

Antimicrobial Agents

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Introduction to Microbes

Spherical



Rod-shaped



Spiral



- Bacteria
 - Single-celled microorganisms that lack chlorophyll
 - Replicate fast (~70 billion per 12 hours)
 - Divided into two major groups: Gram positive versus Gram negative
 - Play an important role in human infections.

- Bacterial shapes
 - Spherical
 - Rod-shaped
 - Spiral

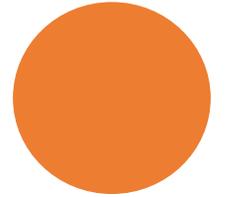
Introduction to Microbes

- Fungi
 - A large group of non-green plants that live by feeding on either living or dead organisms.
 - Lack chlorophyll
 - Over 100,000 species of fungi have been identified. Fungi and bacteria are often found together in nature.
 - Fungi are used in wine, bread, cheese, beer, etc.
 - Fungal diseases



Introduction to Microbes

- Algae
 - Contain chlorophyll and other pigments.
 - Live in fresh or salt water and on land.
 - Classified by their blue-green, red, brown, and green colors.
 - Play an important role in natural aquatic life
 - Pond scum
 - Ringworms in humans



Introduction to Microbes

- Slimes
 - Slimes are combinations of fungi, algae, bacteria, and other organisms.
- Viruses
 - Viruses are parasites that live and reproduce only inside the living cells of their selected host.
 - A virus enters a living plant or animal cell and reproduces itself within that cell.
 - Important diseases of almost all living organisms.



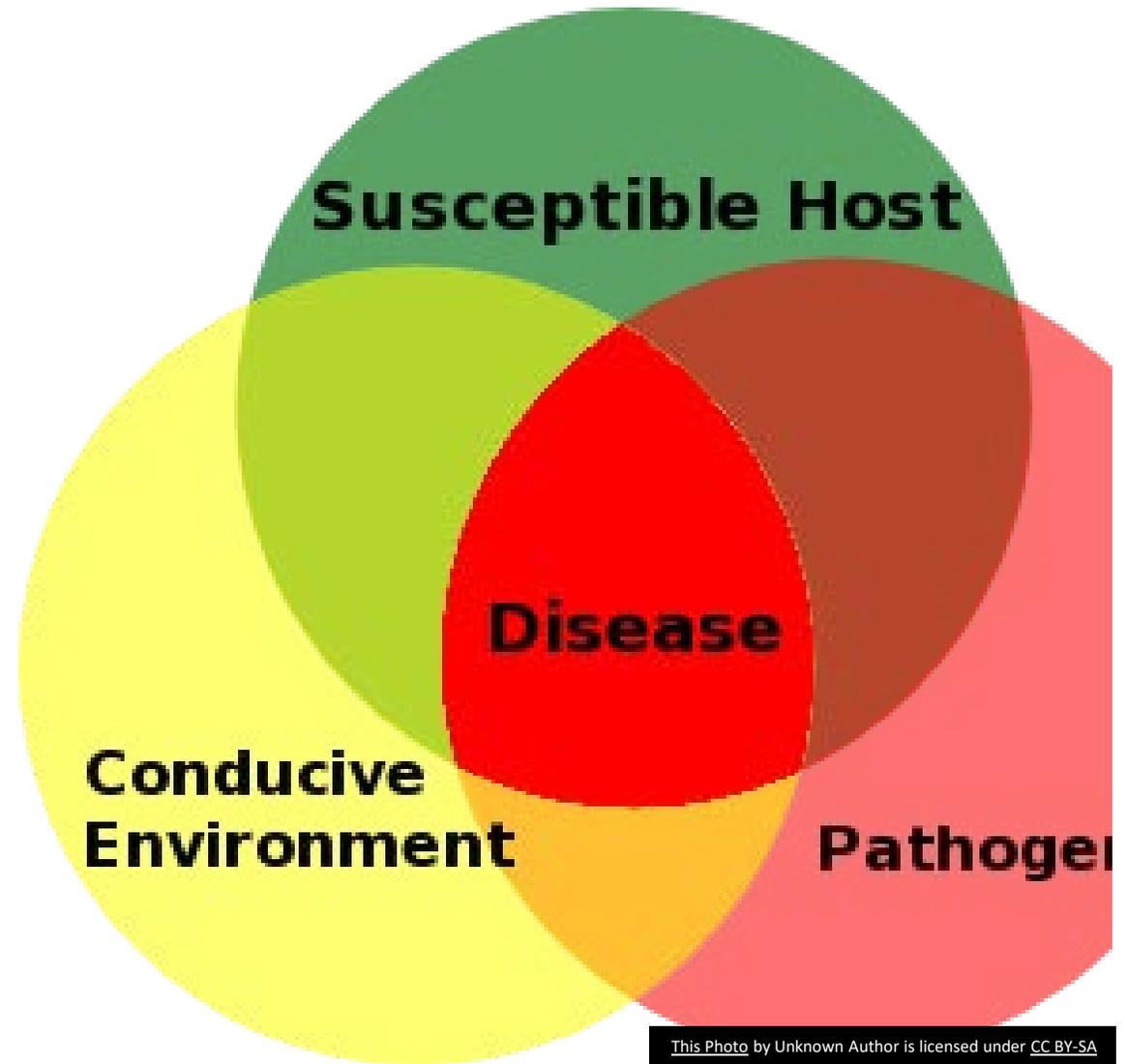
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Control of Microorganisms: Principles of Control

- Prevent their entry
- Keep materials and surfaces constantly clean
- Keep materials and surfaces dry
- Keep temperature low
- Use chemical agents
- Combination of these methods are known as microbial pest control



Control of Microorganisms: Methods of Control

- Prevent their entry:
Nonchemical Control
 - Physical barriers
 - PPE
 - Scrubbing
 - Air Filtration
 - Fluid Filtration
 - Boiling
 - Steam
 - Dry heat
 - Radiation



Control of Microorganisms: Methods of Control

- Prevent their entry: Chemical Control
 - Antimicrobial pesticides
 - Remember, chemicals often will not give adequate control unless they are used in combination with other methods!!!!
- Chemical Groups
 - Halogens: Chlorine, Chlorine dioxide, Iodine
 - Heavy metals: Mercury, Silver, Copper, Zinc, Arsenic, etc.
 - Phenolic Derivatives: Many synthetic chemicals related to phenol (carbolic acid) are in formulations used for disinfecting and sanitizing (orthobenzyl parachlorophenol, orthophenylphenol).



Control of Microorganisms: Methods of Control

- Chemical Groups
 - **Quaternary Ammonium Compounds:** “quats”
 - Organo-sulfur compounds: These are bacterial and fungal control agents in recirculating cooling water systems
 - Alcohols: Ethyl and isopropyl alcohols
 - Aldehydes: Formaldehyde
 - Oxiranes: Ethylene oxide



Antimicrobial Pesticides

- Types of Formulations
 - Chemicals that are effective against microorganisms are called active ingredients
 - The mixture of active and inert ingredients is called the formulation.
 - **Follow the label directions carefully.**





Antimicrobial Pesticides

- Types of Formulations
 - Water-based concentrates are very common. The formulation often contains more than one active ingredient, as well as several inert ingredients.
 - Dry formulations such as powders and granules, are also quite common. Granules, pellets, or briquets for water treatment release the active ingredient slowly over a long period of time.
 - Suspensions or dispersions are either finely divided solid particles in a liquid or droplets of one liquid in another (emulsions).
 - An aerosol is a suspension of fine particles or droplets in air. Use fog or mistgenerating machines to produce aerosols to treat large enclosed areas.

Antimicrobial Pesticides

- Types of Formulations
 - Gaseous antimicrobial pesticides are used to disinfect and sterilize where other agents cannot be used or where the use of a gas is dictated by the need.
- Gaseous agents are always used in unoccupied, enclosed spaces. Special precautions are required to ensure that they will work well and not harm the applicator or other people.



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How Antimicrobial Agents Work

- Factors Affecting Use of Antimicrobial Pesticides
 - Types of Microorganisms
 - Number of Microorganisms
 - Age and Condition of Organisms
 - Nature of Surface
 - Concentration
 - Contact Time
 - Water Hardness
 - pH
 - Soil Surface(s)
 - Abiotic Factors



Equipment, Application Methods, and Chemicals

- Hospital and Medical Services

- A gas sterilizer is a closed chamber in which gases are used to kill bacteria, viruses, and other microorganisms. Ethylene oxide (EO) is the most common gas used.
- Formaldehyde Vacuum Process: A vacuum device is used to remove part of the air from the chamber of a pressurized container. Steam is then admitted, and then formaldehyde gas.
- Fumigators: This process can be used for room disinfection. A heat source (such as an electric frying pan) is used to vaporize paraformaldehyde in an enclosed space to kill microorganisms.



Equipment, Application Methods, and Chemicals

- **Hazards of Gas Sterilizer Products**
 - Product is unstable if heated and may undergo explosive polymerization. Pure EO is flammable. Gas is irritating and liquid is corrosive.
 - Formaldehyde will burn skin and eyes.
 - Paraformaldehyde hazards can be an eye and mucous membrane irritant.
- Non-chemical devices include surgical instruments (in hospital settings).
- **Environmental Disinfectants:** Hospitals and health care facilities must use many different cleaning agents and antimicrobials to ensure that the environment is clean and meets the required standards of hygiene.
- **Fogging and Spraying Applications:** An antimicrobial agent may also be dispersed by an automatic sprayer or atomizer.

Equipment, Application Methods, and Chemicals

▪ **Janitorial Services and Housekeeping**

- Institutions such as hospitals, medical care facilities, **schools** and industry must develop a policy of janitorial maintenance procedures that prevent cross- contamination and protect the people who occupy and use the facilities.
- The following antimicrobials are the most used disinfectants:
 - **Phenolics:** These inexpensive and readily available antimicrobials are active against a wide range of bacteria.
 - **Hypochlorites:** The compound is active against viruses, bacterial spores and other pathogens due to release of free chlorine. However, solutions of the compound have limited stability and are readily inactivated upon contact with organic matter.

Equipment, Application Methods, and Chemicals

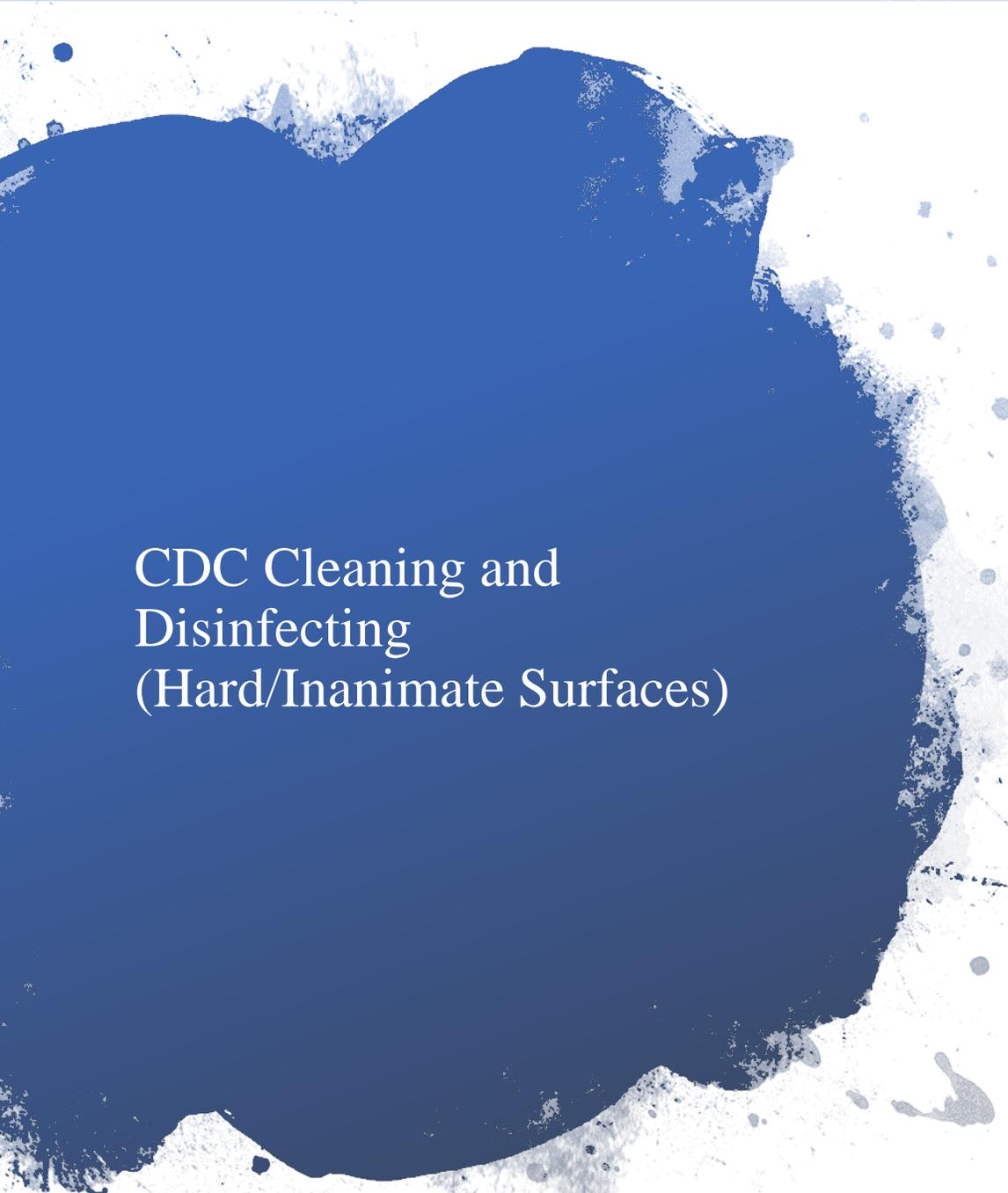
- Janitorial Services and Housekeeping
 - Iodine and Iodophors: The products are highly active against a wide range of pathogens and are most often used on the skin for preoperative scrub procedures.
 - Products containing this antimicrobial are expensive and are therefore not generally used for environmental disinfecting procedures.
 - Quaternary Ammonium Compounds are inexpensive, easy to use and widely applied in food processing areas, locker rooms, toilet, and bath areas as well as garbage storage areas.
 - Whether the janitorial and housekeeping procedures are performed by an in-house staff or outside contractor, it is mandatory that a policy be established to outline the requirements and goals that must be maintained.
 - Users must be trained in the procedures to understand the need for using different antimicrobials in specific environmental locations.



Equipment, Application Methods, and Chemicals

- Janitorial Services and Housekeeping
 - Manually Operated Devices: These devices include such things as: Mops, sponges, brushes, cloths, sprinkling cans, pistol-grip sprayers, and aerosol containers.
 - Steam Cleaners and High-Pressure Washers: These machines use the advantage of heat and the force of high-pressure water to effectively dislodge and remove dirt and particulate accumulations on hard surface areas.
 - Fogging and Spraying Applications: An antimicrobial agent is dispersed by an automatic sprayer or atomizer. They may remove floating infectious particles from the air. However, bacteria that remain on the floor and horizontal surfaces must be removed by mechanical cleansing, regardless of whether fogging has been used.





CDC Cleaning and
Disinfecting
(Hard/Inanimate Surfaces)

- **Cleaning** refers to the removal of germs, dirt, and impurities from surfaces.
- **Disinfecting** refers to using chemicals, for example, EPA-registered disinfectants, to kill germs on surfaces.
- General Recommendations for Routine Cleaning and Disinfection of Households:
 - Labels contain instructions for safe and effective use of the cleaning product, including wearing the proper PPE.
- Check here for current EPA registered products:

<https://cfpub.epa.gov/giwiz/disinfectants/index.cfm>

CDC Cleaning and Disinfecting (Hard/Inanimate Surfaces)

- General Recommendations for Routine Cleaning and Disinfection of Households with People:
 - The caregiver can provide personal cleaning supplies for an ill person's room and bathroom, unless the room is occupied by child or another person for whom such supplies would not be appropriate.
 - Clean and disinfect high-touch surfaces daily in household common areas (e.g. tables, hard-backed chairs, doorknobs, light switches, phones, tablets, touch screens, remote controls, keyboards, handles, desks, toilets, sinks)
- How to Clean and Disinfect:
 - Hard (Non-porous Surfaces). Wear disposable gloves when cleaning and disinfecting surfaces. Gloves should be discarded after each cleaning.



CDC Cleaning and Disinfecting (Hard/Inanimate Surfaces)

Always read and follow the directions on the label to ensure safe and effective use.

- Wear skin protection and consider eye protection for potential splash hazards
- Ensure adequate ventilation
- Use no more than the amount recommended on the label
- Use water at room temperature for dilution (unless stated otherwise on the label)
- Avoid mixing chemical products
- Label diluted cleaning solutions
- Store and use chemicals out of the reach of children and pets

You should never eat, drink, breathe or inject these products into your body or apply directly to your skin as they can cause serious harm. Do not wipe or bathe pets with these products or any other products that are not approved for animal use.

See [EPA's 6 steps for Safe and Effective Disinfectant Use](#) 

Special considerations should be made for people with asthma and they should not be present when cleaning and disinfecting is happening as this can trigger asthma exacerbations. To learn more about reducing asthma triggers: https://www.cdc.gov/asthma/reduce_triggers.html

CDC Cleaning and Disinfecting (Hard/Inanimate Surfaces)

- Soft (Porous Surfaces). For soft (porous) surfaces such as carpeted floor, rugs, and drapes, remove visible contamination if present and clean with appropriate cleaners indicated for use on these surfaces.
- Electronics. For electronics such as cell phones, tablets, touch screens, remote controls, and keyboards, remove visible contamination if present.
- Linens, Clothing, and Other Items That Go in The Laundry. Wear disposable gloves when handling dirty laundry from an ill person and then discard after each use.
- Hand Hygiene and Other Preventive Measures.
<https://www.cdc.gov/handwashing/when-howhandwashing.html>



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GHS BASICS
Globally Harmonized System of Classification and Labeling of Chemicals

Revised Hazard Communication Standard: 29 CFR 1910.1200

GHS = new labels + safety data sheets (formerly MSDS) + new pictograms

CHEMICAL LABELS

The GHS requires that label preparers designate the appropriate hazard warnings using four key elements on each label:

- Pictogram:** A visual warning that identifies the hazard(s) of a specific chemical.
- Signal Word:** A single word to indicate the severity of a hazard. Danger = severe. Warning = less severe.
- Hazard Statement:** Describes the hazard(s) of a chemical dependent on its hazard class and category.
- Precautionary Statement(s):** Describes the measures to be taken to minimize or prevent adverse effects resulting from exposure, improper storage or improper handling of a hazardous chemical.



SAFETY DATA SHEETS (SDSs)

The SDS provides users with 16 standardized categories of information pertaining to a chemical's hazards. This facilitates safe handling of the chemical and allows for safe procedures in the event of an emergency.

- 1. Identification:** Includes the product identifier, the manufacturer's or distributor's name, address, phone number and emergency phone number, recommended use, and restrictions on use.
- 2. Hazardful identification:** Includes all hazards regarding the chemical, required label elements.
- 3. Composition/information on ingredients:** Includes information on the chemical's ingredients, trade secret cases.
- 4. First aid measures:** Include acute and delayed symptoms, required treatment.
- 5. Fire fighting measures:** Lists suitable extinguishing techniques, equipment, chemical hazards from fire.
- 6. Accidental release measures:** Lists emergency procedures, protective equipment, proper methods of containment and cleanup.
- 7. Handling and storage:** Lists precautions for safe handling and storage, including incompatibilities.
- 8. Exposure controls/personal protection:** Lists OSHA's Permissible Exposure Limits (PELs), Threshold Limit Values (TLVs), appropriate engineering controls, personal protective equipment (PPE).
- 9. Physical and chemical properties.**
- 10. Stability and reactivity.**
- 11. Toxicological information.**
- 12. Ecological information.***
- 13. Disposal considerations.***
- 14. Transport information.***
- 15. Regulatory information.***
- 16. Other information.**

*Not required by GHS



PICTOGRAMS

Nine pictograms represent health, physical and environmental hazards.

- EXPLOSIVES:** Self-Reactives, Organic Peroxides
- FLAMMABLES:** Pyrophorics, Self-Heating, Self-Reactives
- OXIDIZERS**
- CORROSIVES:** Skin Corrosion/Burns, Eye Damage, Corrosive to Metals
- GASES UNDER PRESSURE**
- ACUTE TOXICITY (Severe)**
- ACUTE TOXICITY (Harmful/Irritant):** Skin Irritant, Skin Sensitizer, Respiratory Tract Irritant
- CARCINOGEN:** Reproductive Toxicity, Target Organ Toxicity, Aspiration Toxicity
- ENVIRONMENTAL TOXICITY**

English version shown here

6 Steps for Safe & Effective Disinfectant Use



Step 1: Check that your product is EPA-approved

Find the EPA registration number on the product. Then, check to see if it is on EPA's list of approved disinfectants at: epa.gov/listn



Step 2: Read the directions

Follow the product's directions. Check "use sites" and "surface types" to see where you can use the product. Read the "precautionary statements."



Step 3: Pre-clean the surface

Make sure to wash the surface with soap and water if the directions mention pre-cleaning or if the surface is visibly dirty.



Step 4: Follow the contact time

You can find the contact time in the directions. The surface should remain wet the whole time to ensure the product is effective.

Step 5: Wear gloves and wash your hands

For disposable gloves, discard them after each cleaning. For reusable gloves, dedicate a pair to disinfecting COVID-19. Wash your hands after removing the gloves.



Step 6: Lock it up

Keep lids tightly closed and store out of reach of children.

Education works

Precautions for Safe Use of Antimicrobials

Before You Buy an Antimicrobial Agent

- The first and most important step is to determine what type of organism(s) you wish to control.

At the Time of Purchase

- Read the label. **Remember that the label is the law!!!**

Transportation of Antimicrobials

- You are responsible for the safe transport of your antimicrobial agents. Do not leave unlocked antimicrobial agents unattended. You are responsible if accidents occur.

Precautions for Safe Use of Antimicrobials

- Storage of Antimicrobials
 - The label will tell you how to store the product. When antimicrobials arrive, store them in a locked and posted place. Store all chemicals in the original containers. Check every container often for leaks or breaks.
- Mixing Antimicrobials
 - Keep animals and people out of the mixing area. Do not mix or load antimicrobial agents unless there is good lighting and ventilation.
 - When taking an antimicrobial agent out of the container, keep the container and chemical below eye level.
- Applying Antimicrobials
 - Read the label to understand what the product can be mixed with.

Precautions for Safe Use of Antimicrobials

- Cleaning Equipment
 - Clean mops, pails, and other gear used in applying an antimicrobial agent as soon as you finish using them. Follow the manufacturer's directions.
- Disposal
 - EPA recommends ways to dispose of excess pesticides (including antimicrobial agents).
 - Consult local authorities (health or solid waste) for procedures in your area.
 - The EPA recommendations divide containers into three groups: Group I, Group II, and Group III. Each group is based on what can be burned or what it contains.



Precautions for Safe Use of Antimicrobials

- Cleanup of Chemical Spills
 - Keep people away from spilled chemicals. Rope off the area and flag it to warn people. Do not leave unless someone is there to warn of the danger.
 - Read the labeling information to make sure that you use the correct neutralizing chemical or call the manufacturer or distributor of the antimicrobial for assistance.
- Major Spills
 - Report all major spills by phone to your state pesticide regulatory agency.