Seedling Unit

Title: Seedlings
Grade Level: High School
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Science Concepts to be Learned

Main concepts to be invented:

- Living organisms' populations are dependent on environments and resources, which has intense effects on the interactions between organisms.
- Humans modify the ecosystems in which they are a part of through increasing population growth, technological advances, consumption rates, and destruction of habitat.
- Direct harvesting, pollution, fertilizers, pesticides, clear cutting, erosion, and atmospheric changes, and other factors caused by humans affect seedlings success in an ecosystem.
- Growth factors of seedlings depend on pH, light, water, temp, etc...
- During seedling growth, its cells go through the process of division and differentiation.

Learning Objectives

Science Objectives:

- Students will design their experiments on how various environmental conditions affect growth of the seedling.
- Students will relate their experimental findings to how human practices affect environmental conditions for plants, and the potential effects these have on growth.
- Students will identify various parts of a seedling.
- Students will be able to describe the importance of seedling and seedling diversity in forest ecology.

Indicators:
From the State of Ohio Life Science Standards for Grade 10:
4. Summarize the general processes of cell division and differentiation, and explain why specialized cells are useful to organisms and explain that complex multicellular organisms are formed as highly organized arrangements of differentiated cells.

18. Describe ways that human activities can deliberately or inadvertently alter the equilibrium in ecosystems. Explain how changes in technology/biotechnology can cause significant changes, either positive or negative, in environmental quality and carrying capacity.

From the State of Ohio Life Science Standards for Grade 11:
5. Investigate the impact on the structure and stability of ecosystems due to changes in their biotic and abiotic components as a result of human activity.

Technology Objectives:
1. Basic operations and concepts
2. Social, ethical, and human issues
3. Technology productivity tools
4. Technology communications tools
5. Technology research tools
6. Technology problem-solving and decision-making tools

Materials

Computer Functions:
Research tool for Internet search about seedlings and forest ecology
Recording tool for collection of data
Writing tool for scientific report
Analyzing tool for data
Presentation tool for final report of their findings

Software Needed:
Internet access (Netscape/Explorer)
Word Processing Software (Word)
Spreadsheet (Excel)
Power Point

Science Materials Needed:
For exploration activity (for each group of four students):
- Palm Pilot, interface, and appropriate probes (pH, temperature, light)
- Ruler
- Magnifying lens
- Seedling identification book

For explanation activity (every student):
- Germinated bean seeds
- Dissecting kit
- Magnifying glass or stereoscope
- Coloring diagram template

For expansion activity (for the entire class):
Required Materials (teacher provided)
- Starter pots
- Potting soil
- Bean seeds
- Greenhouse or windowsill
- Water
- Paper towels

Other Materials (students requested or provided)
The students' experiments will vary according to their variables and instruments used. Some materials they may need could include the following:

- Water (tap, distilled, stream, rain, soda)
- Light (different wavelengths, strobe, amount, timers)
- Sound (music)
- Fertilizers
- Soil
- Acids (vinegar)
- Bases (milk)
- Probes (light, pH, conductivity, dissolved O_2, and temperature)

Classroom Management/Teaching Strategies

How will you organize the students?
For the exploration activity students will be in groups of four students.
For the explanation activity students will be in pairs of two students.
For the expansion activity students will be in pairs of two students.

How will you use the computers available with your students?
The students will use Power Point to compose presentations. They will also use computers to record and analyze data.

What are the safety issues you should address as the students participate in each of the unit activities?
For the exploration phase
The students will be leaving school to go to a field study area at a local forest, i.e. Wayne National Forest. It is important to obtain permission from the parents and your school. A preview of the field will ensure that the area of interest will be free of hazards. On the day of the trip be sure to have enough adult chaperones to supervise students. A field first aid kit will be thoroughly checked for all items and brought along.

For the explanation phase
The students will be using razor blades and should be reminded to use common sense when using them. Any cuts made should be away from body. Teacher should count all blades before distributing to students and collect and count them after they are no longer needed.

For the expansion phase
Since students will be designing their own experiments, it is crucial to review their experiments before hand and help the students make any revisions that are necessary for a safe experiment. Some safety considerations may be the safe use of electricity, chemicals, and protective wear.

Activities to Support Concept Development

Exploration Phase (Student Activities):

Which process skills will be used? Observing, communicating, recording data, predicting, drawing conclusions.

What will the students do? *Seedling Diversity Search (Time of Year is Important)*

1. Decide on the area of forest and mark it off so students have limits to their search. Remind the students of any safety precautions.
2. Before the trip, have the students do an Internet search on local flora found in the forest and a search on any issues surrounding the forest that has to do with human impact on the forest ecology.
3. Before leaving, ask the students what they have found in their search. Some questions could be:
    a. What types of plants do you expect to see?
    b. Will you see seedlings?
    c. What do you think seedlings look like?
    d. How many different types of seedlings will you see?
    e. Are there any big issues about human impact on the environment that relates to forest ecology?
4. Ask the students what they think affects the growth of plants. Tell them to make observations in the real world with the various probes (temperature, pH, light) in different areas of the forest. Record this data. The students should describe/draw the seedlings and describe the surrounding area where the measurements of the seedlings were made. Some descriptions could include overhead canopy, streams, type of soil, etc… Remind them to record observations in the Palm Pilot.
5. Have each member of the group switch duties. Each student should get to make observations in at least one area using the probes, ruler, magnifying glass, and seedling identification book.
6. When everyone has completed the activity bring them back together and discuss any of their observations that they found as interesting. Ask them if it was hard to find seedlings or if it was hard to find different kinds of seedlings.
7. Before the activity is over ask the students to think about what could be some possible impact on the growth of seedlings from what observations they have made and the internet search that they have done.

Explanation Phase

Background Information

The students will receive notes on the anatomy and function of seeds germinating.
Below is an example of what the students will receive. A brief introduction will be given on the anatomy and functions of the seed, before the experiment begins. The students, throughout the

experiment involving the dissection of a bean seed, will fill in explanations and add to their notes. This experiment will involve group dissections. The students will look at each part of the seed using the notes, textbook and assistance from the teacher to identify structures of the seed. They will then discuss and research what functions the seed parts have using the notes and the Internet. They will color a diagram in order to conceptualize the different parts of the seed's anatomy. After the lab, slides on cell division and differentiation will be shown. The Lab will be explained to the students orally. Below are the preparations and notes for the lab:

Preparation for Lesson

Notes

A. **Coloring diagram**
1. Seed coat
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 → gibberellins 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 gibberellins
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.
12. Seedling absorbs water and minerals from soil; carbon dioxide from atmosphere and sunlight

D. **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
    i. 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

After the lab is completed, the teacher will review the parts of the seeds and clear up any questions the students might have and possibly propose new questions for the students to consider about the seeds. The teacher will also go over the notes and make any additions necessary along with showing extra slides to illustrate the anatomy of the germinated seed. The teacher will then discuss environmental factors affecting the germination of seeds with the students. The students will generate ideas about this from what they have learned. A few additional notes will then be added about environmental factors affecting seed germination such as moisture levels, sunlight, and nutrient availability and soil pH. Remind the students that while we're going through these initial phases of seed development that we'll get into the other factors that impact the continued growth once the seed germinates in the expansion activity.

Expansion Phase (Student Laboratory):
Factors that affect seed germination and seedling growth
In this phase students will apply the concepts of seedling germination and seedling growth to perform two experiments.

I. What factors affect seed germination?
II. What factors affect seedling growth?

I. Seed Germination experiment:
The following steps will be followed over the course of one week.

1) Students are divided into groups of two.
2) Given what the students know about seedling germination, students are to design their own experiment that tests what factors affect seedling germination. The teacher must approve proposals before experiments begin. These factors must reflect what happens in the "real world," meaning their manipulated variables must actually occur in forest ecology, whether natural or from human interaction. Therefore, students may not choose to test the effects of any chemical unless they can justify how that chemical can find its way into an ecosystem and affect seedling germination and growth.

    Sample experiments could manipulate…

    a. Water amounts
    b. Light amounts
    c. pH
    d. Nutrients such as nitrates or phosphates

3) Students are responsible for designing how they will manipulate the germination factors, and will maintain an ongoing dialogue with the teacher about possibilities for their experiment. However the final procedures must be approved with the teacher using a written proposal. Seeds will be germinated using the moist paper towel method and be put in the window of the classroom (unless students are testing these variables). Students will use probes to quantify their measurements of these variables when appropriate and keep accurate data on the variables.
4) A control germination experiment will be maintained under the "normal conditions" determined by the class during the exploration phase that all student groups will be responsible for.

II. Seedling Growth Experiment:
The following steps will last 2-3 weeks, approximately 10-15 minutes per day.

1) After the conclusion of the germination experiments, students will test the factor they chose for seed germination to see how it affects seedling growth. Students may only vary their growth factor with teacher approval through another written proposal.
2) Seedlings that have been sprouted from the control group, therefore under "normal conditions," will be used for these experiments. Students may also plant the seedlings from their germination experiment if they wish, BUT they are to perform the seedling growth experiment on the control seedlings.
3) Students will use probes and PDA's when applicable to quantify their manipulation of growth factors for seedlings.
4) Data tables will be kept on PDA's. A control group will also be maintained under the "normal conditions" determined by the exploration phase. Students will be responsible for observing the control group, and making comparisons between the experimental plants and control plants.
5) Students are to beam each other results so that all experiments are recorded on the PDA's. This is critical since each student will be responsible for all of the different growth factors.

Evaluation Phase

1. A lab report detailing their germination and seedling experiments will be handed in individually or as a group at the teacher's discretion given available time. The lab report will contain graphs and tables representing the data from the manipulation experiments and controls. Students will be provided with rubrics for the lab report
2. Each group will give a presentation tot the class on the results of their experiments. Each presentation will be about 5-10 minutes long, depending on class size. Students will present to the class what variables they tested, and what procedures they used. Students are also responsible for relating what they tested to "real world" events that affect plant growth factors. For example, if students choose to manipulate pH for their germination and seedling growth experiments, they must include in their presentation how pH affects plants in the field. This could include acid rain, acid mine drainage, etc. Students will be provided with rubrics for the presentation. Presentations should use PowerPoint.
3. Student understanding of seed germination and seedling growth will also be tested by examination at the end of the Forest Ecology Unit. Students will be responsible for seedling anatomy, the factors they tested that affect plant growth, and the results of the other experiments in the class.

Specific Technology Standard(s) Addressed:

Student Standard(s):

1. Basic operations and concepts
2. Social, ethical, and human issues
3. Technology productivity tools
4. Technology communication tools
5. Technology research tools
6. Technology problem-solving and decision-making tools

Teacher Standard(s):

1. Technology operations and concepts
2. Planning and designing learning environments and experiences
3. Teaching, learning, and the curriculum
4. Assessment and evaluation
5. Productivity and professional practice
6. Social, ethical, legal, and human issues

Scientific Report Rubric

Title of Report _____

Authors' names:

_____

_____

	Beginning 1	Developing 2	Accomplished 3	Exemplary 4	Score
Introduction	Does not give any information about what to expect in the report.	Gives very little information.	Gives too much information--more like a summary.	Presents a concise lead-in to the report.	
Research	Does not answer any questions suggested in the template.	Answers some questions.	Answers some questions and includes a few other interesting facts.	Answers most questions and includes many other interesting facts.	
Purpose/Problem	Does not address an issue related to the environment.	Addresses an environmental issue which is unrelated to research.	Addresses an issue somewhat related to research.	Addresses a real issue directly related to research findings.	
Procedure	Not sequential, most steps are missing or are confusing.	Some of the steps are understandable; most are confusing and lack detail.	Most of the steps are understandable; some lack detail or are confusing.	Presents easy-to-follow steps which are logical and adequately detailed.	
Data & Results	Data table and/or graph missing information and are inaccurate.	Both complete, minor inaccuracies and/or illegible characters.	Both accurate, some ill-formed characters.	Data table and graph neatly completed and totally accurate.	

Conclusion	Presents an illogical explanation for findings and does not address any of the questions suggested in the template.	Presents an illogical explanation for findings and addresses few questions.	Presents a logical explanation for findings and addresses some of the questions.	Presents a logical explanation for findings and addresses most of the questions.	
Grammar & Spelling	Very frequent grammar and/or spelling errors.	More than two errors.	Only one or two errors.	All grammar and spelling are correct.	
Attractiveness	Illegible writing, loose pages.	Legible writing, some ill-formed letters, print too small or too large, papers stapled together.	Legible writing, well-formed characters, clean and neatly bound in a report cover, illustrations provided.	Word processed or typed, clean and neatly bound in a report cover, illustrations provided.	
Timeliness	Report handed in more than one week late.	Up to one week late.	Up to two days late.	Report handed in on time.	
				Total	

Presentation Rubric

	Beginning 1	Developing 2	Accomplished 3	Exemplary 4	Score
Procedure	Students do not present procedures to the class.	Students only mention procedures.	Students give detailed procedures, but without explanation.	Students present detailed procedure as well as scientific rationale for their procedures	
Explanation	Students do not relate procedures to the "real world" environment.	Students only mention what "real world" environmental factors are represented in their experiments.	Students explain in detail real world environmental conditions they were recreating.	Students talk of the real world conditions as well as explain the effects on plant germination and growth.	
Presentation	Group is disorganized and Runs either over or under allotted time.	Presentation runs in allotted time, but information is not presented efficiently.	Group gets through all the material to be presented, and shows good knowledge of their project.	Group is able to answer questions about the project intelligently, and has superb understanding of their experiment.	
Style	Group has no poster or PowerPoint presentation.	Group has poster or PowerPoint, but is hard to read and follow.	Group has poster or PowerPoint that is accurate.	Group has poster or PowerPoint that is accurate and attractive.	
Graphics	No charts or graphs are used to present data to the class.	Charts or graphs are used, but are poorly constructed and inaccurate.	Charts or graphs are legible, but not explained well by the group.	Charts and graphs are easy to read, accurate, and explained well by the group.	
				Total	

Sources:

Lab report Rubric
Spring Lake Park High School
8001 Able St NE
Spring Lake Park, MN 55432
http://edweb.sdsu.edu/triton/tidepoolunit/Rubrics/reportrubric.html

Biodiversity Inquiry Lesson Plan
Rebecca Heckman, Princeton High School
http://zoology.muohio.edu/labs/heckman_inquiry_lesson.pdf