

## actionbioscience.org lesson

To accompany the interview of Mark J. Plotkin, Ph.D.: “**Bioprospecting: Medicine Quest**” (Oct. 2000) and the excerpt from his book: *Medicine Quest: In Search of Nature's Healing Secrets* (2000)

<http://www.actionbioscience.org/biodiversity/plotkin.html>

---

### Nature's Pharmacy: Killing the Cure? (Oct. 2002)

Lesson by **Sandra M. Latourelle**, Science Facilitator  
Champlain Valley Educational Services, Plattsburgh, NY

Educator's section: p. 1-2
Student handout 1: p. 3
Student handout 2: p. 4-6

#### Grades & Levels:

- **Handout 1:** high school (general)
- **Handout 2:** high school (advanced/AP) – undergraduate (year 1)

#### Time Recommendations:

- **Handout 1:** up to 3 class periods
- **Handout 2:** 4-5 class periods (or more if you choose to make this a portfolio project or long-term research project); this handout includes a laboratory experiment

#### NSES (USA) Content Standards, 9-12:

- 2.2. Science as Inquiry: understanding about scientific inquiry
- 7.3. Science in Personal & Social Perspectives: natural resources
- 7.6. Science in Personal & Social Perspectives: sci. & tech. in local, national, global challenges
- 8.1. History & Nature of Science: science as a human endeavor

Note: View the NSES content standards on this site to choose other curricular applications for additional activities at:

<http://www.actionbioscience.org/educators/correlationcharts.html>

#### Learning Objectives: Students will be able to ...

- examine reasons for preserving both the rainforest and its indigenous peoples
- identify products we use today that come from plants
- explain how and why sources of medicines are found in nature
- define, recognize and identify a *zone of inhibition* on an agar plate (for lab experiment)
- collect, organize and analyze data using laboratory equipment and other tools (for lab experiment)

#### Key Words Include:

bacteriophage, biodiversity, biopiracy, bioprospecting, ecoliving, ethnobotany, genetic engineering, gram negative/positive, hotspot, hypothesize, indigenous, intellectual property rights, primatologist, rainforest, shaman, species, utilitarian

---

## Preparation

### Article Discussion

- The main article is an Actionbioscience.org interview with Mark Plotkin at <http://www.actionbioscience.org/biodiversity/plotkin.html>. The second part of the online material consists of excerpts from a chapter of Plotkin's book, which can be accessed from the interview page to appear in a printable, pop-up window. Questions about the interview & the book chapter excerpts are provided on page 2.

## Student Handout 1

- Projects should be assigned after the class has discussed the Plotkin interview and/or book chapter excerpts.

## Student Handout 2

- Projects should be assigned after the class has discussed the Plotkin interview and/or book chapter excerpts. There are two sections of activities on the handout: **projects** and a **lab activity**.
- It is suggested that the lab experiment be conducted as the culminating activity. It requires the preparation of agar plates (2 per group) and the materials listed below.
- Other optional media tools: PowerPoint & spreadsheet software capable of generating graphs.
- Materials needed for “Lab Activity”** per student group (2-3 students/group)
  - nutrient agar or 2% gelatin plates (2 per group)
  - liquid bacteria for spreading on plate such as *B. subtilis* or *E. coli*
  - spices such as: raw garlic, garlic powder, oregano, paprika, cinnamon, bay leaf, black pepper, parsley, raw onion, and onion powder
  - pair rubber gloves (1 per student)
  - beaker (size predicated on breadth of bacteria spreader)
  - plastic pipettes
  - permanent marking pen
  - bacteria spreader
  - bunsen burner or alcohol lamp
  - ethanol for flaming
  - metric ruler
  - safety goggles (1 per student)

---

## For Educators: Article Discussion

About the interview of Mark J. Plotkin, Ph.D. and his book excerpt

<http://www.actionbioscience.org/biodiversity/plotkin.html>

### A. Questions about the interview by Actionbioscience.org: *Bioprospecting: Medicine Quest*

- How does Mark Plotkin describe utilitarian purpose? Give a specific example of an item from the plant kingdom with a utilitarian purpose. What’s an example from these kingdoms: animal, protist, fungi?
- From what specific organisms will we potentially derive pain relievers?
- For what reason are we bioprospecting for natural products not associated with indigenous peoples?
- Mark Plotkin advocates two items needing worldwide protection at all costs. What are they?
- What is “frankenfood?”
- There is quite a bit of conversation and research going on that involves the use of viruses to thwart bacterial infection. What is the term used for these viruses?
- How should bioprospectors deal with indigenous people and their knowledge?
- Discuss the importance of the following statement: *Biodiversity education is very important since there is still much to discover in nature.*

### B. Questions about chapter 8 excerpt, from *Medicine Quest: In Search of Nature’s Healing Secrets*

- Nature’s pharmacy contains some rather impressive “prescriptions.” Listed below are chemicals derived from that pharmacy. From what is each derived? What medical condition(s) do each help?
  - stimasterol
  - thiarubrine
  - dicumarol
  - ABT-594
- What is the significance attached to each of these organisms in regard to nature’s pharmacy?
  - porcupines
  - penguins
  - dart frogs
  - thrushes
  - chimps
  - wooly spider monkeys
- A plant derivative having vermicious properties is able to perform what function?
- What are the consequences of the diminishing variety of rainforest species?

# Nature's Pharmacy: Killing the Cure?

## Student Handout 1

### Projects

#### Medicinal Plants: Fact Sheet & Quiz

Prepare a fact sheet on paper that lists one-line facts about the potential and already-available sources of medicine from plants. For example: *70% of medicines with anti-cancer properties have ingredients found only in the rainforest (from the video Live from the Rainforest, Program #7: Rainforest Connections).*

Use the fact sheet to quiz other students. How many correct answers were given? Example quiz questions:

- What percentage of anti-cancer medicines have ingredients found only in the rainforest?
- Where can you find important ingredients for the majority of anti-cancer medicines?

#### Rainforest Ethnobotanist

You are an ethnobotanist for a start-up pharmaceutical company about to journey to the Amazon rainforest. Your mission is to catalog at least 4 plants that may be useful to medical research. Research on the Internet and review books and magazine articles to discover medicinal plants from that area. Write a report to the company that will convince them that your choice of plants is good for the company and for the rainforest indigenous economy. Include in your report:

- a sketch or photo of each plant
- a description of the plant, such as its growing habits and geographical distribution
- notes about its potential medicinal benefits (backed up by references from other sources)

#### Family Wisdom

Talk to parents and grandparents or other older people about plants and/or herbs that they may have used to help inhibit infections. Research additional information about these plants. Produce an oral history using video camera or tape recorder.

#### Ethnobotany Apprentice

Choose a middle school class and read them selected sections from *The Shaman's Apprentice: A Tale of the Amazon Rain Forest* by Lynne Cherry and Mark J. Plotkin (Harcourt Brace & Company, 1998). This is a story in which a lesson about medicinal herbs is brought to life through young Kamanya, who dreams of becoming his tribe's next shaman. After the reading, tell the students why you think there is a need to preserve the rainforest and indigenous knowledge for future generations.

#### Rainforest Treasure Hunt

a) Per Student: At home, look for household items that contain or are made from rainforest materials/ingredients, e.g., a mahogany knick-knack. Add pictures of other products from magazines and the Internet to your collection. Make notes in a journal identifying the rainforest material/ingredient in each item.

b) As a Class: Display everyone's collection on a table. Conduct a quiz or other game, such as Jeopardy, with the items. Take turns leading the game, with each leader quizzing other students about the items on the table that he/she has contributed.

# Nature's Pharmacy: Killing the Cure?

## Student Handout 2

### A. Projects

#### Rosy Periwinkle

Research the connection between Childhood Leukemia and the Rosy Periwinkle. Write a report about your findings. Provide a botanical and medicinal description of the Rosy Periwinkle, including information about its geographic distribution. Add plant sketches and distribution maps to your report.

#### Traditional Medicines

Create a visual presentation, e.g., displays or a video, about the history of traditional medicine of one indigenous population anywhere in the world, such as the Maori of New Zealand. Include examples of some of their plant-derived medicines and their uses. Mark a world map to show where these people live.

#### Hot Spices

Archaeologists working on the Anasazi ruins (from over 3000 years ago) in the U.S. southwest have found pepper seeds in the ruins. The Anasazi may have obtained them from traders that came from South America and Mexico. Interestingly, Jennifer Billing and Paul Sherman wrote a paper published in the *Quarterly Review of Biology* in March 1998 on the use of spices by different cultures. In summary, they found that the further south a group of people live, the more spice they use. Your task is to look into their findings and present the main theories as to why geography plays a role in the use of spices.

### B. Lab Activity

*This lab activity will offer a chance for you to get to know the many naturally found antibacterial substances... sitting right on your kitchen shelves.*

#### Procedure – Initial Setup

1. Form lab groups of 2-3. (Note: Each workstation should have materials as indicated in the materials list; make sure to get this list from your professor). Each group will keep its own records with one person designated as the scribe of the group and another as a spokesperson, reporting to the class following the lab.
2. You will be preparing two agar plates each with the *same* source of liquid bacteria. From the spice options provided by your teacher, choose eight different common spices.
3. Discuss what a zone of inhibition is (in this case, that area around the spice which will be free of bacteria), so that you know what to look for.
4. Wear rubber gloves and safety glasses during the experiment.
5. Turn over your two agar plates and use the permanent marker to label the plates on the bottom as shown in Illustration 1 (on the next page).
6. Sterilize your bacteria spreader using alcohol and flame in order to be sure you are starting with sterilized materials so that the plates will only be testing your chosen liquid bacteria. Always use safety precautions with bunsen burners and/or alcohol lamps.
7. Inoculate each of the plates with the same liquid bacteria using the plastic pipettes.
8. Carefully apply your eight chosen spices, either with pipettes or by sprinkling the spice into place.
9. Using the "Experimental Plates" worksheet (see page 6), label each appropriate quadrant in the first column exactly according to the way you labeled your plates. Then sketch out exactly what you see. Be as accurate as possible since you will be making comparison drawings when the plates are analyzed for your final results.

**Nature's Pharmacy: Killing the Cure?**  
**Student Handout 2 – lab activity (cont'd)**



Illustration 1

10. Cover the plates. They may be either placed overnight in an incubator set at 37°C or leave them in a safe environment for 2-3 days at room temperature. Work out a schedule for the appropriate time to return.
11. In your lab journal, write down a hypothesis of which of the spices will have the greatest antibiotic properties and as such, can be used medicinally as well as for taste. Include the reasoning behind your hypothesis. Also, for future reference, list the methodology you used to do the experiment.

**Procedure - Final Results**

1. Carefully arrange your 2 plates as shown on "Experimental Plates" worksheet (page 6). You will be working with column two today.
2. Draw as accurately as possible what you see on the developed plates as your "final results" in the second column (don't forget to label the quadrants again!). Compare the drawings of the original day's plates with what you see now. Are there zones of inhibition around the spices? Do the sizes of the zones, if any, vary? Measure the diameters of any zones of inhibition with a metric ruler and note the numbers on your drawings.
3. Do your results match your hypothesis? Do they come close?
4. Collaborate with your partner(s) on a report for the rest of the class. Designate a spokesperson. The spokesperson's job will be to present a briefing, including the hypothesis determined during the first day's activities and a brief summary of the results of the group's experiment. For example, perhaps the group hypothesized that paprika would have the greatest antibacterial properties but perhaps the zone of inhibition was negligible.
5. As a class, get together for a symposium. Discuss what spices were used, how many student groups chose to test them, and what the results were for each test group.

**Variations on the Experiment:** a) Does preparation affect a spice's potency against bacteria? For example, try fresh vs. dried for garlic, coriander, and hot peppers. b) Does the type of bacteria affect the results? Try the same set of spices with different bacteria to test each spice's effectiveness against other bacteria.

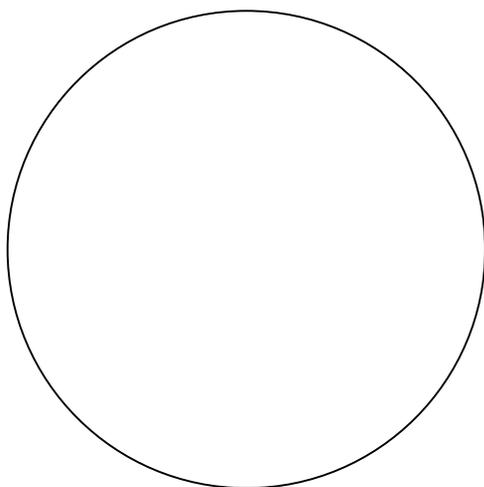
**Variations on the Presentation of Findings:** a) *PowerPoint/HyperStudio/Web Page:* Write, design, and produce a presentation about why the experiment was conducted, the process of the experiment itself, and its findings. b) *Graphing:* Using either standard graph paper or spreadsheet software, graph the results of the lab experiment, using the four worksheet sketches and their levels of antibiotic properties, to show a physical comparison of each spice's efficacy against the given bacteria.

**EXPERIMENTAL PLATES WORKSHEET**

**Liquid Bacteria Used:** \_\_\_\_\_

**Initial Setup**

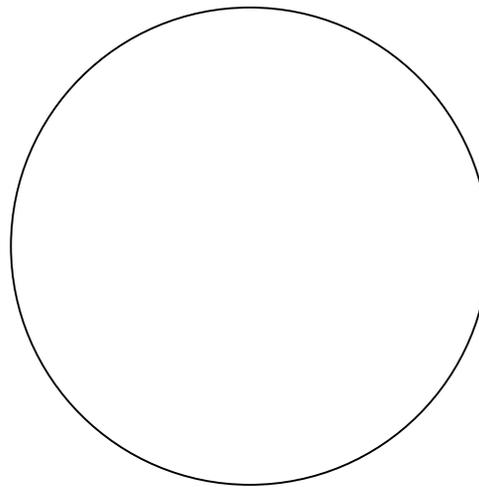
**Date:** \_\_\_\_\_



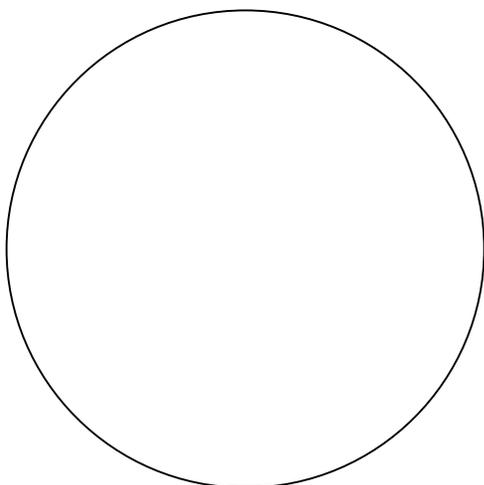
**plate 1**

**Final Results**

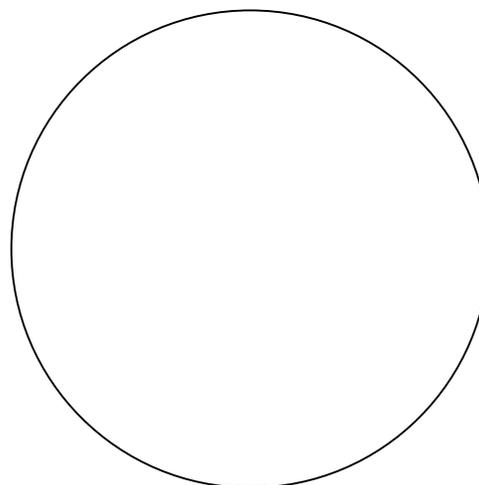
**Date:** \_\_\_\_\_



**plate 1**



**plate 2**



**plate 2**