SCIENCE
BIOLOGY
Unit Study #2

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Science: Nature Studies and Biology

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Welcome to the Invictus Classical Press (ICP) Biology Science Guide!

We at ICP believe that there is truth, goodness, and beauty to be found in the Classical method and Charlotte Mason pedagogy. This curriculum seeks to bring what people love best of each, together into one comprehensive resource.

A Classical Charlotte Mason education is motivated by God's glory and utilizes beautiful and true material within the Trivium-based method. Its goal is the formation and equipping of the whole person made in God's image, who can learn, reason, and persuade people to the enduring truths of God and act virtuously toward their neighbor.

BIOLOGY: PART 2

PLANTS

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PLANTS

LESSON 1

BEAN DISSECTION AND EXPERIMENT

(CORRELATES WITH ICP ANCIENTS MW: WEEKS 3,19-21, 28, 29)

They eat beans mostly, this old yellow pair.
~ From *The Bean Eaters,* by Gwendolyn Brooks

ACTIVITY 1: BEAN DISSECTION

ACTIVITY 2: THE EFFECT OF LIGHT COLOR ON BEAN PLANT GROWTH

DESCRIPTION:

In **Activity 1** of this lesson, students will observe,dissect, and sketch the inside and outside of a bean seed.

In **Activity 2** of this lesson, students will learn, or review, the Scientific Method, before beginning a six-week long experiment that will examine the effect of light color on bean plant growth. The teacher and students will do the set up for the experiment in class and then the students will be sent home with the supplies to replicate it at home. They will record their observations in a Bean Growth Chart, and sketch, or take pictures of the week's progress.

VOCABULARY:

Observe	**Dissect**	**Hilum**	**Radicle**	**Raphe**
Micropyle	**Strophiole**	**Testa**	**Embryo**	**Cotyledon**
Monocot	**Dicot**	**Scientific Method**		

ACTIVITY 1: BEAN DISSECTION

MATERIALS:

- Large bean seeds for dissection and observation (Kidney, Lima, or Pinta beans work well)
- Notebook and pencil
- Diagram of a Bean Seed (included)
- Paper plates
- Sharp knife

DIRECTIONS

PREPARE:

The day before you do this activity, soak enough large bean seeds in a cup of water for each student to have at least two. You need at least two because sometimes the seeds don't break open neatly and need to be discarded.

INSTRUCT:

1. When the students are ready, explain to them that today they will be doing two activities involving bean seeds. In this activity they will be observing, dissecting, and then sketching a bean seed in their notebook or on a separate sheet of paper. This observation activity will allow them to understand where a seed gets the food it needs to grow.

2. Have each student open to the first page of their notebook and title it: Bean Seed Dissection

Hand out a dry bean seed to each student. Let them observe it for a minute and then ask them questions:

- What kind of bean seed is this?
- What color/texture/size/shape/smell (etc.) is the seed?
- Is the bean hard or soft?
- What else can you see?

They should be able to see a small oval dot on the inside curve of the bean, tell them it is called the **HILUM** (Hai-lum), or the **EYE**. **Hilum** means "little thing, or trifle" in Latin. It is a scar left on the seed coat from where it was attached to the funiculus, or ovary wall. They may also be able to see the **RADICLE**, the **MICRO-PYLE**, the **STROPHIOLE**, and the **RAPHE.**

3. When they are done, have them carefully sketch the dry bean. If they are using the notebook, have them skip down a few lines and then write DRY (kind of bean) BEAN on the margin. Older students should label all the parts mentioned above, as well as the **SEED COAT.** Younger students can label just the **TESTA (SEED COAT)** and **HILUM** if desired.

4. Hand out two soaked bean seeds to each student. Direct them to slip off the **TESTA** and set it aside. It should come off very easily. Ask them what it looks like now that it is off the seed. Can they compare it with anything?

5. Tell the students to put their thumb nails on the seam of the bean and gently pull it apart. It should pop open without much effort. You can also use the sharp knife to help open it.

6. Let them observe the inside of the seed for a few moments and then ask them to describe what they see.

7. Explain to them that the inside milky "flesh" of the seed is called the **COTYLEDON.** The **COTYLEDON** is the seed's first food. The **EMBRYO**, which is the small comma-like thing at the top of the **COTYLEDON** "eats" the **COTYLEDON** and uses the energy from it to grow. Until the first leaves appear and photosynthesis begins, the only food the **EMBRYO** gets is from the **COTYLEDON.** Bean seeds have two **COTYLEDONS** (each half of the seed is considered one), therefore they are classified as **DICOTS**. Seeds that have only one **COTYLEDON** are classified as **MONOCOTS**. Corn is an example of a **MONOCOT.** (For a chart outlining Kingdom Plantae, refer to page 31 in the Invictus Classical Press Biology: Part 1 Guide.)

8. After the discussion, have the students sketch and label the two **COTYLEDONS**, the **EMBRYO,** and the **TESTA.** Close the notebooks and set aside.

ACTIVITY 2: THE EFFECT OF LIGHT COLOR ON BEAN PLANT GROWTH

MATERIALS:

- One copy of The Scientific Method (included)
- Notebooks
- Five disposable cups for each student
  (Solo, or clear cups work well – not paper!)
- Ten bean seeds for each student
  (Two for each cup)
- Potting soil
- Spoons
- Awl
- One hole punch
- Two each, red, yellow, blue, and green sheet protectors or cellophane
- Elastic bands, string, or tape

***** The teacher can decide whether to use a separate notebook for other observations, or simply use the worksheets provided for each exercise. Younger students may benefit from the worksheets, but older students who are more capable should use a notebook.

INSTRUCT:

Activity 2 begins with a short lesson on the Scientific Method. The Scientific Method is an organized process for experimentation that enables scientists to ask a question, offer a hypothesis, collect data, and propose an answer to the original question. Using the Invictus Classical Press chart, tell the students about the seven* steps to the Scientific Method:

1. Ask a Question
2. Conduct Background Research
3. Offer a Hypothesis
4. Design and Do an Experiment (Materials and Procedure)
5. Analyze the Data
6. Form a Conclusion
7. Report the Results

*There are different “methods” that scientists propose that range from five steps to eight. If your community is already familiar with a comparable method, go with that. If the experiment is organized step-by-step, and reproducible, it doesn’t really matter.

EXPERIMENT:

1. When you have finished talking about the Scientific Method, it's time to plant some beans! In this activity, they will plant some bean seeds and surround them with different colored cellophane to determine which light helps a plant grow best. The question the students are going to ask is: **What Color of Light do Bean Plants Grow Best in?** The teacher will demonstrate the procedure and then send the supplies home with the students so they can do it at home.

2. Set out five disposable cups on the table and poke some drainage holes in the bottom. Each cup should have the same number of holes. Clear cups have the added advantage of being able to see the roots growing if the seeds are planted close to the sides.

3. Fill each cup almost full with potting soil. Each cup should have the same amount.

4. Moisten the soil in each cup with the same amount of water (3 – 4 tbsp should do). The amount of soil and water you use will depend on the size of the cups. Use your discretion.

5. Have the students help plant two seeds in each cup. Seeds should be planted about ½ of an inch down and then soil brushed over the hole. Try to keep all the seeds planted at the same depth.

6. Set the cups aside and clean up any soil.

7. Take the colored sheet protectors or cellophane out and carefully wrap them around each cup. Secure them in place with an elastic band, string, or tape. Remember to also put a clear sheet around one of the cups - that one is the control.

8. Place the cups by a window that receives a lot of light and watch the bean plants grow!

9. Send the students home with cups, seeds, soil, and sheet protectors.

AT HOME:

1. Repeat the above steps with your child. At approximately the same time every two or three days (you decide which), the seeds should be checked and measured for growth. You should be able to see some green after about a week. Measure from the top of the soil to the top of the plant and then record the growth in your notebook. Make sure to write the date for each entry. Try not to touch the plant at all! If both bean seeds have sprouted, wait until they both have two leaves and then snip the weakest plant off at the soil. Make some sketches in your notebook of the progress over the weeks.

2. Do not allow the soil to dry out, but do not overwater either! Make sure that each cup gets the same amount of water. Record how much water you give in your notebook.

3. If desired, take some pictures to include in your notebook.

The layout for this experiment has been included in this lesson as a reference for you. It is a model to follow, especially for the older students. Notice the imperative sentences in the procedure. This makes the experiment easily reproducible, which is crucial in science.

SUBJECT INTEGRATION:

Bible: Read the Parable of the Sower in Matthew 13:1-23 together and then have the students narrate back what it was about.

Art Appreciation: Print out a copy of *The Sower,* by Jean Francois Millet and do a picture study of it following the same method described in the Invictus Classical Press Fine Art Guide.

Language Arts:

- Print out and read the poem, *The Bean Eaters,* by Gwendolyn Brooks. Memorize it with the student(s).
- Read *Jack and the Beanstalk* together and have them narrate it back to you. After narration, go on a "Parts of Speech Hunt" through the text.
- Make up a funny, simple sentence with bean(s) as the subject and then diagram it together.

SAMPLE EXPERIMENT LAYOUT

THE AFFECT OF LIGHT COLOR ON BEAN SEED GROWTH

QUESTION: What color of light do bean plants grow best in?

BACKGROUND RESEARCH: When plants are exposed to different colors of light, a relationship between growth and color can be observed. Photosynthesis, which is the food-making process in the leaves of green plants, is powered by light, whether artificial or natural. Different colors of light vary in their energy levels. The highest energy light is purple/violet and is at one end of the color scale. It has the shortest wavelengths. The lowest energy light is red, at the other end of the color scale. It has the longest wavelengths. Plant growth is heavily dependent on receiving the correct wavelength of light.

HYPOTHESIS:

I think that the bean plants surrounded by the _____ cellophane will grow the best.

EXPERIMENT:

MATERIALS

- Five disposable cups (Solo, Styrofoam, or clear cups work well – not paper!)
- Ten bean seeds (Two for each cup)
- Potting soil
- Measuring cups and spoons
- Awl (or something to poke holes in the bottom of the cups)
- Colored sheet protectors
- Rubber bands

PROCEDURE:

1. Gather five disposable cups of the same size and poke some drainage holes in the bottom. Each cup should have the same number of holes.

2. Measure out enough potting soil to fill ¾ of each cup. Each cup should have the same amount of soil.

3. Moisten the soil in each cup with the same amount of water (3 – 4 tbsp should do). The amount of soil and water you use will depend on the size of the cups. Use your discretion.

4. Plant two bean seeds in each cup. Seeds should be planted about ½ of an inch down and then soil brushed over the hole. Try to keep all the seeds planted at the same depth.

5. Set the cups aside and clean up any soil.

6. Take the colored sheet protectors or cellophane out and carefully wrap them around each cup. Secure them in place with an elastic band, string, or tape. Remember to also put a clear sheet around one of the cups - that one is the control.

7. Place the cups by a window that receives a lot of light and watch the bean plants grow!

8. Create a Bean Growth Chart and write down the date in the first block and the amount of water you added to each cup.

9. At approximately the same time every two or three days (you decide which), the sheet protectors should be lifted, the seeds watered, and any growth measured. You should be able to see some sprouts after 7-14 days. Measure from the top of the soil to the top of the plant and then record the growth on the chart. Make sure to write the date for each entry, the amount of water you poured in each cup (it should be the same for each one), and then replace the sheet protectors. When the plants grow too big for the protectors, simply take them off and tape them to the window in front of each plant. This changes the conditions of the experiment a little but shouldn't make too much difference overall. Try not to touch the plant unless needed. If both bean seeds have sprouted, wait until they both have two leaves and then snip the weakest plant off at the soil. Make some sketches in your notebook of the progress over the weeks.

10. Don't forget to talk about what is happening beneath the soil! The bean seed embryo is consuming the cotyledons for energy to grow!

11. If desired, take some pictures to include in your notebook.

DATA: Bean growth chart

CONCLUSION:

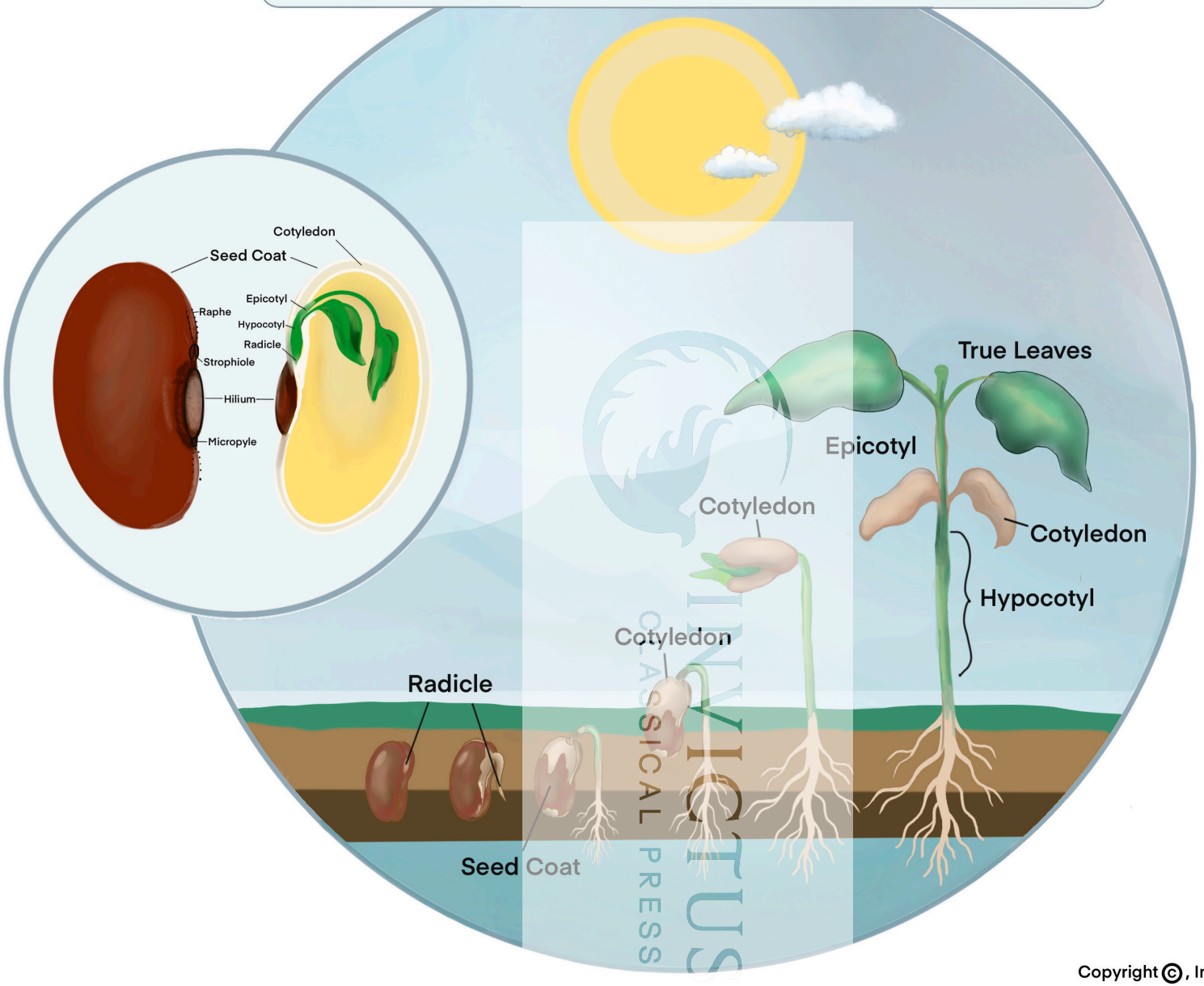
The bean plant under/behind the _____ sheet protector grew the best. My hypothesis was _____.

REPORT:

The bean plant under/behind the _____ sheet protector grew best because…

This has ramifications in the gardening industry because… Gardeners should therefore…

Diagram of a Bean Seed



THE SCIENTIFIC METHOD

ASK a question.

CONDUCT Background Research.

OFFER a Hypothesis.

DESIGN AND DO an Experiment.

ANALYSE the Data.

FORM a Conclusion.

REPORT the Results.

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