POND SCUM AND AGNES PFLUMM

THE AUTHOR'S STE*A*M CURRICULUM GUIDE

HOW TO MOTIVATE YOUR SCIENCE STUDENTS TO READ, WRITE, THINK CRITICALLY, and *COMMUNICATE THROUGH THE ARTS*
THE IMPORTANCE OF ENVIRONMENTAL PROTECTION AND HAVING KNOWLEDGE ABOUT AQUATIC HABITATS

NOTE TO TEACHERS: On June 7, 2006, I attended the first ever **Conference on Ocean Literacy** (CoOL) in Washington, DC. (**http://www.nmsfocean.org/chow2006/cool.html**) I came home inspired and determined to have Agnes Pflumm become an **Ambassador for Environmental Literacy**. **Each of my last two books deals with the very serious issues of human impact on the earth's aquatic environments, both marine and freshwater**. I have made it my life's work to **bring students to science through reading.** It is my hope that my books and curriculum will not only inspire students to read about science but to become **stewards for this ocean planet on which human survival depends.**

TIME FRAME: Will vary according to your own scheduling demands.

STANDARDS: NGSS Science and Engineering Practices and Cross Cutting Concepts, grades 7-8, DCI: Life Sciences / Earth and Space Sciences / Engineering, Technology, and Applications of Science

MATERIALS: As with the other *Agnes Pflumm* books, it is optimal for each student to have a copy of *Pond Scum and Agnes Pflumm*. Most schools are using the *Agnes Pflumm* books at sequential grade levels. Many have purchased classroom sets using grant monies. Collaboration and communication among different grade level teachers can result in a curriculum which reinforces the STEM, literacy, and arts standards required by their states in general and by their schools in particular.

- For example, many schools use ***Agnes Pflumm and the Stonecreek Science Fair*** in the 4th or 5th grade to bring alive the **fundamental process skills associated with Inquiry** *(now referred to as Science and Engineering Practices)*.

- ***No Place Like Periwinkle*** brings to life how forces of nature shape the land and especially **how land, sea, and air merge to create unique habitats like fragile barrier islands, which have been so highly impacted by humans.** These life and earth science strands are most often addressed in the 5th or 6th grades.

- ***Pond Scum and Agnes Pflumm*** seems uniquely suited to the 6th or 7th grade science curriculum, as its **central themes are human impact on watersheds (such as the erosion and run-off of unsecured sediments into streams as well as point and nonpoint source pollution), biodiversity in *and* energy flow through ecosystems, the relationship between biotic and abiotic factors, and the classification of living things through keen observation, study, and drawing.**

- ***Agnes Pflumm and the Secret of the Seven*** weaves into its narrative deeply researched historical data associated with the degradation of previously thriving human cultures and oceanic ecosystems dating to the Age of Exploration and the discovery of the Gulf Stream. It was written to foreground the **Essential Principles of Ocean Literacy** and create an awareness of our influence on the ocean and its influence on us as well as the importance of continued ocean exploration and education.

OBJECTIVES:

(1) **To promote content literacy** in your science classroom through a series of lessons which have been designed to:

a. reinforce content knowledge.
b. provide students with a clear idea of purpose.
c. activate prior learning and advance new content knowledge.
d. ask questions at three levels: literal, inferential, and critical.
e. improve student writing skills through journaling.
f. improve vocabulary skills and content knowledge through graphic organizers.
g. create logical connections between new and previous knowledge.
h. encourage independent reading.
i. bring about positive change in student attitudes toward reading science related materials.
j. teach the **NGSS Standards** in an integrated **STEAM** approach to teaching and learning.

(2) To teach students the **concept of biodiversity** in a community, factors which may affect biodiversity, and how indicator species can be vital clues to environmental quality.

(3) To strengthen student knowledge of **the way scientists classify living things**.

(4) To improve student understanding of the **flow of energy through a pond ecosystem** as well as the roles of producers, consumers, and decomposers in a food web.

(5) To give students the opportunity to **collect, classify, and work** with pond water micro- and macro- invertebrates, and to teach them to document their observations in field study journals.

(6) To introduce students to the science of and **history of microbiology**, the nature of research in this discipline, as well as to give them confidence in **using microscopes and preparing slides** for study.

(7) To enhance student understanding of the **effect of human activities on the stability of ecosystems in a watershed**, especially with regard to the introduction of pollutants into the water and soil:

a. To enable students to learn about the effects of **uncontrolled sediment run-off** into streams.

b. To enable students to discuss the differences between **point and nonpoint pollution** into watersheds.

c. To inform students about **genetic mutations** which may occur in organisms as a result of the introduction of chemical pollutants into their habitat.

d. To encourage discussion of amphibians and fish as important **indicator species**.

(8) To encourage students to **identify and meet local citizens** who have worked tirelessly to protect the environment, effect **mitigation** with commercial land developers, and petition for legislation to insure that habitats are safeguarded in the future.

(9) To familiarize students with the many **governmental environmental protection organizations** and their work.

(10) To drive home the fact that **"perfectly designed solutions do not exist"** and that people must work together to solve problems through the 4 steps of problem solving (as defined in the national standards.)

(11) To convince students that **they can truly make a difference for positive change in the world**.

PREPARATION:

You're about to teach some very important science content and **want to capture your students' interest immediately**. Ideally, you should be armed with the following:

- A copy of *Pond Scum and Agnes Pflumm* for each student.
- A copy of *Agnes Pflumm and the Stonecreek Science Fair* and *No Place Like Periwinkle*.
- A good resource for affordable, durable blank 8 x 10 student journals. I highly recommend the Blank Books available at www.barebooks.com. I count the student work in their sketchbooks as a major test grade for this unit.
- Access to my website www.agnespflumm.com
- An uploaded image of a frog with 3 hind legs.
- These lesson plans.
- Hopefully, a set of microscopes and slides / coverslips.
- A basic water quality testing kit.
- Index cards.
- Pond water samples with viable micro and macro-invertebrates.
- Ideally, a local aquatic habitat which can be studied.
- **Confidence in yourself as a storyteller!**

LESSON 1…. Setting the scene

- As soon as your students walk in, **you should be waiting for them** with your copy of both *Agnes Pflumm and the Stonecreek Science Fair* and its sequel *Pond Sucm and Agnes Pflumm* in your lap. **Hopefully, your students have already learned a lot of science with *Agnes Pflumm*!**

- In order to **set the scene**, hold up your copy of *Agnes Pflumm and the Stonecreek Science Fair* and read the last three paragraphs. Then explain that *Pond Scum and Agnes Pflumm* will begin where the first book left off – with Agnes ruining her shoes by slipping at the edge of the algae covered pond on the campus of Stonecreek Middle School. As such, *Pond Scum and Agnes Pflumm* is a **sequel**. (*No Place Like Periwinkle* is in fact the **prequ**el to *Agnes Pflumm and the Stonecreek Science Fair*. Hold it up for students to see.)

- Write on the board: **SOMETHING IS VERY WRONG!!** Then dramatically read the first paragraph of ***Chapter 1 from Pond Scum and Agnes Pflumm***, having asked students to listen for and write down the biggest hint they hear that there is an environmental crisis in Stonecreek.

- Close your book, and solicit from students the fact that **frogs shouldn't have THREE hind legs! Project the picture of the malformed frog on the overhead**. Are these frogs an ***indication*** that something is wrong with the environment? Of course, the answer is, "YES!"

- Now, distribute copies of *Pond Scum and Agnes Pflumm* and ask students to turn to the back of the book to the section entitled ***THINK ABOUT IT…***

- With your students, read this page, noting the **SEVEN SCIENCE LITERACY SKILLS** they will be developing during this unit on water quality and environmental protection. Ask them to identify their strongest and weakest skills from this list and assure them that by the time they finish *Pond Scum and Agnes Pflumm,* their skills in all of these areas will be much improved. Next, carefully go through the ***Important Instructions*** on how students can organize the learning that will follow. The Appendix was purposefully created to provide essential knowledge about the content and nature of environmental science as a discipline of study.

- Remind students that this book set at a time when there was no internet.

REFLECTION: The **National Assessment of Adult Literacy** (considered one of the best measures of how adults handle everything from completing job applications to calculating tips) found that **"adults who can perform complex reading tasks made an average yearly salary of $50,700 in 2003….$28,000 more than those who lack basic skills."**

POND SCUM: THE REAL STORY

Investigated by (<u>student name</u>)

LESSON 2 …. Activating Knowledge through storytelling and drawing

Turn to the appendix section for Chapters 1-2, **AN *INDICATION* OF TROUBLE**. Invite students to volunteer to **READ ALOUD** the bold- faced background science information material. Ask students to write on the front of separate index cards in their coolest handwritten font the following terms: BIODIVERSITY, BIOLOGICAL INDICATORS, MACRO-INVERTEBRATES, POLLUTION TOLERANCE, SCIENCE, TECHNOLOGY, and ENGINEERING.Then explain that by the end of this book, they will be fluent in

the language associated with these environmental science concepts. The Environmental Protection Agency (EPA) has a comprehensive site on macroinvertebrates as indicators of environmental health: **http://water.epa.gov/type/rsl/monitoring/vms40.cfm** .

- Ask students to make a new entry in their sketchbooks called "Getting to Know Frogs".

- Next, ask students to go to Google Images for "frogs" and have students and quietly notice the similarities and differences between the many types of frogs shown. Then invite volunteers to come up and start a dialogue about the question, "What is the quality of frogginess?" Encourage students to consider all features, especially size, skin, eyes, leg length. Can they agree on one picture that seems to typify frogginess? Ask them to stare at that image and then close their eyes. Ask them if they can "see" the frog behind their closed eyelids. Then, have them do "air drawings" of the frogs with their index fingers. Finally, ask them to complete quick sketches of this frog in their sketchbooks.

REFLECTION AND VISUAL EXPLANATIONS: Frog'-quently Asked Questions (FAQ's) about frogs and toads, Ask students to independently go to the site **http://cgee.hamline.edu/frogs/science/faq1.html**, created by the Thousand Friends of Frogs organization and choose one question which interests them. Ask them to design an illustrated visual explanation of the question on another page of their sketchbooks. Then invite them to teach their visual lessons to each member of their group. ELL students should be paired with a bilingual student if at all possible. Finally, challenge each student to create a videotaped version of their explanation using a drawing app like Educreation. You can ask them to email these to you for group sharing and as an assessment. All student tutorials can be shared on a classroom wiki.

LESSON 3…. ***Science and Technology***

- If your school can acquire one, a flexible video camera attached to a microscope and TV monitor or a special microscope like the *Kenavision* [tm] (which can feed images directly into a TV monitor), is an awesome way to reveal the magical world living inside **a drop of pond water**. Before your students arrive, try to re-create something like the set-up on Agnes Pflumm's desk, illustrated on the cover of *Pond Scum and Agnes Pflumm*. If this is not possible, just refer to the cover illustration for the following lesson on science and technology:

- Invite students to share in a **dramatic reading of Chapter 3**, "Something Borrowed, Something New." NOTE: Any time students read aloud, insist that they sit up straight,

enunciate their words, and speak clearly and with great expression. Remind them of the importance of having good public speaking skills.

- Now is a great time to embark on a discussion of the **difference between science and technology**. Without technology, many if not most of the questions of science could not be answered. In medicine alone, technology allows scientists to extend the range of their human senses to acquire potentially life-saving information about a patient.

- **The relationship between science, engineering and technology** is an important theme in this book. Many students lack an appreciation of the nature of the technology which aids in making scientific discoveries or engineering solutions to real world problems like sewage system management. In middle and high school, students will learn about the following science disciplines:

LIFE SCIENCES
• **Zoology**
• **Botany**
• **Genetics**
• **Human Biology**
• **Ecology**
EARTH SCIENCES
• **Geology**
• **Astronomy**
• **Meteorology**
• **Oceanography**
PHYSICAL SCIENCES
• **Physics**
• **Chemistry**

Instruct your students to open their sketchbooks to new blank page and, using neatly executed typography, write the heading **Illustrated Journal of Science and Technology**. Ahead of time, you should have written the names of each of the above disciplines of science on small strips of paper, folded and put them in a basket. Organize students into five heterogeneous ability groups, and ask the group to choose a leader. Each leader should take two slips of paper from the basket, with one group (a larger group) selecting three. Each group will collaborate to research online to discover at least one example of important technology associated with each disciplines they have selected . In their sketchbooks, each student should create explanatory drawings of how and for what purpose that technology is

used within that discipline. Each group should be then teach the class, using drawings on a class white board, about the technology they researched. The rest of the class will also create similar visual notes. Collect their sketchbooks for a summative performance assessment and share online with parents. Again, these student generated visual tutorials can be recorded with an app like Educreation or Doceri and uploaded to a classroom wiki.

LESSON 4…. An Indication of Trouble

- You should also download and study the incredible curriculum entitled "**Mucking About: Collecting Chemical and Biological Environmental Data with Students**," authored by science educator Karen Spalding of Massachusetts, available as a word document online.

- Finally, I also highly recommend the website entitled **The Stream Study**, developed by the **Save Our Streams** Program of the Izaak Walton League of America: **http://www.iwla.org/index.php?ht=display/ContentDetails/i/1479/pid/1976.** Their publication, *Field Guide to Aquatic Macroinvertebrates*, is excellent. This same organization has created an excellent dichotomous key for benthic macroinvertebrates at **http://www.dep.wv.gov/WWE/getinvolved/sos/Documents/MacroID/DichotomousKey.pdf.**

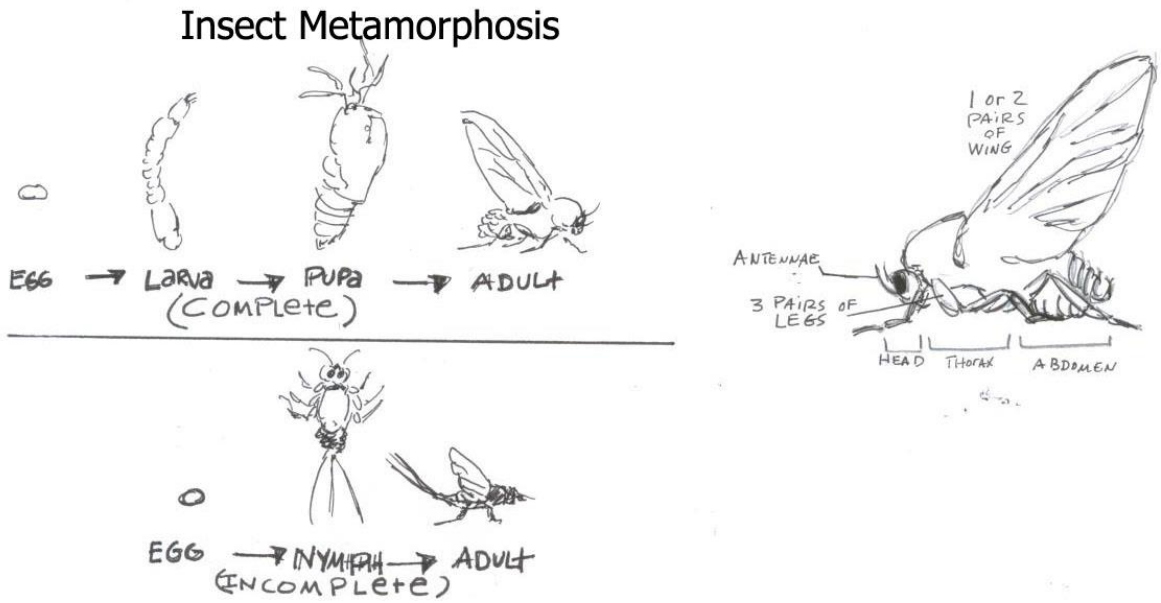
- Remind students that something is very wrong with the water in the Stonecreek watershed, as they learned in the first chapter.

- Now, ask students to take out their sketchbooks and write the word ***POND STUDIES***. Ask them, **"What is a pond? How many different habitats (or zones) are there in a pond? What characteristics do the animals in each zone have?"**

- Next, make a drawing of a pond in profile with your students and ask students if they think that different animals might live, say, in open water as opposed to the bottom ooze? If so, what body adaptations would you expect to find in animals living in different ZONES of a pond? Have students reflect on this.

- Then ask them to do some online research to find where the following "Zones" of the pond are located: Weedy Shallows, Open Water, and Bottom Ooze. Next, have them learn in which zone they would be most likely to find **STREAM BOTTOM MACRO-INVERTEBRATES and to make some drawings and descriptions from their research.** [They should discover that most stream bottom macroinvertebrates (animals without backbones) live in the weedy shallows of a pond and are the larval or nymph form of INSECTS.]

- Then, have students draw with you the stages of both **complete and incomplete metamorphosis** and also note that **adult insects** have antennae, 3 pairs of legs, and a body composed of a head, thorax, and abdomen. Students enjoy using their bodies to choreograph the stages of metamorphosis.

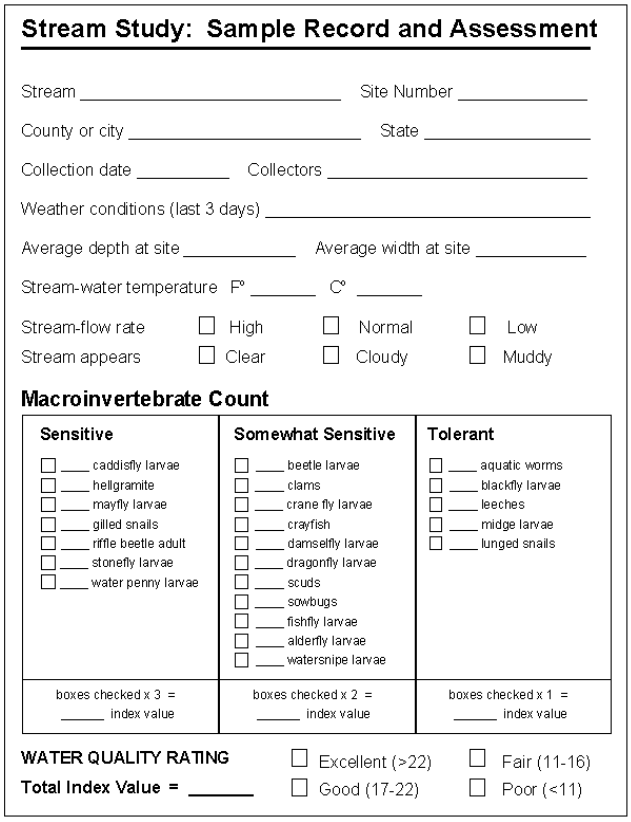


- Next, ask students to view images of a variety of stream bottom macroinvertebrates and note that, indeed,their bodies are adapted to their habitat and diet. Challenge them to argue from the visual evidence which are classified as CLIMBERS, SPRAWLERS, SWIMMERS, BURROWERS, OR SKATERS.

- Now, it's time to address the concept of an organism's SENSITIVITY to its environment (its POLLUTION TOLERANCE). Ask students to reflect on what it means to be *sensitive* to anything. Can they come up with examples of times when a sensitivity could be life threatening? Reflect on the meaning of the expression "canaries in a coal mine". What environmental conditions do canary deaths in a coal mine INDICATE? [Aquatic macroinvertebrates are important INDICATORS of the presence or absence of environmental pollution. Many stream bottom macroinvertebrates, like stoneflies, are very sensitive to pollution and will die, while others, like the midges, can live even in very foul water]. Explain that environmental scientists use the terms SENSITVE, SOMEWHAT SENSITVE, and TOLERANT to describe just how much pollution an organism can tolerate and still not perish.

- Ask students to make entries in their sketchbooks under the topic heading, **Relative Sensitivity of Common Stream Bottom Macroinvertebrates**. Have them make an illustrated guide using quick sketches of the macroinvertebrates in the Stream Study sampling sheet below, using images on this Save Our Streams outreach kit, http://www.azrivers.org/AZRiversTeachersGuide/macros/VASOS_communityoutreachkit.pdf

- Then distribute to each of four groups a copy of the Sample Record and Assessment Form, available from the Stream Study site, and explain that this is the type of data sheet they might use when collecting aquatic macroinvertebrates. Give each group a large sheet of blank paper and then ask them to draw from a basket a single slip of paper describing **different water quality conditions: 1) excellent, 2) good, 3) fair, and/or 4) poor.** Instruct them *not* to reveal to other groups the condition they selected and to draw on their paper a sample of macroinvertebrates which would be indicative of that particular water quality condition. Then, have students circle up and make their own arguments about the water quality based on the evidence their classmates have provided.



Stream Study: Sample Record and Assessment

Stream _____ Site Number _____

County or city _____ State _____

Collection date _____ Collectors _____

Weather conditions (last 3 days) _____

Average depth at site _____ Average width at site _____

Stream-water temperature F° _____ C° _____

Stream-flow rate ☐ High ☐ Normal ☐ Low

Stream appears ☐ Clear ☐ Cloudy ☐ Muddy

Macroinvertebrate Count

Sensitive	Somewhat Sensitive	Tolerant
☐ ___ caddisfly larvae ☐ ___ hellgramite ☐ ___ mayfly larvae ☐ ___ gilled snails ☐ ___ riffle beetle adult ☐ ___ stonefly larvae ☐ ___ water penny larvae	☐ ___ beetle larvae ☐ ___ clams ☐ ___ crane fly larvae ☐ ___ crayfish ☐ ___ damselfly larvae ☐ ___ dragonfly larvae ☐ ___ scuds ☐ ___ sowbugs ☐ ___ fishfly larvae ☐ ___ alderfly larvae ☐ ___ watersnipe larvae	☐ ___ aquatic worms ☐ ___ blackfly larvae ☐ ___ leeches ☐ ___ midge larvae ☐ ___ lunged snails
boxes checked x 3 = _____ index value	boxes checked x 2 = _____ index value	boxes checked x 1 = _____ index value

WATER QUALITY RATING ☐ Excellent (>22) ☐ Fair (11-16)

Total Index Value = _____ ☐ Good (17-22) ☐ Poor (<11)

LESSON 4, PART 2…..Make arrangements if at all possible to do your own local stream sampling.

REFLECTION: Ask students to write an illustrated expository essay on the topic of "Macroinvertebrates as Indicators of Water Quality" and email it to you as a formative assessment.

LESSON 5….*The Cavorting Beasties?*

- Have room darkened as students come in and a microscope set up like that on the cover of *Pond Scum and Agnes Pflumm*. I also recommend that you prepare and have booted up, an in-class powerpoint slide show of images of the **euglena, paramecium, rotifer, amoeba, daphnia, hydra, planaria, nematode, leech, as well as other "beasties"**, whose images can be found online at micro-photographer **Wim van Egmond's** awesome webpage, ***Pond Life Identification Kit*** **(**http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/**) and his *Micropolitan Museum*, found at** http://www.microscopy-uk.org.uk/micropolitan/index.html**.** For any other use of Wim's images, please seek his permission.

  Another very good online source of protozoan and other pond life images (many of which are Wim's) is ***Ron's Pond Scum***,: http://www.silkentent.com/gus1911/RonPond.htm .

  For you and your students, I also highly recommend ***Micscape***, a "free informal monthly web magazine encouraging readers to explore the 'miniature world' around them both on a microscopic and macroscopic scale" " http://www.microscopy-uk.org.uk/mag/indexmag.htmlis

- It's now time for students to earn their **Microscope User's License.** (NOTE: The test for this is a free download at www.agnespflumm.com and should be equated to taking the written test which must be passed before getting behind the wheel of a car.) I do not allow students to use microscopes independently until they have passed this written test with a grade of 80% or above. Explain to students that they will soon be examining live cavorting beasties under the microscopes!

- Place a compound microscope on a table in front of the classroom. Ask students to volunteer facts they already may know about microscopes and how they work. Next, review the parts of the microscope and their functions. I have used this video tutorial by a middle school science teacher: https://www.youtube.com/watch?v=C66lpodO208 . Another video, https://www.youtube.com/watch?v=b1tV3k68cAU, explains how to use a more complex light microscope.

- Distribute a handout with the **parts and functions of a simple compound light microscope** on it and ask students to draw a picture of the microscope with its labeled parts into their science sketchbooks. Schedule your license testing date for two days later. I allow students who earn at least an 80% to have the privilege of using the microscopes by themselves any time I am in the classroom.

HOMEWORK: Prepare for microscope license test.

LESSON 6…. Driver's Ed.

- Set up student microscope stations ahead or time. Assign students to heterogeneous ability groups and ask them to take their completed microscope drawings with them to their assigned lab stations. Have students exchange notebooks and sketchbooks for peer review. Make formative assessments of your own.

- Next, ask students to quiz themselves as to the microscope parts, functions, and proper use.

- Demonstrate the proper technique for making a wet-mount slide. I like this video tutorial: https://www.youtube.com/watch?v=SPg5pfwPPu0 In groups, have students create an illustrated guide called "How to Make a Wet Mount Slide". Explain they will be using this skill in a later lab.

- Next, give that group a prepared slide of something cool like an insect leg. Ask them to each practice placing the slide under the stage clips and bringing it into focus, first with the low power objective, and then with the high. **Then, ask them to discover the relationship between the magnification of the objective lens and how much they can see in the field of view (FOV).** Provide each group with a circular forms (like jar lids) which they draw around to create FOV templates inside of which they should draw exactly what they see at each magnification.

REFLECTION: Using evidence from your drawings, what is the relationship between magnification of the objective and FOV?

HOMEWORK: Study for Microscope License Test

LESSON 7…. The Microscope License Test, then, The Name Game: an Introduction

- After students complete their tests, ask them to take out their copies of Pond Scum and Agnes Pflumm and turn to appendix section, **THE NAME GAME.**

- Ask them to read through the **Dichotomous Key** explanation. Ask students to invent a **mnemonic device** for remembering the **seven parts of a scientific name** from kingdom to species and to email them to you. You should clarify this request by writing an example of an **acronym** like ROYGIBIV, for remembering the colors of light in the spectrum or an **acrostic** like MY VERY EXCELLENT MOTHER JUST MADE US NINE PIZZAS for remembering the

first nine planets in our solar system. Tell them that you will be having a class contest for the best mnemonic by popular vote of entries (posted with no names attached).

- With any luck, you'll finish grading most of the tests before the period is over so that you can announce who has passed. Schedule a re-test for any students not scoring high enough. Ask passing students to bring a copy of their school photo to class to attach to their license. When they bring their "picture ID", issue them the license. Have some glue sticks ready for them to use.

LESSON 8….Preposterous Dichotomous Keys, by Sharon and Ed Donovan, PhD

- On my website , you'll be able to download THE best tool for teaching dichotomous keying I have seen or used. Called *The Preposterous Dichotomous Key*, it is the creation of the dynamic husband/wife science education duo Sharon and Ed Donovan, who have made a career of making science fun and engaging. Be sure to draw large figures of the "aliens" on your board before students arrive for the day. I also highly recommend spending another class period doing their "Baitid" classification with rubber fishing lures.

REFLECTION: What characteristics might be part of a dichotomous key for shoes, things-you-might-find-in-a-desk-drawer, beauty products, etc.?

LESSON 9…The Name Game: Binomial Nomenclature

- Take student through the wonderful powerpoint presentation on this subject created by my friend and fellow educator, Mr. Erik Kreutner. (available on www.agnespflumm.com on the Pond Scum page). Then ask students, working in groups, to create binomial names for the different "aliens" they met in the previous lesson and to justify the reasons these names meet the requirements of appropriate binomial nomenclature.

LESSON 10…The Cavorting Beasties….Classified!

- Now you're ready to dive into a drop of pond water and be introduced to the **Protist Kingdom**, the dubious "heroes" of *Pond Scum and Agnes Pflumm*. In the appendix, you'll read about the **algae** like the **desmids, diatoms, and spirogyra**, lowly protists responsible for manufacturing most of our planet's oxygen and the basis of virtually every food chain, terrestrial, marine, and fresh water. You will also learn about highly toxic and stinky **cyanobacteria** (often called blue-green algae, though they're not really algae at all.) Joining the party are many **micro-animals** like the **Ciliates (paramecia), Sarcodines (amoebae), Rotifers, Arthropods (daphnia), Nematodes (Ascaris), Platyhelminthes**

(planaria), Annelids (chaetogaster and leech), and Tardigrades (water bears). Using the web resources on the website, www.agnespflumm.com, as well as the information in the book's appendix, ask students to create **Cavorting Beasties Flashcards**.

- Explain that you would like for them to **make a set of flashcards** with the drawing of the beastie on the front. On the back, should be the following information written neatly in column form like the following example for the **DAPHNIA:**

Kingdom: ANIMAL
Phylum: ARTHROPOD
Description: Also called a "water flea", the daphnia has antennae and a transparent body through which its beating heart and the egg sac (of females) can be seen. It is the favorite food of the hydra.

HOMEWORK: Complete flashcards and bring them to class.

LESSON 11: The Cavorting Beasties – Live!

- Invite a student volunteer to come up and dramatically read **Agnes Pflumm's Cavorting Beasties performance**. Ask students to take out their flash cards and correctly **match the beastie with their descriptions in the descriptions in this poem.**

- Ideally, you will have pre-ordered or collected living pond organisms representing a variety of the "cavorting beasties" featured in the chant.

- **NOTE ABOUT SETTING UP LABS:** I have found that **running labs "buffet style"** works beautifully. I set up a numbered tray (or shoebox) for each group ahead of time with the materials which will be needed for that day's investigation. Each group is assigned a number and asked to choose a **Materials Captain – M.C.** (who will be responsible for picking up and returning the materials to/from **Lab Central.)** Having noted the name of each captain, you can easily determine who is responsible if a group's materials have not been handled / cleaned properly.)

- For today's lab, each tray should have on it plastic Petri dish or jar covers to use for tracing circular templates to represent the microscope field of vision), microscope slide, cover slip, and tissue (for drying the slide in between different beastie viewings.) Explain that students will make a dated entry in their sketchbooks entitled **"Pond Water Microorganisms Up Close."** Instruct them to **design a page or two with drawings and notes** describing each organism's movement and behavior, as well as its name and average size. The drawing should be put inside drawn circular shapes (Use the jar lids again.) to represent that the

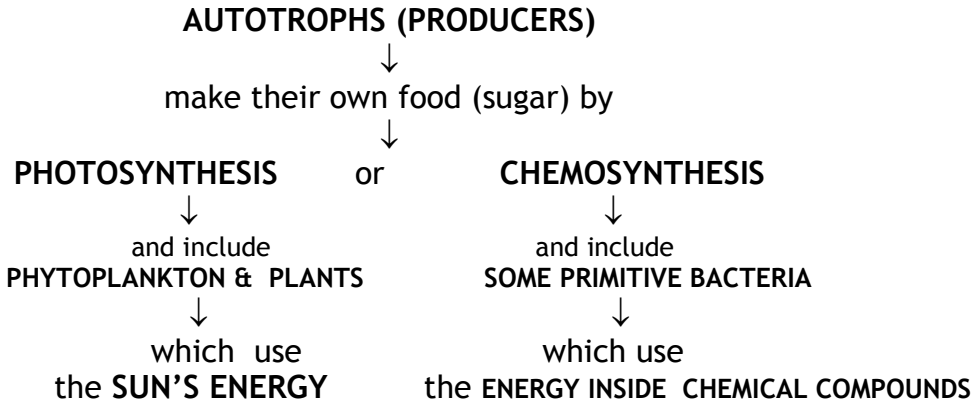
organism has been viewed microscopically. **(Show them a sample page which you have designed and prepared in your own sketchbook.)** Finally, explain that the M.C. will come to Lab Central with a microscope slide to receive one drop of pond water from the living specimens you have ordered. Each group should work with only one sample at a time, drying the slide before returning to you for the next organism.

- **Students in each group will take turns preparing the wet mount slide for each beastie, and getting it in focus** under the microscope on low power first. At the end of the lab, the M.C. will return the tray with clean and dry slide and cover slip on it to Lab Central.

- If there are no questions about the lab assignment, each group should convene at the microscope station that corresponds to their group's number and bring their sketchbooks with them. (Note: This lab will take more than 1 period to complete. If you have ordered organisms by mail from a supply company, be sure to leave the top on your specimen vials a little loose so your beasties won't suffocate!)

LESSON 12….*Eat or Be Eaten: The Chain of Life….A Lesson with Graphic Organization*

- Instruct students to make an entry in their sketchbooks across two pages: **Eat or Be Eaten: The Chain of Life**. Then, have them open *Pond Scum and Agnes Pflumm* to this same section in the appendix**.** Explain that the material on these pages cover one of the most important concepts in biological science – that of **survival - or not.** Then, demonstrate how a simple **concept map** might be made about the concept of autotrophs:



Invite students to experiment with different concept mapping software, like the free trial of Inspiration software at http://www.inspiration.com/visual-learning/concept-mapping to re-create this same concept map. Explain that unless an organism can make its own food, it can't be an AUTOTROPH, but rather is called a **HETEROTROPH.** They might say, "I am a human heterotroph."

You will need to explain the difference between PHOTOSYNTHESIS AND CHEMOSYNTHESIS, being sure to provide images. Note that primitive bacteria living in harsh environments like hydrothermal vents or hot springs can survive in environments no plant or phytoplankton can and that they were likely among the first living things on earth. Finally, have them write on index cards the words **AUTOTROPHS/ PRODUCERS**, **PHYTOPLANKTON, ZOOPLANKTON, HETEROTROPHS**, **CARNIVORES, HERBIVORES, OMNIVORES**, **PRIMARY CONSUMERS**, **SECONDARY CONSUMERS**, **TERTIARY CONSUMERS TOP PREDATORS**, **DECOMPOSERS.** Then have them do a Google Images search of each of these terms to discover the differentiating traits associated with each classification. Ask students to determine which are AUTOTROPHS AND WHICH ARE HETEROTROPHS. In groups, have them generate lists of traits for each as well as a creating simple representative sketches on the back of their index cards.

LESSON 13…. *The Web of Life*

- Ask students to open their *Pond Scum* books to page Chapter 5, "Life and Death Matters." Either assign or ask for volunteers to dramatically read the parts of Agnes Pflumm, Amanda, Aura Lee, Greg, Jennifer, Andy, Liza, Jason, and a NARRATOR.

- Challenge students to determine what position in the Eat or Be Eaten chain – **HETEROTROPHS**, **PRIMARY CONSUMERS**, **SECONDARY CONSUMERS**, **TERTIARY CONSUMERS TOP PREDATORS**, **DECOMPOSERS -** that each of the animals noted in the reading represent.

LESSON 14….Connecting the Threads…

- Now, if possible, **move desks away from the center of the classroom** to create a long aisle.

- **Before this lesson**, you should have 1) prepared **large notecards with a neck string and the names of all the organisms** named in the reading above and 2) and cut a **meter or more piece of yarn or string** for each student. There should be many more phytoplankton and decomposers than other organisms. Give each student an organism notecard and a piece of string.

- Ask them to form the following groups: **PHYTOPLANKTON, ZOOPLANKTON, SMALL CARNIVORES,MEDIUM SIZED CARNIVORES,TOP PREDATORS,DECOMPOSERS,** to come to the front of the class with their strings and organism name cards around their necks. Next, ask all the **PHYTOPLANKTON** to each hand one end of their string to a student who is wearing **ZOOPLANKTON organism.** Next, ask the **SMALL CARNIVORES** to come up pick up the end of the string of one of the ZOOPLANKTON. The **MEDIUM SIZED CARNIVORES** are next to

come up, pick up the end of a small carnivore's string. Finally, the **TOP PREDATORS** will arrive on the scene to pick up their thread. They will be left with one end of their strings dangling. [NOTE: Explain the ZOOPLANKTON are HERBIVORES in this food chain simulation.]

- Now ask every student to pretend that a disease or something else caused them to die. This is the signal for the remaing students, the **DECOMPOSERS** (here, bacteria) to swoop in and do their jobs. Have students hold their noses, to indicate that this is rather stinky, messy job. Ask what would happen on this planet if these organisms were not present?

- Now, have students reflect that there would have to be huge numbers of students playing the role of producers and primary consumers in order for the food chain not to collapse. Point out that many organisms are part of more than one food chain, thus forming **complex food webs** within a community. Have them read the informational text in the appendix, "Eat or Be Eaten".

LESSON 15…Pond Mural… Understanding Science Content Through Art

- Invite students in groups to draw a large profile of a pond on a large sheet of white paper as you do the same on a paper attached to an easel. Ask three others to come up and label the **Zones of the Pond: Surface Film, Weedy Shallows, Open Water, and Bottom Ooze**. In the appendix, "Zones of the Pond" there is a list of common pond organisms. As in previous lessons, ask students to conduct Google Image searches of these organisms. Have them create a table that indicates the **name** of the organism (hydra, frog, etc.), the **zone of the pond** in which this organism lives, and its **classification** as phytoplankton, zooplankton, small carnivore, medium carnivore, herbivore, omnivore, top predator, or decomposer. You should also have prepared name cards for each of these organisms in this list ahead of time.

- Conduct a group reflection and formative assessment of this classification activity.

- Finally, challenge students to create a mural entitled "Zones of a Pond", in which the following are depicted: Labels for each zone, representative examples of submerged plants, floating plants, phytoplankton and zooplankton, small carnivores, medium carnivores, herbivores, herbivores, omnivores, top predators, and decomposers.

LESSON 16…. *Time out for Reflection*.

Ask students to research, reflect upon, and **write an expository essay** entitled, "Why Fish and Amphibians Are Good Biological Indicators." Remind them to cite their sources of information, and

to include illustrations with their writing. **Such an activity will give students practice in creating arguments from evidence presenting in informational text.**

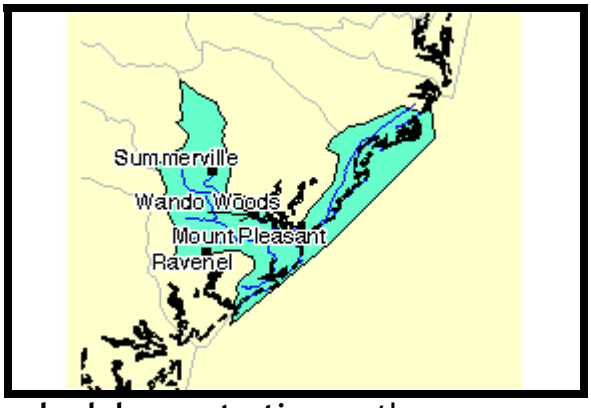
LESSON 17….*Go Fish!*

- The past time of fishing is a healthy one that can bring families and friends together in an outdoor "classroom". Check out events at your local DNR office. The **SC Department of Natural Resources**, for example, sponsors an annual *Youth Fishing Rodeo*, as well as a program called *SC Reel Kids* and *Hooked on Drugs, Not Fish*.

- I also highly recommend the website *Fishing Fun for Kids*, http://www.americaoutdoors.com/fishing/fishing_fun/index.html , based on the book of the same title by Sharon Rushton and Bob Knopf.

LESSON 18….*What's in Your Watershed?*

- Before class, go to the fantastic EPA Surf Your Watershed website at http://www.epa.gov/surf/ , where you can use clickable state maps to locate your watershed. For instance, I live in Charleston, SC. By typing in my zip code, I access this watershed map, which I can enlarge and copy for group activities:



I especially like the EPA **watershed demonstration** on the page on water quality testing: http://www.epa.gov/owow/monitoring/nationswaters/measure.html :

Raise your hand if you live in a watershed.

Is your hand up? Good. Everyone lives in a watershed. A watershed is simply an area of land that drains the rainwater (or snow) into one location such as a stream, lake, or wetland. This means that the runoff from streets, fields, and lawns will eventually drain into those streams, lakes, or wetlands. Cup your hands as if you are going to drink water from a faucet. Your thumbs and fore fingers are like the ridges of a watershed and your palms are like the waterbody that catches the rainwater. Watersheds can vary in size and shape from a couple of square miles to hundreds of thousands of miles. We all live, work, and play in watersheds, and what we do affects everything and everyone else in the watershed.

- When students enter, ask students to take out their writing on why fish and amphibians are good biological indicators, and **invite volunteers to "teach" about their findings** and sources**.**

- Now, ask for 4 **students to stand and read expressively**, Chapter 9, "A Speck on the Map," one paragraph per student, as the rest of the class follows. (NOTE: I often ask students to draw numbers from a hat to determine who gets to read. These students will not draw from the hat for the next reading activity.)

- Now, write on the board the terms, **FRESHWATER AQUIFER** and **WATERSHEDS**.

- Assemble your students into heterogeneous ability groups and have the M.C. come up to Lab Central to get a *Vis-a-Vis* pen, a **copy of the picture of your city's watershed** from the EPA site above, as well as a **laminated copy of a local map of your area**, showing rivers and streams. Ask each team to appoint a reader who will lead them through the watershed demonstration at the above website. Instruct students to **find and circle on the map the names of the rivers in their watershed** and then **make a detailed, labeled drawing** of their county watershed in their sketchbooks.

Written reflection: Ask students to write a brief reflection based on their reading: "Why has Edward Fartlesnap been called into Stonecreek?"

LESSON 19….*A Foul Business* (also a great lesson for integrating science and social studies and could easily fill several class periods)

- While researching the science content for this book, I learned more than I ever thought possible about the science of sewage removal and treatment, a problem as old as civilization itself. For great lessons and links, be sure to go to my web page **"The Scoop on Poop and other Stinky Problems,"** located on my main website **www.agnespflumm.com** .

- One of my favorite websites on this odorous subject is called **"Tracking Down the Roots of Our Sanitary Sewers"** (**http://www.sewerhistory.org/**) written by Jon Schladweiler, the Historian of the Arizona Water & Pollution Control Association,. The site includes historical time lines on this subject from 3200 BC to the present . This scholar really knows his poop, 'er stuff, whatever.

- The online "Straight Dope" article, "What Happens to All the Stuff That Goes Down the Toilet" (**www.straightdope.com/mailbag/msolidwaste.html**) gives a great outline of modern urban area sewage treatment.

- After students are settled, select a **student to dramatically read** the first two paragraphs of Chapter 8 and two others to read the parts of Greg and Jason.

- Under the new, dated topic, "A Foul Business", have students **make a list of all the indicators (from the class reading**) that something is very wrong with the water in the Stonecreek watershed. Be sure they understand that the biodiversity of the fish population is down.

- Now, try this demonstration: Put some brown-colored water (SEWAGE) in a clear plastic container that is labeled "YOUR HOUSE".on a demonstration table at the front of the room. Put a bucket on the floor and a clear siphon tube between the two containers. Clean off the bucket end of the tube with alcohol and quickly pull air out of the end with your mouth (or you can use a suction bulb) to start the water flowing down from the house toward the bucket. **Ask the following questions:**

    - Why is the sewage able to flow out of the house?
    - What do you predict will happen if the bucket's elevation is raised closer to that of "the house"?

Reflection: How do communities in flat areas remove sewage from their homes?

Next, pour the brown water back in the "house", start the siphon up and gradually raise the level of the bucket so that students will see that the stuff will eventually flow backwards into the house!

- Allow students to brainstorm for awhile, and then have them turn the appendix section, "A Foul Business" to learn about the role and function of **sewage lift stations** and what can cause them to malfunction. Fred Winkybok's problem of people flushing their underwear down the toilet is based on a true story. Challenge students to uncover "real life" stories of sewage system catastrophes. This is a great way to **integrate civics with STEM** as well as highlighting the purpose and function of sewage lift stations, and what can happen when they fail. You may want to invite a sanitary sewage engineer to speak in your classes.

- This is also a good time to teach about combined sewage and stormwater systems, common throughout the US. I like the explanation of the toxic hazards associated with **COMBINED SEWAGE OVERFLOWS (or CSO's)** which I found at the King County, WA, Public Health site: http://www.kingcounty.gov/healthservices/health/ehs/toxic/cso.aspx. Remind students that raw sewage backing up into low-lying streets was one of the biggest health hazards associated with **Hurricane Katrina** and ask them to determine the least likely place on earth of becoming a hurricane victim.

- The above article also makes reference to unsuitable levels of contaminants in a watershed. In the event of a CSO, the level of **fecal coliform** (bacteria found in fecal matter, which can make many people sick), soars. That's why the Department of Health and Environmental Control (DHEC) will post areas as being **unsafe for human contact**. More on this later.

LESSON 20…. *Something's Killing Our Fish!*

- To a nature lover, there are few things more disturbing than coming across a dead animal. To one who loves fishing, the sight of a floating, bloated, smelly, glassy-eyed dead fish can not only ruin a day, but be cause for great concern. Why did the poor fella go belly up? In **chapters 8-10**, Jason and Greg are indeed worried about the decreasing fish populations in their favorite streams (even though they may not yet know the word ***biodiversity***.)

- Choose students to be prepared to read the parts of Andy, Jason, Greg, Agnes Pflumm, Liza, Edward Fartlesnap, and the narrator for Chapter 10, "Field Trip". Then have students

turn to the pages in the appendix ,"SOMETHING'S KILLING OUR FISH!, and read this science content silently. Ask them to look up any words that are unfamiliar to them.

- Discuss that forensic scientists are detectives who use clues to discover the reason(s) for an existing problem or situation. Ask students to consider all of the clues detected and to **write out a plausible scenario** for why the fish in a pond might have died (*without* looking ahead to the explanation.) If time is short, you might use this as a homework assignment.

LESSON 21…*The Eutrophication (or Pond Scum) Blues*

- This is my favorite chapter in the book, as again the ever-unpredictable Agnes Pflumm is again suddenly inspired to teach **science content through music**. As in my other books, I encourage you, the teacher, to practice performing the "Pond Scum Blues" as a spoken rap.

- Allow students who may not have had a chance to read and perform read the parts of Jason, Greg, Amanda, Aura Lee, Liza, Andy, and the narrator for a classroom staging of Chapter 11, "Fish Tale." You should play the role of Agnes Pflumm for this scene. I actually have a **traveling "pond"** made from a large sheet of green felt with a brown felt border. Artificial cattails are stuck into blocks of floral foam to simulate the shoreline. In the middle, I place a fake fish. Other **props** include a stick with green yarn hanging from the end (for the Amanda scene), mayo jar, my **orange back pack** with graduated cylinder, sunglasses, and rubber gloves in it.

- Begin the scene by going back to the end of Chapter 10, with Agnes declaring, "EVERYBODY UP; WE'RE GOING OUTSIDE!," followed by the class exclaiming, "WHOOPEE!" Next, direct your six actors to line up at the back of the classroom behind you and then walk towards the front of the classroom where the "pond" is. As you approach the pond, draw back in horror and have students make gagging noises, etc. about how disgusting and smelly it is. When Jason says, " IT'S A DEAD FISH, OH, NO!" etc., calmly ask your actors to sit around the pond, pull on your rubber gloves, and reach for the fake fish, as you speak your lines. When

it's time for the "Pond Scum Blues," let her rip!

- The reading of the rest of the chapter will set the stage for your lessons on water quality testing.

LESSON 22….*The Science of Eutrophication*

- Prepare in advance a series of images depicting ponds in various stages of EUTROPHICATION, but don't use this term just yet.

- Ask students if they've ever heard of an **algal bloom** is, and discuss that these can present a health problem in both fresh and marine environments. (As such, they are called **Harmful Algal Blooms**, or **HABs**.) If you live in a coastal area, I highly recommend learning whether your students can become part of one of N.O.A.A.'s **Phytoplankton Monitoring Networks** and **Marine Biotoxins Programs**.

- On the board, create a participatory, **student-generated concept map / flow chart** showing the steps in the process of eutrophication which might lead to a **fish kill**.

LESSON 23…. *Phytoplankton Up Close*

- Tell students that today they are going to be looking at a few of the most common forms of pond algae (which you can collect or order ahead of time). For an incredible online overview of algae, go to the Micscape site **http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/**, compiled by Wim van Egmond and Dave Walker. Here, you and your students can view incredible photographs as well as read excellent articles on each type of algae. I especially like the article on diatoms at **http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/**, Be sure, too, to look at the **filamentous algae like spirogyra**, whose common name is often "pond scum."

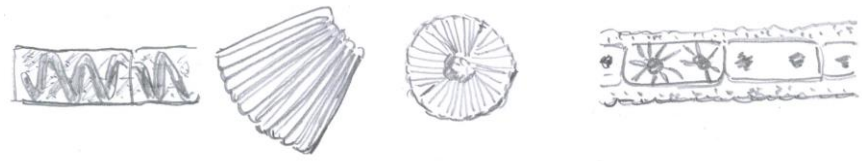
- An excellent resource is the book, ***Guide to Microlife***, by Kenneth G. Rainis and Bruce J. Russell.

- Even if your students are not part of a N.O.A.A. Phytoplankton Monitoring Network, you can log onto **http://www.chbr.noaa.gov/PMN/SpeciesList.htm** for excellent photographs at different magnifications of marine phyto and zooplankton.

- This is also a good time to look at and discuss **cyanobacteria**, commonly called **blue green algae**, though they're actually photosynthetic bacteria. A bloom of cyanobacteria makes a pond look blue-green and can often produce toxins that are harmful to livestock and humans. An excellent overview of this subject can be found at **http://www.lcbp.org/PDFs/bgalgaebrochureEN.pdf**

- Explain to students that they are going to **create a page or two in their sketchbooks** under the topic PHYTOPLANKTON, to include drawings and descriptions of diatoms, desmids, spirogyra, cyanobacteria, etc. together with scientific information in their own words about each of these organisms and their sources of information.

- Organize students into groups and send each one to a microscope station. Have the M.C. from each group come up to Lab Central and collect from you a tray with a microscope slide, cover slip, pipette, tissue, and handout showing drawings or pictures of the types of algae you have on hand. Give each M.C. a sample of one algal form at a time for his group to investigate.



LESSON 24….*Environmental Protection Groups: Who's Who?*

- My research for Chapter 12, "Tricky Business" was indeed a complex effort. I started with a week-long field study experience learning about farm ponds at the **SCDNR fisheries office in Rock Hill, SC,** and worked with biologists Jim Sorrow, Richard Christie, and Robert Stroud. One of the most important things I learned was **how different government environmental protection agencies interact with one another and who was responsible for what in the event of an environmental crisis.** My brain was reeling with acronyms like DHEC, EPA, DNR, NRCS, USDA, etc. Richard's wife, Ann Christie, an NRCS field agent, not only patiently translated the language of this business, but helped me put together the explanatory information in the appendix, "Environmental Protection Groups".

- The reason I put Chapter 12 (and the accompanying appendix explanation) in the book was so that students, too, could begin to understand not only Edward's role as a NRCS biologist but to **show how government scientists often come together to solve a problem** which intersects with each of their specialties and whose **outcome depends on their ability to cooperate.**

- For this chapter, I would suggest that you make name cards for each speaking character with his or her government agency on the card, too. Bring these students and the narrator to the front of the classroom and seat them in a circle around a table as if they were at a meeting. As the drama is unfolding, have the students at their desk **make a chart with the name of each character, their organization, and a brief job description.**

- After the dramatization, ask students to turn to the appendix material and (after reading the material silently) write in their own words in their **vocabulary section the function of the EPA, DHEC, NRCS, USDA, and DNR**. Explain that they will be asked to explain this on a quiz, too, at a later date.

- Go online to each of these organizations to **learn where their local office is**. Each one has an education leader who let you know what programs they have available in your area. Many will even set up school visits.

LESSON 25….. *What's the Point?*

- Now is a great time to do an **inquiry activity on watershed pollution.** I highly recommend the **Earthforce Elementary Education Watershed Field Trip**, available **http://earthforce.org/sites/default/files/Elementary%20Education%20Watershed%20Field%20Trip_0.pdf** Before starting however, **activate prior knowledge** by reviewing the concept map in Chapter 13 entitled "Water Pollution". Ask students to determine those subjects about which they have no prior knowledge at all.

HOMEWORK: (test grade) Ask students to write an **original expository essay** entitled, **"What's the Point".** The following topics should be addressed:

- What is water pollution?
- What is the difference between point and nonpoint pollution?
- Which government environmental protection agencies work to prevent and educate the public about water pollution?
- What are some scientific tests that are used to assess water quality and what do their indicate? (For example, describe tests for dissolved oxygen, or DO, pH, water temperature, turbidity, nitrates, and fecal coliform.)

- Require students to write a complete bibliography of all their sources of information, and note that **cutting and pasting from online sources or other forms of plagiarism will result in a failing grade**.

LESSON 26….*A Perky Problem*

- Have students turn in the book to the septic tank argument between Greg and Jason (just after the septic tank system illustration). Select students to portray Greg, Agnes, Edward, Andy, Mrs. Melrose, Aura Lee, Amanda, Liza, Jennifer, and the narrator. After an enthusiastic performance, re-focus student attention by writing the words, "A Perky Problem" on the board. Next, pull up the excellent online article, **"How to Run a**

Percolation Test". It has excellent math extensions as well as instructional photographs: (**http://www.extension.umn.edu/distribution/naturalresources/DD0583.html**
A great video tutorial on doing your own garden perc test (even though the measurements are not in metrics) is **https://www.youtube.com/watch?v=e6VV6OU3ssA.**

- Assign practice problems for calculating soil percolation rates. This is also a good time to familiarize students with the format of NAEP ICT questions like this one on determining the best playground soil: **http://www.nationsreportcard.gov/science2009ict/soil/soil1.aspx**

- I have conducted many variations of a soil percolation lab. Here's one version:

I. Question: How can we classify different soils and how will their water percolation rates compare to one another?

II. Background Information: See sites above.
Soil Texture triangle explained and lab:
http://www.ext.colostate.edu/mg/Gardennotes/214.html

III. Hypothesis: (Students write their own, based on their background reading.)

IV. Materials:

5 batches of soil with different proportions of sand, silt, and clay prepared ahead of time in buckets, clear plastic drinking straws (usually around 20 cm long), marking pens, paper cups with water, 5 heavy duty plastic cups marked A-D.for soil samples, stopwatches, plastic pipettes. A bin for collecting used soil. Don't tell students their composition.

V. Procedure:

1. Give each M.C. a tray with a plastic cup with a 200 cm^3 (mL) of one of the soil samples A-D.,a marking pen, paper cup of water, and a plastic pipette. Be sure a student in each group has a stopwatch.

2. Instruct groups to mark off the straw in centimeters. Next one student should seal off the bottom of the now graduated straw with a finger while another pipettes water into the straw until it is full.

3. When the timer is ready, the straw should be inverted (with index finger still firmly pressing on the top to keep the water inside) and inserted 5 centimeters into the soil sample. On a count of 3, the top finger should be released, and the time required for 10 cm of water to

percolate into the soil should be recorded. Note: Groups with soil that is mostly clay may have to wait awhile!

4. Next, instruct students to pack the soil in their cup and to repeat the percolation test, this time on packed, damp soil and compare the results.

VI. DATA

- Make a chart on the board, into which group data can recorded, percolation rates calculated, and soil samples ranked according to perk test results.

VII. CONCLUSIONS

- Discuss sources of experimental error.
- Reveal the composition of each sample and discuss which soil samples would pass a perk test for a septic system permit.
- Discuss how you might do this experiment differently to insure more reliable data.

HOMEWORK: (TEST GRADE) Require students to write a complete lab report on the question of rating different soil mixtures according to their percolation rates.

LESSON 27…. *Swimming in What?*

- Edward Fartlesnap's unfortunate "dip in the doo doo" was based on a real life experience of one Robert Stroud, a SCDNR fisheries biologist who was called to investigate a sewage pipe explosion into Steele Creek, near Rock Hill, SC. You know what they say about stuff flowing downstream? Well, even though the sewer pipe was in North Carolina, the fish kill [caused by bacteria using up all the available oxygen (in the process of breaking down the human waste)], occurred downstream in South Carolina waters. The problem of which state should pay for the clean up can be tricky at best. Contact your local Department of Health and Environmental Control (DHEC) to learn how this situation in your area is handled.

- Armed with the above information, stage a mock TV news interview between students playing the roles of Candace Klopp, Edward Fartlesnap, a DHEC official, and the owner of the company whose crew accidentally blew up the sewer pipe. You might imagine that this is a teleconference with Candace in the news station with live feeds to the rest of the characters. You might even bring in actors to portray state representatives.

LESSON 28…. *The Scat Rap*

- Chapter 20, "Caught", will be great fun to act out. Select students to play the parts of the narrator, Agnes, Edward, Thelma Crotts, Andy Crotts, Jason Pitts, and Leonard Crotts. A stuffed animal works nicely for Proton. Label a small box "baby monitor," or use a real one if you have one for Thelma's eavesdropping scene in the pantry. You'll need a newspaper for the scene in which Thelma reads about the exploding sewer and fish kill.

- After you act out the chapter, ask students to turn to the appendix, where the entire text of the "Scat Rap," has been reprinted with permission of the Great Smoky Mountains Institute in Tremont, NC, where it was first written.

LESSON 29….*The Plot Thickens*

- By Chapter 21, "An Interview with Candace Klopp," the **plot is rapidly approaching the turning point.** Like a shark on the hunt, the glamorous, feisty Candace Klopp closes in on Stonecreek Middle School in search of a career-making story. The equally determined Thelma Crotts is feverishly working to bring about a mitigation effort to reduce the adverse effects of over-development in Stonecreek. Agnes Pflumm and Edward Fartlesnap have been called into Mrs. Melrose's office (not realizing that Candace has been invited, too.) Finally, the SRS is firmly united again, this time in pursuit of the reason fish are dying in the Stonecreek watershed.

- Ask students to read the chapter silently to themselves and then turn to the appendix material for this chapter. Ask them if they have ever been in an argument which required a third party to MITIGATE a solution.

- Before class is over, assign students to the parts of Candace, Agnes, Edward, Mrs. Melrose, and the SRS students. Ask them to come to class the next day, dressed for their parts and having rehearsed their lines. Stage Chapter 21 with great drama!

LESSON 30…..*The Issue of Malformed Amphibians*

- Before reading Chapter 22, "The Town Meeting," ask students to turn to the appendix, page 182, "The Issue of Malformed Amphibians," to learn the background of this now-famous environmental science story. Review what you learned earlier about amphibians as important BIOINDICATORS of environmental quality. Be sure, too, to visit the websites **http://www.pca.state.mn.us/hot/frog-bg.html** and the **'Frog'-quently Asked Questions (FAQ's)** on the great site, A Thousand Friends of Frogs, **http://cgee.hamline.edu/frogs/science/faq1.html**, created by Hamline University's Center for Global Environmental Education. Students will especially want to visit a page just for them: **http://cgee.hamline.edu/frogs/students/index.html**.

LESSON 31…. *Low Impact Development and Best Management Practices*

- One of the goals of successful mitigation efforts on behalf of protecting natural habitats is the implementation of **LID and BMPs** – **Low Impact Development and Best Management Practices.** Stormwater runoff is one of the biggest problems for protecting a watershed. In the appendix on this subject, I reference and summarize some of the fantastic articles on Land Use Planning produced by the University of Illinois, available at **http://www.urbanext.uiuc.edu/lcr/fs_land.html**, An organization called the Low Impact Development Center also has a very informative page at **http://www.lid-stormwater.net/background.htm**

- Inform students that in some cities, areas called **constructed wetlands** are being created to further treat wastewater from sewage treatment plants. One such effort that should be celebrated and studied by your students is the **Phinizy Swamp Nature Center** in Augusta, GA, which not only purifies waste water but serves as a beautiful, educational nature center for the public. Be sure to visit their website at **http://www.phinizyswamp.org/PhinizySwamp.htm**. These are all examples of engineering solutions to problems which require knowledge of science and the use of technology to apply or extend that knowledge.

- County extension agents and scientists from the NRCS work with **farmers** to create BMPs to avoid **agricultural run-off** in the form of pesticides, animal wastes, and fertilizers.

- Finally, **commercial and residential builders** must now consider the impact of storm water run-off from their properties in the process of requesting permits.

LESSON 32….. *What can YOU do?*

- On my website, click on the picture of Jason and Greg seining in a stream to pull up a wealth of programs for you and your students to explore! The **EPA's Watershed Information Network** (WIN) is a great place to start. In the appendix, I also provide a list of several community environmental protection efforts in which you and your students may take a part.

LESSON 33 …. *The Play's the Thing*

- In the appendix ("The Power of Role Playing") I remind my readers that there are few better ways of working through a problem, or at least understanding it better, than acting it out. This lesson could also be developed as part of an after school drama program. The guidelines for staging these scenes are given in the appendix. By this time, students should be very comfortable with role playing. Organize students into groups to collectively write a script which is not only entertaining but more importantly demonstrates their understanding of the water quality issues addressed in this book (and listed in the appendix). Require each student to write and sign the statement:

I promise that I have given 100% to this group effort
and have not been a slacker.

- **Finally, ask each student to complete an assessment rubric for each student in his or her group.**

ASSESSMENT RUBRIC FOR GROUP PROJECTS

CRITERIA	Exceeds expectations (20 points) *	Meets expectations (12 points)	Fails to meet expectations (0-4 points)
COMMUNICATION	Shares ideas with peers in a way that adds to the group effort.	Occasionally initiates new ideas or suggestions.	Provides little or no help to the group in the form of constructive ideas.
OPENNESS TO LEARN	Is very willing to try something new and work with other members of the group.	Reluctantly goes along with the group.	Rejects the whole idea of the assignment.
RESPECT	Listens to others; encourages others to contribute ideas; accepts alternative perspectives; is tolerant of the shortcomings of others; and helps others to succeed in class.	Is tolerant of others, but often dominates the group activity or discussion. Listens to the ideas others, but generally maintains personal views and ideas.	Dismisses the thoughts and ideas of others; possibly uses rude language to ridicule. Offers ideas that are limited to his or her personal opinions.

STUDENT BEING EVALUATED: _____

Score: _____ / 60*

* Point values will vary depending on the project.

Your Notes and Innovations Here!