

# *Evolutionary relationships of plants*

Kristína Hudáková

Barbora Trubenová

## 9 Evolutionary relationships of plants

In this activity, students examine live specimens of the four major groups of land plants—mosses, ferns, gymnosperms and angiosperms—and look for their distinctive features. They draw the specimens, emphasizing the important details, identify the correct description of each of the major plant groups and review the key features they have identified. Students use the key characters to complete a character chart and then construct a cladogram based on the data.

### 9.1 Aims

- To review the characteristics of the major plant groups.
- To learn the evolutionary relationships of the major plant groups.
- To practice studying and drawing biological specimens.
- To learn how cladograms are made.

### 9.2 Structure

- First, the classroom is divided into four groups (20 min).
- Then, the students mix to form new groups, each consisting of at least four students. There should be at least one student from each of the previous groups in each new group, and each student should bring with them a specimen of the plant group they were studying during the first part of the activity. Working in these groups takes place during the remaining lesson time (20–25 min).

### 9.3 Materials

- Student sheets
- Live plant specimens belonging to each of the major land plant groups—mosses, ferns, gymnosperms and angiosperms. More than one species per plant group may be used.
- Microscope or magnifying glass
- Cards with descriptions of the land plant groups

### 9.4 Procedure

1. In the first part of the activity, students are divided into four groups, each working with live specimens of one of the major land plant groups: mosses, ferns, gymnosperms or angiosperms. The teacher distributes the student worksheets and the plant specimens to each group. The teacher may bring more than one species from each of the major plant groups (e.g. a fern and a horsetail for seedless vascular plants).
2. In the class arrangement mentioned above, students complete the first part of the activity according to the instructions in their worksheets.
3. After completing the first part of the activity, the students switch groups so that each of the newly formed groups has at least one student from each of the previous groups. In other words, at least one specimen belonging to each of the major plant groups should be brought to each of these newly formed groups by a student from their previous group.
4. In this second class arrangement, students continue working according to the instructions on their worksheets to complete the second part of the activity. They should be able to complete the characteristics table and draw a cladogram according to the presence or absence of a certain characteristic.
5. Students may submit the completed worksheets for evaluation, or they may retain them for the next lesson for the discussion with the whole class.

\_\_\_\_\_ are small and simple plants that usually grow in damp locations. The individual plants are usually composed of simple leaves, one cell thick, covering a thin stem that supports them. They have no roots, just thin filamentous outgrowths called rhizoids. They do not have seeds, flowers, or vascular tissue. The water is absorbed into their bodies across their whole surface and moved inward mostly by diffusion from cell to cell. They reproduce through the alternation of generations, producing gametes and spores. The gametophyte stage is dominant. The embryo develops into a sporophyte attached to and dependent on the gametophyte.



\_\_\_\_\_ have roots, stems and leaves with special water-conducting tissues, like other vascular plants. Some have fibrous roots, while others produce an underground stem called a rhizome. Their leaves are often delicately divided. They form an embryo during reproduction but lack both flowers and seeds. These plants reproduce through the alternation of generations, producing gametes and spores. The spores are produced in sporangia which are mostly located on the bottom side of their leaves. The sporophyte stage is dominant and independent of the gametophyte.



\_\_\_\_\_ include shrubs and trees that are often large and evergreen. These plants have a typical plant body structure, with true roots, stems and leaves, often modified as needles. They contain vascular tissue and are able to perform photosynthesis during most of the year, even in temperate regions. They produce seeds that are usually located on the scales of cones and are exposed to the environment. They reproduce through the alternation of generations. The sporophyte stage is dominant, while the female gametophytes live within the parent sporophyte. Because pollen grains carry the sperm to the eggs, free-flowing water is not required for fertilization. The embryo develops inside a seed.



\_\_\_\_\_ is the most diverse group of land plants. It ranges from small, low-lying plants to large trees. Plants belonging to this group have a typical plant body structure, with true roots, stems and leaves. Flowers, their reproductive organs, are the most remarkable feature distinguishing them from the other seed plants. They all produce seeds that are associated with a fruit or nut. They reproduce through the alternation of generations. The sporophyte stage is dominant, while the female gametophytes live within the parent sporophyte. Because pollen grains carry the sperm to the eggs, free-flowing water is not required for fertilization. The embryo develops inside a seed.

## Evolutionary relationships of plants

The goal of evolutionary classification is to group organisms into categories that reflect their evolutionary relationships. In evolutionary classification, species are placed into groups called clades. A clade is a group of species that includes a single common ancestor and all descendants of that ancestor, both living and extinct.

Modern evolutionary classification uses a method called cladistic analysis. Cladistic analysis compares carefully selected traits to determine the order in which groups of organisms branched off from their common ancestors. This information is then used to link clades together into a diagram called a cladogram.

In this activity, you are going to examine live specimens of the major groups of land plants and look for their distinctive features. You will then construct a cladogram depicting the evolutionary relationships of these plant groups.

### Materials

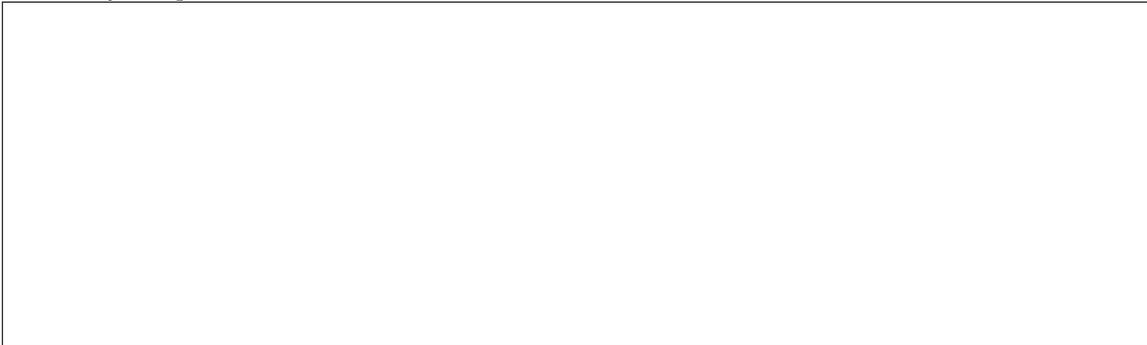
- Live plant specimens belonging to each of the major land plant groups
- Microscope or magnifying glass
- Cards with descriptions of the different land plant groups

### Procedure

#### Part 1: Studying live plant specimens, identifying typical features of the plant group it belongs to

1. You have been given one or more plant species belonging to one of the major plant groups. Carefully study the specimen you have been given. Discuss its features with members of your group. Draw a simple sketch of the specimen in the space provided below. Emphasize the details you consider important.

*Sketch of the plant:*



2. Identify the specimen. Try to use the most exact classification category you can.

*Name of the plant:* \_\_\_\_\_

*Classification:* \_\_\_\_\_

3. Read the four cards containing the descriptions of the major plant groups. Discuss the descriptions within your group and decide which of the texts describes the plant group you have been working with. Write the name of the plant group into the blank space at the beginning of the text and highlight the most important characteristics of the members of this plant group.

4. Glue the card with the description in the space provided below.

**Part 2: Completing the characteristics chart and drawing the plant cladogram**

1. Change your group when your teacher tells you to do so. You are now in a new group with at least three other students, each of whom has a plant belonging to a different plant group from the one you have been working with.
2. Compare the plants brought into your group. Compare the live specimens, their drawings and descriptions. Look for similarities and differences among the plant groups.
3. Fill in the character chart below, writing “0” to indicate that a given character is absent in a certain plant group and “1” to indicate that a given character is present in that group.

	Angiospermophyta	Coniferophyta	Bryophyta	Pteridophyta
seed formation				
development of flowers and fruits				
embryo formation				
development of vascular tissue				

4. Draw a cladogram of the given plant groups using the character chart. Hint: First rearrange the chart according to how many characters are present in a given plant group.

*Cladogram:*