



SURFACE SAMPLING

“IS MY CLEANING SERVICE WORTH THE MONEY?”

DESCRIPTION:

Students will learn how to conduct environmental sampling procedures on surfaces, develop a sampling strategy, and follow an established lab protocol.

RATIONALE:

During the scenario, students acting as Industrial Hygienists will take surface samples from residences around Hydroville to look for evidence of pesticide contamination that may be responsible for causing the Mysterious Illness Outbreak.

PURPOSE/GOALS:

Students will be able to:

- Understand the concept of sampling and develop a sampling strategy.
- Collect environmental (surface) samples under simulated conditions.
- Describe and follow lab protocols used for obtaining environmental samples.
- Demonstrate accurate measurement when sampling.

PREREQUISITES:

TIME ESTIMATE:

Prep: 50 min.

Activity: Two 50-minute class period

MATERIALS:

- Hydroville Learning Log
- GloGerm Powder or GloGerm Liquid (oil)
- UV light

MATERIALS (PER GROUP OF 2 STUDENTS):

- 1 - 12" X 12" surface sample (carpet, tile, vinyl flooring, countertops, and clothing)
- 1 pair of rubber or latex gloves
- Masking tape
- Ruler
- 4 cotton swabs
- Water
- 2 “Sampling Log” forms
- 2 snack-size plastic, resealable bags
- Permanent marker

MATERIALS TO PHOTOCOPY:

- Background Information on Sampling with Questions (1/student if used for homework)
- Transparency 1: Sampling Scenario/Map of Apartment
- Transparency 2: Lab Protocol (Transparency 1 and 2 can be printed back-to-back on card stock and laminated for classroom use)
- Student Worksheet: Sampling Strategy (1/student)

- Student Instructions: Surface Sampling – Lab Protocol (1/group) – These pages can be laminated and reused by other classes.
- Sampling Log form (1/group)

BACKGROUND INFORMATION:

Science is a field of study that uses data to come to some conclusion about a question that is being asked. Data is information that might come in the form of numbers or observations. Epidemiology is a field of science that investigates and tries to understand the causes of diseases and to control those diseases in a population. In epidemiology, all types of data become important. For example, if we want to answer the question, “Who started this outbreak of a mysterious illness?” We will need to gather information related to the symptoms of the illness, how many people have the illness, where and how the people came into contact with the illness, how the illness is spread, and so on.

Many times we need to figure out "how many" of something there are when it is impossible to actually count them all. For example, if you needed to estimate the number of students who drink at least one carbonated beverage each day in a high school with 2,000 students, talking to everyone is probably out of the question. Often people use sampling techniques to get a reasonable estimate in situations like this. Samples are taken to obtain a representative example of a population or matrix (soil, water or air) under investigation. The results of the sample can be applied to the population as a whole. The more samples taken, the more representative the data is of the entire population or area that is being investigated

One of the things epidemiologists are often looking for is the source of the illness or outbreak. For example, if we think the cause of a mysterious illness might be bacterial, we might look for a site where bacteria are living and reproducing. If we think the source might be chemical, we might look in places where the chemical may have been used. Epidemiologists, occupational health officials, and safety professionals assess workplace contaminants and associated worker exposures using microbial or chemical sampling and analysis.

The accuracy of the data collected through these sampling techniques is based on three main factors:

1. The procedures or protocol used for sample collection
2. The type of analysis done on those samples. (How the samples were studied once they were collected)
3. How the data gathered from those samples is interpreted and applied.

In many instances the procedure or protocol for sampling has been developed over many years and is accepted by the professionals as best practice. In the case of criminal investigations, evidence used in court may depend upon very strictly followed protocols for collection. However some instances require professionals such as industrial hygienists to design protocols for sampling in a specific workplace or living area.

Prior to conducting sampling, a sampling survey protocol should be established. This protocol serves as a guide in performing the sampling. The amount of detail necessary will depend on the purpose of the sampling survey and to whom the results will be submitted. As a minimum, the protocol should include the following:

1. **Purpose of the sampling survey.** Why do I want to collect samples? Background information (e.g., previous surveys) should be referenced.

2. **Where to sample.** This identifies expected exposure sites. Where is bacterial or chemical contamination likely to occur?
3. **What types of samples should be collected?** Should air, water, or surface samples be included in the survey?
4. **How many samples should be collected?** Considering the number of exposure sites and potential hazards, how many samples are necessary to assess the various sites within the constraints of the budget for the survey?
5. **How will the samples be collected and analyzed.** What procedures or protocols are you going to follow to collect the samples? How will you collect, package and transport samples? Which laboratory tests will provide the most meaningful data?

When looking at the results from a sampling survey, scientist must take into account errors that may occur in the sampling process. Errors can occur in many ways including:

- Poor sampling techniques
- Not collecting enough samples
- Using contaminated containers for transportation
- Using testing equipment that has not been calibrated

TEAMWORK SKILL:

The skill listed below will be important in this activity.

- Ask for justification for team member’s conclusion or answer.

TERMINOLOGY:

Sampling	Probability
Protocol	Blanks/controls
Microgram	Micrograms per square centimeter ($\mu\text{g}/\text{cm}^2$)

SUGGESTED LESSON PLAN:

Getting Started

1. Assemble a variety of surfaces found in the home that students can practice their surface sampling techniques, such as, countertops, vinyl flooring, tile, carpet, and, clothes. Surfaces should be flat, relatively smooth, light-colored, and approximately 12" X 12" in size. These items can be found at second hand stores or contact flooring/carpeting installers for free samples or remnants. Clean all surfaces. If clothing is used, it should be stretched over a piece of cardboard and taped on the backside.
2. Acquire an indicator called, "GloGerm" from Educational Innovations (1-888-912-7474) or order directly from GloGerm (www.glogerm.com). GloGerm is an invisible, phosphorescent powder that can be detected under UV light. In this activity, GloGerm will represent the substance that the students are sampling for.
3. Obtain an UV light source and other supplies on students’ material list.

NOTE: Black lights can be used in lieu of UV lights, but do not illuminate the GloGerm as brightly or in as much detail as a UV light.

4. Prepare about 15 surfaces to sample for the entire class (1/ pair of students). Each surface needs to be treated with either GloGerm Powder or GloGerm Liquid. The powder is not diluted with any inert material, therefore it is highly concentrated. (You can also try using the GloGerm liquid in place of the dry powder.) Using a dry or moist cotton swab, gently

wipe GloGerm directly onto one of the surfaces. Randomly apply the GloGerm to small areas on the selected samples.

HINT: Apply it so that the GloGerm is not visible; light-colored surfaces can hide the white powder better. Adding small patches of baking soda to the carpet samples or had lotion to the tile or countertop material will camouflage the actual GloGerm location

SAFETY: The plastic particles in GloGerm powder are 5 microns and smaller. When the powder is “puffed” or thrown into the air like dust, it is a potential lung irritant. The GloGerm Company strongly recommends minimizing dust or powder in the air. Goggles or glasses are recommended when applying to the various surfaces.

5. Students can be assigned the “Background Information on Sampling” and questions for homework (page XXX) or this information can be presented in a lecture format.
6. Key points to get across the students:
 - Sampling is representative of an entire system
 - Sampling is done on a portion of an area, not the entire area, because of limited time, energy, and money
 - The probability of representing the entire system increases when the number of samples increases
 - Sampling can misrepresent a larger system even if you are successful in finding what you are sampling for

Doing the Activity

1. To stage this activity, show students Transparency 1: Sampling Scenario/Map of Apartment. Before students can begin sampling they must develop a sampling survey strategy. Distribute Student Worksheet: Sampling Survey Strategy and have students work in pairs to complete the questions
2. Allow students to share their answers to question 4: *Describe a method you would use to collect your samples using a cotton swab and 40 centimeters of masking tape.*
 - a) stress the idea of using the same standard technique when taking all samples
 - b) this would include a standard sample size – in this case a 10 X 10 centimeter square of masking tape
 - c) the cotton swab should remain sterile and not touch other surfaces
 - d) the cotton swab should be wet with a solvent (water in this case) to be able to pick up any cleaning product present
 - e) the surface should be wiped with the same number of passes and in both directions to make certain that all of the surface in the square has been tested.
3. Review Transparency 2: Lab Protocol before beginning lab activity.
4. Students will work in pairs throughout this activity. Hand out Student Instructions: Surface Sampling and the various surfaces to be sampled, one per group. Students will use a cotton swab to sample a surface that has been wiped with GloGerm which represents Cleaner XYZ. (Don’t tell them about the GloGerm.)
5. Review the sampling protocol
Explain that the same strategy can be used to locate Cleaner XYZ on your surface sample.
 - a. Randomly select an area on the sample.
 - b. Mark off 10 cm X 10 cm on the 12” X 12” sample.

- c. Wipe the surface back and forth with a wet cotton swab 10 times like you were following this grid to ensure that you will locate the cleaner within your selected sample area.
- d. Turn the surface 90 degrees and repeat the swabbing technique in step c.

SAFETY: Do not let students handle the surfaces without gloves on.

6. If time permits and the surface to be sampled are large enough, students can collect another sample from a second sample area on their surface.
7. Students should place a wet swabs that hasn't touched any surface in a bag labeled "Blank" as their control.
8. After students collect their samples, and complete their Sampling Logs, they can turn in their swabs and surface samples to you for "analysis". Or you can go around the room and shine the UV light on their swabs and on their selected surface. Did the students select a sample area where the GloGerm was applied? On their first sample? On their second sample? If the sample area was collected where the GloGerm was present, did they find it on their swab? Does the "Blank" swab show any evidence of contamination?
9. Depending on the amount of use by previous classes, you may have to reapply the GloGerm to the samples if you are intending to use them with additional classes.

Wrap-up

1. **Learning Log Prompts:**

How do sampling techniques affect the reliability of the results?

How do you know if you followed the lab protocol and sampling technique accurately?

2. Students may have to complete the Conclusion Questions for the Surface Sampling - Lab Protocol for homework.

ASSESSMENT:

- Submit completed worksheets with responses to specific questions.
- Students complete the Assessment "Designing a Sampling Protocol" (page XXX)

EXTENSIONS:

Mathematics

See the Mathematics Extension section for the following activities:

- Mathematics Extension 3: Ratio Activity (complete before Math Extension 4, "Tagging")
- Mathematics Extension 4: Tagging

Science

Repeat this same sampling protocol looking for bacteria. Use petri dishes to culture the samples. The more bacteria, the better the sampling technique used and location for bacterial cultures.

RESOURCES:

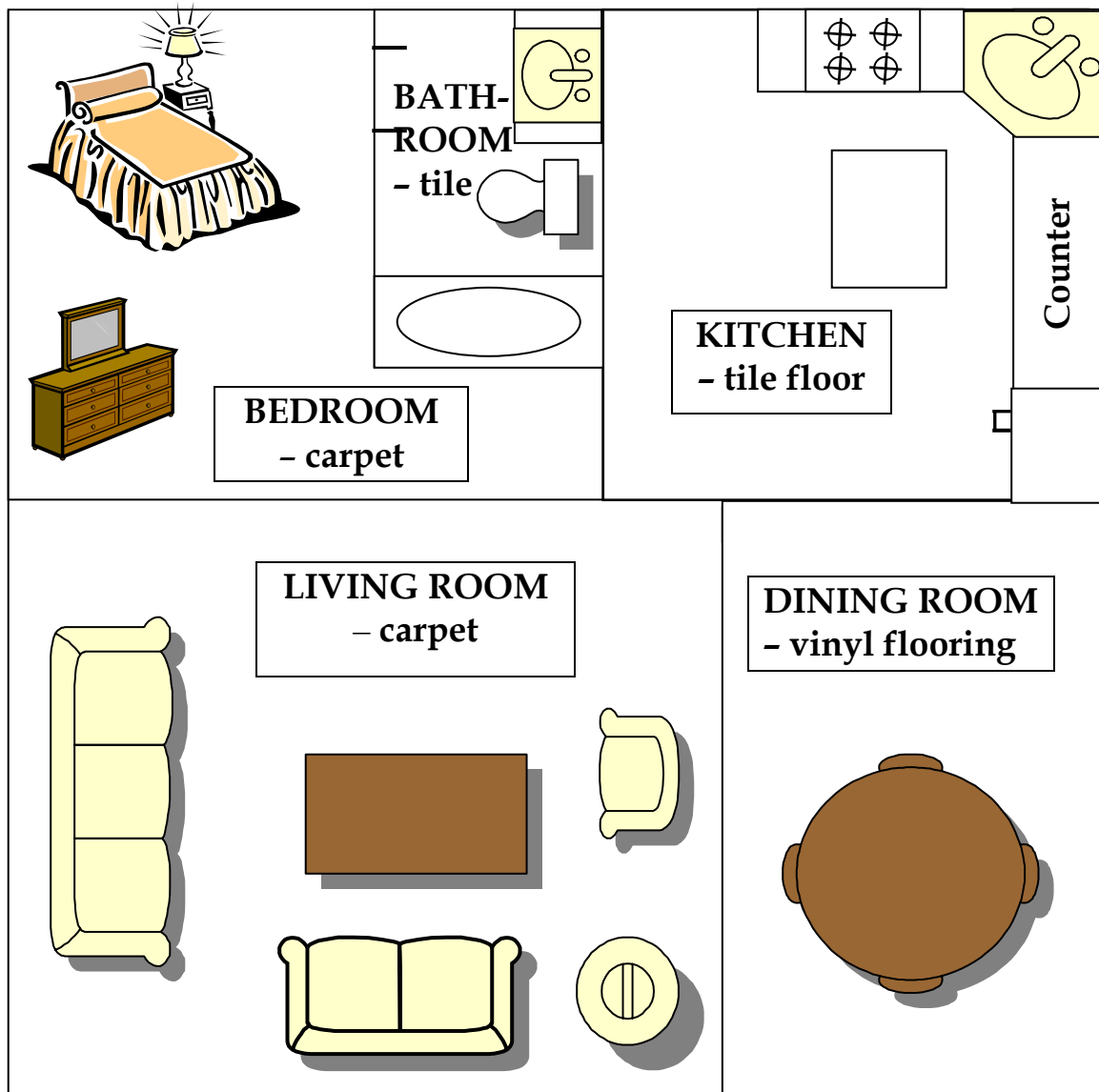
- Doherty, Maura, MPH. WISE STEPS, INC., TRAINING AND CONSULTATION. June 1989
- ToxRap. Toxicology, Risk Assessment & Pollution. Mystery Illness Strikes the Sanchez Household. EOHSI. Environmental and Occupational Health Sciences Institute. 1998
- GloGerm. <www.glogerm.com/>.
- OSHA U.S. Department of Labor. Sampling for Surface Contamination: <www.osha-slc.gov/dts/osta/otm/otm_ii/otm_ii_2.html#1>.

TRANSPARENCY 1:

SAMPLING SCENARIO/MAP OF APARTMENT

Scenario: You are a young, ambitious forensic scientist who recently hired a cleaning service to come in and clean your apartment. You want to see if they are actually cleaning all of the rooms and are using the environmentally friendly cleaning product, Cleaner G, that you recommended. Therefore, you want to sample your apartment for Cleaner G after the cleaning service is gone. Because it is an “all-purpose cleaner” G can be found on many surfaces.

Your job is to design a sampling strategy. Because of time and cost restraints, you are limited to taking 8 samples from rooms in the apartment. Write down your ideas on the student worksheet: Sampling Strategy.



Before you sample:

- ⇐ Have a sampling plan with a list of needed equipment for collection, packing, storage, and shipping
- ⇐ Know why, where, how, and where you want to sample (Develop a Sampling Strategy)

In deciding how to sample for chemicals, there are a few simple rules:**Protect yourself from potential chemical exposure**

- ⇐ Wear clean, impervious (rubber/neoprene) gloves to protect your hands when sampling
- ⇐ Dispose of your gloves after use

Document each step

- ⇐ Keep a logbook giving details of the sampling investigation
- ⇐ Give the time, dates, and a description of the sampling activities
- ⇐ Include any photos taken of the sampling site

Sample Collection

- ⇐ Use clean gloves and tools for each sample
- ⇐ Collect uncontaminated comparison samples first, and the most contaminated samples last
- ⇐ If you are sampling more than one sample site be sure that your sampling technique is the same every time. The only variable that is changed is the location of your surface sample or type of surface.
- ⇐ For quality control purposes, send comparison samples (blanks) of jars, rubbing alcohol, foil, swabs, or other collection material used at the site for comparison with the collected sample

Shipping Samples

- ⇐ Send samples to the laboratory with a Sampling Log noting the types of samples gathered and when, how and why they were collected
- ⇐ Use the proper methods for packing, storing, and shipping the samples to the analytical lab
- ⇐ Seal and label each sample so that they are easily identified and kept secure until analysis

TEACHER KEY

Sampling Strategy

1. What do you hope to accomplish and what specific chemicals are you sampling for?
Students are sampling for the Cleaner G in their apartments to see if the cleaning service is using chemicals to clean and doing a thorough cleaning job.
2. What type of sample will you use?
Surfaces: carpet, tile, vinyl flooring, countertops, table and bureau surfaces
Air samples: sample for volatile compounds in the cleaner
3. Select 8 areas that you want to sample and prioritize them.
Answers will vary, but they should only be areas found in the apartment and include all rooms.
4. Describe a method you would use to collect your samples using a cotton swab and 40 centimeters of masking tape.
Answers will vary.
5. Date: Use today's date Time of day: Use today's time Number of samples: 1-2 samples

Lab Protocol - Conclusion Questions:

1. What type of surface did you sample and where might it have been located in the apartment (in what room?)
Answers will vary depending on the types of samples that were handed out. Only the rooms that appear on the apartment map can be sampled: living room, dining room, kitchen, bedroom, and bathroom.
2. Did you find any trace of Cleaner G? Explain why you did or did not find it.
All students should have found the cleaner, but answers may vary.
3. Imagine that the 10 cm X 10 cm grid was placed over the surface you were sampling. If Cleaner G was present on your sample site and you used the proper swabbing technique, how many times could you have collected it on your swab? Draw a diagram of your technique.
2 times; once for each pass
4. Give several examples of how you can increase your chances of finding Cleaner G in your apartment?
You can increase your chances of finding the cleaner by taking more samples or following lab protocol accurately and precisely.
5. Explain why Cleaner G was probably not found on all of the surfaces sampled.
Cleaner G may not have been on all of the samples or in some small amount that could not be detected. Also, different types of surfaces might not show the presence of the cleaner because of their texture.
6. In this activity, you were trying to measure the amount of Cleaner G found on a 10 centimeter by 10-centimeter surface. The analytical lab reported that the swab you sent them from this sample contained 50 micrograms of Cleaner G.
 1. What is the total size of the area you sampled? *100 cm²*
 2. What is the unit of measurement used to indicate the concentration of Cleaner G? *micrograms*
 3. What is the concentration of Cleaner G in this sample? *50 µg/100 cm²*



**STUDENT PAGES
FOR
SURFACE SAMPLING

FOLLOW THIS PAGE**

SAMPLING BACKGROUND INFORMATION

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Prior to conducting sampling, a sampling survey protocol should be established. This protocol serves as a guide in performing the sampling. The amount of detail necessary will depend on the purpose of the sampling survey and to whom the results will be submitted. As a minimum, the protocol should include the following:

- 1. Purpose of the sampling survey.** Why do I want to collect samples? Background information (e.g., previous surveys) should be referenced.
- 2 Where to sample.** This identifies expected exposure sites. Where is bacterial or chemical contamination likely to occur?

3 What types of samples should be collected? Should air, water, or surface samples be included in the survey?

4. How many samples should be collected? Considering the number of exposure sites and potential hazards, how many samples are necessary to assess the various sites within the constraints of the budget for the survey?

5. How will the samples be collected and analyzed. What procedures or protocols are you going to follow to collect the samples? Which laboratory tests will provide the most meaningful data? How will you collect, package and transport samples?

When looking at the results from a sampling survey, scientist must take into account errors that may occur in the sampling process. Errors can occur in many ways including:

- Poor sampling techniques
- Not collecting enough samples
- Using contaminated containers for transportation
- Using testing equipment that has not been calibrated

SAMPLING BACKGROUND INFORMATION QUESTIONS

Read the attached "Sampling Background Information" and use it to answer the following questions:

1. Define the following terms used in the reading:

Epidemiology

Data

Protocol

Sampling Survey

2. Why is sampling used when trying to answer a scientific question?

3. What are three things to keep in mind when considering the accuracy or validity of any microbial or chemical sampling procedure?

4. What points should a microbial or chemical sampling survey protocol include as a minimum?

5. What are three sources of potential error in any sampling protocol?

6. You are a newly-hired epidemiologist for the state department of health and have been asked to investigate a food poisoning outbreak in your home town. You developed a hypothesis as to the cause of the outbreak after interviewing people who have become sick. Your hypothesis is that the source of outbreak was salmonella bacteria in the food from a local fast food restaurant.

What kind of sampling approach will you use to confirm your hypothesis? Explain your answer.

Write the sampling survey protocol you would propose for sampling the restaurant in the space below.

SAMPLING STRATEGY

Is my Cleaning Service Worth the Money?

1. Why do I want to collect samples?

The first step in developing your sampling strategy is to decide the reason why you want to sample. *What do you hope to accomplish and what specific chemicals are you sampling for?*

2. What types of sample should I collect?

Once you know why you want to sample, you are ready to consider what to sample in the priority areas. The items you might sample include:

- **Air:** personal or area samples
- **Surfaces:** flooring (vinyl, carpet), tile, countertops, sinks, furniture, clothing
- **Soil:** around the priority areas
- **Water:** drinking, underground well, and surface water
- **Foliage:** leaves and stems

What type of sample will you use?

3. Where should I sample?

Once you decide why you want to sample, then you are ready to think about where to sample. Sampling should take place at any location where the chemicals are suspected. *Select 8 areas that you want to sample and prioritize them.*

4. How will I collect, package, and transport samples?

Once you have decided why, where, and what to sample, you are ready to look at how the sampling should be done. Prioritize the types of sampling possible and decide which would be the most relevant. It is important that you pick the key areas you want to sample. To avoid many of the common sampling problems or errors follow a prescribed lab protocol, which includes standard collecting and handling methods. *Describe a method you would use to collect your samples using a cotton swab and 40 centimeters of masking tape.*

5. When will I sample?

Time of day, length of sampling, and number of days after contamination are important to understanding the physical and chemical properties of the cleaner. *Use today's date and time.*

Date: _____ *Time of day:* _____ *Number of samples:* _____

STUDENT INSTRUCTIONS:

SURFACE SAMPLING – LAB PROTOCOL

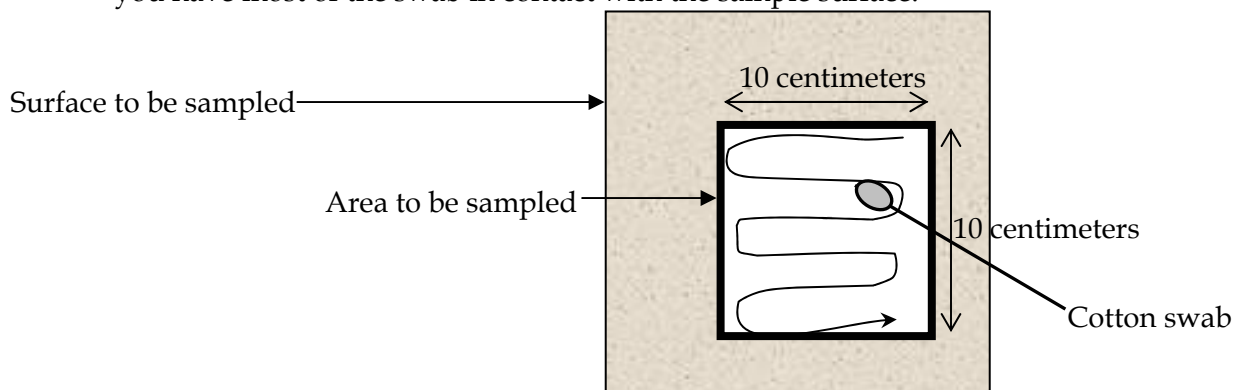
Occupational health and safety professionals use sampling to assess workplace contaminants and worker exposures. The validity of the sampling is based, in part, on the procedures used for sample collection and analysis, and data interpretation. In many instances these procedures use approaches that have been refined over many years and are accepted by the professionals as good practice. The following instructions are based on these practices.

Materials

- 1 surface to sample: carpet, tile, vinyl flooring, countertops, and clothing
- Rubber or latex gloves
- Masking tape
- Ruler
- 2 cotton swabs
- Water
- 2 “Sampling Log” forms
- 2 snack-size plastic, resealable bags
- Permanent marker

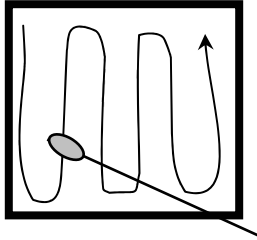
Procedure

1. Working in pairs, you will be assigned one of the surfaces that is found in your apartment to sample, e.g., carpet, tile, vinyl flooring, countertops, or clothing.
2. You cannot sample the entire surface designated to you so you must randomly select an area where you think the chemical may be present.
3. Before you pick up your surface to sample, put on a clean pair of rubber or latex gloves.
4. Measure a 10 centimeter X 10 centimeter square anywhere on the surface of the object. This is the sample area. Adhere masking tape to the surface to indicate the location of your sample area. Try not to touch the area to be sampled.
5. Take a sterile cotton swab and moisten it with water.
6. Using the cotton swab, wipe the sample area in a side-to-side “s” like motion 10 times, each time wiping in a new position and crossing the entire square. Hold the cotton swab at an angle so that you have most of the swab in contact with the sample surface.



STUDENT INSTRUCTIONS - PAGE 2

7. Wipe the same area again up and down in a direction perpendicular to the direction of your first wipe. Use the same "s" motion so that the entire marked surface area gets wiped twice.



8. Insert the sterile cotton swab into a clean, resealable plastic bag. Label the bag with the identification number (ID#). Write directly on the outside of the bag using a permanent marker.
9. Record all data for your initial sample in a "Sampling Log".
- ID #
 - Sampling Location (Room)
 - Time of Day
 - Date
 - Type of Sample: Surface Sample (also named the surface sampled, e.g., countertop, tile, carpet, etc.)
 - Names of People Who Collected Sample
 - Total Area Sampled (cm²)
10. Prepare a control cotton swab by wetting a sterile swab the same way as the swab used in the initial sampling. Place the swab in a resealable plastic bag, labeled "blank". The lab uses the blank to see if there are any chemicals found on it and then they compare it against the samples you collected.
11. Record all data for your blank (cotton swab) in Sampling Log; list the comparison samples included in the package.

NOTE: If you are sampling more than one sample site, be sure that your sampling technique is the same every time. **CONTROL ALL OF THE VARIABLES!**

12. Calculate the total surface area that you sampled and record in Sampling Log.
13. At this point, the samples would be placed in a shipping package along with the "Sampling Log" and sent to a laboratory for analysis. The collected samples and comparison samples would be shipped to the lab overnight express in separate containers. Get a receipt so you can prove when the samples left your possession.

Name _____

SAMPLING LOG

INFORMATION TO BE COLLECTED	Sample Information
ID #	
Sampling Location (Living room, bedroom, etc.)	
Time of Day	
Date	
Type of Sample (describe surface area)	
Names of People Who Collected Sample	
Total Area Sampled (cm ²)	
Blanks sent to lab	

SAMPLING LOG

INFORMATION TO BE COLLECTED	Sample Information
ID #	
Sampling Location (living room, bedroom, etc.)	
Time of Day	
Date	
Type of Sample (describe surface area)	
Names of People Who Collected Sample	
Total Area Sampled (cm ²)	
Blanks sent to lab	

STUDENT INSTRUCTIONS - PAGE 4

Conclusion Questions: (Write answers in Learning Log ☺)

After completing your surface sampling lab protocol, answer the following questions:

1. What type of surface did you sample and where might it have been located in the apartment (in what room?)

2. Did you find any trace of Cleaner G? Explain why you did or did not find it.

3. Imagine that the 10 cm X 10 cm grid was placed over the surface you were sampling. If Cleaner G was present on your sample site and you used the proper swabbing technique, how many times could you have collected it on your swab? Draw a diagram of your technique.

4. Give several examples of how you can increase your chances of finding Cleaner G in your apartment?

5. Explain why Cleaner G was probably not found on all of the surfaces sampled.

6. In this activity, you were trying to measure the amount of Cleaner G found on a 10 centimeter by 10-centimeter surface. The analytical lab reported that the swab you sent them from this sample contained 50 micrograms of Cleaner G.
 1. What is the total size of the area you sampled?

 2. What is the unit of measurement used to indicate the concentration of Cleaner G?

 3. What is the concentration of Cleaner G in this sample?

ASSESSMENT: DESIGNING A SAMPLING PROTOCOL

The health department has been alerted to a number of respiratory illnesses among children that have been linked to participation in story hour at your local library. The illness is suspected to be caused by a mold which grows on wet surfaces. The affected children attended story hour in the children's reading room with their mothers, after story hour they selected several books and checked them out at the circulation desk. Before leaving the library, the mothers took their children to the lady's restroom.

You are an industrial hygienist and have been hired by the city to try to confirm the presence of this mold in the library. The city's budget is very tight and they only have \$1500 for this analysis. Each of your samples cost \$150 to collect and analyze in your laboratory. Answer the questions on the following sampling survey and then design the step-by-step protocol for sampling the library.

- 1. Purpose of the sampling survey.** Why do I want to collect samples? Background information (e.g., previous surveys) should be referenced.
- 2. Where to sample.** This identifies expected exposure sites. Identify expected growth sites. Where do you think that this mold would live in the library? BE SPECIFIC
- 3. What types of samples should be collected?** Based on information available to you, do you want to collect air, water, or surface samples? Explain your decision.
- 4. How many samples should be collected?** Considering the number of growth sites and potential hazards, how many samples can you take within the constraints of the budget for the survey?
- 5. How will the samples be collected and analyzed.** What procedures or protocols are you going to follow to collect the samples? Which laboratory tests will provide the most meaningful data? How will you collect, package and transport samples? Write out the specific protocol steps that you will take to collect samples in the library.