Module Overview

Targeted grade levels: Grades 7-12

Module length: 2 to 4 weeks

Prior student background: None needed, though basic biology is helpful

Abstract: This module provides great flexibility. You can choose some or all of the activities. Each section is posted in separate pdf files on the PlantingScience website, on the Plant Themes / Pollen page. Activity Set A is a basic orientation to plant anatomy in relation to where pollen is found in flowers and cones, viewing pollen with a compound microscope, and growing pollen tubes. The pollen tube activity is ideal for a guided or open inquiry investigation. Activity Set B outlines protocols and suggestions for inquiry investigations into atmospheric pollen. Activity Set C outlines protocols and suggestions for inquiry investigations into animal pollinators and their interactions with flowers. Each Activity Set contains a summary, list of materials, protocols, possible inquiry questions, background information, and additional resources and references. Availability of pollen-shedding plants and weather conditions will affect choice of activities and timing of session participation. The documents offer suggestions for online dialogue with scientist mentors for ideas, feedback and suggestions.

Collaboration and Support: This module was developed for the PlantingScience program of the Botanical Society of America in collaboration with Beverly J. Brown, Nazareth College of Rochester; Stephen Saupe, College of St. Benedict, St. John’s University; Teresa M. Woods, Kansas State University; Betty Indriolo, St. Sebastian School; and Valdine McLean, Pershing County High School. Additional funding has been provided by the National Science Foundation, and the Monsanto Foundation.
You Will Need:

- **Access to computers**
  - Necessary for online communication with scientist mentors
  - Helpful for entering, pooling and analyzing data (such as in Microsoft Excel)

- **Time for dialogue with mentors**
  - Scheduled time for students to communicate with mentors online
  - Time for teachers to monitor dialogues
  - Time for teachers to assess and award credit for online participation

- **Lab notebooks**
  - Important for ongoing record of observations, data collection, sketches, notes, concept maps and ideas
  - Optional: selection of pens, pencils and/or paints for illustrating
  - Optional: digital camera for taking pictures and/or videos of plants and student work

---

1 PlantingScience evaluations indicate that teachers who require students (for credit) to post to scientists-mentors have greater student engagement and meaningful dialogue with online mentors.
Learning Goals: Students will:

1. Understand the role of pollen in plant reproduction.
2. Understand where pollen originates in flowers and cones.
3. Understand biotic and abiotic means of pollen transport.
4. Be able to view and describe pollen as seen under a microscope.
5. Establish research questions and experimental design to investigate phenomena related to pollen.
6. Conduct inquiry investigations related to pollen, its role in plant reproduction, and means of pollen transport.
7. Follow good lab techniques of note-taking, labeling, monitoring and troubleshooting.
8. Develop microscopy skills.
9. Collect appropriate data.
10. Analyze data to find trends and/or patterns:
    a. Represent data graphically to look for trends and patterns.
    b. Interpret and understand the meaning of data results.
11. Develop logical conclusions based on evidence of experiment.
12. Collaborate with and communicate with classmates.
13. Communicate with scientist mentors throughout the experiment, including establishment of questions and experimental design, data collection, and development of conclusions.
14. Share results with classmates and scientist mentors.

Alignment of Learning Goals and Activities

<table>
<thead>
<tr>
<th>Activity Set</th>
<th>Learning Activities</th>
<th>Learning Goals</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Background for Inquiries Investigating Pollen</td>
<td>Activity 1: Plant Dissection – Where’s the Pollen? 1,2,5,7,9,11,13,14</td>
<td>pp. 8 - 17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity 2: Collect and Examine Pollen 1,2,4,7,8,9,11,13,14</td>
<td>pp. 18 - 20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity 3: Growing Pollen Tubes 1,4,5,6,7,8,9,10,11,12,13,14</td>
<td>pp. 21 - 26</td>
<td></td>
</tr>
<tr>
<td><strong>B</strong> Exploring Pollen in the Atmosphere</td>
<td>Main Activity: Exploring Pollen in the Atmosphere 1,2,3,4,5,6,7,8,9,10,11,12,13</td>
<td>pp. 34 - 45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extension: Make or Use a Pollen Reference Library 3, 4, 6, 8, 9, 11</td>
<td>p. 47</td>
<td></td>
</tr>
<tr>
<td><strong>C</strong> Field Study of Flowers and Pollinators</td>
<td>Activity 1: Pollinator Visitation Rates 1,2,3,5,6,7,9,10,11,12,13,14</td>
<td>pp. 52 - 57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity 2: Insect Visitor Composition 1,2,3,5,6,7,9,10,11,12,13,14</td>
<td>pp. 58 - 61</td>
<td></td>
</tr>
</tbody>
</table>
Suggested Lesson and Activity Planner

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Register and meet scientists online</td>
<td>Activity Set A: Investigating Pollen</td>
<td>Activity 1: Flower/cone dissections</td>
<td>Activity 2: Examining pollen</td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td></td>
<td>Activity Set A: Investigating Pollen</td>
<td>Activity 3: Growing pollen tubes</td>
<td>Analyze results, develop conclusions, share &amp; communicate</td>
<td></td>
</tr>
<tr>
<td>Week 3</td>
<td></td>
<td>Activity Set B: Exploring Pollen in the Atmosphere</td>
<td>Collect atmospheric pollen</td>
<td>Analyze results, develop conclusions, share &amp; communicate</td>
<td></td>
</tr>
<tr>
<td>Week 4</td>
<td></td>
<td>Activity Set C: Field Study of Flowers and Pollinators</td>
<td>Conduct field observations / collect data</td>
<td>Analyze results, develop conclusions, share &amp; communicate</td>
<td></td>
</tr>
</tbody>
</table>

Teams are encouraged to post online 2-3 times per week. This icon is a reminder that important opportunities for team research blogging exist. Teams can blog from school or home. PlantingScience evaluations indicate that teachers who require students (for credit) to post to scientists-mentors have greater student engagement and meaningful dialogue with online mentors.
Materials Needed

Activity Set A:

Activity 1: Plant Dissection – Where’s the Pollen?
- Selection of flowers (including catkins) from store or outdoors, ready to shed pollen (see suggested flower list in Activity 1).
- Selection of “male cones” ready to shed pollen
- Dissecting probe, pin or toothpick
- Single blade razor
- Dissecting tweezers
- Scissors
- Pen or pencil
- Dissecting microscope and/or hand lens

Activity 2: Collect and Examine Pollen
- Selection of flowers (including catkins) from store or outdoors, ready to shed pollen
- Selection of “male cones” ready to shed pollen (if available)
- Microscope slides with cover slips
- Dissection probe, pin, or toothpick
- Scotch tape
- Glassine envelopes or plastic sandwich bags to store pollen for future use
- Marking pens
- Compound microscopes (best if high power is at least 400X)

Activity 3: Growing Pollen Tubes
- Four different types of fresh pollen
- Microscope well slides with cover slips
- Sterile petri dishes (glass or plastic)
- Paper towels or filter paper or coffee filters – one for each petri dish
- Box of plastic drinking straws – the type that bend
- Scissors
- 10% sucrose solution (a few drops per slide)
- Sterile pipettes
- Compound microscopes
**Activity Set B:**

- Access to outdoor sites to set pollen traps to collect atmospheric pollen
- Microscope slides
- Cover slips
- Petroleum jelly (e.g., Vaseline)
- Duct tape
- Scotch tape
- Pasteur pipettes (as thin as possible)
- Paper towels
- Scissors
- Compound microscope (best if it can magnify up to 400X or higher)
- Calberla’s solution (pollen stain)
  - 5 ml glycerol
  - 10 ml 95% ethanol
  - 15 ml distilled water
  - A few crystals of fuchsin basic stain
  - Distilled water
- Possible storage space for students’ collected pollen traps (trays or labeled cabinet shelves)
- Calculators

**Activity Set C:**

- Access to outdoor site with flowering plants over a series of days – options include:
  - Natural field site (meadow, shrubs, small trees)
  - Garden or flower beds
  - OR – you can set potted flowering plants in an outdoor setting – it is recommended that you let them set for 60 minutes to a few hours prior to students observing so insects might locate them before students observe
- Field notebooks for students (graph paper type ideal)
- Calculators
- Graph paper and/or computer database (e.g., excel) for data analysis
- Optional: hand lenses, binoculars (using in reverse fashion, they serve as excellent magnifiers)
- Optional: field guides for students to identify plants and insects
- Optional: cameras

**ORDER IN ADVANCE**

Be sure to order Fuchsin Basic Stain (crystals).

It can be ordered from Science Kit at [http://sciencekit.com/fuchsin-basic-stain/p/IG0015250/](http://sciencekit.com/fuchsin-basic-stain/p/IG0015250/)