Lesson 2: Life Cycle of Brassica Plants
Part I: Planting Seeds

Summary
Students will plant seeds and observe their plants develop through each stage of the life cycle: germination, growth, flowering, and seed formation. They will record their observations in a journal and calendar. They will experience providing a plant with all that it needs to grow and reproduce, including harvesting and replanting seeds.

Objectives
- Students will be able to draw and label the main parts of a plant: roots, stem, leaves, buds, flowers, and seeds.
- Students will understand that plants grow and develop through stages of a life cycle.
- Students will practice measurement and recording observations accurately in a journal and on a calendar.
- Students will be introduced to the idea that we, as animals, depend on plants for food, and that plants depend on animals for reproduction.

Materials
If using a FOSS kit, you can use the materials and list provided by FOSS.
Per Student:
1 planter cup with holes (3 oz)
2 Brassica seeds (“Fast Plants”, bok choy, or Chinese mustard)
1 label
1 half-paper towel
Student journal and pencil
Growth Calendar (two choices at end of lesson)

Per group:
1 cup to hold the seeds
extra paper towels
1 ½ liter container of water
A small vial, such as a film canister, about ½ volume of planter cups

For the class:
1 container of Brassica seeds (Bok Choy or Chinese Mustard)
2 basins of potting soil (about 4 liters/qts)
1 Planter tray (to collect class planters)
1 bottle of liquid fertilizer (see teacher prep)
eyedropper
4 demonstration planter cups (3 oz)
1 scissors
1 vial
1 marking pen for labels
1 Large Class Calendar
1 dry erase pen for class calendar
newspaper for working area
water

Grow lights or outdoor growing space (see Appendix for Cheap and Easy Greenhouse)

**Making Connections**
Students may be able to name different kinds of green vegetables in the brassica family (see background). Many of these “greens” were first brought to Hawaii by Chinese plantation workers, who grew much of their own food in home gardens.

The Farmer’s Market Connection homework assignment will be assigned once the students have had a chance to get to know their plants a bit.

During the previous activity, students may have suggested growing new plants from seeds as a way to find out if seeds are alive—and this is their chance to try it out. Students may be able to suggest most of the things plants need to grow, and can be allowed to direct the activity as much as possible.

**Teacher Prep for Activity**
This unit requires a lot of early prep, but much of what you gather for this investigation will be re-used for each of the others.

1. Establish your growing area. For 24 hour/day grow lights, put a prominent sign on the set-up to tell others (custodians) not to turn off the light at night. For an outdoor area, check in with other teachers/staff, who can help protect your plants from other curious children, and to be sure there are no conflicts. Outdoors, a greenhouse roof (at end of lesson) will protect the plants from birds, wind, and vandals, and increase the amount of heat to speed up flowering.

2. Purchase pots. Breakaway planters in 2-4” sizes are the cheapest. They come as a whole tray—separate them ahead of time. Tiny pots will save lots of money in potting soil. The small space stresses the plants a little, so they flower earlier, too.

3. Prepare soil for distribution: Fill each of two basins with about 2 qts of potting soil. Place these where students can rotate past to fill their planter cups.

4. Each group will need their own cup of seeds (at least 2 seeds per child). Also, make a cup with some seeds for your demo, and put some in a jar with a screw-tight lid to pass around. Be sure you have fresh seeds that have been kept cool and dry. “Fast Plants” (*Brassica rapa*) seeds can be purchased from Delta Education. Bok Choy seeds are locally distributed by Aina Ola Seeds at most supermarkets and Longs Drugs. Seeds are cheap, so you might try doing two different kinds, and comparing how they grow—use separate pots for each variety.

5. Cut paper towels—each student needs ½ a towel (if indoors).
6. Prepare labels or provide permanent markers.

7. Plan for water: each group will need one ½ liter container (16 oz sour cream container) and film canister-sized vial at the time of planting. Two days later, all the plants will be watered at once by pouring ½ liter of fertilized water into the tray that holds them. This allows the roots to get the water, helps keep the stems from rotting, and helps the students remember that roots = water. Only re-fill the tray with fertilized water when it is dry.

8. Liquid fertilizer: Purchase a concentrated liquid fertilizer such as FoxFarm Big Bloom Concentrate Liquid Plant Food (0.01-0.3-0.7) or FoxFarm Tiger Bloom Organic Based Liquid Fertilizer (2-8-4). Notice both of these mention “blooms” and the (N-P-K) numbers show that they are lower in N (Nitrogen) than in P and K (Phosphorous and potassium). This means faster blooming! Typical liquid fertilizer instructions are to add 4 drops to for each ½ liter each time you water, (except for the initial planting day—the iron in fertilizer can stop the seeds from sprouting). Follow the instructions on the label of your fertilizer bottle for vegetable seedlings.

9. Cut out pictures of brassica vegetables and make a small poster, or buy examples of brassica from the farmer’s market for the students to pass around (since these are stinky plants, this is always fun). After school, reuse them to make a great healthy dinner!

**Background**

A seed is a magnificent work of nature. It is the living result of successful plant reproduction, efficiently packaged for storage, distribution, and survival. Every seed is a living organism prepared to produce a plant similar (though not identical) to the parent plant that gave rise to it. Microscopic inspection of a seed will reveal a tiny embryo (resulting from the fusion of the female egg inside the ovule and the male sperm inside the pollen grain), a relatively large starchy or fatty food supply and a tough wrapper called a seed coat that surrounds the whole thing. Some seeds, like those of grass, clover, and garden flowers, may remain viable for a few months to a few years, while others, like those of evergreen trees and some cacti, can stay alive for decades!

Seeds have different requirements to trigger the onset of germination. Some seeds are ready to germinate immediately. Citrus seeds and the huge seed found in an avocado can be planted as soon as they are separated from the fruit that surrounds them (and roots sometimes develop even before this!). Other seeds, including tomato, pumpkin, pea, and sunflower, must dry out thoroughly before they can receive the message to start growing. Others must be subjected to more exacting conditions before germination. Some, like spruce seeds, must be cold for a while, and some closed-cone pines germinate only after the seeds have been scorched in a forest fire. Others must soak a long time in water, pass through the gut of an animal, or tumble over rocks and gravel to abrade the seed coat before germination will start. Each of these seed adaptations enhances the chances for that seed to sprout only when it reaches the appropriate habitat, and the appropriate conditions. In other words, it improves its chances for survival.

**Brassica** is a genus of plants that includes bok choy, cabbage, Chinese cabbage (won bok), collards, cauliflower, broccoli, kale, and turnip. Ann Kondo Corum, author of Ethnic Foods of Life Cycle of Brassica Plants

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Hawaii, tells us that many of these familiar vegetables were developed in China, where instead of getting most of their protein, vitamins, calcium, and other minerals from dairy products, people got them by “eating their greens.” Because of their love of vegetables, Chinese people of northern China long ago perfected farming methods so that they could have fresh vegetables through the winter months. Their methods included planting varieties of vegetables that were resistant to the cold, selecting the most successful individuals for propagation, protecting crops with straw mats that could be removed on warm days, and planting them on decomposing (heat-producing) manure. To the Chinese, fresh produce has never been considered a luxury, but a necessity (Corum, 2000).

When the first Chinese plantation workers arrived in Hawaii it is not surprising that they brought their favorite vegetables along with them. Many workers grew much of their own food in home gardens. The cold-adapted brassicas had to be slowly adapted to their new tropical climate by again selecting only the most successful plants for seed collection. Today, we buy varieties of bok choy and mustard seeds from local producers who are careful to label them “slow-bolt” or “heat-tolerant” to assure consumers that their plants will grow well in Hawaii.

One especially “fast-bolting” (bolt means to set flowers—usually making the leaves bitter) variety of brassica was developed by the University of Washington for research and education, and has a life-cycle of just one month. Brassica rapa can be purchased under the trade name Wisconsin Fast Plants, and used in this activity. Standard bok choy or mustard seeds, which have a naturally fast progression through their life cycle, can be used in Hawaii’s warm climate. With the help of grow lights and a little dehydration, they will cycle nearly as fast—6-8 weeks. Previous classrooms used Aina ‘Ola seeds: a slow-bolt, heat tolerant variety. You could try others that are not selected for a hot climate and therefore may bolt quickly here in Hawaii. If your classroom is air-conditioned you will either need to do this experiment outside, use a heat lamp along with the grow lights, or place the tray of seedlings in a window or mini-greenhouse with warm afternoon sun.

Brassica rapa grows best when it is kept moist and well fertilized. To do this we suggest putting water in the tray in which the planter cups stand. The water will soak up into the cups. Overwatering will cause the seedlings to “pinch off” along the stem and die, so *add water only after the tray is dry*. At that time add liquid fertilizer to \( \frac{1}{2} \) liter of water (or amount needed to cover holes in bottom of cups) and pour it into the tray.

Bok Choy needs a little “water stress” to trigger it to bolt early: after 3 pairs of leaves develop, reduce watering. Water only when the plants start to look a little wilty.

The light that shines on the brassica plants should be as intense as possible, for the fastest progression. If you will be keeping the plants indoors, you *absolutely must* use horticultural grow lights, or this experiment will not work. Household fluorescent lights are too dim. It’s best to keep the lights within 3 and 7 cm from the top of the plants. If you will be growing plants outdoors, be sure they will receive *direct sunlight from dawn to dusk*. Placing them next to a building will generally block their sunlight for half the day, and the life cycle will not be completed in a reasonable amount of time.

Life Cycle of Brassica Plants
Part I: Planting Seeds
Definitions:

bok choy: a green leafy vegetable, considered a Chinese introduction.
brassica: a genus of mostly edible plants including bok choy, mustard, broccoli, and cauliflower.
germination: the process by which a plant emerges from a seed.
sprout: The first visible growth of a plant upward from the soil or seed.
growth: the process of getting bigger.
root: the part of a plant that grows under the ground, absorbing water and nutrients in solution.
water: a critical compound for all life. The liquid portion of cells and living material.
fertilizer: material added to a plant to help it grow. Includes nutrients such as calcium, nitrogen, phosphorus, and potassium.
light: packets or waves of energy that can be used by plants to make energy.
nutrient: a substance that is required by a living thing. Food.
kuleana: responsibility and privilege. It is your kuleana to water the plants today, Charlie.

Procedure
1. INTRODUCE BRASSICA
   a. Call the students to the rug.
   b. Remind them of their discussion about plants the previous day. Did they suggest growing seeds? Show and tell about your brassica vegetables/poster. Ask the students if they can think of any meals they have eaten recently with any of the brassica vegetables in them. It may not be easy, but the goal is to get the students a little excited about green vegetables!
   c. Ask the students what the class could do to make you some delicious vegetables. [Plant seeds!]
   d. Explain that each student is going to plant some brassica/bok choy seeds and watch what happens for several weeks. Pass around a container of seeds for the students to see (and get it back before proceeding).

2. DEMONSTRATE THE PLANTING PROCEDURE
   While still at the rug, hold up the planter cup. Explain that each of them will have the opportunity to plant two of the tiny seeds in his or her own cup. Model the planting procedure.
   a. Label your cup.
   b. Scoop up a heaping cup full of soil. Level off the soil so that it is even with the top of the cup.
   c. Tamp down the soil gently.
   d. Pour two brassica seeds onto a paper towel, then place them on top of the soil. Caution the students that the seeds are very tiny and that they will need to handle them carefully.
   e. Cover the seeds with a tiny bit of soil and press down slightly.
   f. Place the cups on a half sheet of paper towel. Add one vial of water to each cup.

3. START BY LABELING CUPS
   a. Send students to their tables.
   b. Have “getters” obtain labels, sharpies, and planter cups for each student in the group.
4. **LINE UP FOR SOIL**
Place newspapers under your soil basins, and call groups up to *quickly* fill their cups—they can tamp down the soil once back at their seat.

5. **DISTRIBUTE SEEDS**
Call the “getters” to come up and get a cup of seeds and the paper towels, and let planting continue.

6. **COVER THE SEEDS**
After pressing in seeds, students can pinch a little soil from the edge of their cup to sprinkle over their seeds.

7. **WATER THE SEEDS**
   a. Getters get their $\frac{1}{2}$ liter of water and vial for their group.
   b. Remind students to put their planter cup on a piece of paper towel before adding one vial of water.
   c. Ask getters to return water as soon as all planters have been watered.

8. **PUT CUPS IN THE TRAY/ CLEAN UP**
   a. Call groups to place their planter cups into the class tray.
   b. Check for good work: Gently cover exposed seeds with soil.
   c. Have students tidy up their areas and put materials away.

9. **REGROUP FOR DISCUSSION**

10. **DISCUSS LIGHT REQUIREMENTS**
    a. Call attention to the light source (sun or grow lights).
    b. Ask where they think the plants should be positioned. Guide students toward the conclusion that plants need light and that they will grow faster the more of it they have.
    c. Possible concerns students will have might include plants getting too hot (as long as they have enough water, they can cool themselves off by evaporation), or plants getting tired by growing all night (light provides them with energy, so when they are in the dark, they actually run low on energy—the closest a plant comes to being “tired”). Addressing these concerns helps affirm students caring and respect for the plants.

11. **DISCUSS FUTURE CARE PROCEDURE**
    a. Ask what the students think they will need to do to take care of the plants for the next few weeks.
    b. Explain that watering will be accomplished by pouring water into the tray rather than into the individual cups.
    c. Ask students why that might be a good idea [roots “drink” the water, and they will be growing down to the bottom.] Also explain that water will be added *only* when there is *no* standing water in the tray. The water will be mixed with a small amount of fertilizer.

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12. MAKE A CALENDAR ENTRY
Have students mark their calendars to indicating the day that they planted their brassica seeds. Mark the class calendar as well.

12. MAKE WORD BANK ENTRIES
Suggestions:
- brassica
- bok choy
- plant
- soil
- light
- water
- fertilizer
- nutrient
- kuleana

13. MAKE CONTENT CHART/KWL ENTRIES
If using a concept chart or Know/Want to know/Learned chart, make entries.

14. EXIT PASS:
- What kind of plants are we growing?
- What do your brassica plants need to grow?

15. PREPARE SOME RESERVES
After class, set up a planter cup for any absent students and three or four reserves. Put these into the tray with the rest. If a student’s planter fails to sprout, simply transfer the student’s label to one of the reserves.

Assessments
Ongoing assessment will be based on student’s ability to follow directions in planting and caring for their brassica. Daily observations in the calendar should reflect reality, use vocabulary words, and include measurements. Exit Pass helps identify those students who missed the point entirely.

Resources

Life Cycle of Brassica Plants
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Ohioro, Kathy. Growing Vegetables in Hawaii. Bess Press, Honolulu. Her book talks about the plants that do well here and how to grow them, and also includes recipes and nutritional information for each plant.

Any gardening or hydroponics book from the library!

**Extension Activities**

Bean Maze: Divide a large shoebox or t-shirt box into 9-12 cubicles, using extra pieces of cardboard. Poke a whole through the side of each “cubicle” to make a maze. Fill one corner cubicle with moist soil, and plant a bean seed. Seal the box with duct tape, leaving just one quarter sized hole for light at the end of the maze. The bean will travel through the box, following the light. If the dividers in the box are not fairly flush, the bean may find a way to “cheat” its way through! Check on the bean after a week, or whenever it emerges. How did it know which way to go?

**Literature Connections**

Pumpkin Day by Nancy Elizabeth Wallace. Two rabbit children happily plant their pumpkin patch in anticipation of Halloween, months away. The story takes children through the life cycle of a pumpkin plant from seed to fruit to seed, with excellent level of detail and visibility for each stage of development. A perfect story to read aloud to second graders.


The Carrot Seed by Ruth Krauss and Crockett Johnson. A little boy plants a seed and is determined to take care of it.
Bok Choy Life Cycle Calendar

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Brassica Life Cycle Calendar

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Cheap and Easy Greenhouse!

Materials
• 3 each: ¾” x 10’ white pvc pipe
• 1 sheet: UV resistant clear plastic, 8-9 feet wide
  (length depends on your plans)
• Duct Tape.
• Optional: 1 aluminum/steel pole, (the kind used
  for EZ-corner-tent posts) + hacksaw + hammer.
  Cut to 6 pipes of 16” length.

Methods
• Lay clear plastic out flat on the ground. It should be 10’ wide, and as long as you like, but
  probably not more than 12-18 feet.
• Place on pole each at the end and the middle of the plastic.
• Roll the two end poles in the plastic 2 times, (two layers around the pole).
• Duct tape all the poles securely into place.
• With one person at each end of the pole, bend it into a rainbow, and push into ground about
  8”.
• If ground is too hard, hammer the aluminum EZ corner poles into the ground 8 inches.
  Then stick the PVC ends into these holders.