What is Life?

Unit Introduction: This unit is based upon FOSS Diversity of Life Course. This unit is only the beginning of a deep exploration of life on Earth; "What is Life" and " Microscopic Life." In this unit, students will begin to define life operationally. They will investigate "stuff" in order to develop an understanding of life's basic design, characteristics and functions. Some of the larger concepts of life addressed in this unit include;

1. Life happens in cells
2. Cells are aquatic
3. Cells all have the same basic requirements for survival (as do complex organisms = strand to future unit "macroscopic life")
4. Life is diverse
5. Most life is unicellular
6. All organisms are adapted to where they live (strand to future unit that will use the bog samples, and expand on differences they discover on their field trip)

Students will work alone, in pairs, in groups four and as a class. Groups of four are designed with rotational, defined student roles (*reporters, getters, project managers, and technicians)*. Getters gather required materials, Project managers make sure researchers are on task and are in charge or logistics of an activity, Technicians orchestrate the procedure, Reporters make sure all are entering observations and or information into their notebooks, and report findings to class.

Brief Description of Group to be Taught: This unit is designed for two multicultural, multiability seventh grade classes (35-40 students) in an urban K-8 school. Previous skills needed for this unit are science notebook use, compound microscope use, and group-work skills.

Science module: *Diversity Of Life, (investigations 1 and 3)* FOSS Life Science Curriculum (Delta Education, 2003).

Unit Length: 1 school day of field work and 8-10, 55-minute sessions

Public Presentation: Students will work in groups and as a class, in conjunction with the Technology in Education specialist, Art teacher, and science teacher, to produce a class pod-cast presentation of their discoveries. This pod-cast will be developed throughout the larger Diversity of Life Course, and will be transmitted as the culminating activity after all units in the course are complete.

Activity 1:

"What's in the Pond?" - The Field Trip

Relationship of this Lesson to the unit: This will be the engaging activity and start of the "Diversity of Life" Unit. Students will visit Houghton's Pond and Ponkapoag Bog in the Blue Hills Reservation, in order to observe, experience and collect data and samples of "life."

Massachusetts Frameworks Strand and Learning Standard:
Strand 2: Life Science (Biology)
Learning Standard:
Classification of Organisms:
1. Classify organisms into kingdoms according to characteristics they share.
Living Things and Their Environments:
13. Give examples of ways in which organisms interact and have different functions within an ecosystem that enable the ecosystem to survive.
Energy and Living Things:
14. Explain the roles and relationships among producers, consumers and decomposers in the process of energy transfer in a food web.
15. Explain how dead plants and animals are broken down by other living organisms and how this process contributes to the system as a whole.
Changes in Ecosystems Over Time:
17. Identify ways in which ecosystems have changes through geologic time in response to physical conditions, interactions among organisms, and the actions of humans.
Strand 1: Earth and Space Science
Learning Standard:
Earth's History:
6. Describe and give examples of ways in which the earth's surface is built up and torn down by natural processes (i.e.: drumlins and eskers)

Concepts:
- The world is a laboratory.
- Life exists in many shapes, forms and environments.

Process:
- Measuring and collecting data
- Observing

Science Habit of Mind:
- Be curious. Be careful and accurate in observations.
- Keep records of investigations and observations and do not change them later

Other Subject Area Objectives:
- Embedded: ***writing*** in lab notebooks; ***drawing*** of organisms & habitats: **history**- discussion of area's history: **Geology –** discuss and hopefully see local drumlins: **math** – percentages, estimation and areas

Session Length: 1, 55 min. class and I school day

Materials Needed:

Permission Slips (distributed 3 wks prior; collected completely 1wk prior)
Extra shoes or boots (collected with permission slips)
Obtain permission from Park Service for sampling in the park (1-2wks prior)
Make appointment for Ranger to give a presentation (do ahead)
Bus Transportation
Lunches
Bug spray
Digital camera

For Each Group of 4 (8-10 groups):

- 1 Chaperone
- 1 PVC quadrat
- Large sample net
- 2 Water basins or buckets
- 1-2 large containers with lids
- 4-6 small containers with lids
- 2 pond guides
- 2 magnifying glasses
- Rubber gloves
- Field notebooks
- “Minipond Setup” handout
- 1 ½ Liter container with lid
- Plastic spoon

Class Activity 1
“Life in the Pond and Bog”
Day 1

TIME	PROCEDURE	CONCEPT
Before class	Choose “buddies” (2s) and research groups (4s) Check over permission slips and spare shoes Review history of the Blue Hills Reservation and local field guides Prepare slide show of previous year’s trip Confirm bus and chaperones Put up details of this activity on the “Activity Agenda” on side board.	
10 mins.	Assign “buddies” and research groups; discuss roles, responsibilities and practices expected. Discuss behavior requirements and expectations for the trip. Ask for questions about the trip; what they expect, what they want to see and do, what they are worried about, etc.	Responsibility
25 mins.	Have each research group discuss and record what they think they will encounter, observe or experience on the trip. Be able to explain why (previous experience, from field guides, from other ponds). Let research groups choose to research bogs or lakes, via the library and computer lab. (Try to make sure there are enough groups researching each.) Have them create information reports on their topic – characteristics, inhabitants, dynamics, and how they developed geologically. Make hypotheses about what importance they hold in the ecosystem/environment/community, human impact on, etc.	Formulating Hypotheses
10 mins.	Reporters present their ideas and information Make a class data chart of bog and lake comparisons (have each record the final class consensus in their field notebooks	
5 min.	Show slide show from last year’s class trip to the Blue Hills	
5 mins.	Have students put their science notebooks away. Review Pond Field guides for (HW), include a list of 5 specific things you want to find. What about them makes you interested in them? Where do they fit in their ecosystem (i.e.: producer or consumer, particular niche, symbiont or parasite)?	

Class Activity 1
Day 2

TIME	PROCEDURE	CONCEPT
Before the trip	Inventory supplies and materials for the trip Check that all requested lunches from the school are ready	
10 mins.	Take attendance make sure all students that have permission slips are accounted for. Send any without permission to Mr. Smith's class for the day Have them get their materials, shoes, lunches	
35 mins.	Load Bus and drive to the Reservation On bus: Give "responsibility" assignments (who is responsible for what materials) Quick reminder of their personal responsibilities (behavior, procedures, etc)	
25 mins.	Benchmark lesson on use of quadrats for studying ecosystems and populations; estimation of content and area Discuss sampling and recording procedures Reinforce the idea that they should disturb the environment al little as possible – they should try to leave a place the same or better than they find it; humans impact on nature Introduce the Miniponds: "We will be looking at different types of living organisms. It is important to provide each of them with an appropriate habitat. Some of them are small aquatic organisms. We need to put together a minipond habitat now so it will be nicely aged and ready in the next couple weeks when it is time to start our work with aquatic organisms." To Prepare Miniponds: Each group of four will create one minipond. Have the "minipond setup" handout for each group a. Place one spoon of soil in the bottom of a half-liter container. b. Add a small quantity of the dried leaves, dead grass and twigs collected on the field trip (no more than ¼ full) c. Add water sample from the pond to ¾ full. If there is not enough pond water, have them add bottled water. d. Place the lid on the container e. Label the container with group number, period, and date. Check that all chaperones know the return to "base" time	

90 mins.	When you arrive, have research groups head out around the pond Have them collect samples of “life” (digital cameras and drawings of things that can not or should not be disturbed, and physical samples (that are allowable; that wont disrupt ecosystem or organism) Make sure each group collects a water sample Have them take population surveys with quadrats and record information for at least one quadrat per group As they perform their research circulate around the pond and monitor progress Help identify or answer questions Photograph the expedition Return to base at designated time	
20 mins.	Presentation from park rangers on local habitat and history	
30 mins.	Lunch and free time	

10 mins.	Load bus and go to the bog Brief reminder of bog info and safety – required gloves	
90 mins.	Have research groups head out around the bog and perform similar tasks as for pond; altered some for bog fragility – only one water sample per group, one quadrat, closer monitoring As they perform their research circulate around the bog and monitor progress Help identify or answer questions Return to base at designated time	
35 mins.	Take attendance, inventory supplies Load Bus and drive to the school For HW – Have students write down their ideas about what things they have observed or collected today are living and what things are nonliving. Ask them to write down what they think defines living things, including examples that distinguish living and nonliving things. Return materials to science room and dismiss students	

Assessment (Activity 1)

	Method	Novice	Competent	Expert
Process Skill Measuring and collecting data Observing	Observation, field journal notes, ideas an questions generated in research	Few, inaccurate, incomplete records, observations or illustrations; poor data sets for quadrats.	Observations, records and illustrations mostly accurate and complete; relatively good quantitative quadrat data but may lack depth of data or number of replications	Accurate, detailed records and illustrations. Numerous, in-depth quantitative quadrat data. Made observations on relationships of items observed.
Habit of Mind Be curious. Be careful and accurate in observations. Keep records of investigations and observations and do not change them later	Observation, field journal notes, ideas an questions generated in research	Few, inaccurate, incomplete records, observations or illustrations; poor data sets for quadrats. needed constant reminders.	Observations, records and illustrations mostly accurate and complete; relatively good quantitative quadrat data but may lack depth of data or number of replications; needed some prompting.	Accurate, detailed records and illustrations. Numerous, in-depth quantitative quadrat data. Made observations on relationships of items observed: no prompting required to record data
Concept Life exists in many shapes, forms and environments	Observation, field journal notes, ideas an questions generated in research Homework	Student understands that there are things that are alive and that are innate, but may not see or understand less obvious examples of “living.” May not understand the ability of things to be living in harsh environments (acidic)	Student understands that life is diverse. Can find many examples of living things during the exploration. Understands life can exist in harsh environments but maybe not relate that ability to adaptation	Student can find many examples of living things during exploration. Sees relationships to environments and adaptation of life. May understand life cycles

Class Activity 2
"Got Life?"

Relationship of this Lesson to the unit: This will be the second activity in the "Diversity of Life" Unit. Here students will begin to differentiate living and non-living things, developing an operational definition of "living."

Massachusetts Frameworks Strand and Learning Standard:
Strand 2: Life Science (Biology)
Learning Standard:
Classification of Organisms:

1. Classify organisms into kingdoms according to characteristics they share.

Concepts:

- Living and non-living things may seem similar, but can be distinguished by closer examination and definition.

Process:

- Defining operationally

Science Habit of Mind:

- Be curious. Be careful and accurate in observations.
- Seek better reasons for believing something than "Everybody knows that…"

Other Subject Area Objectives:

- Embedded: ***writing*** in lab notebooks; ***drawing*** of organisms

Session Length: 1, 55 min. classes

Materials Needed:
For Class:

Camphor crystals
1 Ziploc bag
1 Petri dish
1 set of living/non-living pictures
Pictures of "discoveries" from the trip
Overhead projector

For Each Group of 4 (5-6 groups):

- 2 sets of living/non-living cards
- Field notebooks from trip
- "What is Life" handout

Class activity 2
"What is Life?"
Day 1

TIME	PROCEDURE	CONCEPT
Before class	Prepare camphor crystals – one packet for each class, sealed in plastic bag Print out photos from the trip; large enough for class to see samples – try to decipher what each is of. Put up details of this activity on the "Activity Agenda" on the side board. On the Board: "Got Life?: Living – Non-Living" chart	
5 mins.	Collect homework Introduction: "Over the next several weeks we will be studying life. We will try to figure out how living things are similar to each other and how they are different from each other. We will study the characteristics of living things that separate them from things that are not alive." On the board write: What is life?, How can you tell when something is living and when something is nonliving?, Describe some examples.	
15 mins.	Have Camphor demonstration: Place the Petri dish on the overhead projector. Fill it half way with water. Point out that the size of the Petri dish seems larger on the projection screen – the projector magnifies the dish. Instructions for students: In "part 1" of the "What is Life" handout, write down everything they observe happening in the Petri dish. Teacher then sprinkles camphor crystals on the water Allow 2-3 minutes for individual observations Then have groups compile a list of observations (3-4 min) Have each group share one observation and create a class list Have students add any new ideas to their own lists on their handouts. Ask: *How can you explain what you observed? Why do you think the little objects are doing what they are doing? Who thinks the material is alive? Who thinks it is nonliving? What is you evidence to support your ideas?*	Observing
5 mins.	Discuss the evidence of Life: Ask: *How many of you think you can tell if something is living? What evidence do you look for to make that determination?* Define evidence, as information that supports or proves a point – evidence of life would be observations that support or prove that something is alive. Write a list of what they come up with on the poster paper under the title "Evidence of Life"	Defining operationally
10 mins.	Introduce the picture cards: "These cards show objects that may be living of nonliving. Work in pairs to organize them into 'living' and 'nonliving' piles."	Categorizing

	Explain procedure: Have them take turns choosing a card and placing it in a pile. They should explain their choice of pile to their partner – “you can just tell” is no a proper argument! If both partners agree, they continue with the second partner selecting and explaining. If they cannot agree, they should create an “undecided” pile. Have them record their results in part 2 of “what is life” handout.	
10 mins.	Create the “piles” on the board: Hold up the cards and ask one person from a group where it belongs and why. Continue with someone answering from each group until cards are complete. Show them the pictures from the field trip and ask in which piles they belong. Question results: “Does everyone agree that this picture is in the correct category? Could this picture be placed in another category? Why? What might lead you to think it belonged there?” Prepare for answers such as “it moves,” or “it breathes and needs oxygen.” (a rocking horse moves, fire needs oxygen) Clean up – getters return picture sets	Operational definition of life
10 mins.	Discuss “organisms”: Write the definition of Organism on the board “Any living think, plan animal or other, is an **organism**. Organism is the most general word used to refer to an independently living thing.” Revisit “Evidence of Life” list Ask: “Is everything on this list a characteristic of all organisms? Are there other characteristics of organisms we need to add to our list? For Homework have students reanalyze their answers in part 2 of the “what is Life” worksheet and compare with the created class consensus list. For Homework – Have them categorize items from home into “organisms” and “non-organisms.” At least 6 each. They should include reasoning.	Thread to tomorrow

Assessment (Activity 2)

	Method	Novice	Competent	Expert
Process Skill Defining operationally	Class participation, Homework	Will offer simplistic or "non" arguments for defining life. Will simply accept definitions of others without thought or evidence; little effort or participation in class or HW	Will question definitions of others, but will not argue strongly if they disagree; will offer definitions, but may have flaws; may use some evidence for definitions. Good effort in HW and class	Will understand definitions and will only accept those offered with solid reasoning or evidence. Excellent HW and participation in class
Habit of Mind Seek better reasons for believing something than "Everybody knows that…"	Homework, Data sheets, class observation	Will offer simplistic or "non" arguments for defining life. Will simply accept definitions of others without thought or evidence.	Will question definitions of others, but will not argue strongly if they disagree; will offer definitions, but may have flaws; may use some evidence for definitions	Will understand definitions and will only accept those offered with solid reasoning or evidence
Concept Living Vs. Non-living	Homework, worksheets and	Will have poor understanding of or will not accept most evidence for differentiating living and non-living.	Understands offered definitions of living and non-living, may not be able to offer own evidence for defining.	Has clear understanding and can offer solid evidence for operational definitions.

Class Activity 3
"Characteristics of Life?"

Relationship of this Lesson to the unit: This will be the third activity in the "Diversity of Life" Unit. Here students will begin to develop a working list of characteristics of "life." They will be able to differentiate the concepts of living, nonliving, dead, and dormant.

Massachusetts Frameworks Strand and Learning Standard:
Strand 2: Life Science (Biology)
Learning Standard:
Classification of Organisms:
1. Classify organisms into kingdoms according to characteristics they share.
Structure and Function of Cells:
2. Recognize that all organisms are composed of cells, and that many organisms are single-celled (unicellular).

Concepts:

- All living organisms share common characteristics; they grow, consume nutrients, exchange gasses, respond to stimuli, reproduce, need water, eliminate waste, and are composed of cells.

Process:

- Sets up experiments
- Defining operationally

Science Habit of Mind:

- Be curious. Be careful and accurate in observations.
- Seek better reasons for believing something than "Everybody knows that…"

Other Subject Area Objectives:

- Embedded: ***writing*** in lab notebooks; ***drawing*** of organisms

Session Length: 4, 55 min. classes

Materials Needed:
For class:

Large Poster-paper sheets for creating class "Characteristics of Life" list
Baking pan
6 droppers
Plant cuttings
Assorted containers
Toothpicks
1 container, ½ liter
2 sets of cards, called "Liquid Stations Instructions"
1 "Evidence of Life" overhead
1 "Life in Different Environments" overhead
6 graduated cylinders

Blank paper
3 500 ml beakers
Red food coloring
Kosher salt
Sugar
Paper towels
Scissors
Brine shrimp eggs
Bottled water

For Each Group of 4 (5-6 groups):

5 vials, 12dr with caps
1 vial holder
6 labels
2 Hand lenses
1 Cotton ball
5 Zip bags, small, labeled A-E
A Red sand and spoon (5ml)
B Dried yeast and minispoon (half packet)
C Polyacrylate crystals (dyed red previously) (5ml)
D Radish seeds (5ml)
E Brine shrimp eggs and minispoon (10 minispoons)
4 "Five Materials Observation" worksheet
4 "Is anything alive in here?" worksheet
4 "Life in different environments." Worksheet
4 "Life on Earth" handout for homework

Class Activity 3
Day 1

TIME	PROCEDURE	CONCEPT
Before class	Prepare Unknowns (in accordance with materials list above) and liquid environments (30 ml Kosher salt + 300ml water; 30ml sugar + 300 ml water; 300 ml water alone) Plan liquid stations – There should be three stations for liquids that are far enough apart to prevent mixing up of liquids; each station has one liquid, two copies of the stations' instructions, two graduated cylinders, and two medicine droppers Obtain plan cuttings: ivy, mint family, small tree or bush branch with leaves, sweet potato, cut flower. Culture Brine Shrimp	
5 mins.	Review "Evidence of Life" list and evidence statements Create a "Characteristics of Life" Display with well spaced, labels for each characteristic listed on the class' "Evidence for Life" list. Explain that this is an emerging **operational definition** for living organisms (a working definition based on current information)	
10 mins.	Introduce Mystery Bags: "I have five different materials to look at. They may be living, but I am not sure. Lets see what we can find out by observing them and using our operational definition of life to guide us."	Differentiate

	Have students observe contents of the 5 bags (A-E) with hand lenses (keep bags closed) After 3-4 minutes ask students which bags they think may have living material in it. Ask: "What might we do to get more information about the materials to help us determine if they are living? Suggest a set of investigations to find out if providing aquatic or moist environment will yield more evidence to determine if the contents are alive or not. Have students fill out the first column of "Five materials Observations" handout; include illustration and scale.	
15 mins.	Explain there are "3 environments" available (3 liquid stations) for exploration. Each group will provide only one of the environments for all five of their materials – assign liquid 1,2,or 3 to each group (2 groups for each liquid) Have students use "Is anything alive in here" handout as their protocol: Set up the vials – make sure they label all items well Observe and assess student ability to follow protocol Have one set of groups go to each liquid station (when they finish, send up second groups) Teacher - Monitor and guide liquid addition Students - add unknown materials	Sets up investigations
10 mins.	Review Living/ Nonliving and Undecided groupings: Ask: "are there any items in the undecided category that you think should be moved to living or nonliving? Have you discovered any additional characteristics of life that should be incorporated into our operational definition?"	Operational definition
10 mins.	After ten minutes, ask students to observe vials again. Have them record observations on the "Five Materials Observation" handout. Make sure they record something for every vial – "No Change" should be marked for items that do not appear different.	Observation
5 mins.	Clean up and return materials HW- Proposals for pod-cast presentations (content, techniques, grouping tasks, etc.)	

Class Activity 3
Day 2

TIME	PROCEDURE	CONCEPT

Before class	Have materials ready	
20 mins.	Have getters get the vial set for their group Have students record the 24hr observations on their handouts Ask: "do you notice any changes in the vials today? Do you see evidence of life in any of the vials? Which ones?" If groups have popped lids or froth, ask them to speculate about what may have happened. Have groups observe another group's vials who used a different number liquid – suggest the notice differences in smell, appearance, etc.	
15mins.	Discuss Liquid 2 results: Let the students know that liquid 2 is sugar. Sugar is a source of food and was added in case any of the materials were alive and need food. Ask: "Did any of the vials with added sugar show any interesting results?" Ask if they determined why. Tell students: "Material B was yeast. The bubbling and popping cap are the result of gas exchange going on in the vial. Gas exchange is evidence of life. The yeast is alive." Assure skeptics that they should and will investigate this statement further.	Introduce gas exchange as evidence of life
15 mins.	Take out the plant cuttings – ask: "Are these living? Are they Organisms?" [Wait] "What will they need if they are alive?" When someone suggests putting them in water, set up rooting jars. They will observe these over the many weeks.	Sets up investigations
5 min.	Clean up HW - For homework have them read " Life on Earth" handout and answer questions at the end. Remind them to review unit so far for mid-unit exam.	

Class Activity 3
Day 3

TIME	PROCEDURE	CONCEPT
Before class	Make sure materials are available	
20 mins.	Collect answers to HW questions. Have getters get the vial sets and hand lenses for their group.	

	Have groups continue to fill out "Five Materials Observations" data sheet Ask: "Are there any changes in the vials today? Are there any new materials showing evidence of life? Which ones?" Monitor their recording to be sure they use illustrations and reasoning. Have students fill in the last column with their living/nonliving evidence. Have students organize their data on "Life in Different Environments" handout. Ask them add in the liquid identifications, and if they have identified any of the other materials, have them add them. Confirm correct responses and let them know the others. Have them complete the liquid environment questions.	
20mins.	Compile a data chart with Class consensus: Have saltwater groups report their results. Record the info on the "class list" and have students add this to their sheets. Repeat this for Sugar water groups and Plain water groups Analyze Data: Ask students to take 3-5 minutes to work in their groups to make sense of their data. Ask: "How many of the materials appeared to be alive when you first observed the bags? How many of the materials appear to be alive now, 2 days after they were placed in the liquids? How does the environment affect organisms? Have reporters share their group's ideas. Look for (and add if necessary): "Some organisms can appear to be nonliving. When organisms are put into an appropriate environment, they can become active. Different organisms have different environments that allow them to become active." Review which organisms became active in which environments. -Yeast needs fresh water and sugar -Seeds need fresh water and air -Brine shrimp need salt water	Differentiate living, non-living, dormant and dead
10 mins.	Discuss definitions:	
5 min.	Clean up – have them add the brine shrimp to a larger culture to save for extension for later in the larger course. HW – revise pod-cast proposals	

Class Activity 3
Day 4

TIME	PROCEDURE	CONCEPT
25 min	Collect HW Have students take Mid-Unit summative exam	
30 min	Have groups work on pod-cast projects Make sure they are working on content and/or technical skills for project	

Assessment (Activity 3)

	Method	Novice	Competent	Expert
Process Skill Sets up experiments Defining operationally	Class participation, Worksheets	Doesn't follow protocol carefully. Incomplete worksheets, or little input in operational definitions.	Follows protocol well, but may have a few mistakes. Participates in operational definition discussions, but may not relate them to external circumstances	Follows protocol, no errors. Understands reasoning behind steps of protocol. May offer alternate ideas. Can relate operational definitions to other situations
Habit of Mind Be Curious. Seek better reasons for believing something than "Everybody knows that	Homework, worksheets, class observation	Will offer simplistic or "non" arguments for defining characteristics. Will simply accept definitions of others without thought or evidence. Minimal class participation	Will question definitions of others, but will not argue strongly if they disagree; will offer definitions, but may have flaws; may use some evidence for definitions. Participates in class	Will understand definitions and will only accept those offered with solid reasoning or evidence. Participates in class and leads experiments or discussion
Concept All living organisms share common characteristic s	Class participation, Homework, worksheets, mid-unit quiz	The student identifies at least one point to discuss, but has little or no relevant new information to offer. Can't relate the characteristics list to external world; all organisms.	The student identifies at least one point to discuss and can adds some of their own ideas. Ideas may not be complete. Understands the connections between the organisms we observe and all organisms.	Accurately presents all content; shows reflection about own learning by correcting inaccurate information, support accurate information with evidence, or enhancing the information initially given. Can relate class observations to all organisms.

Activity 4:
"The Hunt For Life"

Relationship of this Lesson to the unit: This activity is part I and II, of Investigation 3, microscopic life, of this of the FOSS Diversity of Life Course, and the fourth activity in my unit. (Day 2 and three of this activity were used for my field experience at the Baldwin School in Cambridge, MA, April 25th and 26th. The plan was altered from the one below because paramecium cultures had not arrived in time. Parts of the alternate day plan I used was not included in my unit here, but will be discussed in the reflection at the end of this unit plan).

Massachusetts Frameworks Strand and Learning Standard:
Strand 2: Life Science (Biology)
Learning Standard:
Classification of Organisms:
1. Classify organisms into kingdoms according to characteristics they share (Protista vs. Plantae)
Structure and Function of Cells:
2. Recognize that all organisms are composed of cells, and that many organisms are single-celled (unicellular).
4. Recognize that within cells, many of the basic functions of organisms are carried out. The way in which cells function is similar in all living organisms.

Concepts:
- Cells are the basic unit of life
- Paramecia are both single cells and living organisms.
- To observe and understand the differences between something that is living and something that is an organism (Organism: is an independent living thing).

Process:
- Conducting investigations
- Classifying organism vs. non-organism

Science Habit of Mind:
- #2= look at things closely before drawing conclusions. Don't base conclusions on a single observation. Deliberate and examine until you are as sure as you can be

Other Subject Area Objectives:
- Embedded: ***writing*** in lab notebooks; ***drawing*** of organisms & cells

Session Length: (3) 55-minute period

Materials Needed:
For Each Group of 4 (6 groups):

2 Microscopes
1 microscope kit
1 Dropper bottle of Congo Red-dyed yeast
1 plastic cup
Colored pencils

4 *Looking as Elodea* handouts
4 *The Lowly Paramecium* handout & questions
4 *Paramecia* Handout
4 *Feeding Time* Handouts

For the class (24 students):

1 Basin, clear, 6 liter
8 springs of *Elodea*
FOSS CD-ROM
1 Petri dish
Vinegar (day 2)
Paramecium culture
Water

Congo red stain (day 2)
3 droppers
1 overhead projector
1 transparency *Paramecia* (no.3)
1 transparency *Feeding time* (no 4)

Class Activity 4
Day 1
"THE HUNT FOR LIFE"

TIME	PROCEDURE	CONCEPT
Before class	Prepare the *Elodea* wet mount center: Use plant samples from field trip if possible, or have small samples of pond water ready for slide preparation in order to have opportunities for students to see paramecium on their slides while observing the *Elodea*. Have plants in a basin, just covered with water, droppers, slides and coverslips Review wet mount procedure Review cytoplasmic streaming using the FOSS CD-ROM – have projector hooked up in order for students to see it also when needed in class.	
5 mins.	Introduction: Tell students, "The microscope allows us to observe things that are too small to see with our eyes alone. Today we will use the microscopes to look at living material to see what we can learn. We will start by looking at the leaves of an aquatic plant called *Elodea*." Have pairs preview the first two tasks of the "Looking at Elodea" worksheet Benchmark demonstration of a wet-mount preparation: Explain how the leaves grow out from the stem at an angle towards the tip. Mention how this will allow them to orient the plants in order to determine tops and bottoms of the leaves, because mounts should be made with the tops of the leaves up. Remove half a leaf and place topside up onto a slide. Cover with a coverslip. Use a dropper to flow one drop of pond water under the coverslip.	
10 mins.	Have each group go to the wet-mount station and prepare slides. As the look at the slides, remind them to observe the leaves on several planes (focus up and down through the leaf). Ask: "What do you see when you look a the *Elodea*? [Squares and rectangles] "When you focus up and down through the leaf, what do you notice?" [Green squares and rectangles] "Are the rectangles flat, like designs drawn on the surface of the leaf, or are they three-dimensional?" [3-D, like blocks or bricks] "Are the blocks empty?" [No they have green dots inside] "How many layers of these blocks do you see?" [Two – a layer of big ones and a layer of small ones]	Following protocol

	Make sure students are completing part one of the worksheet	
20 mins.	Call attention. Ask: "Does anyone know what these boxes we are seeing are?" [Wait] Explain; "They are **cells**. Cells are the units from which the *Elodea* leaf is made. The cells are too small to be seen with the naked eye but can be seen well with microscopes." Have students to set the microscopes to 400x and complete part 2 of the worksheet. (Remind them about how to estimate size from earlier microscope investigation on "Field of View and Magnification") Try to ensure students are drawing only what they really see; proportionate, detailed, etc.	Cells are basic units of life
10 min.	Discuss cell size: Ask: "Are all of the cells in the *Elodea* leaf the same size?" [No] "How many layers of cells are there in an *Elodea* leaf?" [Two] "Are the large cells on the top of the leaf or the bottom?" [Large on top] "How bid are the cells?" [Large ones are about 0.1mm long and the small ones are about 0.05mm] Present the history of the word CELL: *In the middle of the 17th century, more than 300 years ago, the microscope was a new invention. A man named Robert Hooke was one of the first people to use one to look at plants. He looked at a thin slice of cork under the microscope and saw that it was made of hundreds of subdivisions. He thought they looked like little rooms. They reminded him of the tiny rooms, called cells, that monks lived in at the monastery. In a book that he wrote in 1665, Robert Hooke was the first to describe the tiny units in the plants that he observed as cells. The work caught on and is still used today.*	
5 mins.	Have students to review the answers to item 3 in part 2 on their worksheets. Ask: "Did you notice anything moving inside any of the cells? What did it look like?" [Wait] Have some explain what they saw. [If any mention "bugs" moving on the slide outside the cells, have them describe what they saw, hypothesis about what it was, and draw their observations in part 3 of their worksheets] – Let them know they will investigate them further in the next activity. Show FOSS CD-ROM of the Cytoplasmic streaming. Explain, "Cells are filled with fluid called **cytoplasm**. Cytoplasm can sometimes be send moving inside the cells of living plants." Ask if anyone knows what the "green balls" moving in the cytoplasm are. Wait – then offer the term **chloroplasts,** structures that give plant their green color and allow photosynthesis. Let them know they will	Thread to next activity

	investigate this more in 8th grade when they study photosynthesis in detail.	
5 mins.	Clean up	

Class Activity 4
Day 2
"THE HUNT FOR LIFE"

TIME	PROCEDURE	CONCEPT
Before class	Check the paramecium cultures. Divide some of the culture into 6 cups. Organize the materials for the lesson Review procedures and facilitating questions <u>ON the Board</u>: "Organism" definition Agenda and timeline for project managers If/Then list (if you cannot find a specimen, try X then Y) HUNTERS (2)= find initial specimens PROJECT MANAGERS = keep everyone on task REPORTERS = report findings to class	Patience and persistence
5 mins.	Introduction: Review definition Living and non-living: living things are defined by: [Requires H2O and a source of NRG, eliminates waste, has gas exchange, reproduces, grows and responds to stimuli] **Was the Elodea alive**? **What is the evidence**? (Cytoplasmic streaming) Discuss what they saw on the Elodea slides. **Did anyone see anything else on the slides they thought was alive? What made them think it was alive? What do they think it is? Is it living or nonliving – what is your evidence?** Introduce "Paramecia" (single=paramecium) **Ask students to anticipate problems they may encounter in trying to observe the paramecia** (small and fast)	Review and connect to previous parts of the BD Course
20 mins.	Discuss and demonstrate the paramecia wet mount using cotton filaments Have them prepare the slides – encourage them to move the cups of paramecia smoothly and let them settle while they add the filaments. Draw a drop of solution from the BOTTOM of the cup and drop onto the filaments – cover with cover slip Start search on 4x objective (describe what to look for: tiny jiggling ovals in one area or moving quickly) Have students fill out the Paramecia Handout Circulate –make sure they are seeing the right organisms -Make sure they are recording the internal structures as well as outer	Scientific procedure for microscopy Observe and record Data accurately and

	shape -Refer to Investigation 2 if asked how to measure the paramecium (i.e.: field of view at each magnification - so they can approximate size)	in detail
5 mins.	Reporters discuss their observations: I Look for: Movements (internal and external)? Inside the paramecium – organelles? Outside the paramecium – cilia, groove)? Size? (Less than 0.5mm) Make a class list	Reporting and Analyzing observations
15 min.	Compare Paramecia with Elodea – - **What** did the microscopic structures look like in each? [Elodea cells look like bi-layer of green bricks] -**What** about the Paramecium? Did it look like cells? [No bricks, but did have things inside] -**Do** the insides look similar? [Both have round structures, but color differences] Introduce paramecia as Single-Celled Organism – not made up of cells because each paramecium is itself a single cell (Just like the "bricks" of the Elodea are individual cells) *Elodea plant is a multicellular organism *Paramecium is a single-celled organism *Both the plant and the paramecium can live on their own *The single Elodea cell is alive but not independent and therefore not an organism Ask groups to discuss "How are Elodea cells and paramecium cells different? (Let them discuss 3-4 min) Have them enter the ideas in a data chart (list of similarities and differences) in their science notebooks, Reporters offer consensus to the class and we create a class list on the board. Review ORGANISM – have them write the definition into their lab notebooks "Remember our definition of an organism is any living thing- a plant, and animal, or any other life form – that is free-living. An organism is always free-living, that is, it is not a part of a larger organism. -**Can** a single cell be a living organism? (Yes) -**Can** a single cell NOT be a living organism? (Yes) -**Is** an Elodea leaf cell a living organism? (No) -**Is** a paramecium cell a living organism? (Yes) **Is** it Living? What is your evidence? *[If they say because it moves, ask if*	Understand *organism* Classify Organism vs. Alive

	Styrofoam floating down a river moves - is it alive?] **Could** you observe all listed things in our definition of *living organism*? (No) **Did** you see it eat or use NRG? Give off Waste? Reproduce? **How** can we see some of these? Discuss feeding Tell students that in their next class, they will be able to observe the paramecia feeding – to confirm the operational definition of LIVING – requires food.	Thread to tomorrow
5 mins.	Have students clean up benches, microscopes, kits and put their science notebooks away. The Lowly Paramecium – read and answer questions (HW)	

Class Activity 4
Day 3

TIME	PROCEDURE	CONCEPT
Before class	Check the paramecium cultures. Divide some of the culture into 6 cups. Organize the materials for the lesson Set up Congo red Demonstration (put a Petri dish on the overhead; add a few ml. of H2O and few drops of Congo red yeast - should be pink) Review procedures and facilitating questions	
5 mins.	Introduce feeding – One characteristic of living organisms is the need for food Hand out Feeding Time worksheet Go over procedure: a. Prepare the wet mount with paramecium b. Add one drop of Congo red-dyed yeast to the mount before cover slip c. Locate paramecium and look for evidence of it's eating the yeast d. Observe first in 100x and then 400x - Record observations with text and drawings Demonstrate the Congo red color change (dye makes it easier to see and is and acidic indicator) – "watch what happens when acids interacts with the Congo red yeast" Demonstration: a. Add a few drops of vinegar to the solution and let students observe the change - **What** happened when I added the acid to the Congo red? [Turned blue] - **How** can this be used as an indicator of feeding? [Acid turns the red to blue] **digestive enzymes?**	Review and connect to previous Day

30 mins.	Feeding investigation: (it will take 15-20 min for the dye to turn blue in the vacuoles) Circulate and ask facilitating questions: The paramecia don't have legs. How do you think they move? How do they get the yeast inside their bodies? Do they have mouths? How do they get rid of waste? What keeps the insides from spilling out? What does the yeast inside the paramecium look like?	Observation
15 mins.	<u>Distinguish between "alive" and "organism"</u> *Characteristics of life are also the characteristics of cells. ***Life happens in cells and only in cells** ***Cells are the fundamental units of life** – some live alone, and some live with millions of others *Both are alive *Not all cells can live independently, therefore not all cells are "organisms" Introduce **Protist:** Ask about the Kingdoms of life – paramecia, single-celled organisms are in PROTISTA [Greek root = early, very first] – most are single-celled, with well-defined nucleus. NOT animals because animals are always multicellular. **Is there anything we need to add to the Characteristics of Life chart?** -"Is made of cells" should be added Summarize: Ask groups to present their findings (Water-expelling vesicles – bubbles that seem to burst)	Classification
5 mins.	Have students clean up benches, microscopes, kits and put their science notebooks away. Microscopic Life worksheets (pg19) – read and respond (HW)	

Assessment (Activity 4)

	Method	Novice	Competent	Expert
Process Skill Conducting investigations Classifying organism vs. non-organism	Observation, lab notes, ideas an questions generated in research	Few, inaccurate, incomplete records, observations or illustrations;	Observations, records and illustrations mostly accurate and complete	Accurate, detailed records and illustrations. Made observations on relationships of items observed.
Habit of Mind Be curious. Be careful and accurate in observations. Keep records of investigations and observations and do not change them later	Observation, lab notes, ideas an questions generated in research	Few, inaccurate, incomplete records, observations or illustrations; needed constant reminders.	Observations, records and illustrations mostly accurate and complete; needed some prompting.	Accurate, detailed records and illustrations.. Made observations on relationships of items observed: no prompting required to record data
Concept Cells are the basic unit of life. <u>Organism</u>: is an independent living thing; can be unicellular or multicellular	Observation, Worksheets. Homework	Struggles with the idea of cells; little or not understanding of organisms being free living.	Understands what cells are, and may recognize that they are the basic units of life, but may not understand that all living things are made of them. May have some understanding of organisms.	Understands all living things are made of cells. Generates evidence to support the idea that paramecia are organisms. Understands organisms are free-living.