



Plants of the World

Educator Guide

Presented by The Field Museum Education Department

INSIDE:

- Introduction to Botany
- Plant Divisions and Related Research
- Curriculum Connections
- Focused Field Trip Activities
- Key Terms

The Field
Museum

Botany is the scientific study of plants and fungi. Botanists (plant scientists) in The Field Museum's Science and Education Department are interested in learning why there are so many different plants and fungi in the world, how this diversity is distributed across the globe, how best to classify it, and what important roles these organisms play in the environment and in human cultures.

The Field Museum acquired its first botanical collections from the World's Columbian Exposition of 1893 when Charles F. Millspaugh, a physician and avid botanist, began soliciting donations of exhibited collections for the Museum. In 1894, the Museum's herbarium was established with Millspaugh as the Museum's first Curator of Botany. He helped to expand the herbarium to 50,000 specimens by 1898, and his early work set the stage for the Museum's long history of botanical exploration.

Today, over 70 major botanical expeditions have established The Field's herbarium as one of the world's preeminent repositories of plants and fungi with more than 2.7 million specimens. These collections are used to study biodiversity, evolution, conservation, and ecology, and also serves as a depository for important specimens and material used for drug screening. While flowering plants have been a major focus during much of the department's history, more recently several staff have distinguished themselves in the areas of economic botany, evolutionary biology and mycology. In particular, The Field's bryophyte and lichen collections are of worldwide significance.



Main Themes

The following themes may be useful in framing how to connect the Field Museum's botany collections and related exhibitions with your curriculum:

- Biodiversity of plants and fungi on Earth
- Evolutionary history of plants and fungi
- Importance of plants and fungi in the environment and as a part of human cultures

All images courtesy of The Field Museum.

Botanists use key characteristics to classify plants in four divisions: mosses and liverworts (bryophytes), ferns (pterophytes), cone-bearing plants or conifers (gymnosperms), and flowering plants (angiosperms). The production of **seeds** and the development of **vascular tissue** can be used as a basis to separate the divisions.

Seed plants produce seeds, an effective means of reproduction in dry environments. All seed plants have vascular tissues. Some seed producing plants flower (flowering plants/angiosperms) while other seed plants produce seeds in cones (conifers/gymnosperms). Seeds contain an embryo that can develop into a new plant. The embryo is surrounded by nutrients that help the seedling germinate.

Non-seed plants such as ferns (pterophytes), liverworts and mosses (bryophytes) reproduce by spores. Spores are generally microscopic in size and are often located on stalks or the underside of the leaf. Unlike seeds, fertilization happens after the spore germinates, and spores do not contain nutrients.

Vascular plants, including ferns, conifers, and flowering plants, have complex tissues such as stems, roots and leaves that conduct water and other nutrients. Non-vascular plants such as liverworts and mosses move water and nutrients by osmosis and diffusion. Because non-vascular plants are small (typically one cell thick) they do not need conducting tissues and a complex system to move water; whereas vascular plants are large, and need a more complex system.

Plant Group	Plant Structure		Reproductive Strategy		
	Vascular Complex tissues conduct water & nutrients	Non-vascular Water & nutrients moved by osmosis & diffusion	Seeds produced in cones	Seeds produced in flowers	Spores
Mosses & Liverworts <i>bryophytes</i>		✓			✓
Ferns <i>pterophytes</i>	✓				✓
Conifers <i>gymnosperms</i>	✓		✓		
Flowering Plants <i>angiosperms</i>	✓			✓	



Flowering Plants

There are a number of botanists at The Field Museum who study flowering plants. Their research interests cover such topics as the diversity of neotropical plants, taxonomic revisions of diverse plant families, forest ecology—especially as it relates to conservation biology, the restoration of prairies and oak-savannas in the Chicago area, and the search for new anti-AIDS and anticancer compounds in plants. Related podcasts:

Science at FMNH fieldmuseum.org/explore/science-at-fmnh

- Episode 30 - Floral Diversity and *Pedicularis*
- Episode 31 - Floral Color and Flower Evolution
- Episode 32 - Floral Tubes and Flower Evolution
- Episode 33 - Floral Beaks and Flower Evolution



Fungi and Lichens

Field Museum mycologists are interested in documenting and understanding the diversity and biogeography of fungi and the effect of human activity on this diversity, the evolutionary relationships among fungi, and the mutually beneficial symbioses such as lichens that some fungi form with plants. To do this, these scientists travel the world collecting new species, documenting diversity, and studying fungal ecology. At the Museum they study the Museum's collections using computer-assisted microscopy, high speed computers, and molecular biology techniques to further investigate these questions. Related podcasts and videos:

Science at FMNH fieldmuseum.org/explore/science-at-fmnh

- Episode 9 - Ascomycete Fungi
- Episode 10 - Sexual and Asexual Reproduction in Fungi
- Episode 11 - Decomposition

The Field Revealed fieldmuseum.org/explore/the-field-revealed

- Video: *Leavitt's Lichens* July 13, 2012



Mosses and Liverworts

Field Museum scientists study the two main groups of bryophytes: mosses and liverworts. Field Museum bryologists (scientists who study bryophytes) have broad research interests that include systematics, biogeography, conservation, and education outreach. They have active field programs throughout the world, especially in Australasia and Oceania, and southern South America. Bryophytes are considered evolutionary and ecologically significant. Due to their small size bryophytes have important physical properties enabling them to be effective monitors and indicators of global warming and climate change. Related podcasts:

Science at FMNH fieldmuseum.org/explore/science-at-fmnh

- Episode 1 - Early Land Plants
- Episode 2 - Environmental Significance of Early Land Plants
- Episode 3 - Oil Bodies Inside Early Land Plants
- Episode 4 - Threats for Early Land Plants



Economic Botany

Economic botany is broadly defined as the study of the relationship between people and plants. This interdisciplinary study encompasses the fields of anthropology and botany as it explores the countless ways humans employ plants for food, medicine, textiles, shelter and more. Today, economic botany continues to make significant contributions to anthropology, botany, and environmental conservation. Related videos:

The Field Revealed fieldmuseum.org/explore/the-field-revealed

- Video: *Discovering New Plant Species in the Amazon* February 1, 2013
- Video: *Botanical Exploration in Fiji* January 6, 2012
- Video: *Plant Mounting* December 22, 2011

Learning Standards

The Field Museum's botany collections on display in the exhibitions *Plants of the World*, *Evolving Planet*, and *Restoring Earth*, and available to borrow through the *N. W. Harris Learning Collection*, may be used to meet **Common Core State Standards** in Math and Language Arts and Illinois Learning Standards in Social Science and Fine Arts. However, the collections most closely align with the following Disciplinary Core Ideas addressed in the life science strand of the **Next Generation Science Standards**:

- **Core Idea LS1:** From Molecules to Organisms: Structures and Processes
- **Core Idea LS4:** Biological Evolution: Unity and Diversity

Field Museum Exhibitions

Plants of the World

Marvel at world-famous plant models from algae to orchids. You won't believe these are models crafted from glass and wax. See pages 8–12 for focused field trip activities.

Evolving Planet fieldmuseum.org/evolvingplanet

Take an awe-inspiring journey through 4 billion years of life on Earth, from single-celled organisms to massive dinosaurs and our extended human family.

Abbott Hall of Conservation Restoring Earth fieldmuseum.org/restoringearth

Discover how The Field Museum is leading the way in conservation, by providing the tools to conserve wilderness and protect the Earth's biodiversity, improving local livelihoods, and fostering human connections with nature.

Before you visit The Field Museum with your students, download our Field Trip Planning Guide and current Student and Educator Programs Catalog to help you plan a successful learning experience: fieldmuseum.org/schools.



Classroom Resources

The *N. W. Harris Learning Collection at The Field Museum* gives educators and parents the chance to borrow artifacts and specimens from the Museum's collection for their classrooms and homes. With over 400 unique Exhibit Cases (mini-dioramas) and 70 Experience Boxes (hands-on kits) your options are endless! Using the Learning Collection is simple. Visit our website for details: harris.fieldmuseum.org

Check out these plant-related materials:

Great Lakes Plant Diversity Experience Box

Investigate a large collection of plant specimens found across the Midwest and learn more about the diverse ecosystems of the Great Lakes Region.

How Seeds Travel Experience Box

Explore a collection of diverse seeds alongside a selection of mounts illustrating the growth and development of plants.

Prairie Life Experience Box

Examine plant, mammal, and bird specimens and connect the physical characteristics of these organisms with the prairie ecosystem.

Woodland Plant Exhibit Cases (32 different species)

Prairie Plant Exhibit Cases (7 different species)



Organizing a fun and meaningful field trip to The Field Museum requires focus!

With 19.5 acres of exhibitions, The Field Museum has more treasures than anyone can see in one day. To set your students up for success, we recommend focusing your field trip on one or two relevant exhibitions or even a few galleries within one exhibition.

To help you get started, we have designed sample focused field trip activities to engage your students in exploring plants. Each focused field trip includes the three essential components of a focused field trip: pre-, during, and post-field trip activities. In addition, the activities are designed for specific grade levels and align with the **Next Generation Science Standards** (NGSS):



Elementary Focused Field Trip: Parts with Purpose (page 9)

Students will travel to *Plants of the World* and choose one plant to observe closely. Students will then examine four parts of that plant and explain the function of each part. Supports NGSS 4-LS1-1.

Middle School Focused Field Trip: Plant Reproduction (page 10)

Students will travel to *Plants of the World* and identify the plant parts that are involved in the process of reproduction of one particular plant. Students will then explain the plant reproduction strategy of the plant and analyze advantages and disadvantages of this strategy. Supports NGSS MS-LS1-4.

High School Focused Field Trip: Common Ancestry (pages 11-12)

Students will observe three plants in *Plants of the World* and then identify three plants in *Evolving Planet* that appear to share a common ancestor based on similar anatomical structures. Students will draw their observations and explain their reasonings. Supports NGSS HS-LS4-1.

Name _____ Date _____

Parts with Purpose

Think (before you explore)

What do plants need to live and grow and reproduce? Write *at least* three answers below.

Observe and Explain (in the exhibition)

1. Travel to the *Plants of the World* exhibition located on the upper level of The Field Museum.
2. Take a few minutes to explore.
3. Choose one plant to observe closely: _____
(Name of Plant)
4. In the box below, sketch the plant. Label the parts of the plant.
5. Choose four parts of the plant and write the function of each part next to the label.

Share and Compare (after you explore)

Share your plant sketch with a classmate. Compare the plant parts you sketched with the plant parts that your classmate sketched. How are the same parts similar and/or different?

Name _____ Date _____

Plant Reproduction

Think (before you explore)

What do you already know about how plants reproduce?

What questions do you have about how plants reproduce?

Observe and Explain (in the exhibitions)

Travel to the *Plants of the World* exhibition located on the upper level of The Field Museum. Choose one plant to sketch carefully on the *back of this paper*. Label the plant's reproductive parts.

In your own words explain how this plant reproduces.

Analyze and Interpret (after you explore)

If this plant was located in a dry environment with some wind, do you think this plant could successfully reproduce? Why or why not? Explain your reasoning and refer to specific plant parts in your explanation.

If this plant was located in a wet environment with little wind and some flowing water, do you think this plant would successfully reproduce? Why or why not? Explain your reasoning and refer to specific plant parts in your explanation.

Name _____ Date _____

Common Ancestry

Think (before you explore)

Circle the two plants below that you think are most closely related to each other.



Why do you think these two plants are closely related to each other?

Investigate (in the exhibitions)

Review the instructions below before you begin. If you have questions, ask.

Part 1 - *Plants of the World*

Travel to *Plants of the World* exhibition located on the **upper level** of The Field Museum. Find three plants to observe and record your observations in the first row of boxes on page two. Write the plant's name and create a scientific drawing of the plant.

Part 2 - *Evolving Planet*

Next travel to the *Evolving Planet* exhibition located on the **upper level**. As you walk through this exhibition, identify plants that could share common ancestry with the plants you observed in *Plants of the World*. Record your observations of these plants in the bottom row of boxes on page two. Write the plant's name and create a scientific drawing of the plant.

Part 3

Explain the similarities you notice between the two plants. Record your observations in the middle row of boxes.

Analyze (after you explore)

Do you think the plants you observed at the Museum are related to each other? Why or why not?

Part 1: Plants of the World

Plant 1 _____

Sketch of specimen:

Plant 2 _____

Sketch of specimen:

Plant 3 _____

Sketch of specimen:

Part 3: Explain

Similarities between
these two plants

Similarities between
these two plants

Similarities between
these two plants

Part 2: Evolving Planet

Plant 1 _____

Sketch of specimen:

Plant 2 _____

Sketch of specimen:

Plant 3 _____

Sketch of specimen:

Bryophytes: A general term used for mosses, liverworts and hornworts. Bryophytes are generally small, soft plants that often grow together in clumps or mats in damp or shady locations. Together, bryophytes are the second largest group of land plants after flowering plants and are pivotal in our understanding of early land plant evolution. Many bryophytes have an amazing capacity to absorb incredible amounts of water. Bryophytes are ecologically very significant and are important environmental indicators, potential indicators of global warming.

Ecology: The study of the interaction between organisms and their environments.

Economic botany: The study of the relationship between people and plants.

Fungi: A group of organisms, or kingdom, separate from plants, animals, and bacteria; the study of fungi is known as mycology, which has traditionally been regarded as a branch of botany.

Lichens: Organisms comprised of symbiotic systems consisting of fungal and algal or cyanobacterial components. These organisms possibly represent the first permanent terrestrial organisms and have a great ecological and biological significance, playing a role in decomposition, erosion, and the cycling of carbon and nitrogen. Lichens contain properties demonstrating potential medicinal activity.

Non-seed plants: Plants that reproduce mainly through spores.

Seed: A reproductive structure that has been fertilized and as a result contains an embryo which will develop into a new plant. A seed contains nutrients to help the seedling germinate and is large in comparison to the size of spores.

Seed plants: Plants that reproduce through the production of seeds. In a dry environment, this reproductive strategy is more effective than producing spores. All seed plants have vascular tissues; some seeds are found in flowers and fruits. Other plants produce seeds in cones.

Spore: Typically minute, often one-celled, reproductive unit capable of giving rise to an off-spring without sexual fusion. Spore-producing organisms include bacteria, fungi, algae and some plant groups. In plants, a spore is a haploid reproductive cell (containing only one set of chromosomes) which gives rise to a gametophyte.

Vascular tissue: In vascular plants, vascular tissue make up the specialized complex structures that conduct water through the plants, such as, roots, stems, and leaves. The primary components of vascular tissue in plants are the xylem and phloem. These two tissues transport fluid and nutrients internally.