The stem of a monocotyledonous plant (Item No.: P1442301)

Curricular Relevance

Area of Expertise: Biology

Education Level: Age 14-16

Topic: Cell biology, microscopy

Subtopic: Plant and animal cells

Experiment: The stem of a monocotyledonous plant

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	30 Minutes	1 Student

Additional Requirements:

- Stems of monocotyledonous plants, diameter max. 3 mm; e.g. maize, tulip, spider plant (Chlorophytum spec.)
- Water

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Information

The stem of plants must accomplish various functions. It supports the leaves, the lateral branches, and the blossoms. The mechanical supportive tissue (collenchyma) is responsible for the necessary stability and elasticity. Did you ever come to think about how a 20m-tall tree is capable of transporting water all the way from its roots to its crown? Or how it may be possible that assimilates from the leaves ever arrive at the roots? We want to explore this pathway of transportation, for which all plants possess a one-way traffic system. The vascular bundles contain vessels for transporting water from the bottom up, and sieve tubes for transporting assimilates from the top down to the bottom. The structural arrangement of the vascular bundles in the dicotyledonous plants differs distinctly from the arrangement found in the monocotyledonous plants.

Information on obtaining materials

Finding suitable material is the decisive prerequisite for the success of the students. The teacher must search for stems which measure at maximum 3mm in thickness, possess a not too soft consistency, and are not yet too lignified and consolidated.
Suitable among the potted plants is the spider plant (*Chlorophytum*).
Recommendable from the flower and vegetable garden are, for example: representative of the lily plants (Liliaceae) such as asparagus (*Asparagus spec*.), daylily (*Hemerocallis spec.),* tulip (*Tulipa*), garlic (*Allium sativum*) and leek (*Allium porrum*), provided that they have grown a stem (blossom). Recommendable among the grasses (*Poaceae*) is, in particular, maize (*Zea mays*) as a juvenile plant.

Information on the stem

The stem is the element that connects the roots with the leaves. It is longitudinally structured in nodes, from which the leaves and the lateral branches branch off, and the intermediate parts (internodes).
Sections shall be made in the area of the internodes.
The vascular bundles in the monocotyledonous plants (monocots, liliopsida) are distributed over the entire cross-section of the stem, however, more densely packed towards the exterior. They are fully surrounded by sclerenchyma and therefore distinctly visible. The meristematic tissue (cambium) in the center is absent in most monocotyledons and so is their secondary growth potential. Some tree-like lily plants produce a cambium secondarily outside the vascular bundles (Draceae).

Safety measures

- Attention! Count the number of scalpel blades at the end of lessons in order to prevent accidents that also might occur afterwards!
- Ethanol is extremely flammable. Extinguish all open flames!
- Wear protective glasses!

Hazard- and Precautionary-Statements

Ethanol:	
H225:	Highly flammable liquid and vapour.
P210:	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

ad 1: Theoretical preparation
The students should be acquainted with basic concepts and schematic representations before they start processing the specimens. To introduce the terms, they should see at least a germinating cereal grain (with one cotyledon) and a germinating bean (with two cotyledons). These terms will be memorized with more ease when illustrated.
How to distinguish the leaves should also be demonstrated (predominately parallel-nerved in case of monocotyledonous plants, and predominately net-veined in case of dicotyledonous plants).
The differentiation of rooting types may be done without, as the students will not see these structures.
Examples of monocotyledonous plants should come from the immediate environment of the students and be familiar.

ad 2 and 3: Slide preparation and microscopy
Depending on the resilience of the tissue, the manual cutting technique with or without devices (elder pith) shall be applied, or the sections should be made on a firm substrate. Illustrations should be made available in order to identify and label the parts phloem, cambium, and xylem. (Note: The cambium is missing in the monocotyledonous plants!)
Staining the cross-section may be recommended as a differentiation method to quicker students.

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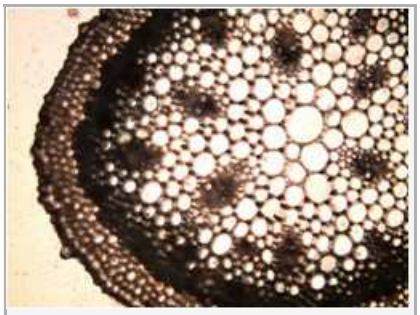
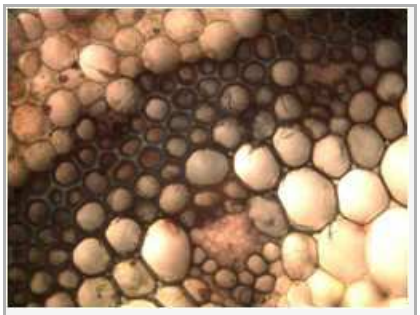
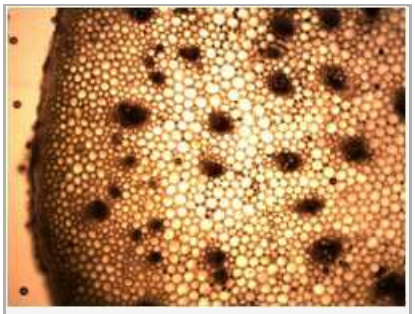


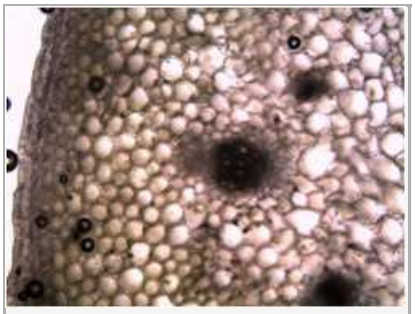
Chlorophytum (100x)



Chlorophytum (400x)



Tulipa (40x)



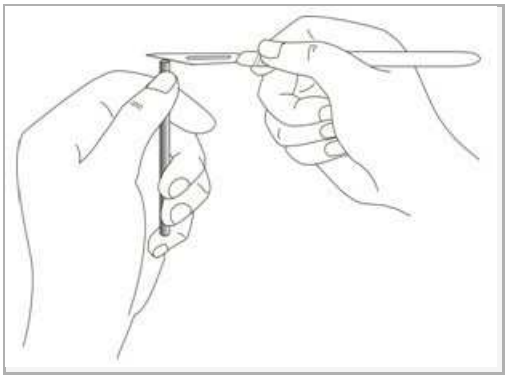
Tulipa (100x)

The stem of a monocotyledonous plant (Item No.: P1442301)

Task and equipment

Task

Explore the structure of the stem and the arrangement of the vascular bundles in monocotyledonous plants!



Equipment

Position No.	Material	Order No.	Quantity
1	Euromex BioBlue BB.4250 microscope	EUR-BB-4250	1
2	Microscopic slides, 50 pcs	64691-00	1
3	Cover glasses 18x18 mm, 50 pcs.	64685-00	1
4	Beaker, low form, plastic, 100 ml	36011-01	1
5	Dropping pipette with bulb, 10pcs	47131-01	1
6	Tweezers,straight,pointed,120mm	64607-00	1
7	Scalpel holder	64615-00	1
8	Scalpel blades,rounded tip,10 off	64615-02	1
9	Chemicals set for TESS advanced Microscopy	13290-10	1

Set-up and procedure

Hazards

- The blades of the scalpel are very sharp! Their removal from the aluminum foil and the sections made with them must proceed with great caution.
- Ethanol is extremely flammable. Extinguish all open flames!
- Wear protective glasses!


Information

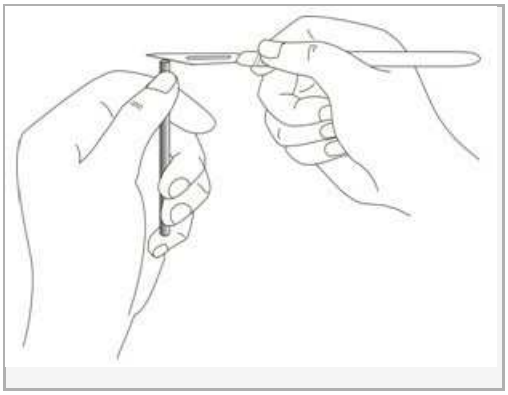
The stem of plants must accomplish various functions. It supports the leaves, the lateral branches, and the blossoms. The mechanical supportive tissue (collenchyma) is responsible for the necessary stability and elasticity. Did you ever come to think about how a 20m-tall tree is capable of transporting water all the way from its roots to its crown? Or how it may be possible that assimilates from the leaves ever arrive at the roots? We want to explore this pathway of transportation, for which all plants possess a one-way traffic system. The vascular bundles contain vessels for transporting water from the bottom up, and sieve tubes for transporting assimilates from the top down to the bottom. The structural arrangement of the vascular bundles in the dicotyledonous plants differs distinctly from the arrangement found in the monocotyledonous plants.

1. Theoretical preparation

- Consult your biology textbook about the following terms: dicotyledonous und monocotyledonous.
- Look at the graphical representation of a vascular bundle. Memorize the appearance of the wood part including the vessels (xylem), the meristem (cambium) and the sieve tube (phloem).
- Which plants belong to the monocotyledonous plants? Give 10 examples!

2. Slide preparation

- Preparation of the microscopy solution: add a few drops of ethanol to the water. This will to some extent expel the air from the stem. Prepare the slide.
- Remove any disturbing leaves. Look for an appropriate site between the nodes.
- Sections are made as thin as possible by drawing the scalpel towards your body. If you should not succeed you may make the cuts on top of the slide.
- The thin sections are placed directly in the drop on the slide using forceps.



3. Microscopy

- View the specimen under the microscope with the lowest power and describe the structural arrangement of the vascular bundles in the report.
- View the specimen under the microscope at intermediate power. Look at a vascular bundle. The vessels (tracheary elements) for water transport are very large. Try to differentiate the xylem, the cambium and the phloem. Can you find the cambium?
- Draw a cross-section of the stem in the report. It shall illustrate how the vascular bundles are arranged and at which sites the stem possesses particularly thick-walled cells. The latter are wooded and account for stability.

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Report: The stem of a monocotyledonous plant

Result - Observations

View the specimen under the microscope with the lowest power and describe the structural arrangement of the vascular bundles:

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Evaluation – Question 1

Draw a cross-section of the stem. It shall illustrate how the vascular bundles are arranged and at which sites the stem possesses particularly thick-walled cells.