Section 1 - Introduction to Seeds

Learning Goals/Objectives

- Know where to find seeds in fruits and vegetables.
- Understand What a seed is.

Materials needed

- ❑ A variety of fruits and vegetables (starfruit, strawberries, zucchini, orange, squash, pomegranate, avocado, beans, corn, coconut, etc.) If unable to have physical materials, colour pictures will do.
- ❑ 2-3 hoops to make a sorting space (or a Venn diagram)
- ❑ Chart paper, markers
- ❑ Ruler or digital calipers (for measuring size)

Approximate time – 60-70 minutes in total (broken into 2 exploration phases)

Implementation

- On the chart paper, come up with a list of ways that the fruits and vegetables can be sorted. Students may come up with…color, size, shape, texture. If they arrive at how they grow or by fruit and vegetable…use this as a keystone term.
- As a group or in small groups (you can set up a station) sort the fruits and vegetables – take photos or record the sort on the chart paper.
- Once students arrive at "by fruit or vegetable" or by "how the fruit is grown" use this as a discussion point to lead the conversation around the following facts.
- Fruits develop from a flower of a plant and contain seeds.
- Vegetables are the edible part of a plant and may not play a role in the reproduction of the plant.

- If needed – re-sort based on these new criteria – make a list of other fruits and vegetables that fit these criteria. Are there any fruits or vegetables that are difficult to sort (tomatoes, kiwi, watermelon?) - what makes these difficult to sort?

- Once the group arrives (or is lead) to the following statement
  - "fruits contain seeds" and "vegetables are the part of a plant we eat (it may not have seeds)"
- Discuss the purpose of a seed
  - "A seed is a small object produced by a plant in order to make a new plant."
  - "Seeds carry the beginning of a plant inside of them."
- Estimate how many seeds might be in a fruit – (you could bar graph this)
- Cut the fruits open and have students count the seeds inside (you could include GMO plants that have NO seeds if you wish)
- Record the name of the fruit, where the seeds are located and how the seeds are dispersed on the chart paper. (you can use the 11 x 17 master attached (name to be decided later)

Picture	Name	properties	Draw the seed (or configuration in the fruit)
	Is it a fruit or vegetable?		
	Estimated number of seeds		
	Actual number of seeds		
	Where are the seeds located in the fruit		
	A secondary lesson could discuss How are the seeds dispersed? (circle) Wind, water, expelling, cultivation, gravity, attaching to or digested by animal		

- Once done, compare.
  - seed estimations to the actual count.
  - fruit size to seed size (use a ruler to measure)
  - (secondary lesson) methods of dispersion

Conclusions

Make a list of fruits we eat regularly – do these fit the criteria?
Make a second list of vegetables we eat regularly – do these fit the criteria?

Concluding statement

"fruits contain seeds" and "vegetables are the part of a plant we eat (it may not have seeds)"

Follow up activities…

Choose a fruit or vegetable not provided and write a short story…"my story…"
Colouring pages
Memory match game
Fruit and vegetable card sort

Section 2 - Exploration of Seeds

Learning Goals/Objectives

- Be able to explain what germination is and how germination occurs
- Understand what a seedling is and how to keep it healthy

Materials needed

- several types of seeds (different sizes preferred)
- sealable sandwich bags
- Paper towels or cotton gauze pads
- Hand lens/magnifying glass
- Microscale (500 gram) (if available)
- Optional – digital microscope or 12 mP phone camera connected to projector or large screen

Time for lesson – 20-60 minutes (allow 24 hours for seed soak) plus germination and observation times (3-7 days)

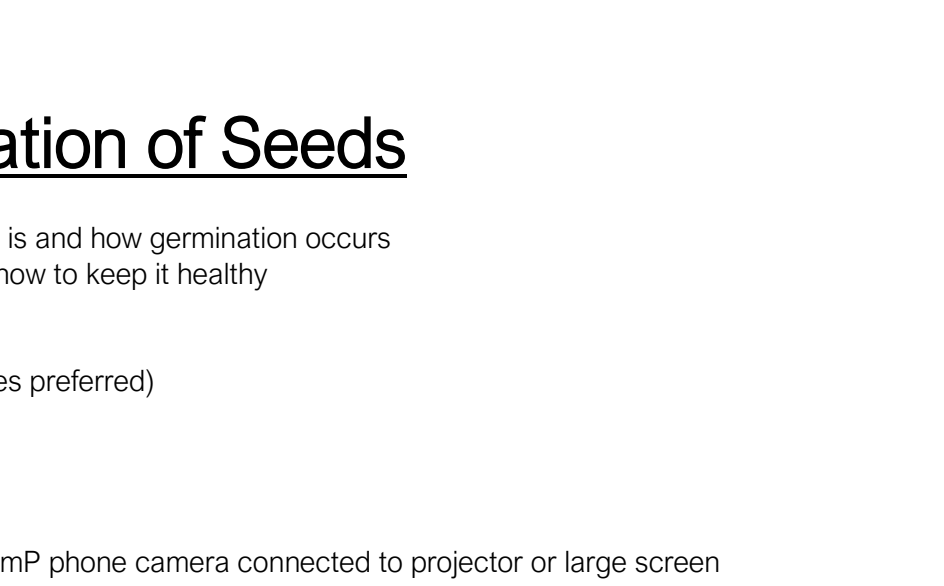
Implementation

Revisit the following statement

"fruits contain seeds" and "vegetables are the part of a plant we eat (it may not have seeds)"

Lima beans are the largest seed for small fingers to handle – try to choose seeds that grade 3 fingers can handle.

- Look at some different seeds (corn, apple, bean, pea etc) look for the following



Look for the Micropyle as well – the small hole that seeds have that allow water to enter the seed.

Discuss the parts

- Seed coat – sturdy wall to protect the seed. Some seed walls need special circumstances to breakdown (milkweed seeds need cold temperatures for 3-4 months) with an intact seed wall – some seeds can remain viable for many years (corn grown from 25 year old seeds)
- It is designed to absorb water and split when it has absorbed enough. Some seed coats need to be scrubbed by weather conditions to soften them.

- The testa is a failsafe trigger – it stops a seed from germinating in the wrong conditions (too dry, too wet, too hot…)
- Endosperm – the first meal – stored carbohydrates that the embryo will use to boost it's first days of growth. If an embryo uses up all the endosperm before it reaches the surface of the soil – it may wither.
- Small seeds in top of soil, larger seeds just below…the process will take of itself.

- Seeds will germinate in the right conditions – usually warmth and water are all a seed needs to germinate.
  - Some seeds need special treatment beyond moisture and warm temperatures for germination to begin.

Discuss

- Two common treatments needed include exposure to cold temperatures (also called stratification) and exposure to conditions that cause chemical or mechanical damage to the seed coat (also known as scarification).
- These special treatments evolved as survival mechanisms.
- (For example, many seeds of northern plants need a certain amount of exposure to cold temperatures before they germinate. If a seed dropped to the ground in the fall, would it be a good idea for it to begin growing and be a young seedling right before winter arrived? Of course not, which is why this built-in need for a period of cold before sprouting is so important. Other seeds germinate better in dark conditions (example is a pansy seed) and others need light exposure to germinate (example is a lettuce seed).)
- If you purchase seeds, you will most likely find planting instructions on the seed packet. If you collect seeds from nature, you may need to research their germination requirements online.
- Even under the right conditions some seeds may not germinate – this is a valuable idea to track as the lesson continues.

Sorting

Put up a class chart with the headings: size, shape, color and texture (and any other properties such as smell, that might have been suggested). Ask the class under which category each of their descriptive words belong. For example:

Size	Shape	Color	Texture
huge	oval	brownish	rough
tiny	round	tan	fuzzy
big	bumpy	spotted	smooth
	long	red	bumpy

Implementation continued

1. Give each (pair of?) student two lima bean seeds, ½ cup of "old" water, and a hand lens (the digital microspore can be set up at a station). Have student examine the seed, sketch the seed and note any outer parts. Students can also measure the dry weight of the seed at this point and record this.
2. Have students place their seeds in water for twenty-four hours and examine them regularly. Be sure to start some extra seeds in case some do not germinate. Ask: What do you predict will happen to the seeds while they are soaking?
3. After twenty-four hours, ask: How did your seeds change while they soaked in water? Did this match your prediction? What do you think was happening inside the seed? This would be an opportunity to measure the new mass of the seed to record how much water has been absorbed.
4. Have students help one another carefully peel the outer coat from one of the seeds. Then guide them or help them to pull the coatless seed in half with a fingernail.
5. On the same drawing students made in step 1 above, ask students to draw a picture of the inside of one of the split seeds. Ask: How does what you see inside the seed compare to your original prediction? Does any part of the inside of the seed look like a familiar plant part? Which? Do you think the seed is alive? Why or why not?
6. Have students place their seeds (both the whole bean seed and the seed that was split in half) in a plastic bag with a moist paper towel (or cotton) for a week. Ask: What do you predict will happen to the seeds during the week?
7. Continue observing the seeds daily for a week. Students should record changes by making new drawings next to their originals. Consider having students make a growth chart to record changes during germination, by folding a long strip of paper like an accordion and clipping it with a paper clip. Draw on one section at a time as the seed grows. When complete, unfold to view the sequence.
8. At the end of the week, discuss findings. Ask: How did different parts of the seeds change during the week? What happened first? Next? Did everyone's seeds change at the same speed? In the same order?

Growing Idea: you could germinate one bean seed every day for seven day, you'll end up with all the stages of germination at one glance!

Follow up-Conclusions.

- Which different parts of the seed turned into what you predicted? Did any surprise you? Which?
- Do you think seeds are living or non-living? What did you observe to make you believe that?
- After exploring seeds inside and out, why do you think seed coats are so hard?
- What new questions do you have about your seeds?

Extensions

1. Collect old and new seed packets. What do you think the date on the package is for? Before the seeds are packaged, are they tested and meet the required germination standards. You may have seed left from a previous garden season, or many times stores, or local gardeners are willing to donate old seed packets for teaching programs. If they were stored properly (in a dry, cool spot, out of sunlight) most seeds will still be viable after a couple of years. To make a good comparison in your experiment, try to include some of the oldest seeds you can find, along with some newer ones.
2. Plant seeds from different types of plants and compare their germination rates.
3. If you have both old and new seed packets of the same variety and kind of plant, you can plant seeds from both and compare the germination rates. Some kinds of seeds, such as parsley, onions, sweet corn, spinach, and peppers, tend not to stay viable for more than a year or two. Including both older and fresh seeds of kinds that do not store well can help demonstrate strong results in your experiments.
4. Did some seeds have higher germination rates than others? Did age of the seed seem to matter?
5. Were there any characteristics of the seeds that seemed to influence the germination rate (like size or thickness of the seed coat)?
6. What kind of uncontrolled variables may have influenced our results? To get the brainstorming started ask: Were the seeds previously all stored in the same place? Were their any environmental factors that could have affected them before we planted them?
7. Do you think the conditions we provided may have factored into the results? What could we do to test some of these variables we have identified?
8. Follow up this test by planting the same seeds in the same way but give them different conditions. Try placing them in a dark or light place or place them in locations with different temperatures. If you are planting in soil, you can try planting the seeds at different depths. If you planted in plastic bags, you could try planting them in soil instead. Additionally, you could try treating them differently before planting. Soak the seeds in water or expose them to different conditions, such as placing them in a freezer for a certain amount of time or heating them in an oven.

Section 3 - Investigation of Seeds

Learning Goals/Objectives

- Apply knowledge of growing a plant from a seed
- Understand what a seedling is and the conditions needed to keep it healthy and strong
- Explore the concept of sub-irrigation and it's practical application when growing seedlings

Materials needed

- ❑ Small plastic (or cornstarch based) cups
- ❑ Potting soil (or prepared soil with the 3 main ingredients)
- ❑ Water (preferably older water (let it sit for a day or two to allow chemicals to evaporate) or collect rainwater in clean containers from a trusted source)
- ❑ Thumbtacks (if using the corn starch cups – you will need to heat a needle to puncture the brittle material – this is best done by an adult or a volunteer)
    - Tealight candle(s) if heating the needle
- ❑ A tall-sided bin or a solid metal pan (2-5 cm tall walls to allow for watering) Do not use an aluminum sheet – this is NOT strong enough to allow transport
- ❑ OPTIONAL - Spoons or small scoops – soil is a healthy organic component of gardening and studies show it has healing properties and may even contribute to positive mood behaviours
- ❑ If working inside – plastic (or washable – cloth) table coverings (large cardboard sheets can be obtained from Costco – these are 4 x 4 sheets that can be stored and reused through the unit. They dry quickly and absorb water. They can be broken down and used for sheet mulching later or recycled.
- ❑ Popsicle stick or tape for labelling seeds
- ❑ Waterproof (or permanent) marker (or label maker if available)
- ❑ Chart paper (1" graph paper) for charting germination dates and growth heights or (attached tracking sheet)

Implementation

- Define and explain what a seed is
- Explain where we find seed in fruits vs. vegetables
- Define germination and what is required for germination to occur
- Explain the importance of consistent watering once a seed has germinated and begins to grow
- List the factors necessary for good seedling development
    - Regular and consistent watering
    - At least 4 hours of sunlight per day.
        - *You will be able to tell if your seedlings are not getting enough sunlight as they will become "leggy". Meaning they will be very long and slender because they're reaching for more sunlight.
- Draw on the board how sub-irrigation works and be sure to tell students to poke holes AT THE BASE of the cup and NOT on the bottom
- Demo how to poke holes around the base of the cup (approx. 25 holes)
    - demo how to fill cups with soil. Filling them to the top and then pressing soil down with two fingers gently but firmly to remove air.
- Pour water into cups for purpose of saturating soil as well as pushing out any air bubbles that are in the soil
- Explain how deep a seed needs to go below the soil *you want the seed planted as deep as 2x its own size. **For flat seeds such as cucumber that will be laid down, 1X its own length is enough. Example: if your seed is 1 cm, that means your seed will be planted 2cm deep
- Water one or more times until you see water start to percolate out the bottom of the cup
- Draw on the board how high you want to fill the bins with Kids' Growing City – Spring Curriculum – 10-week Program water for purpose of sub-irrigation. Basically, you want the water to be slightly above the holes on the cup. Enough for the water to be drawn up through the holes and into the soil but not too much that make the water level in the soil to be too high and therefore overwater. (10 Minutes) Hand-on-Activities (time allotted): • Cover tables/work areas/desks with tablecloths
- Hand out one cup and one thumbtack to each student
    - if you are using cornstarch based cups, you will need a heated pin (adults only) A station could be set up with a volunteer for this. (A tealight candle will provide enough heat to warm a needle held in a pliers or clamp to make the pin holes)
- Instruct students to poke approx. 25 holes as base of cup ** go around and double check to ensure students are poking holes in correct location
- Hand out bins of potting soil and get students to fill cups with soil. Once filled, get students to place cups in empty bins provided
- Pass out cups (or jars, watering cans etc.) of water and instruct students to pour water onto the soil until they see water start to drip out the holes at base of cup. At this point you want soil to be approximately half an inch from top of cup, so water does not overflow out of the cups.
    - For bigger seeds, such as tomatoes or cucumbers, have students poke a little hole with their fingers and plant seed(s) away from edge of cup. If you are "sprinkling" smaller seeds, such as arugula or basil, simply cover the soil surface with a thin layer of seeds and then cover with a very thin layer of soil.
    - Water once more especially if you added dry soil on top.
- Add enough water to the bins (or pan) to completely cover holes (you could mark a water line – track this over several days to note water absorption and evaporation
- Label each bin with the name of the seed and date it was planted. Add a stick to each cup with the date and name of the students. Now would be a good time to assign a water schedule. Put up the tracking chart. Fill in the estimated date of sprouting. Watering group can be responsible for the tracking and recording.
- Place in a location that gets at least 4 hours of direct sunlight indoors, preferably in your own classroom. (30 minutes)
- Discussion Questions:
    - What is a seed? - A baby plant that is sleeping in a shell
    - How do we "wake-up" or germinate a seed? - Water it enough that the shell swells and cracks - Then water gets in and splashes and wakes up the baby plant
- Once a seed begins to germinate, where does it get its food?
    - Mommy/Daddy plants have packed food for the baby inside the shell
- Where do we find the seeds in a fruit? A vegetable?
    - For example, if you were to cut a carrot in half, where do find the seed?
    - How about an apple? - Fruits contain the seed on or inside them. Vegetables grow seeds on the flower later in the season.
- Once a seed starts germinating, what is the most important thing to remember? - WATER!
- If a seed dries out after it has been germinated, will it still grow? - Nope! It dies. What happens if you poke holes on the bottom of the cups? Will the water be able to get in the cups and water the seedling?

Sub-irrigation lesson

- Draw on the board how sub-irrigation works and be sure to tell students to poke holes AT THE BASE of the cup and NOT on the bottom
- Demo how to poke holes around the base of the cup (approx. 25 holes)
- Next demo how to fill cups with soil. Filling them to the top and then pressing soil down with two fingers gently but firmly to remove air.
- Next demo how to slowly! pour water into cups for purpose of saturating soil as well as pushing out any air bubbles that are in the soil
- Explain how deep a seed needs to go below the soil - *you want the seed planted as deep as 2x its own size. **For flat seeds such as cucumber that will be laid down, 1X its own length is enough.
    - Example: if your seed is 1 cm, that means your seed will be planted 2cm deep
- Water one or more times until you see water start to percolate out the bottom of the cup