The **purpose of this tip sheet** is to help you as a scientist mentor **anticipate and respond** to students as they post online about their pollen and pollinator investigations.

**Expect teachers to adapt module for their students:**
Teachers coordinate student access to outdoor areas to collect pollen &/or observe pollinators. The equipment available and class experience with inquiry learning will influence the direction investigations take and which of the three activities teachers choose to use.

• Please see the theme’s Teacher Guide for learning goals, suggested activities and schedule planner.
• Connect with your team’s teacher via the Classroom Group for details.

This module introduces students to several tools in the toolkit of pollination biologists and palynologists. Investigations last for two weeks or more and the module is appropriate for grades 6-12. The Investigation Theme offers three different activity sets that teachers can mix and match.

**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.

**Juicy questions for student investigations.**
• Where does pollen come from? Where does it go?
• What does pollen have to do with me?
• Why is there so much pollen in the air at certain times?
• Is all pollen the same?
• Are all pollen grains viable? How quickly does a pollen tube grow?
• Who are potential pollinators? What plants do they visit?
• Are only insects pollinators?
• Do pollen grains germinate on any stigma?
• Are all stigmas exactly the same?
• Might the type of pollinator affect the appearance of the flower? How would that happen?
What are students thinking when it comes to pollen and pollination?

It is common for students to believe...

- Pollination is the same as fertilization.
- Pollination involves only the transfer of pollen from anther to stigma, which excludes pollen transfer in gymnosperms.
- Only insects are pollinators.
- Animals have to be involved for pollination to occur.
- Pollen is the male gamete.
- Plants cannot sexually reproduce.
- Sexual reproduction always involves mating.

Attending to students’ ideas and thinking

As students blog about their investigations, they reveal their ideas about what pollen is and how sexual reproduction in plants work. By attending to students’ thinking, attention shifts from a right-answer orientation to uncovering student ideas and reasoning. As experts, we often make assumptions about what a student is meaning and connect concepts in ways novice learners cannot. Assumptions are often turned on their heads when probed. Also, responding as a naïve mind opens up possibilities in the discussion. **How does the study of pollen reveal the interconnectedness among biotic and abiotic factors in our environment? What do pollen and pollinators have to do with the diversity and adaptations of plants?** This process of armchair inquiry, or **digging into juicy questions**, is a highly valued process in science.

Anticipating technical problems and conversation threads

Helping students realize that experiments don’t always work first time is important, as problem solving and trouble-shooting are highly valued in science and other work places. However, don’t let the students get overly bogged down in technical debugging at the expense of thinking about the big ideas.

- **No pollen caught in traps / No pollinator visitors.**
  Weather conditions (temperature, wind, etc.) can impact outdoor environmental sampling. Heavy rains pose real problems! Abundance and diversity of plants in the environment will also influence the kinds of pollen available, while placement of the traps can affect what pollen is actually caught. Visitation rates will be influenced by what types of flowers and pollinators are available.

- **Making sense of pollen images.**
  The microscope slides set out as pollen traps will also trap miscellaneous airborne particles and debris, complicating pollen grain identification. Many stains that work for pollen also stain fungal spores. Students will likely also struggle with matching pollen to reference slides or online pollen databases.

- **Pollen tubes won’t grow.**
  The pH of pollen growth medium and calcium availability affects pollen tube growth. Conditions, such as temperature and humidity, can be quite taxon specific.

- **What’s cool to kids?**

  **Potential big idea prompts:**
  - What features might enable pollen to be transferred by wind versus insects?
  - How does pollen morphology affect pollen’s distribution and its ability to fertilize another plant, or itself?
  - What factors might decrease a pollen grain’s viability?
Students will easily relate to conversations about pollen as allergens. Other unfamiliar connections will be highly intriguing to students, e.g., how is pollen used to find oil deposits and in paleobotany research? how can pollen be evidence in forensic investigations?

Resources and References

Perhaps useful to you as a mentor
Comparative morphology and dispersal methods
http://life.illinois.edu/help/digitalflowers/
Ecological Society of America’s Pollination Fact Sheet
http://www.esa.org/ecoservices/poll/body.poll.fact.html

Perhaps useful to student teams
Plants Are Cool Tool Episode 4: Desert Blooms and Marathon Moths
https://www.youtube.com/watch?v=8IPQTsOcfqw
Missouri Botanical Garden Pollination
http://www.mbgnet.net/bioplants/pollination.html
U.S. Forest Service Wildflowers Pollinators
http://www.fs.fed.us/wildflowers/pollinators/index.shtml
Fertile Eyes – ChlorFilm 2009 video winner (Potentially too risqué!)
http://www.chlorofilms.org/index.php/crpVideo/display/videoid/44
Forensic palynologist Vaughn Bryant interview with Dr. Biology
https://askabiologist.asu.edu/podcasts/pollen-natures-tiny-clues