section of branch of small-leaved lime

Malvaceae
Tilia cordata
SMALL-LEAVED LIME, LITTLELEAF LINDEN, PRY TREE
wood C.S.

The cross section of a small-leaved linden clearly shows the structure of a perennial tree. On the outside is the distinctly coloured, multi-layered rhytidome. Below this is the multi-layered bark body, and inside is the xylem with the annual rings.

DO YOU KNOW?
- The small-leaved linden is a 25-30 metre tall tree with heart-shaped leaves.
- On the axis of the inflorescence there is a membranous leaf that acts as a flying device.



Cross-section of xylem and phloem of small-leaved lime

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GLOSSARY

allelopathy: the effect of higher plants and microorganisms on each other's development through the production of an active substance. We can speak of positive and negative allelopathy when the active ingredient of the donor organism helps or inhibits the growth of the host organism.

pith: usually found in the centre of plant stems and may play a role in nutrient storage.

endocarp: the inner layer of pericarp of fruits.

epidermis: the outer layer of the plant is called the epidermis, which can protect the plant from external influences.

exodermis: the protective layers of the root after the primary rhizodermis.

exocarp: the outer layer of the fruit's pericarp.

annual ring: is the growth of the trunk in one year in the case of woody plants.

Xylem: tissue suitable for transporting water in the case of roots

phloem: responsible for nutrient transport

photosynthesis: synthesis of organic compounds using sunlight

phloem: simple bundle for nutrient transport in roots

rhytidome: tertiary skin tissue, also known as bark, is found in woody plants.

cambium: secondary transport element producing meristem, lateral meristem.

contractile root: root capable of contraction, a shoot-derived root formed on underground shoots.

cortex: layer under the epidermis which can store nutrients.

mesophyllum: the central part of the leaf, bounded by two epidermis layers, capable of photosynthesis.

mesocarp: the middle layer of pericarp of fruits.

bracts: from the axils of which the flowers of the inflorescence develop.

meristem: the tissue whose cells retain the ability to divide throughout the life of the plant.

complex bundle: bundle which can contain xylem and phloem.

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parenchyma: the name of isodiametric cell groups.

pericycle: the outer cell layer of the root stele in young roots.

pericarp: the part of the fruit that develops from the wall of the ovary in the case of a true fruit. It may be dry or fleshy.

rhizodermis: the primary dermal layer of the young root.

rhizome: underground shoot, mostly with short stems, modified for storage.

spore: reproduction structure.

Solidifying tissues: tissues that provide the strength and load-bearing capacity of the plant body, with locally or uniformly thickened cell walls.

sclerenchyma tissue: for reinforcement with thick-walled cells.

sorus: group of sporangia in the fern leaves.

stomata: gas exchange pores with guard cells.

assimilation parenchyma: place of photosynthesis.

vascular bundles: contain xylem and phloem, which are responsible for transport water, ions and produced nutrients.

guard cell: special cells that can form the stomata. Their shape is bean-shaped in dicots, but elongated in monocots.

xylem: transport for water and ions

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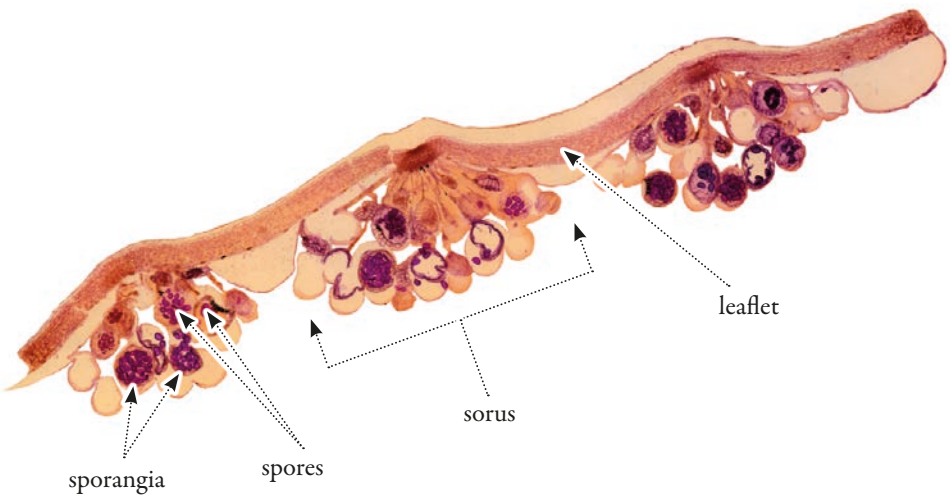
TEST YOUR KNOWLEDGE!

Below you can test your knowledge. You have to guess which of the plants in the book it belongs to. The solutions can be found at the end of the test.

Task 1.

WHICH FERN LEAF CAN BE SEEN IN THE PICTURE?



A Eagl fern

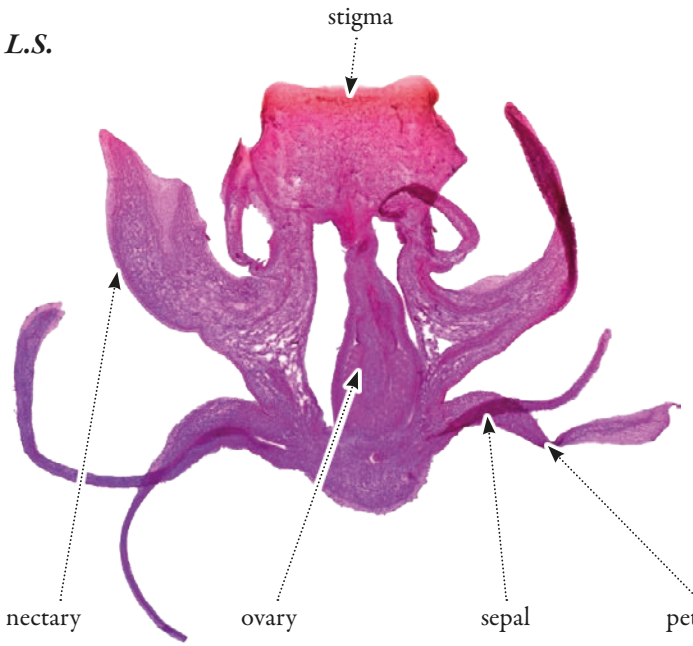
B Male fern

C Common polypody

Task 2.

WHICH PLANT CAN BE SEEN IN THE PICTURE?

L.S.



C.S.

A Rose

B Milkweed

C Wild tobacco

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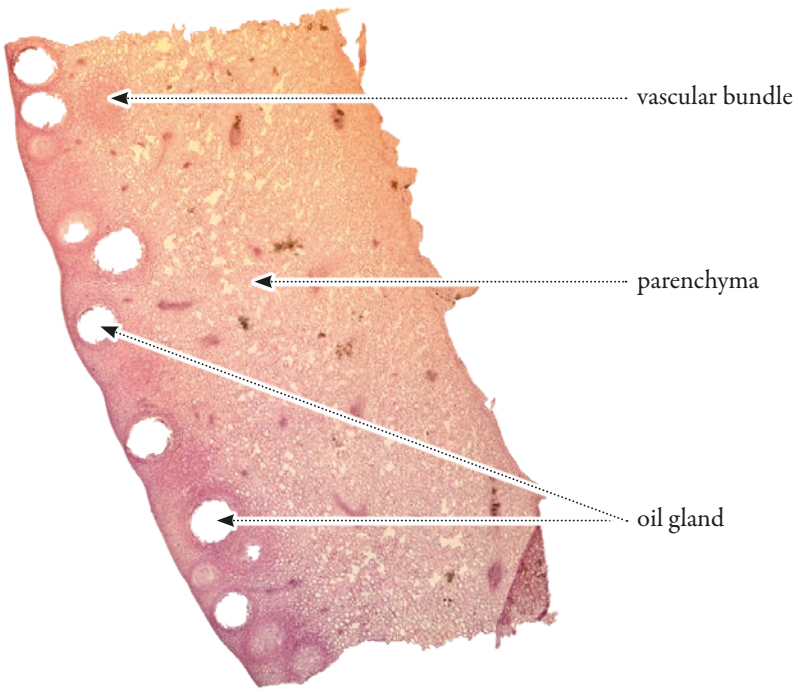
Task 3.

FROM WHICH PLANT HAS BEEN MADE THIS SPECIMEN?



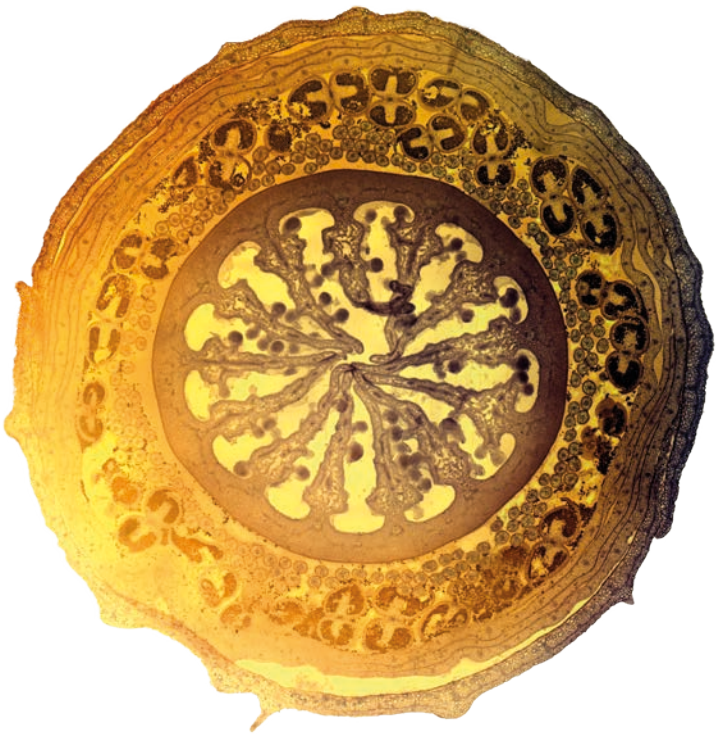
A Banana

B Lemon

C Walnut

Task 4.

FROM WHICH PLANT HAS BEEN MADE THIS SPECIMEN?



A Tomato

B Common poppy

C Lemon

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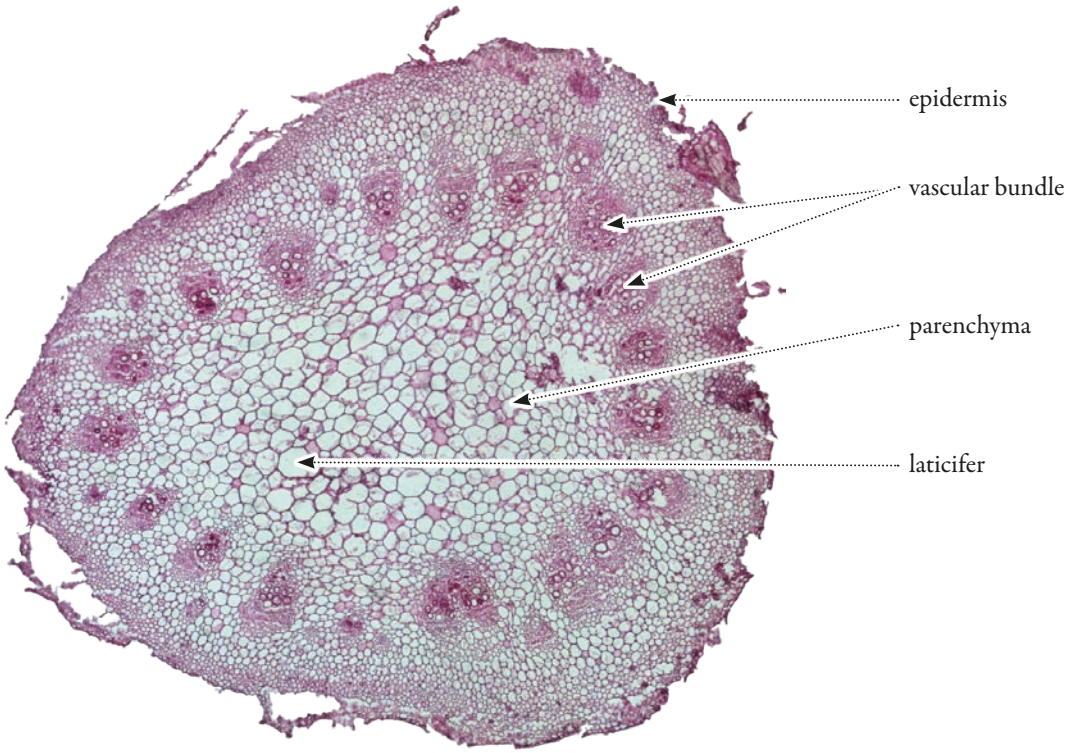
Task 5.

FROM WHICH PLANT HAS BEEN MADE THIS SPECIMEN?



A

B

(Solution: 1.C; 2.B; 3.B; 4.B; 5.A.)

WHY WAS THIS BOOK WRITTEN?

The aim of this book is to raise awareness of plants in order to avoid the plant blindness that is becoming increasingly common today. Plants do not only play the role of a green backdrop: the food industry, the pharmaceutical industry, energy production and sustainable biotechnological applications all support the essential importance of plants. Recognising the micro-world of plants can help to increase interest in plants among students or even interested adults who do not have the opportunity to look inside plants using a microscope. The plant world is an integral part of the world around us, knowledge of which can contribute to human survival not only from a scientific point of view, but also from an emotional one. Today's digital tools can be a useful addition to learning about the world of plants. Our aim is to make these unknown acquaintances as widely known as possible.

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ABOUT THE AUTHORS

DR. LÁSZLÓ BAKACSY

Dr. László Bakacsy is a university researcher at the University of Szeged, working and teaching in the field of environmental sciences at the University of Szeged. He has participated in or been an organising member of numerous study tours and science popularisation activities. As a doctoral student and later as a lecturer, he participated in the ERASMUS+ programme, which enabled him to visit many European botanical gardens. In 2024, he received the SZTE Golden Chalk Award in recognition of his teaching activities. His current research includes the study of population dynamics and ecological interactions of invasive plant species at fine spatial scales. He has also contributed to a number of scientific publications, for example on the invasion of milkweed (*Asclepias syriaca L.*) and the possibilities for its control.

DR. ÁGNES SZEPESI

The author of this book is a lecturer at the University of Szeged, who has introduced many students to the world of plants in recent years. She considers it important to bring plants to the forefront of lectures and exercises in plant anatomy, plant cell biology and plant physiology. During her numerous international Erasmus teaching visits, she has successfully combined her enthusiasm for plants with the knowledge of plant physiology that is an integral part of her research. Her research was awarded with the Zoltán Magyary Postdoctoral Fellowship in 2014 and she won the NKFIH Young Investigator Grant in 2019. From 2023, she is leading the Plant Metabolic Physiology research group at the Department of Plant Biology, SZTE, focusing on plant responses to abiotic stress, especially polyamine metabolism. As a conference organiser and invited speaker, she has had the opportunity to present her research at several international conferences.

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DETAILS OF THE BOOK PUBLICATION, ACKNOWLEDGMENT

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The authors express their gratitude to all the motivating family members, teachers, colleagues and students who contributed to the birth of the idea of this book.

NOTES

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NOTES