

Biodiversity Inquiry Lesson Plan
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I. Title: Seed Germination

II. Lesson Summary: Students will design an experiment to test the effect of variables determined by the students on the germination of seeds.

III. General Goal: I want students to examine the basic conditions necessary for the germination of a Blue Lake bean seed. There will also be process goals that will be achieved along the way since the students will be required to submit a full lab report by the end of the experiment describing what they found through their experimentation.

IV. Duration:

This experiment will occur over a three week period of time, but the seeds we will use have an expected germination of 5-7 days. The experiment will be assigned one week prior to the actual beginning of the experiment so that the students have time to determine what they want to test and WHY they want to test that variable in regard to germination of a typical seed.

In class time for the experiment will occur as follows:

1 – 50 minute class for students to plant seeds and implement the variables

13 – 15 minute periods at the beginning of class for watering, application of continued variables, measurement of seedlings, etc.

1 – 50 minute class for finalizing of results and clean-up.

V. Objectives:

1. Students will set up environments similar to what seeds may face in the “real world” for examination over a three week period of time (*ie. drought, excess rain, no nitrogen, contaminated water supply, etc*) to determine their effects on germination. This will be determined by the students, but approved by me before the implementation of the lab. I will direct the inquiry in this regard.
2. Students will write a complete lab report stating their question, hypothesis, control, variables, procedures, data table, graphs, conclusion and evaluation.
3. Students will share their information with the members of their class during a 5-8 minute presentation on the day that the lab report is due.

The following objective is written verbatim from the International Baccalaureate (IB) Syllabus Details. These are the objectives that will appear on their culminating test for the IB class.

4. Explain the conditions needed for the germination of a typical seed. (*Seeds vary in their light requirements and therefore this factor need not be included*)

5. Water is needed for germination

6. Germination can be affected by a number of different variables.

VI. Prerequisite Knowledge.

Students will begin this activity prior to any class discussions of germination and the needs of seeds. The only prerequisite knowledge or background that the students will have will be what they bring to class from their own gardening experience at their homes. I am making the assumption that the students have planted a seed in the past, either at their home or in their former science classes....elementary level, etc.

VII. Background Information

After further thought and discussion with Jim, I have decided that the information that follows is not background, but will be given after the inquiry is completed. The only background information the students will have will involve the knowledge they bring with them to class. This will be different for different students because some have had a garden, some have grown things from seeds in former science classes, etc. The students will receive these notes AFTER the inquiry is complete.

The following is an excerpt from the notes I will be giving in class prior to the implementation of the experiment. These have been taken directly from notes I will present in class. There are other notes that will be presented in a larger topic called Plant Science, but this is the section on germination that I feel will directly pertain to this experiment.

III. Germination

A. Coloring diagram

1. seed coat (testa)
2. cotyledon
3. micropyle
4. embryo shoot
5. embryo root

B. Dormancy

1. 5000 years old?
2. right conditions? germination!!!
3. aid in survival and conservation of plant species

C. Metabolic Pathway

Seed soaked in water → gibberellin activated → activation of amylase → breakdown of starch → maltose produced → activation of maltase → glucose produced → glucose used in respiration → Energy!

1. water enters the seed through the micropyle
2. water moves into the cell by osmosis
3. seed swells, seed coat bursts
4. water activates gibberellin
5. gibberellin activates amylase
 - a. hydrolyzes starch to maltose
 - b. maltose is hydrolyzed by maltase to glucose
6. glucose is transported to the embryo
7. embryo absorbs glucose and uses it for respiration (oxygen included)
8. embryo undergoes cell division and growth
9. embryo root grows down; embryo shoot grows up
10. nutrients needed are in the cotyledon
11. nutrients exhausted? leaves appear and photosynthesis begins(hopefully.....)
12. seedling absorbs water and minerals from soil; carbon dioxide from atmosphere and sunlight

C. Factors needed for germination

1. Water
 - a. activates hormones and enzymes
 - b. seed swelling and bursting of seed coat
 - c. hydrolysis of storage compounds into monomers
starch----->glucose
 - d. transport of simple materials
 - e. many metabolic reactions
2. Oxygen
 - a. needed for aerobic respiration
 - b. no respiration? no energy!!
 - c. no energy? no metabolic activities
 - d. no metabolic activities? no germination
3. Suitable temperature
 - a. enzyme activity requires optimum temperature

VIII. Preparation for Lesson

Materials required: (provided by teacher)

plastic starter pots

potting soil

seeds

greenhouse(there is one attached to my classroom, believe it or not)

water

Materials requested/provided by students

The students are in charge of the materials that they need aside from what is listed above. This year, the students tested different kinds of water: tap water, distilled water, and stream water; different kinds of light: blue light, sunlight, black light; amount of light: constant, 12 hours of light, 12 hours with out, no light; etc. There were some students who deprived their seeds of oxygen and some who watered their seeds with carbonated water. Some checked to see what effect a strobe light or music had on germination. The results have been interesting. The students began this activity on Wednesday, September 12, 2001 and will conclude their data gathering on Wednesday, October 2, 2001. The lab reports are due on Monday, October 8, 2001.

Experimental design will be decided/implemented by the students during class time. Some students may want to test other things that weren't tested in the past, they may want to test temperature differences, so light bulbs may be needed, they may want to test carbon dioxide concentration, so a CO₂ tank and a method of it's distribution to the plants might need to be designed, and hopefully, there will be other things that the students will think of to test and and we'll have to come up with something I haven't even thought of yet!!!

Maintenance of Organisms

1. Plant seeds according to student specifications during day one
2. Students will be given 15 minutes a day during class for three weeks to water/care for seeds, record growth, and other observations
3. Students will make final observations and replant seeds for routine care in the greenhouse until harvest time.

IX. Instructional Strategy

Engagement

Students will choose the variables for their seed environments themselves for implementation and experimentation

Exploration

The students will design the experiment and explore the effects that their variable will have on the germination of the seed. The students will be involved with the actual design, implementation, recording of results of the experiment on a daily basis for a three week period of time. The students will decide how many seeds pots they will use, how many seeds they will put in each pot, the range of pH(for example) that they want to test, etc.

Discussion/Explanation

Students will give a 5-8 minute presentation of their findings to the class. (It has to be no more than 8 minutes or it will last longer than one bell)

Students will record their data for the three week period of time to observe the germination of their seeds. The students will also be required to graph their data as part of their written lab report.

Students will write a formal lab report according to IB specifications and it will be assessed according to the rubric in the following section.

The students should conclude that in order to have a seed germinate, they need to water the seed. The student should also conclude that it doesn't matter what form the water comes in (ie. coke, diet coke, coffee, with lots of nitrogen, little nitrogen, etc) if there's water, it will germinate. This is at least true for the Blue Lake Bush Beans. There are other seeds that require movement through a digestive tract, or burning, etc and that will be discussed later in the unit. The students may also realize that germination and GROWTH are two separate events and that if the seed germinates under certain conditions, it may not GROW under those conditions

X. Assessment

I will be using the lab report rubric as assigned by the International Baccalaureate Organization to assess their formal lab reports. This will assess process. The rubric will be included as an appendix at the end of this lesson plan.

I will also be assessing their presentations to the class to listen for the conclusions I mentioned in the above section. This will take the place of the infamous 3x5 card. This will assess the content they have learned. Students will be responsible for the content learned by the other students. I intend to ask a test question on the unit test regarding germination. The question will be phrased as such: "What are the factors discussed in class that will affect germination?" Students will be expected to answer using data that was presented in class by groups other than their own.

XI. Comments

I have conducted this activity with my IB students on ONE occasion. I felt the activity was successful overall because my students were able to collect data and present it to me according to the IB rubric for lab reports. However, I think that the main problems involved with this activity involve how much the students think about WHY they want to test their question. For example, if they want to test the effects of caffeine on plants, they need to examine why this would be important to find out. If they want to test amount of water plants receive, they need to think about why plants might exist in environments with lots of water, little water, etc. There are some real variables that do occur in the "real world" that can be tested and that is where the students need to focus their energy. The students have most likely made observations regarding germination of seeds, (ie. baby trees growing in their gutters, weeds in the garden, dead areas of ground along the side of the road, etc.) If they haven't made these observations, there will be time prior to the implementation of the inquiry activity to try to make some observations and then that that drive their experimentation.