Introduction

The Fast Plant and Its Butterfly

Investigating the Life Cycles of Wisconsin Fast Plants (Rapid cycling *Brassica rapa*) and the Brassica Butterfly (*Pieris rapae*)
The Fast Plant and Its Butterfly Materials Needed

- Brassica Butterfly eggs - order eggs on the first day of planting.
- Fast Plant or Radish seeds
- Growing system materials
- Fast Plants Standard seeds
- Butterfly Feeder
- Scale Strips (provided with instructions as a black line master)
- Butterfly Box (available from Carolina Biological Supply Company or make your own)
- Cabbage leaves
- 6 gallon size Ziploc™ bags
- 6 straight pins

Time Requirements
Total number of days 55
(Not all days are class intensive. Review Calendar and Reference Outline for more details)

Investigating the Life Cycles
How an insect gets from a tiny egg to an adult butterfly is a fascinating process. Students will observe what actually happens with the Brassica Butterflies as they go through their life cycle on Fast Plants. In doing so, students will learn about the life cycle of an economically important insect and the interdependence between two organisms. This activity is designed to be an introduction to the life cycles. For information on additional investigations and experiments with these two organisms visit the Fast Plants website at: www.fastplants.org

Concepts
Students will cover the following concepts:

1. Life cycle of two organisms
   Wisconsin Fast Plants
   The Brassica Butterfly
2. Form and function of the two organisms
3. Interdependence between two organisms
4. Symbiotic and parasitic relationships between plants and insects
5. Environmental conditions necessary for both the Fast Plants and the Brassica Butterfly to live and reproduce.
Wisconsin Fast Plants™ and the Brassica Butterfly

Fast Plants are rapid cycling brassicas, members of the cabbage and mustard family. They have been developed through 25 years of selective breeding to be used by plant researchers and by teachers in the classroom. They have a life cycle of 35-40 days (seed to seed) and can easily be grown in the classroom under continuous fluorescent light.

The Brassica Butterfly is a butterfly species ubiquitous across North America found in nearly all gardens growing cabbage, broccoli, and other crucifers. The butterfly's life cycle begins with 5 larval stages and then transitions to an adult through a process known as metamorphosis. The adult butterfly will emerge from a chrysalis approximately 25 days from egg. It mates, lays eggs, and lives as an adult butterfly for another 2-3 weeks with proper nutrition.

The rate of growth and development of Wisconsin Fast Plants and the Brassica Butterfly is affected by temperature and nutrition. (not drawn to scale)
Introduction

The relationship between insects and plants is complex. Insects rely on plants as a source of food, as shelter from predators, and as a place to mate, lay eggs, and grow their young. Many plants need insects for reproduction; without insects, many plants would never be pollinated and many seeds would never be dispersed. While many of these relationships are symbiotic (both insects and the plants benefit), the relationship between the Brassica Butterfly and brassica plants is not.

Brassica Butterflies have evolved closely with brassica plants. Brassicas include plants such as cabbage, broccoli, turnips, and Wisconsin Fast Plants. Throughout their life cycle, the Brassica Butterflies utilize virtually all parts of the brassica plant: as larvae they forage on leaves, as chrysalises they are sheltered from predators, and as adults they drink nectar and lay eggs on the leaves. In return, the butterflies pollinate the flowers of brassicas so the plants can reproduce. However, this relationship ultimately destroys the plant; the young, developing larvae, who devour the plant leaves, have the capability of defoliating and killing a plant. This devastating relationship can be very costly to brassica farmers as they attempt to combat the butterflies with expensive pesticides and other means.
## Calendar and Reference Outline

<table>
<thead>
<tr>
<th>Time Line</th>
<th>Brassica Butterflies Life Cycle</th>
<th>Brassica Diet</th>
<th>Fast Plants Life Cycle</th>
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<td>5 Days prior to eggs arriving</td>
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<td>Plant one growing system per student group of the Brassica Diet</td>
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<tr>
<td>Day 1</td>
<td>Eggs</td>
<td>Plants are 5 days old</td>
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<td>Place the egg strip on the plants</td>
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<tr>
<td>Day 2-11</td>
<td>L₀ - L₁ larvae</td>
<td>Observe larvae in plant material</td>
<td>0 das (days after sowing)</td>
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| Larvae hatch and grow. Find, observe, sketch, measure and plot measurement data on a graph | Discard remaining plants | Plant Wisconsin Fast Plants seeds | 18 das 
Seedlings emerge and by day 8 the first and second true leaves have emerged. |
| Approximately Day 10 or 11 | L₀ - L₁ larvae                  | Observe metamorphosis (spinning of pupa to emergence of butterfly = 8 days). Observe emergence. | 9 - 11 das 
Flower buds are developing. |
| Tend larvae. Observe, sketch, and measure larvae. Plot data on a graph |                                | 12 - 16 das                                | 12 - 25 das 
Flowers are beginning to open for pollination. Observe butterfly pollination. |
| Day 27-35          | Observe pollination of Fast Plants, mating, and egg laying on the leaves |                                | 25 - 35 das 
Observe butterfly pollination and elongation of seed pods. |
| Observe emerging larvae on the Fast Plants leaves. |                                |                                                 |                                                             |
| Day 35-45          | Observe larvae eating and growing on the Fast Plants. |                                | 36 - 45 das 
Do you think that the Fast Plants are going to produce seed? |
| Is there enough food in the box for them to survive? |                                |                                                 |                                                             |
| Day 46-55          | Optional: Remove and place larvae from the Fast Plants onto another crop of plants to continue the life cycle or collect larvae and chrysalis for overwintering experiments in a refrigerator. |                                | Remove plants from water and let them dry. |
|                                |                                               |                                                 | Harvest any remaining seed.                                |
|                                |                                               |                                                 | Store seeds in a cool dry place for future experiments.     |
**Teacher Instructions**

5 Days prior to eggs arriving  - ORDER EGGS

Have each group of students plant one growing system of the Brassica Diet (see growing instructions). The Brassica Diet is a mixture of Fast Plants, turnips, and radish seeds. The Fast Plants should emerge first for the young larvae to eat. Place the plants into the Butterfly Box with the light on.

Day 1 : Eggs

Immediately after eggs arrive, cut the egg strips into six pieces, one per group. Each group should receive 6-8 eggs. Place the egg strips (egg side down) on the plants. Photocopy the black line master of the scale strips and have the students cut out individual scales strips (one for each of them).

Day 2-11 : L₁ - L₃ larvae

After the larave hatch, they will tend to cannibalize other eggs prior to moving to the plants. The L₁ and L₂ stage larvae are very small and fragile. They should not be handled by the students. Have the students work with care when finding, observing, and estimating the length with the scale strips of the larvae. Have each group plot their measurement data on a graph over time.

Approximately Day 10 or 11: L₁ - L₃ larvae / Plant Fast Plants (0 das)

Purchase a large green cabbage head from the market and discard the outer leaves. Have each group transfer their larvae from the Brassica Diet to a leaf of cabbage. With a straight pin, poke 5-6 holes in a Ziploc™ bag, put the leaf into the bag. Push the straight pin through the midrib of the leaf and attach the bag onto a bulletin board.

Once the larvae have been transferred, wash all of the growing system materials in warm soapy water. Rinse well. Have each group of students plant 8-10 Fast Plants seeds (see growing instructions). Place the planted Fast Plants into the Butterfly Box with the light on. Raise the growing systems up to approximately 10 cm from the light bulb. This will provide high light conditions that will optimize Fast Plants growth and development.

Day 11-18: L₁ - L₂ larvae / Fast Plants Early Growth and Development (1-8 das)

Students should continue to observe the feeding behavior of the larvae and estimate length while the larvae eat the cabbage leaf in the bags. Depending on the relative humidity in your area, you may have to have the students replace the leaf in the bag.

Have each group tend and monitor the growth and development of the Fast Plants. Measurements of plant height can be taken every three days to plot the growth and development over time. Be sure to keep the water reservoirs full.

Day 18-20: Chrysalis Formation / Flower Buds Developing on Fast Plants (9-11 das)

Once all of the chrysalises have formed, have each group carefully transfer them onto the scale strip using double stick tape to stick them to the strip (see scale strip). Place the scale strips into the Butterfly Box.

Lower the Fast Plants to maintain the 10 cm distance between the tops of the Fast Plants and the light bulb and fill water reservoirs.

Approximately Day 21-26: Metamorphosis and Emergence / Fast Plants Flowering (9-15 das)

Place the screen on the box. Keep the Fast Plants 10 cm from the light bulb for optimal light. Check water reservoirs and fill if necessary.

Day 27-35: Butterflies, Feeding, Egg Laying and Pollination / Fast Plants Pollination (16-24 das)

If there are not enough flowers out for the Butterflies to feed on, set up an artificial feeder system (included) by mixing one teaspoon of sugar, 1-2 drops of honey, and 1-2 drops of yellow food coloring in hot water. Shake well and be sure to saturate the wick with the sugar solution before placing in the lid.

Day 35-45: Larval Development / Seed Development

During this period you and your students will begin to realize whether or not you have enough plant material to sustain the newly hatched larvae. If you do not you have several options: 1.) plant more plants and transfer larvae. 2.) set up another feeder bag with a cabbage leaf. 3.) dispose of some of the larvae.

Day 46-55: Larval Development / Seed Development
Getting Ready

Five days prior to starting this activity:

Order the Brassica Butterfly eggs from Carolina Biological Supply Company at 1-800-334-5551 or fax the request form to 1-800-222-7112.

The eggs will be shipped from Monday - Wednesday via one or two day Federal Express. The eggs will begin to hatch within 12 -24 hours of arrival and should be placed on the Brassica diet plant material immediately.

Set up Butterfly Box

The screen on the box is not needed until approximately Day 26 in the activity when the butterflies emerge.

Plant the Brassica Diet

Five days prior to the date the eggs are to arrive, plant one growing system of the Fast Plants / Radish per student group. See growing instructions (Appendix 1). Be sure to place the plants in the Butterfly Box with the light on.