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 investigations on a Brassica rapa population.

**Expect a guided-inquiry approach from teachers:**
PlantingScience provides Brassica rapa seed stock (C1-123) for an F2 generation varying in trichome number, stem and leaf color. Teachers provide growing systems. Depending on class background, teachers may focus more on recording variation or analyzing patterns of inheritance.

This guided-inquiry module is designed as a whole-class experiment lasting a 6-week life cycle of Brassica rapa, Wisconsin Fast Plants®. Growing conditions, seed stock, and timing of activities are guided for the class in order to provide students with a foundation for examining data within a population of plants. Pooling data from student teams to analyze as a class reveals patterns of inheritance in the population. Growing plants in two environments (high and low nutrient treatments) illustrates that phenotype is the result of genotype interacting with environmental influences. Selecting a seed stock for easily visible quantitative (trichome number) and discrete traits (stem coloration; leaf coloration) allows teachers to go beyond Mendelian patterns of segregation if student background permits. Teachers may choose to focus on observing and recording attributes of growth, development, and reproduction throughout the life cycle, and then introduce genetics concepts once students have worked with class data set the population. Teachers, particularly those with genetics elective classes, may explore extensions beyond one generation.

**Juicy questions for student investigations.**
- What makes one individual differ from another in a population?
- How much do traits vary in a population? Do traits vary over time and development?
- How does environment influence variation?
- How is hairiness inherited? Can hairiness be selected for?
- Is there a relationship between nutrients in environment and the number of seeds produced?
- If I know parental traits, can I predict in what proportions traits will be expressed in the F2?

**What are students thinking when it comes to genetics, variation, plant life cycles?**
As students blog about their projects, they reveal their ideas. It is common for students to believe....
- plants cannot sexually reproduce.
- during the life cycle of a flowering plant, fruit develops before the seeds.
- variation between species is a result of adaptation to environment not genetic differences.
- individuals can adapt to a changing environment. These adaptations are heritable.
- one parent contributes genes for some traits, and other traits come from the other parent.
- one gene is always responsible for one trait.
Attending to students’ ideas and thinking

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.

Although students memorize the 3:1 ratio expected of a monohybrid cross with simple dominance in a Punnett square, they are often unable to adequately describe simple dominant and recessive patterns of inheritance. All state standards include Mendelian inheritance, while only 3 of 20 state standards recently examined specify student learning about polygenic inheritance and only 2 specify the environment’s role on phenotype. Thus, it is not surprising that most traits are polygenic and interactions between genes and environment are “missed” concepts. **What “regulates” the expression of traits in an individual? Are traits randomly distributed in a population? Do some traits tend to show up together? What influences whether a trait is passed to the next generation?** The links between genetics and evolution are often also missed. This process of armchair inquiry, or **digging into juicy questions**, is a highly valued process in science.

Anticipating technical problems and conversation threads

In addition to linking concepts, this module builds student skills in analyzing data and tending to living plants (teachers and students say caring for plants adds excitement to the class). Helping students realize that experiments don’t always work first time for scientist 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 also thinking about the big ideas.

- **Tending to plants across a life cycle.**
  Student teams will each be responsible for tending Brassica rapa from seed-to-seed. Despite student attempts to keep conditions except the nutrient treatment constant, conditions may fluctuate in the classroom or in the growing systems. Across the life cycle, some plants are likely to die, which will impact sample size. As the plants are self-incompatible, those individuals selected for pollination crosses influence genes in the next generation.

- **Counting trichomes.**
  Trichomes are a quantitative trait that students are guided to observe and record on the first true leaf. Seeing and counting hairs becomes easier with practice. Prior to this inquiry, students may not even have noticed that some plants have hairs!

- **Making sense of the data.**
  Students are encouraged to calculate the mean, standard deviation, range and graph frequency histograms. These will likely be challenging tasks for students, and a rich area for discussion.

Resources and references

Secrets of Plant Genomes Revealed [http://www.plantgenomesecrets.org/](http://www.plantgenomesecrets.org/)
Role of Environment in Plant Pigment [4 min video] [http://www.youtube.com/watch?v=kMWa3Km_6bk](http://www.youtube.com/watch?v=kMWa3Km_6bk)