iBIO STEM Kits: Plant Growth

iBIO STEM Kits welcomes you to a SCIENTIFIC JOURNEY!

This kit contains the materials you will need to build a self-watering growth chamber and plant some seeds. The purpose of this kit is to challenge you to do a controlled experiment to investigate a variable that may affect the germination and growth of a plant. You will be tracking the results of your experiment over a period of two weeks and will evaluate your findings as a scientist. What does this mean?

Scientific exploration is different than just playing around because it asks you to think about HOW you investigate. This means you need to do your investigation by observing what happens when you change an element of your design that you have carefully chosen. Good observation will help you to understand WHY something happens. Scientific exploration also means that you record WHAT you see or measure so that you can alter your design based upon what works for you. The STEM Kit Journal that you are holding will help to guide your investigation and give you a place to record your observations, create your design and document your changes.

We have video guidance for your investigation at this website: **www.ibio.org/stemkits**

There are many resources for you to use at this website. This type of investigation is associated with some very exciting careers! We hope that you will explore these resources while you are doing your investigation!

Let's Get Started!

FIRST, you will need to prepare your workspace. Having a clear space where you can see all of your materials and tools is very helpful. A kitchen table will work nicely. To make your clean up easier, you should protect your surface by laying out some used newspaper or opening up a paper grocery bag.

SECOND, you want to unpack your materials. Use the list below to identify which materials are used in each part and organize them in your workspace. There are some additional materials that you will need to supply from your home.

Kit Materials for Part A:

Plastic jewelry bag
2 foot piece of string
2 cotton balls
2 corn seeds**

Welcome Kit Materials for Part B:

1 ruler
Measuring Cup Set

Kit Materials for Part B:

3 plastic 4oz cups
2 peat pellets
6 toothpicks
1 pushpin
3 plastic 9oz cups
9 fertilizer pellets**
3 sandwich baggies
6 Wisconsin Fast Plant Seeds**
3 6-inch pieces of clothesline

Materials needed from Home:

Water
Markers
Bowl

****Disclaimer: The seeds and fertilizer pellets included <u>should not</u> be ingested. Please monitor young children around the seeds and fertilizer pellets.**

LAST, you need to be prepared for experimenting safely. You will need to ask an adult for help or supervision when you need to use the pushpin to punch holes at the end of the cup.

Plant Growth - Life Science Investigation

Adapted from Wisconsin Fast Plants at fastplants.org

Part A: EXPLORE: Make a Germination Necklace

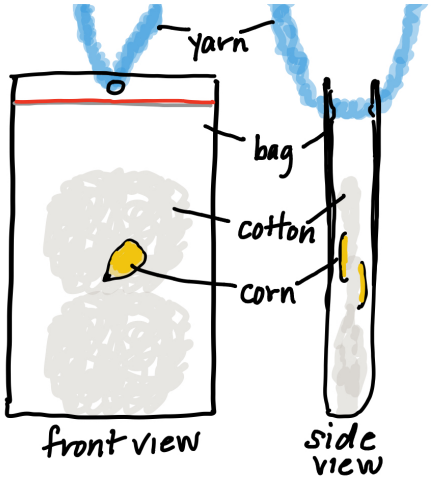
Here's what each camper will need:

1. Plastic jewelry bag
2. 2 ft piece of yarn or string
3. 2 cotton balls
4. 2 corn seeds
5. Water

Seeds will develop, under the right conditions, into a new plant. Have you ever watched a seed grow? We are going to create a live corn necklace, which you will care for and observe as it grows. If you want to, you can use two corn varieties—so that you can observe and compare them as they germinate.

Procedure:

1. You should have two corn seeds. Get one plastic "jewelry" bag, two cotton balls, a piece of yarn or string, and a cup of water.
2. Dip the two cotton balls in the water so that they are completely wet but not dripping wet. Too much water will keep the seeds from germinating (sprouting), because the conditions will not be right.
3. Place the cotton balls in the plastic bag. Make sure that the cotton fills up the plastic bag almost to the top.
4. Place one corn seed on one side of the cotton ball so that it is held in place between the plastic and the cotton ball about halfway up the bag.
5. Place the second corn seed on one the other side of the cotton ball so that it is held in place between the plastic and the cotton ball about halfway up the bag.
6. Seal the bag so that there is air in the bag, but that it is not blown up like a balloon.



7. Create a small hole in the bag ABOVE the seal. String the yarn through the hole in the jewelry bag. Tie a knot in the end of the string to form a necklace.
8. The necklace can be worn inside your shirt so that your body heat will keep the seeds warm. You can hang it someplace else, but it will grow much more slowly.

Keeping track of the germination of your Seeds

1. Each day, at about the same time, use a ruler to measure the length of roots and leaves as they grow.
2. Make yourself a data chart like the one shown below. Observe, measure, and collect data on the corn plant germination and growth for at least a week.
3. Once you see growth of the root or the shoot (leaves), use your ruler to measure the length in millimeters (mm). This is the smallest unit on the metric side of your ruler.
    a. It may be difficult to take the seedlings out of the bags and then to put them back in without breaking the roots. To prevent the breakage of roots, measure the roots through the bag instead.
    b. The roots will curl, so you may need to measure them in sections, add the lengths of the sections, and then estimate the total length.
    c. Make observations about the seed every day. Are you seeing fuzz? Has the seed coat cracked? Has it been pushed off? Are the shoots green?
4. It is possible that the cotton ball may become dry. If so, add a little more water to wet the cotton ball, but do not add so much that there is excess water in the bag, and seal it securely.
5. At the end of the week, you can plant your corn in a pot of soil and put it outside. If you care for it by watering and fertilizing, the plant will continue to grow, and it may produce a cob of corn!

	Corn Kernel 1			Corn Kernel 2		
	Root Length	Shoot Length	Observations	Root Length	Shoot Length	Observations
Day 0	*0 mm*	*0 mm*	*The seed is smooth and no growth is visible*	*0 cm*	*0 cm*	*The seed is smooth and no growth is visible*
Day 1						
Day 2						
Day 3						
Day 4						
Day 5						
Day 6						
Day 7						

Part B: Build: Make a Self-Watering Growth Chamber

Materials in your kit:

1. 3 plastic 4 oz cups
2. 3 plastic 9 oz cups
3. Two peat pellets
4. 3 - 6 in. pieces of cotton or polyester clothesline
5. 6 Wisconsin Fast Plant Seeds
6. 6 toothpicks
7. 9 fertilizer pellets
8. 1 push pin
9. Water
10. 3 sandwich baggies
11. A location directly below a light source
12. Ruler

When you set up this controlled scientific experiment, you will be able to investigate the amount of fertilizer that is best for plant growth and observe the complete life cycle of your plant. If setting up THREE chambers seems to be too excessive, try setting up only TWO chambers: No fertilizer pellets and 3 fertilizer pellets.

Procedure:

1. Fill a medium sized bowl with water. Place the two peat pellets into the water. They will begin to expand. Leave them for 5-10 minutes. Place the three 6-inch pieces of clothesline (or felt strips) into the bowl of water to soak.

Mark the Water Reservoir

2. Find the three 9 oz plastic cups. These cups will be your water reservoirs. Put your ruler into the cup and measure 3 cm from the bottom of the cup. Use a sharpie to make a mark. **This is your waterline.** Do the same thing in the other two cups.
3. Fill each of the three cups to the water line that you just made. Set them off to the side and out of the way.

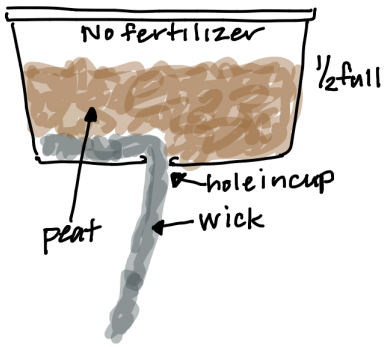
Making the Growth Cups

4. Find the three 4 oz cups. These will be the growth cups. Label one cup “No Fertilizer.” Label the second cup “3 Fertilizer.” Label the third cup “6 fertilizer”.
5. Use a push pin to make a hole on the bottom of each 4oz plastic cup. Again, be patient. You do not want to split the cup. This hole will need to be made bigger so that it is wide enough that you will be able to thread the cotton clothesline (or felt strip) through it. Gently move the push pins to make a bigger hole.
6. Find your three 6-inch sections of clothesline. This is called the wick. It will be used to draw the water up from the water reservoir.
7. Thread the wick through the hole on the bottom of each cup so that half of the wick is in the cup and half is hanging out of the cup. Leave the wick in place. You may need to adjust the size of the hole. If the wick slips out of the cup, you might need to temporarily tape it in place.
8. Fit the 4 oz cup into the top of the 9 oz water reservoir. The wick should be hanging into the water. If the wick does not touch the water, you will need to adjust it so that it does.

Part C: Investigate: Is more fertilizer better for Wisconsin Fast Plants?

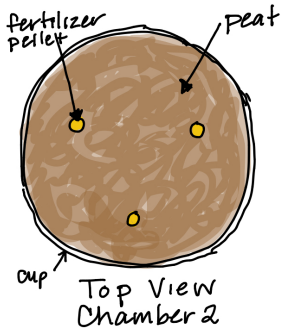
Setting up the Growth Cups

9. The peat pellets should be completely expanded. Take them out of the water and place them on a paper towel or a plate. Open the pellets by using your scissors to cut the casing.
10. Put the peat from one of the pellets into each growth cup. Your wick should now be under the peat as you can see in the diagram.



Adding the Fertilizer

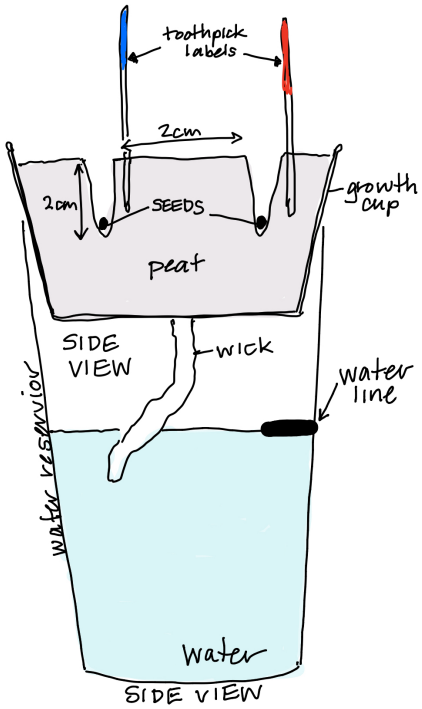
11. Find the fertilizer pellets.
12. Put fertilizer pellets on top of the dirt based on the label you put on your cup. Do not put any pellets in the cup for "No Fertilizer." Put three pellets in the "3 Fertilizer" cup. Put 6 fertilizer pellets in the "6 Fertilizer" cup.
13. Use the peat from the second peat pellet to fill up the 3 growth cups. Make sure that all three cups have the same amount of peat.



Planting the Seeds

14. You should have 6 toothpicks. Use your markers to color the top of each toothpick a different color. This is how we will be keeping track of which plant is which.
15. You will be planting two seeds in each container. Use your toothpick to make two holes that are 2 cm deep in the peat. The holes should be at least 2 cm apart from one another.
16. Drop one seed in each hole. Cover them lightly with peat. Mark the location by pushing a toothpick into the soil next to the seed.
17. Plant two seeds in each growth cup.
18. Use a plastic sandwich bag to cover the cups, creating a mini-greenhouse. Place the three growth chambers under a light source. It will help growth if this is a warm area.

NOTE: These plants need to remain indoors for the duration of their life cycle. When plants are moved from indoors to outdoors, they experience "shock" that could damage or kill them. For this experiment, put your growth chambers in the light near a window or under a light source.



Part D: Tracking the data: Is more fertilizer better for Wisconsin Fast Plants?

You will need to make a data chart for each growth chamber.

Caring for your plant and Measuring Height EVERY TWO DAYS:

Plants take time to grow, so we will need to be patient, although Fast Plants (*Brassica rapa*) grows quickly, so we will be able to take data on a regular basis.

1. You will be watering and measuring the height of your plants in each chamber every two days.
2. To water, add 10ml (1Tbsp) of water to each chamber. You will also need to make sure that the water reservoir has water up to the line you drew inside the cup.
3. To measure height, you will need to use a metric ruler.
4. You will be measuring the plant from the level of the soil to the top of the plant. If your ruler has a border at the zero end, you may need to push your ruler into the soil so that the zero lines up with the soil level.
5. You will be measuring height in mm for each plant and record the measurement on your chart.
6. You will need to calculate the average for the two plants in each system.

   Plant 1 Height + Plant 2 Height = Total Height

   Total Height ÷ 2 = Average Height

7. Record the average on your chart.

Pollinating Flowers

At some point, a healthy plant will make a yellow flower. When your plant makes a flower, it needs to be pollinated in order to make seeds. If your plant was outside, insects (like bees) would do this for the plant. Our plants are inside, so you will need to be the pollinator.

1. You will need **one or two cotton swabs** to use as a pollination stick.
2. Very gently and in a circle, rub the tip of the cotton swab in the center of the flower. This will pick up the pollen. You may see the yellow pollen on the tip of the cotton swab.
3. Using the same swab, rub the pollen in the same way on another flower.
4. Continue using the same swab on the rest of the flowers, even if they are on other plants.
5. Store the cotton swab in a plastic bag or cup to use anytime you see new flowers.

Opening Pods and Counting Seeds

Eventually, the pollinated flowers will make seeds. On the Brassica rapa plant, the seeds are contained in pods. As the seeds mature, the pods will thicken and elongate. The number of seeds produced by a plant will tell us how successful the plant has been over its 40 Day life cycle.

1. On Day 30, allow the plants to dry out. When plants and pods are brown and crispy, they are ready to harvest! Start by removing all of the pods from the plants in your first growth chamber.
2. Put the pod on a plate or paper towel so that they do not roll away.
3. Use your fingernails to pry open the pods and reveal the seeds.
4. Count the number of seeds produced and record it on your data chart.
5. Repeat this process for each growth chamber.

Conclusions:

Which of your plants was most successful?

Which amount of fertilizer had the plants with the biggest height and largest number of seeds?

DATA CHART

Growth Chamber 1: 2 seeds with NO FERTILIZER PELLETS					
Date	**Day of Growth**	**Plant 1 Height (mm)** **Toothpick Color** _____	**Plant 2 Height (mm)** **Toothpick Color** _____	**Total Height for both plants** **Height 1 + Height 2 =**	**Average Heights for both plants** **Total Height ÷ 2 =**
	0	**0**	**0**	**0 + 0 = 0**	0 ÷ 2 = 0
	2				
	4				
	6				
	8				
	10				
	12				
	14				
	16				
	18				
	20				
	22				
	24				
	26				
	28				
	30				
	32				
	34				
	36				
	38				
	40				

FINAL DATA:

Plant 1: Number of Pods _____ Number of Seeds _____
Plant 2: Number of Pods _____ Number of Seeds _____

DATA CHART

Growth Chamber 2: 2 seeds with 3 FERTILIZER PELLETS					
Date	**Day of Growth**	**Plant 3 Height (mm)** **Toothpick Color** _____	**Plant 4 Height (mm)** **Toothpick Color** _____	**Total Height for both plants** **Height 3 + Height 4 =**	**Average Heights for both plants** **Total Height ÷ 2 =**
	0	**0**	**0**	**0 + 0 = 0**	0 ÷ 2 = 0
	2				
	4				
	6				
	8				
	10				
	12				
	14				
	16				
	18				
	20				
	22				
	24				
	26				
	28				
	30				
	32				
	34				
	36				
	38				
	40				

FINAL DATA:

Plant 3: Number of Pods _____ Number of Seeds _____
Plant 4: Number of Pods _____ Number of Seeds _____

DATA CHART

Growth Chamber 3: 2 seeds with 6 FERTILIZER PELLETS					
Date	**Day of Growth**	**Plant 5 Height (mm)** **Toothpick Color** _____	**Plant 6 Height (mm)** **Toothpick Color** _____	**Total Height for both plants** **Height 5 + Height 6 =**	**Average Heights for both plants** **Total Height ÷ 2 =**
	0	**0**	**0**	**0 + 0 = 0**	0 ÷ 2 = 0
	2				
	4				
	6				
	8				
	10				
	12				
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	36				
	38				
	40				

FINAL DATA:

Plant 5: Number of Pods _____ Number of Seeds _____
Plant 6: Number of Pods _____ Number of Seeds _____

Final Conclusions

1. Which of your plants was most successful? _____

2. How did you decide your answer? What makes a plant more successful?

3. Why do you think we needed to grow two plants in each chamber?

4. Why do you think it is important to average the heights for both plants in the chamber?

5. What was the most surprising thing that you learned about keeping a plant healthy?

6. What is a pod? Why do you think these plants make pods? Can you think of vegetables we eat that have pods?

7. Is fertilizer important for a garden? How do you know?

8. If you were going to grow some plants in your garden, how much fertilizer would you use? Why?

Extension:
Plant the corn from your Germination Necklace in a pot filled with potting soil. How much fertilizer will you add? How often will you water your new plant? How will you know that your plant is healthy?