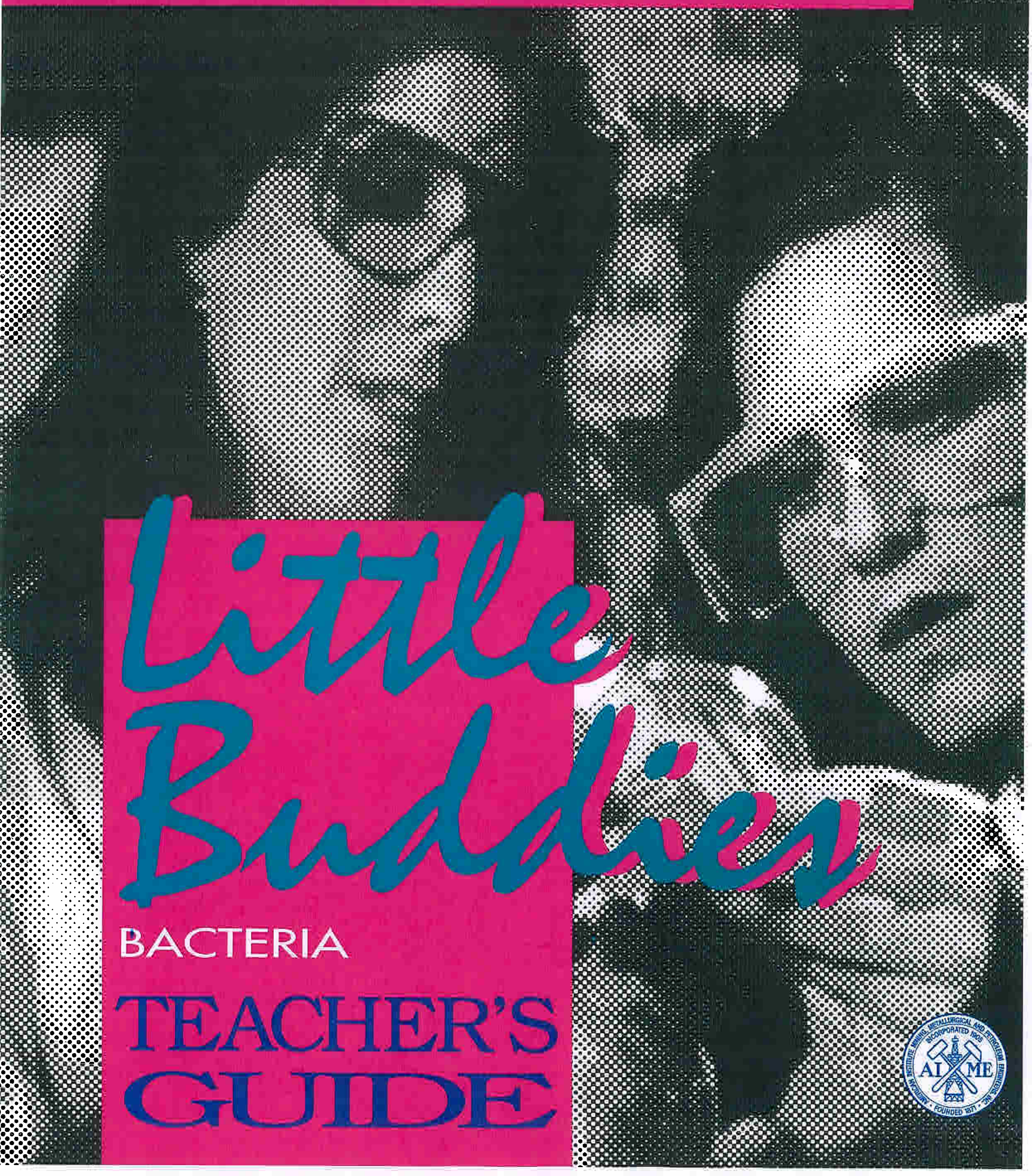
F

TRANSFORMATIONS
SCIENCE, TECHNOLOGY & SOCIETY



Little Buddies

BACTERIA

TEACHER'S GUIDE

TRANSFORMATIONS: Science, Technology & Society

Program Goals

- ▲ to enhance and enrich science instruction in Middle School classrooms
- ▲ to explore ways that technology takes scientific knowledge and applies it to meeting society's needs and solving society's problems
- ▲ to foster among students a spirit of inquiry, encouraging and developing their problem-solving skills
- ▲ to help create citizens who are cricital thinkers, prepared to make informed decisions about complex social/technological issues that will confront them in decades to come

LITTLE BUDDIES

Microbes and Mining

This unit explores the important aspects—and recent technological applications—of microbes, especially bacteria. The video includes a lab visit with a chemical engineer working to isolate bacteria that could be used to extract specific metals from low-grade ore, and a field visit with an engineer using bacteria and water to do just that—extract copper from low-grade ore. The topics developed in this Guide are

- ▲ Microbes
- ▲ Mining

Curriculum Connections: Life Science, General Science, Earth Science; a literature unit on "cooperation" or "friendship"

Summary of the Video

As the band members relax, their activities inadvertantly revolve around bacteria: Simone talks of the penicillin that has cured her brother of pneumonia while she eats yogurt she learns is bacterially cultured. And Billy discovers a moldy sandwich in the refrigerator.

An animation sequence shows how bacteria have adapted as life has evolved, and how humans have developed uses for them– as medicines, to produce foods, to clean up oil spills, and in mining. Simone visits Debbie Langhans, a chemical engineer with the U.S. Bureau of Mines. She sees the bacterial cultures Debbie is working with, cultures of bacteria naturally associated with an ore. Debbie demonstrates how she is working to isolate the various strains in the culture, trying to find the strain or strains that will eat away anything but the particular ore being mined– in this case, manganese.

Debbie's work is based on the ore extraction technology currently being used with copper, technology Simone sees when she visits Hunter White, a metallurgist with Phelps Dodge. He takes her through a copper field where naturally-occurring bacteria are sprinkled with slightly acidic water to help them "cook" and to flush the copper "leftovers" from the rock. Simone also visits the plant to see how the copper is converted, using electrolysis, into metallic copper that is 99.99% pure.

The theme song, "Small Sly," ends the video:

> You're small, you're sly
> And I've got my eye on you
> You're cool, you're smart
> You've been there from the very start
>
> You know we all can do things
> But you can do more
> You travel all over the world
> To those distant shores
> You're mean, you're clean
> Don't know where to begin with you.

Suggestion for Using Unit F: "Little Buddies"

Page 3 — Introduction to the Teacher

Here you will find additional background information on the science and technology presented in "Little Buddies".

Page 4 — Introduction to the Students

This section gives you material for introducing "Little Buddies" to your students, including a statement of the purpose of the unit; suggestions for connecting the unit to students' experience; definitions of key concepts and terms; and directions for the Video Study Guide (see below).

Page 5 — Topic 1

Page 6 — Topic 2

These pages focus on the two topics in "Little Buddies": Microbes and Mining. Each page furnishes options for introducing the topic to students and a wide array of ways for students to respond to the topic, including labs that are carried out through the Activity Masters.

Choose any of the topics as your focus, depending on where you are in the curriculum.

Video Study Guide

You can use the video guide (Activity Master 1) to focus students' attention on and check their comprehension of the video.

Video

Running time for the video is 17 ½ minutes. You may want to preview the video and choose a Stop Point for conducting a discussion, carrying out an activity, or making a comprehension check. The video may also be show straight through.

Pages 7-13 — Activity Masters

The first blackline master is the Video Study Guide for "Little Buddies". The other masters give students hands-on opportunities in the form or activities and labs.

Page 14 — Extension

This final section includes suggestions for science fair projects and research topics, ones that build on concepts explored in "Little Buddies" Also listed are related resources for interested students to pursue, including book titles and organizations to contact.

LITTLE BUDDIES: An Introduction for the Teacher

"Little Buddies" investigates the nature of microbes, mainly bacteria, and some of their technological applications, especially their use in mining low-grade ore.

Below is a more detailed explanation of concepts presented in the video and developed in this Guide.

How are bacteria classified?

Bacteria went unnoticed until Anton Van Leeuwenhoek observed them under his single-lens microscope in 1684; they were not a serious object of study, moreover, until the mid-1800's. Initially, when all life was classified as plant or animal, bacteria were classified as plants: Cyanobacteria—blue-green bacteria—were considered a kind of algae (they did, after all, contain chlorophyll); other bacteria were thought to be related to fungi.

Once the electron microscope was developed, scientists observed that bacteria lack nuclei; instead of a nucleus surrounded by a membrane, a bacterium has circular strands of nucleic acids. Nor do these one-celled organisms have the energy-producing organelles common to other cells—mitochondria or chloroplasts (in plant cells). Scientists then set up the kingdom *monera* for simple one-celled organisms that have no nuclei and included in it two phyla—**cyanobacteria** and **schizomycetes** (bacteria).

Classifying bacteria themselves has also proved difficult because they have little structure to use in determining relationships. They are frequently classified by shape—bacilli (rods), spirilla (spirals), and cocci (spheres); or by metabolism—anaerobic (need an oxygen-free environment), aerobic (need oxygen in their environment), or capable of living in both environments.

How do bacteria reproduce? eat?

They reproduce by fission, with one cell splitting into two equal cells. The cell contents double up prior to splitting, and each new cell has equal parts. Because they have no nuclei, bacteria do not reproduce by mitosis, as other organisms do.

All bacteria need water to live. They absorb nutrients directly from the environment around them. Enzymes help break down nutrient molecules to extract energy for the bacterium's use. The enzymes in a bacterium are usually quite specific and act only on one substance or a few related substances. The bacterium must attach itself closely to the nutrient source so that, as the enzymes break it down, the resultant smaller molecules can be absorbed.

Bacterial eating habits can have great importance. As nitrogen-fixing bacteria feed, they break down nitrogen and make this vital element available for plant use. Lithotrophic (rock-eating) bacteria get their energy from the elements in rock, eating some and releasing others in the process. Lithotrophic bacteria are the "miners" in microbial mining.

What is microbial mining?

About forty years ago, scientists isolated the specific strain of bacteria—**thiobacillus ferroxidans**—capable of separating copper from ore. These bacteria feed on the sulfur and iron in the rock, leaving behind the copper, which can be flushed out with water.

Today, 30% of the copper produced in the U.S. comes from microbial mining. This cost- and energy-efficient process makes it possible for the mining industry to recover copper from ore containing only .4% copper, the kind of low-grade ore heretofore ignored or left behind in mine dumps.

What is electrolysis?

This process uses electric current to break down a complex compound into simpler ones or to separate a compound into its elements. The substance to be changed is called the electrolyte. Most electrolytes are dissolved in water because H_2O is neutral enough to dissolve acids, bases, or salts; doesn't usually produce great heat; and doesn't usually lead to violent reactions.

The electric current is applied through electrodes. causing the electrolyte to dissolve by dissociation—the substance's molecules break into charged particles called ions. An ion with a negative (-) charge (anion) is drawn toward the positive (+) pole of the electrode (anode), while an ion with a + charge (cation) is drawn toward the - pole of the electrode (cathode). Many metals will form a deposit on the suitable cathode. As the video for "Little Buddies" demonstrates, this kind of process is used to produce metallic copper which is 99.99% pure.

LITTLE BUDDIES: An Introduction for Students

Introducing the Unit

Present the goals of "Little Buddies" to students:

- ▲ to realize the important roles—positive and negative—that bacteria play in the life processes on our planet;
- ▲ to work with and observe bacteria and other microbes;
- ▲ to discover some of the technologies that exist or are under development to put microbes to practical use;
- ▲ to explore one applied use of microbes—the microbial mining of copper—and contrast it with traditional mining;
- ▲ to appreciate that biotechnology, the use of living organisms to solve practical problems, is an active and growing field;

They should **not** feel, however, that they are responsible for memorizing the technological processes and tools described in the video.

Connecting the Unit to Students' Experiences

Ask students how many bacteria they think their bodies contain

—the answer is *billions*. Without the chemical reactions carried on by bacteria, there would be no life on this planet. Bacteria have been around since life began, but biotechnology is quite a young science. We are just beginning to explore the growing number of ways we might use or direct bacteria and other microbes to improve our lives.

Key Concepts and Terms

Students will be exploring and extending their understanding of the words listed below (in bold face) by topic area. You might write these words on the board and briefly discuss them to determine which are familiar to your students.

Topic: Microbes

- ▲ A **microbe** is an organism you must use a microscope to see. Bacteria, yeasts, and molds are all microbes. Another term for such an organism is **microorganism.**
- ▲ A single microbe is microscopic, but **colonies** can grow big enough to be seen.
- ▲ **Molds** in the **penicillin** family can be used to treat various infections or diseases caused by certain harmful bacteria.
- ▲ A **bacterium** is an organism composed of a single cell. While some **bacteria** cause disease, others are useful or critical to life on Earth. Useful kinds of bacteria cause organic matter to decay, keeping the cycle of life going; break down and make the vital element nitrogen available for plant use; and can be used in making various foods and medicines.
- ▲ **Sterilization** is a heating process used to kill all organisms and microorganisms, including harmful bacteria, on or in the object being sterilized.
- ▲ Bacteria reproduce by **fission**. In fission, the bacterial cell doubles its contents and splits into two equal cells.
- ▲ When bacteria are studied, they are grown in containers that include a **nutrient solution**. These nutrients are chemicals needed by the bacteria for their life activities.
- ▲ In working with combinations of bacteria, scientists may need to **isolate**, or set apart, particular **strains** (varieties) of bacteria to observe their characteristics.

Topic: Mining

- ▲ Bacteria found around copper ore thrive best in an **acidic** environment, where there is a relatively high concentration of hydrogen ions, in contrast to an alkaline environment, where there is a low concentration of hydrogen ions.
- ▲ Rainwater **percolates** through the earth, passing through soil and rock pores. The water **leaches out** substances, washing out whatever is **soluble**—whatever dissolves in the water. That is, the rain **solubilizes** these substances.
- ▲ In refining ore, engineers often use a process called **electrolysis**: An electric current is passed through a solution containing liquid, usually water, and the metallic substance, called an **electrolyte**.
- ▲ Electrolysis breaks a compound into its component parts—various metals, nonmetals, charged particles called **ions**—to obtain a purer form of the target metal.

VIDEO STUDY GUIDE

To focus or direct students' viewing of the video, distribute Activity Master 1, the Video Study Guide. You might have your students work individually, or small groups could each be responsible for a particular section of the Study Guide. Allow time—stopping the video at various points or after the video is over—for students to discuss their responses.

LITTLE BUDDIES: Microbes

Introducing the Topic: Options

▲ Encourage students to collect "Unbelievable Bacterial Facts" as they explore this unit. Start them off with a few:

Δ There are more bacteria in your intestine than there are cells in your body.

Δ Bacteria are so small that 10,000 of them would only be about 1 cm long.

Δ Some bacteria eat rock.

▲ Write **bacteria** on the board above two columns: **harmful and helpful.** Have students brainstorm together or in small groups to come up with ways bacteria fit in both columns

Examples: harmful—disease, infection, food spoilage and poisoning, bad breath; helpful—make food, used in medicines, help humans and animals digest, decay matter, "fix" nitrogen for plants, clean up oil spills.

STUDENT INVOLVEMENT: OPTIONS

Indicates an activity that would take less than a class period.

Indicates an activity that could take most of a class period.

Indicates an activity that would go beyond the class period.

Discuss the Video.

Video Guide notes can help students answer these and other straighforward questions:

▲ What are some facts you learn about microbes from the animated sequence?

Oldest life on earth; been on Earth over 3 billion years; can live where it's freezing and where it's boiling hot; are on us and in us; help make medicines, treat cancer, produce foods, clean up oil spills and mine minerals.

▲ To what use does Debbie want to put bacteria?

Recover manganese from ore.

▲ How is she growing the bacteria? What do the bacteria eat?

In columns containing manganese ore and molasses; carbon.

▲ What does she have to do with the bacteria to find the answer she seeks? What complicates the process?

Take bacteria from column, identify strains, isolate each strain to see its effect on manganese; numerous strains to identify; may not be one strain but combination of strains needed to separate manganese most effectively.

Lab: Lactobacilli (Activity Master 3).

Materials needed: **See Master.** Divide students into lab groups to complete the lab.

Answers: 1. so light can pass through; 2. to stain bacteria for easier viewing; 3. rod-shaped—lactobacilli.

Lab: Microbe City.

Materials needed: **soil, mud or sand to fill container that is at least 15 cm deep ; water; clear plastic sealer and rubber band for container; nutrients (hard-boiled egg yolk, excellent sulfur source, and shredded newspaper, excellent carbon source; also try cheese, meat, powdered calcium sulphate).** This long-term activity was developed by Boston University's School of Education (project **Microcosmos**). Have lab groups follow this procedure: Mix soil with water to a creamy consistency. Remove soil debris. Mix sulfur source with carbon source and some mud; pour into column. Knock column against hard surface to settle contents and remove oxygen. Let the column rest for 24 hours. Remove water that forms at top. Cover and put in well-lit, warm place. In 3-6 weeks, microbes are visible in well-defined layers.

Lab: Comparing Cultures (Activity Master 4).

Materials Needed: **See Master.** This lab includes a 3-day wait to give the cultures time to develop. Note that sheet cautions students not to remove the clear plastic that covers the cultures. Have students discuss results.

Answers: 1. uncontaminated controls; 2. uncontaminated, A refrigerated; 3. contaminated with finger, C refrigerated; 4. unrefrigerated; one contaminant is cleaner; 6. E; 7. warm, dark place with more contaminants added.

Lab: Moisture and Microbes (Activity Master 5).

Materials needed: **selection of dried food samples for lab groups to select (i.e., rice; cereal; dried beans, milk, beef, fish), also see Master.** This lab includes a one-week wait for microbes to develop. Display foods; let lab groups choose, prepare, and store samples. After students have observed the results, give them a chance to discuss what happened.

Homework: Millions of Microbes.

Review **fission** with students (listed on Guide p. 3). A bacterium splitting every ½ hour can grow into a billion cells in just 15 hours (as noted in the video). Ask students to set up a graph with intervals of 1 hour along the x-axis and the corresponding number of bacteria along the y-axis. Then ask them to calculate how long it would take for a bacterium to grow into one million cells

10 hours.

LITTLE BUDDIES: Mining

Introducing the Topic: Options

▲ Encourage students to collect "Unbelievable Bacterial Facts" as they explore this unit. Start them off with a few:

 Δ There are more bacteria in your intestine than there are cells in your body.

 Δ Bacteria are so small that 10,000 of them would only be about 1 cm long.

 Δ Some bacteria eat rock.

▲ You might begin this activity by having the whole group discuss some common uses of bacteria (in food and medicine, say) and some of the issues facing the mining industry today (*e.g.*, finding new sources of ore when much has already been mined). Then divide students into brainstorming groups, and set them this challenge: How could bacteria be of important use to the U.S. mining industry? Have groups come together to discuss and evaluate one another's responses: Which seem realistic? Which seem unlikely?

STUDENT INVOLVEMENT: OPTIONS

Indicates an activity that would take less than a class period.

Indicates an activity that could take most of a class period.

Indicates an activity that would go beyond the class period.

Discuss the Video.

Video Guide notes can help students answer these and other straighforward questions:

▲ What kind of metal is Hunter mining for? Why is he working with bacteria? What do these bacteria eat? What do they leave behind?

Copper; help recover copper from low-grade ore that wouldn't otherwise be used; sulfur and iron; copper.

▲ What purposes does the water serve?

Provides bacteria with needed acidic environment, washes out copper in solution down into canyons where it's channeled and collected.

▲ What is done to the ore-containing solution to separate out an almost pure metal? How pure?

Electrolysis—an electric current is passed through solution; 99.99%.

▲ Simone links Hunter's work to conservation. Is she right? Why?

Yes—copper gets used, water is recycled, bacteria are naturally occurring.

Group Discussion: Changing Times.

Point out that in the U.S., high-grade copper ore (ore with a high percentage of copper) has been largely used up after years of mining. Ten years ago, the average mine yield was about 6% copper. Today, the mined ore typically yields .6% copper. Ask, What affect do you think this has had on the mining industry and on manufacturers of copper goods?

Activity: Two Methods of mining and Refining Copper (Activity Master 2, 2 pp.).

Review with students what they learned from the video about the microbial mining and subsequent refining of copper. Then have students—in groups or cooperative pairs—complete the sheet. Afterward, encourage them to compare and discuss the two methods.

Answers: 1. dry process; 2. microbial, dry process would be too costly—money and energy; 3. electrolysis to produce metallic copper.

Demonstration: Electrolysis of Water.

Materials needed: **can, electrician's tape, large glass beaker, water, dilute sulfuric acid, 2 test tubes, wire, 2 dry cells in a series, matches.** Cut two strips from a can, and wrap the tape around the strips: Fill beaker 3/4 full with water; add a few drops of acid. Bend each strip end in opposite directions, and hook each strip on the side of the beaker. Put a test tube filled with water over the lower end of each strip. Connect the strips to the dry cells. Have students compare the rate at which the gases form in the tubes. Lift out a gas-filled tube without tipping it over. Bring a burning match near the opening. If an explosive pop is heard, the gas is hydrogen. Test the other tube. Explain that this separation of a compound (water) into its component parts (hydrogen and oxygen) is called electrolysis.

Homework: How Much Ore?

Low-grade copper ore contains about .4% copper. How many pounds of low-grade ore are needed to yield 1 lb. of copper? **(250)** A typical house contains 400 lbs. of copper. How many pounds of low-grade ore are needed to produce enough copper for a house? **(100,000)**. In the future, low-grade ore may be mined with only .3% copper. How many pounds of ore will it take then to yield one pound of copper? **(333)**

VIDEO STUDY GUIDE

This guide is designed to help you get the most out of the video for "Little Buddies." Look over the questions below before you watch the video. Use the space under the questions to take notes. What does the video tell you in answer to the question?

1. What are some facts you learn about microbes from the animated sequence?

2. Debbie Langhans is a chemical engineer working with bacteria. To what use does she want to put bacteria?

3. How is Debbie growing the bacteria? What element do the bacteria eat?

4. What does she have to do with the bacteria to find the answer she seeks? What problems complicate the process?

name: ______________________ class: ________ date: __________

VIDEO STUDY GUIDE, continued

5. What kind of metal is Hunter White, a metallurgist, mining for? Why is he working with bacteria? What do these bacteria eat? What do they leave behind?

6. The ore field is sprayed with water. What purposes does the water serve?

7. What is done to the ore-containing solution to separate out an almost pure metal? How pure is it?

8. Simone links the work Hunter White does to conservation. Is she right? Why?

9. What are your favorite parts of the video? Why?

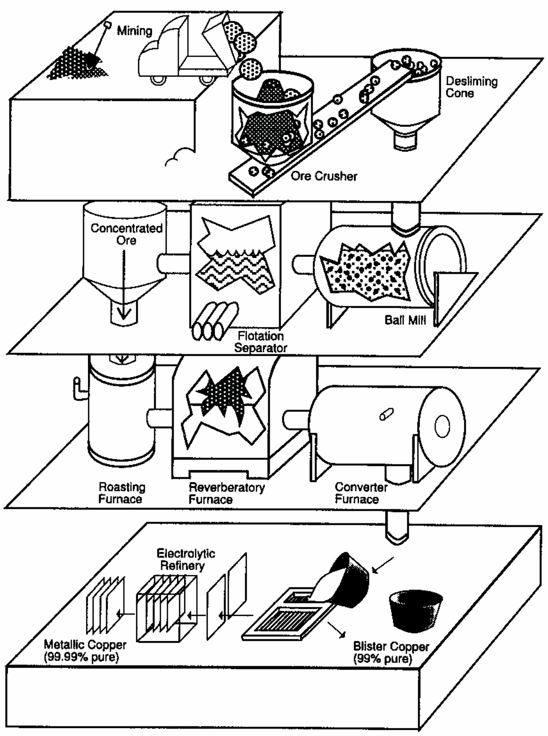
name: ______________________ **class:** ________ **date:** __________

TWO METHODS OF MINING AND REFINING COPPER

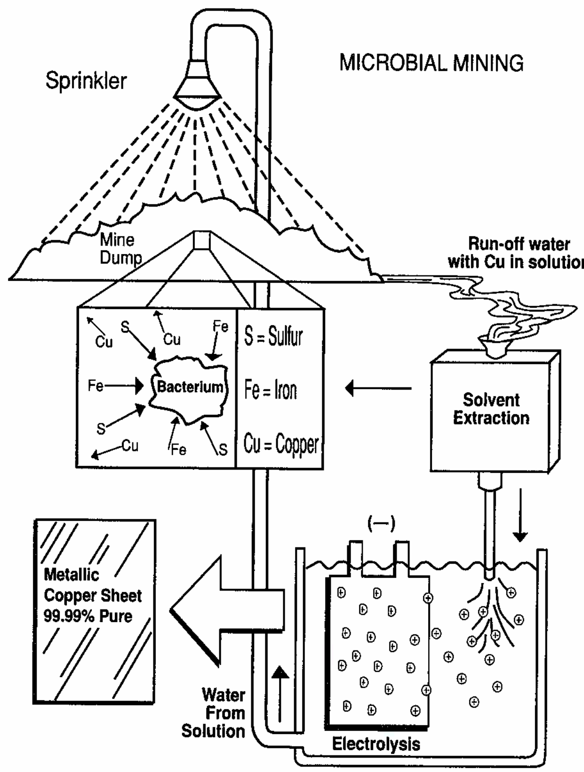
Below are diagrams of two major ways of mining and refining copper. You should be familiar with microbial mining from watching the video for "Little Buddies."

Look at page 2 of this Master. The steps for the Dry Process are listed. On the lines below the heading **Steps in Microbial Mining**, list the important steps in this process, based on the diagram and on what you have learned.

DRY PROCESS COPPER REFINING



MICROBIAL MINING



name: ______________________ class: ________ date: __________

TWO METHODS OF MINING AND REFINING COPPER, continued

Consider these two methods of mining/refining as you answer the questions that follow.

STEPS IN THE DRY PROCESS

1. Ore is broken loose in the strip mines and loaded onto the trucks.
2. The ore is brought from the mine and crushed.
3-5. Unwanted earthy materials are removed from the ore.
6-8. The concentrated ore is treated in 3 types of furnaces.
9. Copper leaving the final furnace, called blister copper (99% pure), is molded into thick slabs.
10. The slabs may be further refined through electrolysis.
11. The resulting slabs of metallic copper are 99.99% pure.

STEPS IN MICROBIAL MINING

1a. ____________________

1b. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

1. Which method requires more energy? ____________________

2. Which method would you use if you had a low-grade ore? Why?

____

3. Are any stages of the two processes identical? If so, which?

____

name: ____________ class: ________ date: ________

LACTOBACILLI

Bacteria that cause food poisoning are unwelcome visitors in our foods but bacteria are a necessary part of some foods, such as yogurt. See for yourself what the bacteria in yogurt—**lactobacilli (lacto** means "milk")—look like.

PART A BEFORE THE LAB:

Read through the procedures, and then answer the questions below.

1. Why do you think you add water to the yogurt?

 ____

2. Why do you think you add methylene blue to the slide?

 ____

3. Bacteria are either rod-shaped (bacilli), round (cocci), or spiral-shaped (spirilla). What shape will the bacteria in yogurt have? Why do you think so?

 ____

 ____

PART B PROCEDURE FOR THE LAB:

1. Combine a small amount of yogurt with water to make a very thin mixture.
2. Use dropper to place a drop of yogurt mixture onto slide.
3. Use other dropper to add one drop of methylene blue to slide.
4. Place a cover slip over slide.
5. Look at your slide under a microscope, under low and high power.

MATERIALS NEEDED

Per lab group

- ▲ Microscope
- ▲ Slide
- ▲ Cover slip
- ▲ Small dish and stirrer
- ▲ Small amount of plain yogurt
- ▲ Water
- ▲ 2 Medicine droppers
- ▲ Methylene blue stain

OBSERVATIONS:

Do you see any bacteria on the slide? How many? What do they look like? Write and draw your observations here and on the back of this sheet.

name: ______________________ **class:** ________ **date:** ________

COMPARING CULTURES

In this lab, you will be growing and comparing 5 different microbe cultures. All will be feeding on cottage cheese nutrient, but each culture will be handled differently.

Safety Note: Do not unseal containers after microbes have begun growing. Always wash your hands carefully after working with microbes.

PREPARATION:

Make a chart with these headings: Container Label, Container Treatment, Results.

PROCEDURES

1. Using masking tape, label the 5 containers A, B, C, D, E,
2. Place 2-3 tsps. (10-15 mL) of cheese in each container, spreading it on the bottom.
3. Cover containers A and B with clear plastic wrap..
4. Have each lab member stick one finger in the cheese in container C and another in container D. Cover both.
5. Wash your hands thoroughly. Have each member stick a newly-washed finger in the cheese in container E. Cover it.
6. Place containers A and C in the refrigerator. Place containers B, D, and E in a cabinet or other dark place.
7. Fill out column 2 in your chart.
8. Wait 3 days, and then observe the five cultures.

MATERIALS NEEDED

- ▲ Cottage cheese
- ▲ Teaspoon
- ▲ 5 Clean containers
- ▲ Clear plastic wrap
- ▲ Masking tape
- ▲ Access to refrigerator

OBSERVATIONS:

Do you have fuzzy molds? Slimy yellow, orange, or white yeasts? Shiny, smaller, moist-looking bacteria in shades of yellow, cream, or red?

Fill out column 3 in your chart. On a separate sheet, draw what you see in each container, labeling the drawing with the container letter. On the same sheet, number 1-7, and answer these questions:

1. How were A and B different from the other cultures?
2. How were A and B treated the same? differently?
3. Why were some containers refrigerated?
4. How were C and D treated the same? differently?
5. How were D and E treated the same? differently?
6. What treatment resulted in the most microbe growth?
7. What conditions can cause the most bacteria growth?

name: ______________________ class: ________ date: __________

MOISTURE AND MICROBES

How does moisture affect microbial growth? This lab will give you an opportunity to find out

Safety Note: Do not touch microbe samples with your hands. Use a needle or probe when taking samples to view under the microscope or lens. Always wash your hands after working around microbes.

PROCEDURES

1. Choose two types of dry food.
2. Place 1 tsp (5 mL) each of Food 1 in Jars A and B.
3. Place 1 tsp. (5 mL) each of Food 2 in Jars C and D.
4. Add 6 tsps (30 mL) of water to Jars A and C.
5. Close each jar tightly, and label it with food name and with "wet" or "dry."
6. Put jars in warm, dark place for one week.

MATERIALS NEEDED

Per lab group

- ▲ 2 dried foods (from your teacher)
- ▲ 4 clean jars with lids
- ▲ Teaspoon
- ▲ Water
- ▲ Masking tape (for labels)
- ▲ Microscope or hand lens

OBSERVATIONS:

1. Compare your four samples, and describe them below:

JAR (LABEL)	OBSERVATION (eye)	OBSERVATION (under microscope or lens)
______	______	______
	______	______
______	______	______
	______	______
______	______	______
	______	______
______	______	______
	______	______

3. Look at all the samples you and your classmates developed. Which food produced the greatest microbe growth?

____

4. Which has more microbes—wet or dry samples? Why? Where did the extra microbes come from?

____

name: ______________ **class:** ________ **date:** ________

LITTLE BUDDIES: Extension

Interested students may wish to pursue ideas and concepts raised by this unit. You could direct them to the suggestions and resources listed on this page.

Possible Research Topics

- ▲ Find out about oil-eating bacteria, which can be used on oil spills to accelerate the clean-up process.
- ▲ Visit your doctor's office, a test laboratory, and/or a pharmacy to inquire about the procedures followed to prevent the spread of microorganisms.
- ▲ Investigate the effects of folk remedies on the growth of a staphylococcus epidermis.
- ▲ Investigate the seepage of human waste bacteria along our shoreline and discuss its ramifications.
- ▲ Trace the life cycle of disease-producing microbes, such as the bacteria that cause typhus or Rocky Mountain spotted fever.
- ▲ Find out how and why electroplating is done.
- ▲ Explore and compare the various methods that have been used to mine copper.

Suggested Science Fair Projects

- ▲ What is the effect of preservatives on yeast growth?
- ▲ What is the effect of heterotrophic bacteria on beef and fruit spoilage?
- ▲ What is the effect of different mouthwashes on streptococcus salivarius?
- ▲ Observe the bacteria count in milk at various temperatures.
- ▲ What are the determining factors that foster bacterial growth in pond water?

Resource Center

Books to recommend:

Bacteria: How They Affect Other Living Things by Dorothy Hinshaw Patent (Holiday, 1980)

The Disease Fighters: The Nobel Prize in Medicine by Nathan Aaseng (Lerner, 1988)

The First Book of Microbes by Lucia Z. Lewis (Watts, 1972)

Garden of Microbial Delights: A Practical Guide to the Subvisible World by Dorion Sagan and Lynn Murgulis (HBJ, 1988). An adult book but accessible to good readers.

Gold and Other Precious Metals by Charles Coombs (Morrow, 1981)

The Smallest Life Around Us by Lucia Anderson (Crown, 1978)

Organizations to contact:

American Society of Microbiology
1325 Massachusetts Avenue NW
Washington, DC 20005

Carolina Biological Supply Co.
2700 York Road
Burlington, NC 27215
(excellent source for all biologicals)

Microcosmos Project
Boston University
School of Education
605 Commonwealth Avenue
Boston, MA 02215

Office of Public Information
Bureau of Mines
Department the Interior
2401 E Street NW
Washington, DC 20241

Phelps Dodge Copper Products Co.
2600 North Central Avenue
Phoenix, AZ

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