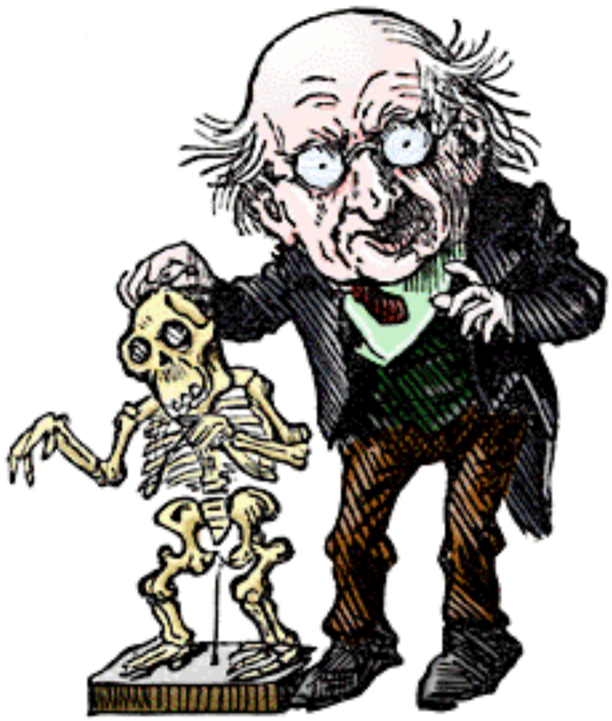

Differentiation in Biology

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Name- ____

I CAN DO SOMETHING!

The purpose of this "get acquainted" activity is to start thinking about the different areas of intelligence. Participants are to mix freely and try to get seven different people to sign the blanks (each participant may sign her/his own sheet once). In order to record a name in the blank, the person signing must actually perform the task (not just say that she/he can do it). The object is to be one of the first people to collect different signatures for every task.

Find Someone Who Can:

_________________________tell a joke or make a pun.

_________________________finish this numerical sequence: 81, 196,100, 169, 121, ___, and explain the logic behind it.

_________________________within 20 seconds name 6 traits scientists use to sort plants into categories.

_________________________hop on one foot 3 times in a row without losing balance.

_________________________can tell you how tall you are within 1/2 an inch.

_________________________can sing the "do-re-mi-fa-so-la-ti-do" sequence backwards and on key.

_________________________can name 5 clubs or organizations in which s/he held an office.

_________________________tell you 5 times s/he "went against the crowd" because of a personal conviction.

M. I. And Your Science Classroom

(adapted from J. Abruscato's *Teaching Children Science*, 2001)

Logical-mathematical (Number/Puzzle Smart)

• Emphasize the underlying patterns students observe in science activities.
• Have students think about the steps involved in all deductions and activities.
• Stress numbers, measuring, and other mathematical concepts whenever possible.

Linguistic (Word Smart)

• Begin concept studies with popular children's books.
• Emphasize writing down predictions, observations, and writing in science journals.
• Encourage students to keep personal science dictionaries.
• Connect creative writing activities to science concepts.

Musical (Music Smart)

• Use songs, raps, and music selections to accompany the introduction of new concepts and/or to practice vocabulary.
• Encourage students to make up their own songs using science concepts.

Visual/Spatial (Picture Smart)

• Encourage students to use models and pictures to demonstrate understanding.
• Present new material through videos and pictures.
• Connect graphs to information whenever possible.

Bodily/Kinesthetic (Body Smart)

• Provide ample opportunities for students to use science materials and equipment.
• Whenever possible, have students demonstrate new learning through movement and dance. (i.e. acting out the metamorphosis of a butterfly).

Interpersonal (People Smart)

• When doing a cooperative activity help students "de-brief" not only their findings but also how well they worked together.
• Provide opportunities for students to share their findings, discoveries, and questions with their classmates.

Intrapersonal Awareness (Self Smart)

• Encourage the use of personal journals and reflective activities.
• Allow students to choose solitary, independent work occasionally.

Naturalist (Nature Smart)

• Use activities from programs such as Project Learning Tree, Project WILD/Aquatic, and Project WET that link science to the natural world.
• Use natural objects or media using natural objects to illustrate points.

How To Use Cooperative Learning:

Secondary Learners

In working with secondary learners it is important to remember that:

- Group members are responsible for the performance of each individual learner.
- Group members are individually accountable and must be able to report on or explain the team's results.
- The groups are to be assigned by the teacher. Their make-up should be heterogeneous with respect to sex, race, socioeconomic status, ability/learning styles, cliques, and other important factors.
- Leadership is shared on a rotating basis. Each team member has a job and responsibilities.
- The teacher is a resource; students are in charge of their own learning.
- Time must be allowed for group processing and self-evaluation.

The job assignments I use for traditional grouping are these:

Group Leader
1. Reads all directions to group
2. Leads the discussions
3. Checks the data sheet
4. Helps with clean-up
5. Is the only one who can ask a question of the teacher

Materials Manager
1. Is responsible for collecting and returning all materials & supplies to the appropriate place(s)
2. Is the only one who can get up for materials and supplies
3. Makes sure the everyone in the group has equal access to the materials and supplies
4. Checks the data sheet
5. Helps with clean-up

Time Keeper
1. Holds the team stopwatch (or watches the clock)
2. Keeps group on task and reminds them about time
3. Is responsible for getting the group to finish on time
4. Checks the data sheet
5. Helps with clean-up

Data Collector

1. Collects the data for the activity
2. Records data on the appropriate form or sheet
3. Returns data sheet to teacher and/or records group data on class data sheet
4. Makes sure all other team members check the data sheet
5. Helps with clean-up

Since this is not a perfect world, and all class populations are not divisible by four, I have a fifth job that can be assigned in a group:

Encourager

1. Monitors other team members to make sure they do their own jobs
2. Takes responsibility for praising and affirming jobs that are well done
3. Records comments and actions that show positive interpersonal communication
4. Reports recorded data to group at de-briefing session
5. Helps with clean-up

If a group of four has one member absent, two of the jobs can be combined for that day.

Part of the group's participation grade is based on how well each team member performs her/his job. Points are deducted if one team member does another team member's assigned responsibility.

Group Participation Number Line

Date: ____________________

Group Number:___________

Group Members Present: ______________________________________

____

____

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0

Participation Points Earned: __________

There is nothing chaotic about cooperative learning that is well-planned and well-managed. Teachers should plan activities that are challenging and yet doable if the group members work together. Tasks should require the concentrated efforts of all team members doing their jobs and working with in the allotted time. Materials and supplies should be out and sorted before students arrive. During the cooperative learning activity it is the responsibility of the teacher to monitor the students and:

- Give immediate feedback and reinforcement for learning
- Re-teach certain concepts if necessary
- Clarify directions
- Encourage oral elaboration
- Affirm positive interactions and efforts
- Informally assess student learning and collaboration

Another way to ensure that the cooperative learning activity is organized and has a smooth closure is to allow time after clean up and whole group information sharing to ask the groups to evaluate how they interacted with one another. Either verbally or in their journals students can answer questions like these:

- Tell how involved each of your team members was in the decisions your group made.
- How do you feel about the work your group did today? Why?
- What would you would like to tell your teammates about how you felt during today's activity or the way you feel now?
- What could your team do to improve the way you get along and/or work together?
- What is your favorite thing about being on this team?

Teachers need to keep a close watch on the personal interactions going on within groups. Happy well-functioning groups matched with appropriate tasks and given adequate time constraints run smoothly.

Alternative Ways to Use Cooperative Learning

1. **Within a lecture or presentation:**
   The teacher is discussing, modeling, or explaining something. S/he pauses to ask small groups to summarize, categorize, debate, describe, or otherwise react to the presented material.
2. **With higher level questioning:**
   The teacher asks small groups to come up with a team consensus on something to do with analysis, synthesis, or evaluation of the concept being discussed.
3. **As practice reinforcement:**
   The teacher asks students to get with their groups to practice, memorize, or review the given concepts.
4. **Decision-making/problem solving:**
   The group is to reach a decision or solve a problem presented by the teacher. The teacher is leading a class discussion on the separation of church and state in the United States Constitution. She asks small groups to meet and decide whether or not to include the words, "Under God" in the Pledge of Allegiance. Groups are to figure out a way for students to say the Pledge without violating the spirit of the law.

5. **As a review:**
The teacher asks a question. Team members put their heads together to discuss the answer. The teacher calls out a color, and the person who has that color dot will answer the question as the teacher whips through the groups.

6. **In a tournament or game format:**
There are several models for using cooperative learning in a tournament or game format. Student Teams-Achievement Divisions (STAD) and Teams-Games-Tournament (TGT) are two of the more popular ones.

7. **With peer editing:**
Team members proofread each other's work and offer suggestions for improvement. This practice helps both the "corrector" and the "correctee."

8. **As an assessment:**
A Gallery Walk (sometimes called Carousel Walk) is a way to assess students in groups. The teacher puts large pieces of newsprint around the room. On the top of each is a question for which there are several answers. Student groups are given different colored markers and asked to write one correct answer to each question. Answers cannot be repeated on a page. The teacher can informally assess student learning by listening to them as they "think out loud" in their groups (Slavin calls this *oral elaboration*). Or teachers can more formally assess the answers by noting the flow of answers used by each colored group.

9. **Research projects or group investigations:**
Group work on projects can promote sharing of the load and commitment to a time line. Often times students who are procrastinators when it comes to doing their own work will get motivated by their peers to finish their part of the assignment.

10. **Checking homework:**
Even though homework is for independent practice, many teachers Have limited time for checking and correcting it during a rushed day. Group members can check each other's work for accuracy.

For more information on the specific techniques mentioned in this chapter or for lessons designed around particular age groups and subject areas consult your local bookstore or the Internet. Cooperative learning strategies abound. Using small group interactions is a powerful teaching tool that can be used to enhance the learning cycle and most other effective teaching strategies. Different marchers hearing different songs still need to learn to work successfully in groups when the need arises. Learning interpersonal communication skills helps students to become better citizens. Working in groups helps students "get better together."

GALLERY WALKS

The Gallery Walk is an assessment that capitalizes on the "people smart" intelligence. It can be used as a diagnostic, formative, or summative assessment. The teachers poses challenge questions for students to answer in small groups (2 to 5). Student groups rotate among the questions written on large pieces of newsprint or giant poster paper placed around the room. Each group has a different colored felt-tip marker with which they give one answer per poster. Answers cannot be duplicated.

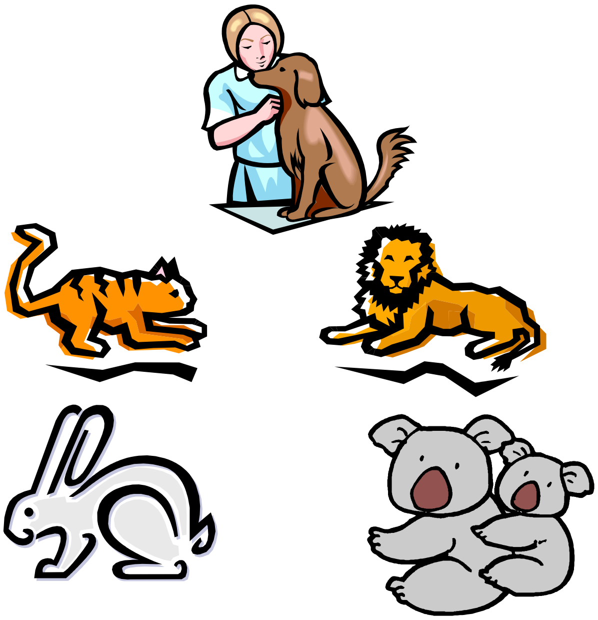
Example:

Imagine that you are a bright orange butterfly. A predator moves into your habitat that preys on bright orange butterflies. *What could you do so that the population of bright orange butterflies survives?*

1. Start coming out at night when predators can't distinguish color very well.
2. Sit with wings folded up tight so color can't be seen.
3. Sit underneath leaves where they are less likely to be seen.
4. Spend time in fields of bright orange flowers where they would be hard to see.
5. Migrate to an area where other bright orange colored butterflies contain a poison and predators avoid <u>all</u> brightly colored butterflies.
6. **Move to a place where there are no predators.**

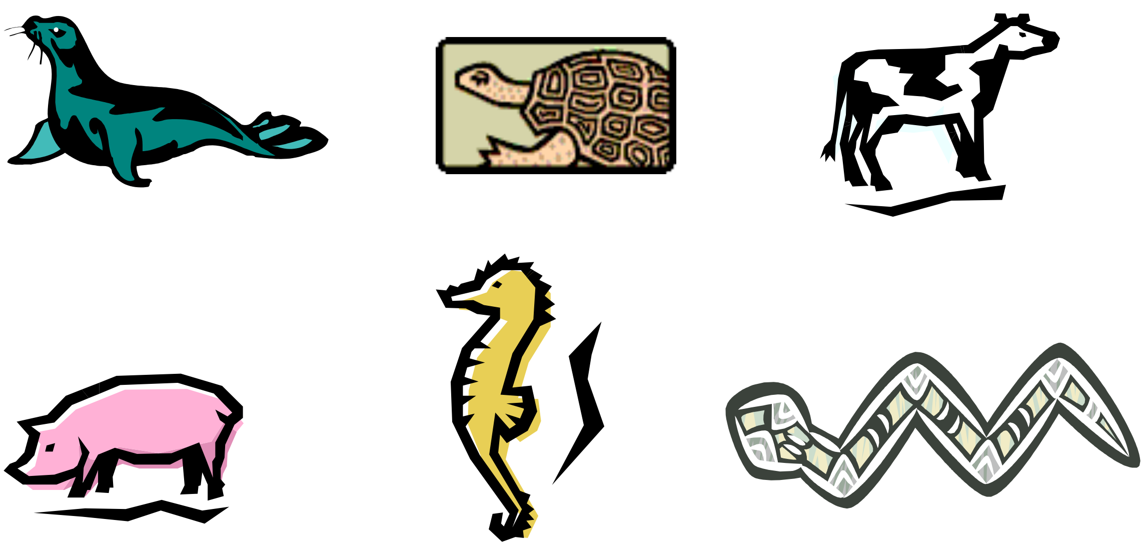
BARFS/NOT BARFS

These Are Barfs:



These Are NOT Barfs:

Which of These Are Barfs?



Logical Analytical/Linguistic

Science Fact Sense

____ = Number of ___________________________________

a.	**3**	**= N O B in the M E**
b.	**7**	**= N O C in the R**
c.	**206**	**= N O B in the AS**
d.	**6**	**= N O S of a SF**
e.	**1**	**= N O C in P**
f.	**4**	**= N O C in the H H**
g.	**3**	**= N O A in a WM**
h.	**3**	**= N O B P on an I**
i.	**93**	**= N O M M from the E to the S**
j.	**46**	**= N O C in most H C**

Make up your own:

Topic: ____

____

____

____

____

____

____

____

Performance Assessment

Performance tasks are often used in science to assess a student's ability to manipulate materials or apparatus as well as apply knowledge to solving real life problems. For example, a student might be asked to measure the volume of an irregular object with the use of an overflow can, a graduated cylinder, and water. Students can demonstrate successful performance by applying their knowledge and skills to a new situation or in a new way.

The assessment developer should have in mind a clear picture of what a successful performance would "look like." Development of the criteria (rubric) by which the performance will be assessed can involve both the assessor and the assesses. Clear standards must be communicated to the assesses beforehand so that they fully understand what is expected of them. The best assessments are woven into the instructional strategies and serve to reinforce the concepts expected to be mastered.

Demonstration Assessment

Because performance assessments are sometimes limited by the amount of time and supplies a teacher is able to devote to them, a satisfactory alternative is that of a demonstration assessment. For this assessment students watch their teacher or another performer make a presentation that incorporates their prior knowledge but forces them to apply it in a new way or to a new situation. After observing the occurrence, the student is required to bring together understanding of processes, procedures, and concepts in order to explain the phenomena. Generally students are asked to describe observations, use appropriate vocabulary, make appropriate inferences. A demonstration assessment requires a pre-determined general rubric and should be clearly communicated to students before the actual assessment.

Teacher Demonstration Checklist

In deciding whether a particular activity or demonstration is consistent with good science teaching, the following checklist (adapted from J. Abruscato's *Teaching Children Science,* 2001, p. 83) may prove helpful:

____ 1. Did the teacher have all the necessary materials ready? Did the demonstration take place without unnecessary delay?

____ 2. Was the demonstration straightforward and free from confusing complexities or details?

____ 3. Could all the students observe the demonstration without problem?

____ 4. Was the teacher prepared and confident? Was it obvious the teacher had practiced and was knowledgeable about all aspects of the concepts being conveyed?

____ 5. Was the teacher able to build suspense with the demonstration? Were the students surprised by an unexpected or dramatic result?

____ 6. Was the demonstration made with attention to the safety of all involved? Did the teacher model correct safety procedures? (i.e. wearing safety glasses, using a mitt, etc.)

____ 7. Did the demonstration directly relate to the topic of study and/or essential science understandings?

____ 8. Was the appropriate amount of time allocated for this demonstration? Was time given for drawing conclusions?

____ 9. Did the students have an opportunity to give reactions, ask questions, make statements?

____ 10. Did the demonstration provide an important learning experience for the students?

Mitosis Assessment Activity

Assessment Goals:

- Describe what happens to a cell during **interphase.**
- Name each of the **four phases of mitosis** and present them in the correct order.
- Correctly identify each of the organelles present in each phase. Include these organelles: **centrioles**, **chromosomes**, **chromatids**, **spindle fibers**, **nuclei**,
- Explain the **actions of the organelles** in each phase.
- Show the actions of the **nuclear membrane** and **cell membrane** at each phase.

Date- ____________________ Title- _________________________________

Group Members: ____

____

PRESENTATION OR MODEL (25 points)- ___________

- Describes the events of interphase.
  5 4 3 2 1
- Demonstrates each stage accurately.
  5 4 3 2 1
- Correctly identifies the major organelles present in each phase.
  5 4 3 2 1
- Correctly explains the actions of the major organelles in each phase.
  5 4 3 2 1
- Correctly explains the actions of the nuclear and cell membranes in each phase.
  5 4 3 2 1

TEACHING METHOD: (15) - ___________

- Activity taught concept correctly.
  5 4 3 2 1

- All students *could* participate.
  5 4 3 2 1

- Activity promoted learning.
  5 4 3 2 1

ORAL PRESENTATION: (20) - ___________

- Everyone has a part.
  5 4 3 2 1

- Part stated (not read).
  5 4 3 2 1

- Given accurately and clearly.
  5 4 3 2 1

- Definitions are explained correctly
  5 4 3 2 1

TOTAL SCORE - ___________

COMMENTS:

Different Ways to Find Out What Students Understand

Make a chart or diagram	**Do a demonstration**	**Create a dance**
Write a letter to the editor	**Make a scrapbook**	**Design a Web Quest**
Conduct a discussion	**Participate in a debate**	**Create a puppet show**
Create an advertisement	**Make an editorial video**	**Keep a journal log**
Write an essay	**Design a structure**	**Create a report**
Participate in a simulation	**Develop a collection**	**Make a plan**
Create a poem	**Write and do a rap**	**Make a mural**
Do a photo essay	**Design a game**	**Create a new product**
Create an invention	**Present a news report**	**Do an experiment**
Teach someone else	**Judge an event**	**Make a model**
Write an analogy	**Conduct an interview**	**Develop a rubric**
Participate in a mock trial	**Create cartoons**	**Write a book**
Design and teach a class	**Create a flow chart**	**Make a learning center**
Devise a new recipe	**Give a performance**	**Draw a blueprint**
Write a monologue	**Defend a theory**	**Do a self-assessment**
Illustrate a math concept	**Create a brochure**	**Solve a mystery**
Do a multimedia presentation	**Develop an exhibit**	**Critique a book**
Write a diary from the perspective of someone else	**Set up a system of checks and balances**	**Do a Gallery Walk (Carousel Walk)**

Exploring Germination

(from Louisiana Tech's Project LIFE Program)

Description

Students design an experiment to collect qualitative and quantitative data on what happens when a variety of seeds are exposed to moisture (Wisconsin Fast Plants, mustard, radish, pinto beans, large lima beans, canned corn, rice, etc.). They record their data in Learning Logs. Students use the data they have collected to identify the essential elements of the germination process.

Time Frame

Students provided dried seeds and other needed materials and instructed to set up their own experiment. The first observations (3 hours, 6 hours, 12 hours) will be made at home that night; subsequent observations can be made during class time.

- 20 minutes on first day for students to set up their experiment
- 10 – 20 minutest on each of the following 5 days for students to record data
- 30 minutes on last day for students to discuss findings.

Materials

(The number of each item will depend on the size of the class & the experiment designed by the students)

Plastic petri dishes or zip lock bags
Absorbent paper towel, filter paper, or coffee filters
Seeds of varying sizes including Wisconsin Fast Plants, radish, pinto bean, large lime bean. Other seeds that work well include green pea and sunflower (5 of each per student). You might want to also include canned corn or rice.
Rulers or calipers (1 per student)
Hand magnifiers (1 per student)
Electronic balances
10 ml graduated cylinders
100 ml graduated cylinders
Learning logs

Advance Preparation
Obtain materials
Label seed containers
Lay out materials on side table for student to obtain
Make sure that students know how to set up Learning Logs and record data in them.

For the Teacher
It is important that seeds be kept moist but not submerged in water throughout the 5 days that students are making observations. This means that larger seeds will need more water than smaller seeds. It is best to start observations on a Monday so that students can observe changes at the first observation times. Depending on your students, you may want to allow students to take materials home to make their 6- and 12-hour observations. If the teacher does not want to send materials home with the students, the teacher can prepare demonstration set ups for several types of seeds and allow the students to carousel through the seed stations to make their 6- and 12-hour observations. It is important that students see the changes at these early hours in order to note the initial uptake of water and the splitting of the seed coat. This learning experience will fit nicely into a unit on plants.

Procedure
1. Tell students that they are going to observe some seeds over time to determine if dried pinto beans and other kinds of seeds are alive. Ask students what evidence they would need to be convinced that dried seeds are alive. Students will probably say that if the seeds sprout and grow into new plants they are alive. Ask student what seeds need to be able to sprout. They will probably mention water, light or dark, warm or cool temperatures, etc. Tell students that they will be given some basic guidelines they must follow in making their observations. Basic guidelines include:

a. Seeds are to be handled the same way by all groups. For example, all seeds will be placed on moist filter paper in covered petri dishes. The arrangement you pick will depend on the materials you have available. You do not want the students to use soil because it will be too difficult to make observations.

b. Both qualitative and quantitative data must be collected.

c. Data must be collected at time 0, and at 6 hours, 12 – 15 hours, and 24 hours. 48 hours, 72 hours, 96 hours.

d. Each student is responsible for collecting data on at least two kinds of seeds including 1 small and 1 medium or large seed.
e. Within the group, at least 4 kinds of seeds must be studied. Students may study more seeds if there are adequate supplies.
f. Data must be recorded in their Learning Logs.

2. Give students about 10 minutes to discuss which seeds they want to study and to collect their materials. Record on a class data chart what type seeds each group will study. Be sure at least one group observes canned corn.

3. Give students about 15 minutes to collect their initial data (mass of cells, size of cells, etc. They should make drawings and write observations).

4. If you have set up demonstrations for 6 and 12 hours, have students carousel through the different stations and record their data.

5. Provide about 10 minutes each class period for students to make additional observations.

6. On day 5 ask students to prepare a diagram of the process that each of their seeds went through and answer the questions on the following student sheet. Students need to include drawings of their seeds at each stage and should include the name of the seed type on their poster.

7. During discussion you will want to emphasize the following concepts:
- All seeds follow basically the same pattern when they germinate
- Seeds swell as they take up moisture. This process is called *imbibition*.
- After water uptake, the seed coat softens and eventually splits.
- The *radicle* (true root) emerges.
- The *hypocotyl* (stem) emerges. It is often bent in a U-shape.
- The root develops branch roots.
- Seed leaves emerge and turn green when exposed to light.
- The stem bends and grows in a direction away from the center of the earth.

Additional Information:
- Seeds must have access to moisture in order to germinate but must not be covered with water.
- Seeds can drown when they are covered with water because they cannot access the oxygen they need to carry out cellular respiration.
- Cellular respiration is the process that releases stored chemical energy from starch (after conversion to glucose) so that the developing embryo can grow while it is underground and unable to photosynthesize. Aerobic cellular respiration requires oxygen.
- A correlation exists between size and length of time required for seeds to germinate. Larger seeds take longer to germinate. Seeds that take longer to

germinate require more starch to sever as an energy source before they can begin the process of photosynthesis.

Formative Assessment
The review of students' entries in their Learning Logs is an excellent formative assessment to which a grade can easily be assigned (see rubric). Students can also be asked to use their Learning Log observations in a variety of ways in class (see suggestions) that will provide the teacher opportunities to identify misconceptions and assess the students' current level of understanding.

Summative Assessment
The Germination and Growth Student Sheet, the diagram of the germination process developed by the students, and the class discussion and presentation by groups of the results of their experiment serve as a summative assessment for this learning experience. Students could also be asked to produce a written report of their investigation.

Germination of Seeds
Student Sheet

You are to observe at least two kinds of seeds of different sizes (small vs. large) that have been exposed to water for various lengths of time. You will use both dry seeds as well as seeds that have been soaked for 24 hours. Your observations are to be recorded in a data table of your own design.

- type of seed
- average mass of dry seed
- average volume of dry seed
- average mass of soaked seed
- average volume of soaked seed

For the seeds you expose to moisture you will need to record the following:
- length of time exposed to moisture
- observations of seed exposed to water
- suggested planting depth (from packets or teacher-supplied chart)

Be sure to include observations for 0 hours exposed to moisture, 3 hr, 6 hr, 12 hr, 24 hr, 48 hr, 72, hr, and 96 hr.

Once you have collected all of your observations, you will be working with your group to design experiment to learn more about the effects of the environment on the germination process.

Germination and Growth
Student Sheet

1. Germination is the process that occurs when a seed emerges from a dormant stage and actively beings to grow. What is one thing that must be present before germination can occur? Give data/observations what support this answer.

2. List in order the steps that occur in the process of germination and early growth.

3. Do all types of seeds follow the same pattern as they germinate and begin to grow? How do they differ? Give data/observations to support your answer.

4. Remove the seed coat from a soaked lima bean seed and locate the immature plant called the embryo. Note the 3 parts of the embryo – the epicotyl (plummule) or true leaves, the hypocotyls or stem, and the radicle or true root. The two large bean halves are the cotyledons. Place a few drops of iodine solution on the cotyledons. What do you observe? What do you infer from your observation? What do you think the compound that is stored in the cotyledon is used for?

5, How are seed size and length of time to germinate related? What evidence supports your hypothesis?

6. Why must farmers wait until their fields are not completely saturated with water before planting seeds? (Answer this one from the perspective of a seed!)

Germination and Growth
Teacher Sheet

1. Germination is the process that occurs when a seed emerges from a dormant stage and actively beings to grow. What is one thing that must be present before germination can occur? Give data/observations what support this answer.

Water must be present before germination will occur. The seeds that were dry did not show any signs of germination but even those seeds that had only been exposed to water for 33 hours were starting to swell.

2. List in order the steps that occur in the process of germination and early growth.

- *The seed swells.*
- *The seed coat splits.*
- *The radicle (root) emerges.*
- *The stem and leaves emerge. The stem leaves emerge. The stem on most seeds pushes out first, and the leaves follow.*
- *Branch roots develop on the main root, they appear as a circle of fuzzy structures around the main root just above the tip.*
- *The stem straightens out and starts to grow towards the top of the petri dish. The leaves turn green.*

3. Do all types of seeds follow the same pattern as they germinate and begin to grow? How do they differ? Give data/observations to support your answer.

All of the seeds follow the above pattern (the sunflower seed is slightly different, but the general outline is the same). The time at which each step occurs is different. The larger seeds take longer to go through the steps.

4. Remove the seed coat from a soaked lima bean seed and locate the immature plant called the embryo. Note the 3 parts of the embryo – the epicotyl (plummule) or true leaves, the hypocotyls or stem, and the radicle or true root. The two large bean halves are the cotyledons. Place a few drops of iodine solution on the cotyledons. What do you observe? What do you infer from your observation? What do you think the compound that is stored in the cotyledon is used for?

The cotyledons turn blue/black when the iodine solution is placed on them. Iodine solution is a light yellow/tan color until it comes into contact with starch then it turns blue/black. The starch stored in the cotyledon serves as an energy source for the developing plant until it emerges from the soil and can begin the process of photosynthesis.

5, How are seed size and length of time to germinate related? What evidence supports your hypothesis?

Seeds that take longer to germinate would need a larger reserve of food because it would be longer before they could start to make their own food through photosynthesis.

6. Why must farmers wait until their fields are not completely saturated with water before planting seeds? (Answer this one from the perspective of a seed!)

Seeds that are submerged in water will "drown" from lack of oxygen. Oxygen is required for the seeds to carry out respiration and release energy from the stored starch/glucose that can be used by growing new plants before they start to carry on photosynthesis.

Extensions

To engage students in thinking about vegetative growth, students are provided with potatoes from the grocery store or with seed potatoes from a nursery. Students are challenged to "make the potatoes grow" and to do so in a way that will provide information about the conditions that influence whether or not the potato grows. Students can look at temperature, amount of moisture, type of moisture, and light. In addition, they can consider questions such as, "Can a part of a potato grow?" "How much potato is required before growth will occur?" "Is soil required for potato growth?" "Does the type of medium a potato is planted in matter?"

Students will have to think about what is the energy source for their potato, what kinds of energy transformations are taking place, and what is the value of the potato tuber to the potato plant. To help guide students' thinking, the teacher can generate student sheets similar to those used in the germination experiment. This learning experience can lead to very good discussion of the role of cellular respiration and mitosis in vegetative growth.

Resources

Wisconsin Fast Plants Home Page http://fastplants.org
Resources, activities, information and opportunities to participate in on-line projects for teachers, students, and scientists. Includes *Bottle Biology*.

Compton's On-line Encyclopedia
http://wwwcomptons.com/encyclopedia/ARTICLES/0125/01453312_A.html
A comprehensive article on plants with sections on seeds, sexual reproduction, and asexual reproduction.

Walker Farm Seed Germination Guide
http://www.walkerfarm.com/thompsonmorgan.htm
Information on seeds and seed structure, hints on seed raising for a wide variety of plants, and descriptions of special treatments that are sometimes needed to break seed

dormancy. The site includes a long list of seed types with specific conditions for sowing and optimal germination.

Colleen Fiegel's Web Page http://biologyweb.org/BiologyProjects.htm
A site with links to everything in every area of biology. This site is maintained by a high school biology teacher from southern Louisiana and is a must for anyone who teaches high school biology.

Center for Inquiry-Based Learning at Duke University
http://www.biology.duke.edu/cibl/
Check out this site's wide variety of exercises and activities for students in grades 5-12. Go to science exercises and select Seed Germination for a description of a long-term experiment in which students plant seeds and watch germination and early growth. Students design their own experiments using materials from a basic set provided by the instructor.

Potato, Food Resource Home Page
http://www.orst.edu/food-resource/v/potato.html
A site with links to everything you ever wanted to know about potatoes and more!

GUIDELINES FOR SCIENCE JOURNALS (for students)
Debbie Silver, Louisiana Tech University Project LIFE

1. **Who should write in your journal?**
   YOU should. Your teacher will also write in your journal to answer your questions and make comments.

2. **What should you write in your journal?**
   - Thoughts you have had on the science topic of the day, what you have learned, or how you learned it.
   - Thoughts you have about your group, this class, the teacher, or yourself.
   - Questions you have – both answerable and unanswerable.
   - Further explorations you would like to try.
   - Suggestions you have for improving our classroom climate.

3. **Where should you do your journal writing?**
   In the notebook or folder you have specifically designated for it.

4. **When should you write in your journal?**
   - Before or after class each day.
   - As you are preparing, reading, or studying for class
   - Anytime you have insights, questions, of thoughts you would like to get down on paper.
   - During assigned journal-writing time.

5. **Why should you write in your journal?**
   - To record ideas that you might otherwise forget.
   - To provide a record for you to read later on so that you can see growth in your learning.
   - To facilitate your learning, problem solving, writing, reading, discussions, and relationships in this class.

6. **Who will read your journal?**
   Only your teacher or whoever you give permission to read it. Unless it involves your safety or the safety of others. **ALL information will be kept in confidence by your teacher.**

7. **How should you write in your journal?**
   In wonderful, long flowing sentences with perfect punctuation, spelling, and handwriting . . .
   OR
   In single words that express your ideas, in short phrases, in sketches, in numbers, in maps, in diagrams, in sentences, in poetry, or in whatever style best fits the ideas you are trying to express.

Some possible divisions include:

LEARNING LOG

a. **CLASS NOTES** (vocabulary words, lists, clarifications given by the teacher, or discoveries made by groups/individuals).
b. **SPONGE ACTIVITIES** (lead-in questions, "mind bogglers," puzzles, problems solving questions, etc. related to the topic).
c. **LEARNING ASSESSMENTS** (concept maps, drawings, or student explanations assigned by teacher to determine the depth of understanding)
d. **QUESTIONS AND COMMENTS TO THE TEACHER** (students pose or answer questions about the science topic in a written dialog with the teacher).
e. **EXPERIMENTAL DESIGN AND DATA** (record set ups and data from experimental designs in cases where a specific data sheet is not provided).
f. **LONG TERM OBSERVATIONS** (descriptions of plant growth, animal behavior, charts, graphs, etc.)

JOURNALS

a. **FREE WRITING** (students may write on any feelings they have about their like to have answered or explorations they would like to do).
b. **SUGGESTION BOX** (students write suggestions for improving the lesson, interpersonal relationships, or any other aspects of the classroom climate).

Why Discrepant Events?

Debbie Silver

Teaching is an active verb that requires the engagement of the learner. Because it has become harder and harder to capture the attention of students, discrepant events are a way to stimulate interest in a particular topic.

For instructional purposes discrepant events can be described as an investigation in which the new information that is introduced is inconsistent with information previously thought to be true (misconceptions). Piaget refers to this type of learning when he describes how learners can be motivated to learn if they experience a sense of "disequalibration." As long as the learner's environment is stable, mental activity is not necessary. But when an unfamiliar problem arises the learner must use prior experience, new insights, and/or peer interaction to solve the problem and reestablish *equilibration*. Equilibration can be restored through *accommodation* whereby the learner creates or restructures his/her thought patterns or through *assimilation* whereby the learner incorporates the new information into existing thought patterns.

A discrepant event can encompass all of the above. It arouses interest and allows for exploration, discovery, questioning, and discussion. This involvement and interaction between students and their environment will initiate linking and application. Discrepant events can be used to help students learn.

Characteristics of Living Things

(from Louisiana Tech's Project LIFE Program)

Description

This teacher demonstration can be used to assess students' prior knowledge about living things as well as engage the students in their study.
The substances appear to "move, interact, eat, and mate," but they are not alive.
This demo provides an excellent lead-in to distinguishing between observation and inference.

Materials

- 10 -15 ml water (with red food coloring)
- 10-15 ml alcohol (with green food coloring)
- 10 -15 ml corn oil
- wax paper
- *` 3 disposable pipetts
- overhead projector

Procedure

1. Place a piece of wax paper on the illuminated overhead projector. Place a large drop of corn oil in the center of the wax paper. Carefully drop 3 or 4 small drops of red water into the corn oil. Do NOT tell the students what the liquids are. Explain that you are going to feed some unusual organisms that you caring for. Tell them you need their help in closely observing the process to determine if the organisms are alive and able to eat the "food." Tell the students that eh organism are the red material and the yellow substance (corn oil) is the medium in which they live. Slowly place a single drop of green "liquid food" on the wax paper so that it barely touches the edge of the corn oil. Ask the students to watch carefully.

2. Students should observe that nothing appears to happen. After a short delay, the red liquid dots will seem to "sizzle" along one edge and then move towards the outer edge of the drop of corn oil where the green "food" was placed. The red liquid drops may seem to interact with one another. If all of the red liquid drops are not affected, additional drops of green "food" can be placed at other locations around the perimeter of the corn oil. Be sure to have several squares of wax paper available to allow repeats of the demonstration.

3. Ask students to describe what they observed. Allow them to work in small groups to develop a list of observations and relate those observations to the characteristics of living things. Generate a list of such characteristics as—they move, require energy, reproduce, carry out metabolic functions, grow, develop, etc. Be sure to make the distinction between what students actually *observed* and what they *inferred*.

For the Teacher

The observed movement in the demonstration actually occurs because of the characteristics of the molecules in the 3 different liquids.

Water is a polar molecule with one end of the molecule having a slightly positive charge and one end of the molecule having a slightly negative charge. These small differences result in water being highly cohesive (like molecules being attracted to themselves).

Corn oil is non-polar and is made of molecules that have a backbone of carbon-hydrogen chains. The corn oil molecules are not held together as tightly by cohesion because the molecules do not exhibit any significant differences in charge from one are to another.

Alcohol is a molecule that has one end that is slightly charged (the polar head) and one end that is not charged (the non-polar tail).

When the red water is dropped onto the corn oil, the attraction of the water molecules for each other (cohesion) causes the water to form a distinct drop that does not mix with the corn oil. Because water is denser than corn oil, the water sinks through the corn oil and comes to rest on the surface of the wax paper. Alcohol is less dense than corn oil. When the drop of green alcohol is placed next top and in direct contact with the corn oil, the non-polar end of the molecule dissolves slightly in the corn oil and the alcohol moves across the surface of the corn oil. Because the layer of green alcohol that is moving is very thin it cannot easily be observed. When the layer of alcohol encounters the water droplet, the polar end of the alcohol mixes with the water molecules causing a lowering of the surface tension. (Surface tension is lowered because the alcohol molecules come between some of the water molecules and decrease the strength of cohesion between the molecules.) When the two liquids mix, the loss of surface tension causes the water to spread out and bubble. The delay in the process occurs because of the time it takes for the alcohol to move across the corn oil to reach the water. If several drops of water are placed on the corn oil, the resulting movement is even more dramatic.

(This demonstration and discussion can be used to introduce the concepts of hydrophobic “water hating” molecules and hydrophilic “water loving” molecules. Corn oil is an example of a hydrophobic compound; oils in general do not mix with water.)

Sampling Sewer Lice

Bottle 1 7-Up® (or other clear carbonated drink), Mountain Dew® (or other yellow-colored drink), and a touch of any dark-colored drink
Bottle 2 7-Up® and Mountain Dew®
Bottle 3 7-Up®

Tips:

- You can use standard or white raisins, but try them before you do this demonstration for students (some work better than others).
- Add raisins about 15 – 45 minutes before demo. Setting the bottles on an overhead projector will provide better illumination as well as a heat source for activating the motion of the raisins.
- Keep lids on the bottles or jars so that students cannot smell the contents.

Helpful Internet Sites

Activities for Secondary Science Students
http://www.asta.edu.au/st2003/audience/secondary.html
Excellent resource. Science & Technology Directory for 2003-2004.

Classroom Activities for Secondary Science
http://www.greece.k12.ny.us/task/activities/secondscience.htm
More resources and activities for secondary science teachers

KCK Secondary Science Assessment Prompts
http://kancrn.kckps.k12.ks.us/science/assessment/prompts.cfm
Great downloadable resources for alternative secondary science assessments

ICT Teaching and Assessing Science
http://ecs.lewisham.gov.uk/talent/secsci/TaLENT_SC5.htm
Ideas for teaching and assessing secondary science through ICT

Problem Solving in Elementary Schools
http://www.indiana.edu/~reading/ieo/bibs/probele.html
ERIC resources that address problem solving. Useful links to other Internet resources.

Science Lesson Plans
http://www.col-ed.org/cur/science.html#sci1
This site, sponsored by the Columbia Education Center in Oregon provides a tremendous collection of elementary/middle level science lessons.

Sensational Science Activities
http://www.tufts.edu/as/wright_center/fellows/jbm_info/jbm6.html
Home page created for secondary science educators by John Banister-Marx. Good stuff!

Supplements to Science Lessons
http://www.monroe2boces.org/programs.cfm?sublevel=350&subsubpage=82&subpage=54&master=3
BOCES2 website provides an array of elementary science lesson supplements. Excellent resources for teachers trying to differentiate instruction on particular topics.

Teachernet Science Resources
http://www.teachernet.gov.uk/teachingandlearning/subjects/science/primaryscience/
One of the best sites on the internet for all kinds of activities, ideas, and integrated lesson plans for primary school science.

Using Lower Secondary Science Activities to Engage Below Level Students
www.eddept.wa.edu.au/outcomes/**science**/suppLsec.pdf
This downloadable PDF file has excellent ideas for differentiating secondary science activities for below level students.

Compiled by Debbie Silver, 2005

LIST OF RELATED CITATIONS ***Differentiating Biology***
Dr. Debbie Silver

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Feldkamp-Price, B.; Rillero, P.; & Brownstein, E. (1994). "A Teacher's Guide to Choosing the Best Hands-on Activities." *Science and Children (31)* 6, pp 16-19.

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Silver, D. (1998). Engaging students in the learning cycle. *Principal*, 77 (4), 62-64.

Vatterrot, C. (1995). Student-focused instruction: Balancing limits with freedom in the middle grades. *Middle School Journal, 28* (2), 28-38

Periodicals for Science Teachers
Science Scope (middle grades-- a journal of the National Science Teachers Association) 3140 N. Washington Blvd., Arlington, VA 22201 http://www.nsta.org

The Science Teacher (secondary—a journal of the National Science Teachers Association) 3140 N. Washington Blvd., Arlington, VA 22201 http://www.nsta.org