VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS
www.Agriculture.Vermont.gov

Applicator Certification Training Manual for

Disinfection & Antimicrobial Pest Control

Vermont Category 7F

2020

Adapted for use in Vermont with permission from the University of Maine Cooperative Extension, Pest Management Unit. Originally titled Microbial Pest Control Applicator Training Manual 7C: Disinfectant and Biocide Treatments; Don Barry, University of Maine Cooperative Extension; Gary Fish, Maine Board of Pesticides Control, 2009.

Sections that were eliminated from the Maine manual before its use in Vermont were "Section 4. Industrial Cooling Water Systems" and "Section 5. Pulp and Paper Making Processes" due to those activities being covered under Vermont Category 7E – Cooling Towers.

"Section 6. Swimming Pools" was eliminated because that activity is not regulated under the Pesticide Regulations in Vermont, and "Section 8. Protecting People and the Environment," "Section 9. Precautions for the Proper Use of Antimicrobials," and "Section 10. The Pesticide Label" were not included since these topics are covered by the CORE Manual and exam.

ACKNOWLEDGMENTS

The first edition of this manual was adapted from:

Microbial Pest Control, University of Georgia, Special Bulletin 24. 1988. R. Bond and D. French. Edited by D. Bynum.

The 2008 edition includes material adapted from:

A Brief Guide to Mold in the Workplace, Safety and Health Information Bulletin SHIB 03-10-10, U. S. Department of Labor, Occupational Safety and Health Administration.

A Brief Guide to Mold, Moisture, and Your Home, U.S. Environmental Protection Agency publication 402-K-02-003, 2002.

Mold Remediation in Schools and Commercial Buildings, U.S. Environmental Protection Agency publication 402-K-01-001, 2001.

Slimcider: Paper Mill Biocide Study Guide by Murray Stevens

Suggested Guidelines for Remediation of Damage from Sewage Backflow into Buildings by Berry, M., Bishop, J., Blackburn, C., Cole, E., Ewald, W., Smith, T., Suazo, N., Swan, S. *Journal of Environmental Health*, October 1994.

Adapted for use in Vermont by Matthew Wood, Public Health and Agricultural Resource Management Specialist, March 2020.

PRECAUTIONS

PREFACE

Vermont Category 7F includes *commercial* applicators using or supervising the use of any pesticide or *non-commercial* applicators using or supervising the use of class A or B pesticides in the management of any microbes or viruses or conducting mold remediation in structures. For certification in category 7F, applicators are tested on this manual and the *Pesticide Education Manual* (Core Manual). **All exams are closed book.**

Certified applicators must demonstrate practical knowledge of microorganisms and their life cycles, viruses, product labels and hazards of disinfectants, sanitizers, sterilizers and biocides, as well as proper moisture and microbial pest management and product application techniques to assure adequate control while minimizing exposure to humans and the environment.

To become certified in category 7F in Vermont you must pass written exams based on all of this manual and the *Core Manual*. Any questions on the study material should be directed to:

Vermont Agency of Agriculture, Food & Markets
Pesticide Certification & Training Coordinator
116 State Street
Montpelier, VT 05620-2901

Phone: 802-828-2431

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SECTION 1
INTRODUCTION

Microorganisms, also known as microbes or germs, include algae, fungi, and bacteria. Viruses are non-living infective particles that threaten human health. These organisms and infective particles are so small that most can be seen only with a microscope or even electron microscope. When these organisms threaten human health or commerce, they become pests. Any substance or mixture of substances manufactured to control these pests is a type of pesticide. These antimicrobial agents include:

- Disinfectants
- Sanitizers
- Bactericides and bacteriostats
- Virucides
- Sterilant
- Algaecides/Algicides
- Fungicides and fungistats
- Antifoulants
- Preservatives
- Slimicides
- Mildewcides

Antimicrobial agents can help keep certain areas free from dangerous bacteria, fungi, algae and viruses. They protect the industrial systems, homes and hospitals that are essential to our way of life. Yet if pesticides are improperly used, they can become as dangerous to our way of life as the microbes we are trying to control. Because of this Congress has passed laws regulating the use of all pesticides (including antimicrobial agents). These laws try to balance the need for pesticides against the need to protect people and the environment from the misuse of pesticides.

FEDERAL AND STATE REGULATIONS

The EPA has the authority to regulate the pesticide industry under the *Federal Insecticide, Fungicide and Rodenticide Act* (FIFRA). This law permits the control of all aspects of pesticide use, from production through disposal of empty containers. Within Vermont, the use of pesticide products is controlled by the *Vermont Agency of Agriculture, Food & Markets' Public Health & Agricultural Resource Management Division.* Every pesticide applicator is responsible for knowing and complying with the appropriate pesticide laws.

General information on federal and state laws for the use and storage of pesticides is in the *Pesticide Education Manual* (Core Manual). Many of the laws help pesticide users develop proper and effective application programs. Recordkeeping requirements make it possible to compare results for different treatments and provide evidence of activities performed in the event of legal action.

Classification of pesticide products

Health and environmental studies carried out by chemical companies during product development determine the use classification of pesticides. The United States Environmental Protection Agency (EPA) classifies chemicals as either "GENERAL USE" or "RESTRICTED USE" pesticides. In Vermont pesticides are broken down further, into three categories, Classes A, B, and C. Refer to *The Vermont Regulations for Control of Pesticides* for more information on how pesticides are classified in this state and the certification standards that must be met in order to apply them to someone else's home or land.

SECTION 2
MICROORGANISMS

Microorganisms are tiny living things, invisible to the unaided human eye. They are typically classified as bacteria, fungi, algae and protozoa. These organisms can be unicellular or multicellular, with each cell capable of sustaining life. Viruses are often grouped with the microorganisms although they are non-cellular, non-living, infective particles.

Microorganisms are found nearly everywhere: in water, air, dust, and soil; in most nonprocessed foods; and in all decaying matter. Humans and animals have microorganisms on their skin and hair, in their intestinal tracts and feces, and in the fluid discharges of their bodies. In fact, the number of single-celled microorganisms that inhabit the human body is larger than the number of human cells that make up the body.

Under normal conditions most microbes are beneficial, in fact most plant and animal life, including humans, could not exist without some kind of microbes. A major function of microorganisms in nature is their role in the decay process. What would happen if there was no microbial activity to break down dead plants and animals?

Microbes are extensively used in industry; they are used to treat sewage, produce organic acids, fermented foods, alcoholic drinks, bread, butter, cheese, antibiotics and other medical products. Of course microorganisms are better known for being harmful and must be controlled. They cause many kinds of disease, damage commercial products, and interfere with industrial processes.

BACTERIA

Bacteria are microscopic, one-celled organisms. They are tiny; magnified 1,000 times, a bacterium would be no bigger than the smallest dot on this page. It would take 400,000,000 bacterial cells to equal the volume of a grain of granulated sugar.

Along with this small size, comes enormous reproductive potential. Bacterial cells reproduce by dividing in half to become two identical, daughter cells. Under ideal conditions, some bacteria reproduce as often as once every 20 minutes, thus a single bacterium could become 70 billion bacteria in only 12 hours.

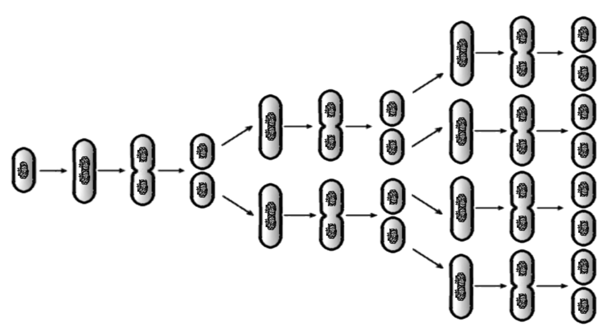
Left to themselves, bacteria cannot disperse very far. Some species have one or more flagella, these are filaments projecting from the cell wall that rotate to provide movement in liquids. Other bacteria produce copious slime to provide a medium for motion. In spite of their limited range of travel, their small size and explosive reproductive potential have allowed them to become a living presence virtually everywhere.

Some bacteria produce poisonous substances (toxins) that can cause diseases, such as lockjaw or food poisoning. Other bacteria produce enzymes that contaminate equipment and food products, foul surfaces that we contact daily, and dissolve or destroy industrial goods and even living cells.

Many commercial processes favor bacterial growth. In general, bacteria will grow between a pH of 4 to 10 but they thrive at a near neutral pH of 6.5 to 7.5. Different species of bacteria commonly found in commercial settings tolerate temperatures from 50° to 150° F. In addition, many species can feed on a wide range of inorganic materials; many industrial chemicals are actually a food source for bacteria.

Types of bacteria

Bacteria are categorized in different ways. Most bacteria can be divided into two major groups based on a laboratory staining technique called a gram-stain. Bacteria that stain violet are called gram-positive; there are many different types of gram-positives but they have relatively simple cell walls. Bacteria that do not stain violet but take a counter stain of another color are called gram-negative. These bacteria have a



Bacteria reproduce by cell division in a process known as binary fission. By dividing once every 20 minutes, a single bacterium can multiply into 1,000 daughter cells after 3 hours and 20 minutes. After 24 hours there would be one-million-billion-billion bacterial cells (assuming nutrients remained available and the colony did not poison itself with its own wastes).

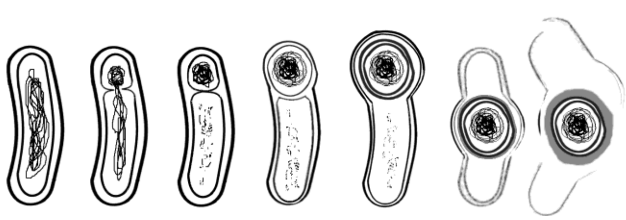
more complex structure to their cell wall. In general, gram-negative species are more troublesome than gram-positive; the outer cell wall of gram-negative species is often toxic and the composition of the cell wall resists chemicals.

In addition to their staining characteristics, bacteria can be grouped by the shape of their cells:

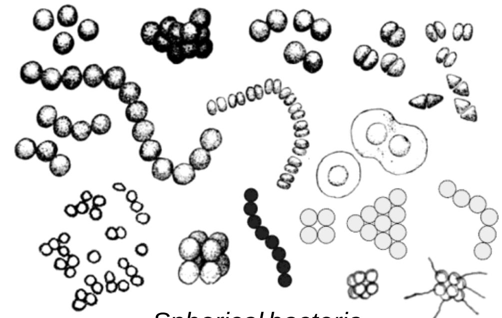
- **Coccus -** round or sphere shaped. Pairs of coccus bacteria are known as diplococcus, beadlike chains are streptococcus, grapelike clusters are staphylococcus, and groups of eight are called sarcina.
- **Bacillus -** rod-shaped. These are generic categories, not all rod-shaped bacteria belong to the genus called *Bacillus*. In general, the rod-shaped bacteria are the most numerous and most difficult to control.
- **Spirillum -** spiral. Spirilla are the largest of these three types. One type of tightly coiled spirilla are known as spirochetes.
- **Filamentous -** thread-like. Filamentous bacteria grow in branching chains that resemble fungal threads. They are often surrounded by a sheath that contains many individual cells.

Spore forming bacteria. When a micro-environment becomes too dry, too hot, or the nutrients run out, some rod-shaped bacteria can survive by producing an endospore—a resting stage in the bacteria's life cycle. Bacterial spore formation is not a type of reproduction because there is no increase in the number of organisms; it is a way of surviving unfavorable environmental conditions.

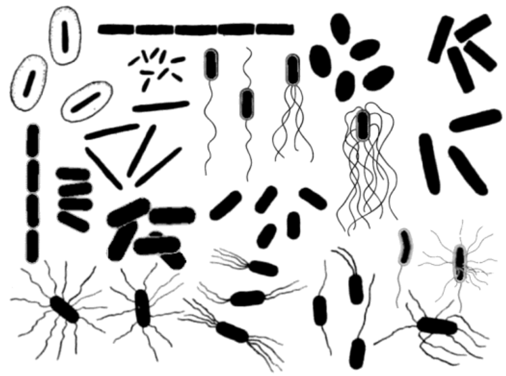
The endospore forms as a small, dormant cell within the existing cell wall. The cell wall breaks open and falls away leaving the bacteria inside a tough, waterproof capsule waiting for favorable conditions to trigger its return to normal growth. The spore stage is highly resistant to extremes in temperature, pH, drying, radiation, and chemicals (including biocides),



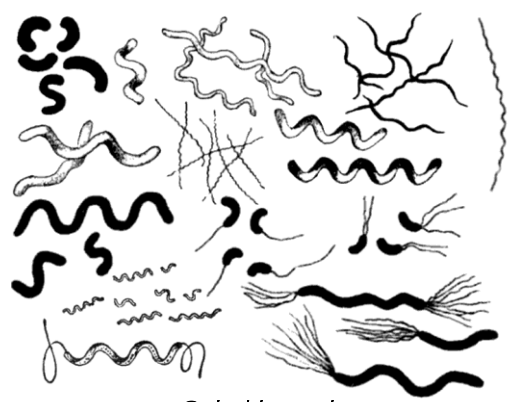
Some Bacillus *species can produce an endospore–an inactive resting stage capable of surviving years of severe conditions and harsh environments, including chemical treatments.*



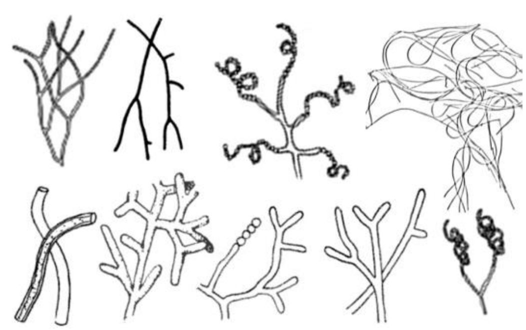
Spherical bacteria
Coccus



Rod-shaped bacteria
Bacillus

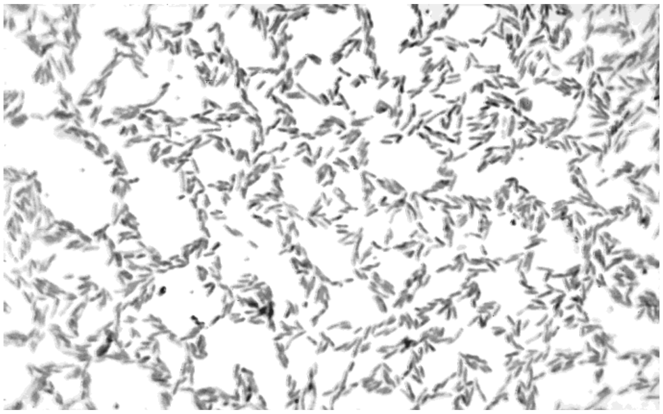


Spiral bacteria
Spirillum



Filamentous and branched bacteria

Bacterial cells usually take one of these general forms: sphere (coccus), rod-shaped (bacillus), or spiral (spirillum). Filamentous bacteria grow in branching chains resembling fungal threads. They are often surrounded by a sheath that contains many individual cells.

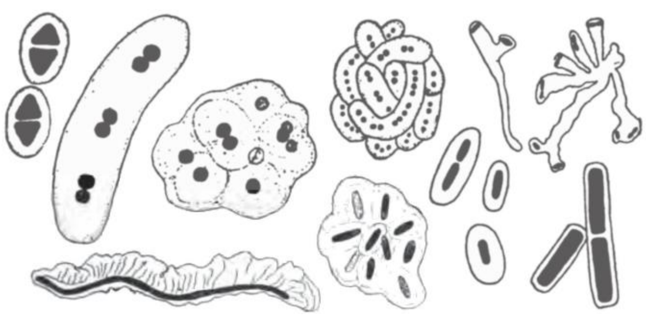


Cells in a bacterial colony coat themselves in a sticky slime that allows them to string together. In wet areas, colonies develop into a flattened, sponge-like maze of layered cells and slime with fluid channels that wash nutrients in and flush wastes out. This structure, known as a biofilm or bacterial mat, is resistant to the effects of chemical control methods.

spores can withstand boiling water for many days. Unless physically destroyed, some spores may remain viable for more than a thousand years.

The most effective treatments for spore formers are oxidizers such as chlorine, chlorine dioxide, or sodium bromide.

Encapsulated bacteria. Most bacteria secrete a thin, gelatinous covering outside their cell walls. This material is soluble in water and gives bacterial colonies their familiar slimy feel. Some bacteria produce so much of this material that they become completely enclosed in a protective layer of slime known as a capsule. Encapsulated bacteria grow in masses of this gelatinous material and are protected from other microorganisms, our immune system, antibiotics and other antimicrobial agents.



Common encapsulated bacteria. These include disease causing organisms, such as Neisseria meningitides, Streptococcus pneumoniae*, and* Hemophilus influenzae*. Microbiological control programs can avoid selecting for more virulent strains by applying pesticides in ways that discourage pesticide resistance.*

FUNGI

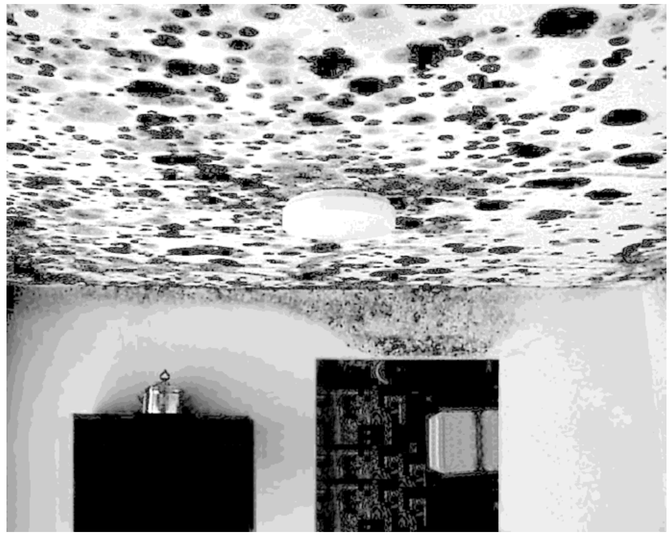
The fungi are a diverse group of single-celled or multicellular organisms that live by invading organic matter and absorbing nutrients; their feeding activity causes rot and decay. Some fungi, such as yeasts, occur as single cells that require a microscope to see but most types of fungi grow as multicellular threads that invade a food source. These threads may be microscopic filaments, or they may be as thick as a shoelace. Eventually the filaments combine to sprout reproductive structures that range from the microscopic fuzz on a patch of mold to the familiar mushroom. At least 1,000 species of fungi are found in the United States.

Fungi commonly reproduce and disperse with spores. The fruiting bodies that release spores range from microscopic structures, to the familiar bracket fungi on trees, and common mushrooms.

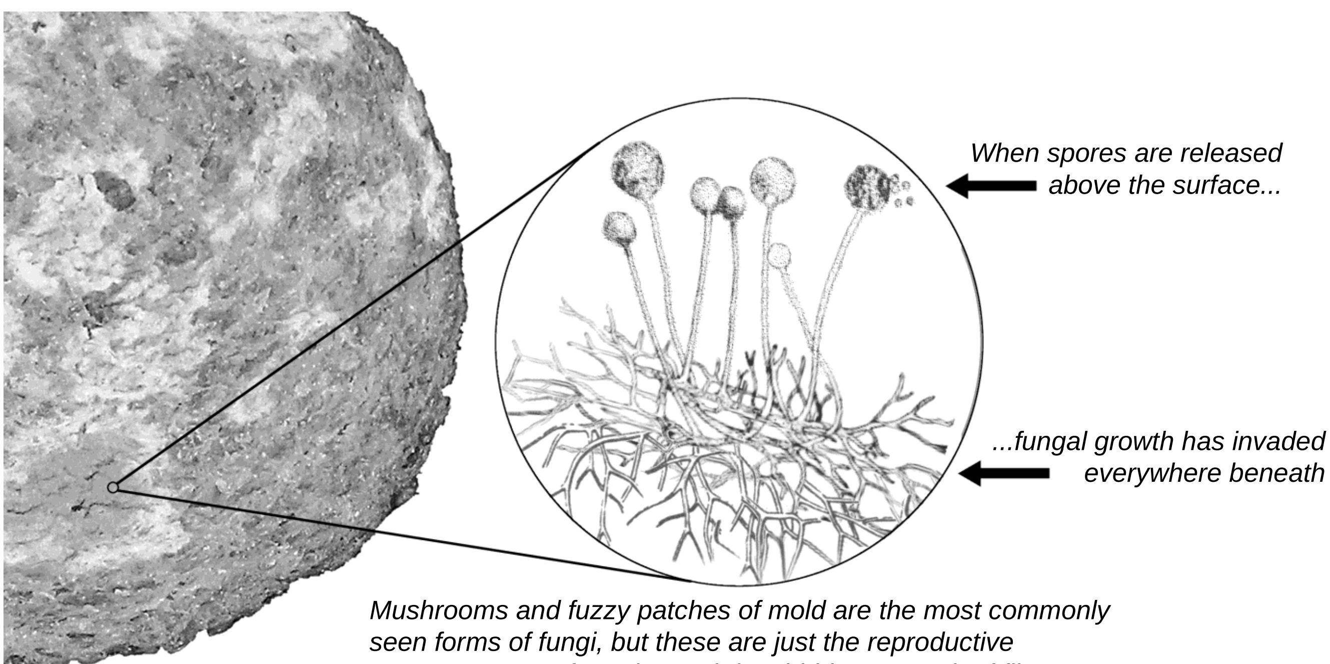
Unlike the plants, fungi have no chlorophyll and do not require sunlight to live. With enough moisture, oxygen, and organic nutrients, fungi will grow almost anywhere on almost anything. Outdoors, fungi play a key role in the breakdown of leaves, wood, and other plant debris. Without fungi, our environment would be overwhelmed with large amounts of dead plant matter. In commerce, fungi are used for the development of antibiotics, antitoxins, and other pharmaceuticals, and for making bread, cheese, wine and beer.

Fungi reproduce in several different ways. Some simply grow from fragments of a larger fungal body; others produce different types of spores. Fungal spores are something like microscopic seeds but, unlike seeds that stay in the soil, fungal spores are naturally present, floating in both indoor and outdoor air. Some fungi have spores that are easily disturbed and waft into the air and settle repeatedly with each disturbance. Other fungi have sticky spores that cling to surfaces. When fungal spores land on a suitable spot, they begin growing and digesting nutrients; any surface that supports fungal growth is gradually destroyed. Note that fungal spores are reproductive structures very different than bacterial endospores; fungal spores may remain viable for years, but they are not as resistant to chemicals, heat, or drying as bacterial endospores.

Some types of fungi are troublesome because they cause decay and mildew, and trap organic debris, including other microorganisms. Other fungi are pathogens that cause internal disease or infections of the skin and nails, but all fungi have the potential to cause health effects. Fungi produce allergens, irritants, and in some cases toxic substances called mycotoxins that may cause reactions in humans. More than 200 mycotoxins have been identified from common fungi, and many more remain to be identified. Mycotoxins may cause reactions when inhaled or ingested, or contacted with the skin. Although some mycotoxins are certainly responsible for human health effects, for many mycotoxins, little information is available.



A water damaged roof has led to extensive spore-forming patches of mold on this ceiling. Allergens associated with mold may remain active for years, even after the mold has died.



Mushrooms and fuzzy patches of mold are the most commonly seen forms of fungi, but these are just the reproductive structures. Most fungal growth is a hidden network of filaments (mycelia) that penetrate and feed throughout a nutrient source.

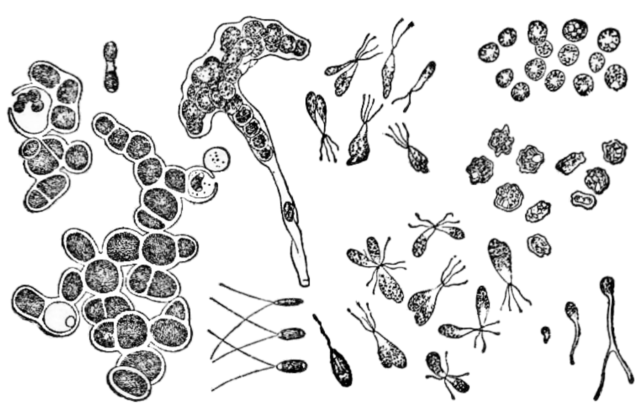
ALGAE

Like plants, algae use sunlight to produce what they need through photosynthetic reactions. Because light is required for photosynthesis, these organisms are found in directly lighted areas that are still damp enough to support their growth. The most common forms in water systems are diatoms and green algae, which may appear as long strands or as free- floating masses. They live in fresh or salt water, and on land, and range in size from one-celled, microscopic cells to 200-foot long seaweeds. Algae are the source of food that makes all other aquatic life possible. Some seaweeds are used as human food and algae have industrial uses. Algae may appear on water as patches of green scum (pond scum). On moist soil, wood or stone algae grows as a green or blue film.

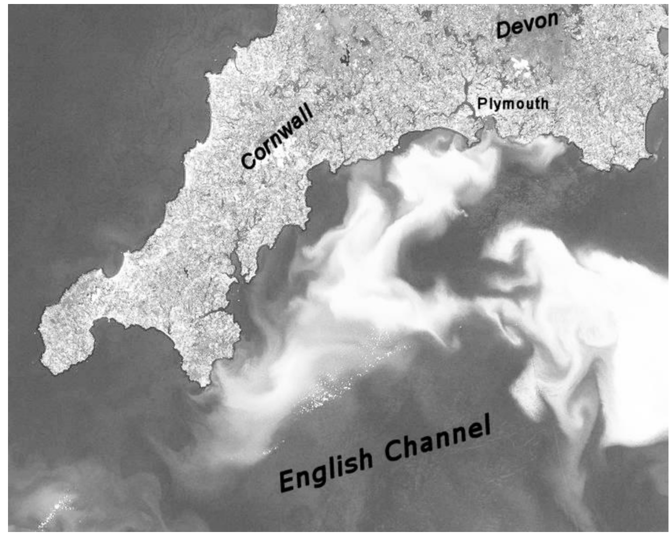
Algae are commonly found in fresh waters and can be introduced into commercial and industrial systems that lack proper freshwater controls. In some cases, algae can be quite troublesome; they may:

- Give drinking water a disagreeable taste or odor
- Cause bathers to itch
- Poison fish
- Clog water filtering systems and water cooling towers
- Interfere with pulp mill operations
- Foul underwater structures

When environmental condition and nutrients are exceptionally favorable, unicellular algae can multiply explosively causing an algal bloom. Algal blooms may occur naturally, or they may result from sewage or fertilizer runoff. Such large masses of algae in a shallow pond or lake water can deplete the oxygen and cause fish kills. Some species of algae produce neurotoxins which can be dangerous in blooms, but most algae have little direct medical importance to humans.



Various algal cells–some mobile others fixed in place. Freshwater algae is commonly called pond scum. Films of algae can also live on surfaces that remain damp enough for growth and light enough for photosynthesis.



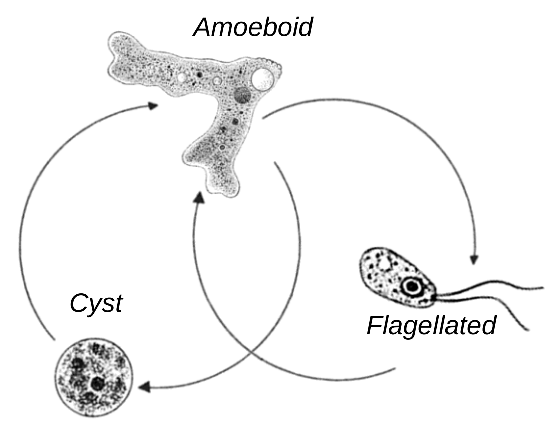
Viewed from space, huge algal blooms form in the English Channel. Some algae produce toxins–red tide, for example–that kill fish, birds and humans.

PROTOZOANS

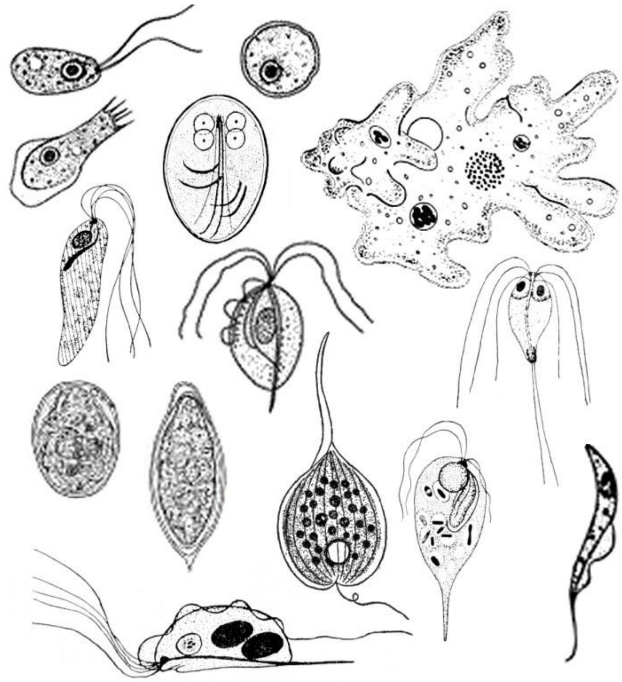
Protozoans are single-celled organisms that exist in a huge variety of shapes and sizes. The vast majority are microscopic, but a few may actually be seen with the naked eye. Some are very mobile; others remain fixed in place. They mostly feed by engulfing organic debris or other microorganisms, although some contain chlorophyll and can make their own food with sunlight.

Similar to the spore-forming bacteria, some protozoans can form a cyst—an inactive stage surrounded by a protective wall—that disperses in wind or water or attached to anything that comes their way. When a better environment is found, the outer wall of the cyst breaks and the cell continues as before.

Some protozoans cause disease, including malaria and amoebic dysentery. Their presence is an indicator that a freshwater treatment program is insufficient.



Protozoan lifecycles may involve various forms, including cysts.

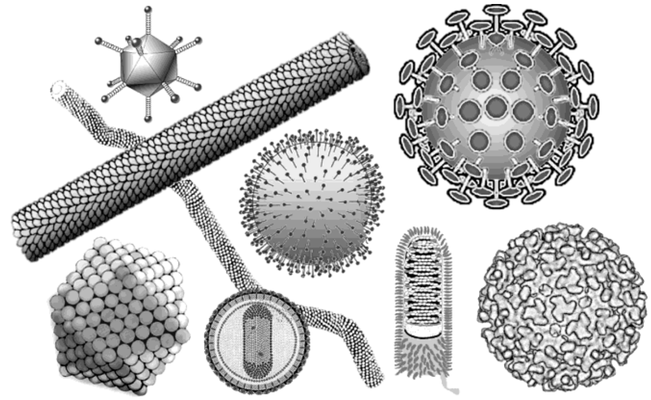


Over 50,000 species of protozoans have been described. Most are single-celled organisms, but some are colonial; some even contain chlorophyll.

VIRUSES

Viruses are about 1,000 times smaller than bacteria and can be seen only with the aid of an electron microscope. Viruses are not cells, they have no internal metabolism, they do not feed or grow, and cannot move on their own. They are infectious particles that will replicate only inside the living cells of their hosts. Because viral particles are entirely dependent on their host's genetic system, they can only infect hosts with specific genes. Many viruses can only infect bacteria, others infect only insects, or only humans, etc. Sometimes a virus will develop the ability to infect new hosts. The new host may have few defenses against such viruses and widespread disease may result. In humans, this scenario is well known in avian influenza and swine flu outbreaks.

A virus enters the cell of a living organism and hijacks the genetic system in order to replicate other viral particles within that cell. The infected cell swells with particles until it bursts, and the released viral particles move to other cells. If no living things are present, viruses can remain infectious for hours or days in organic material such as scabs, blood and body wastes. Because viruses are non-cellular, antibiotics and other treatments that interfere with cell function are useless for controlling viruses.



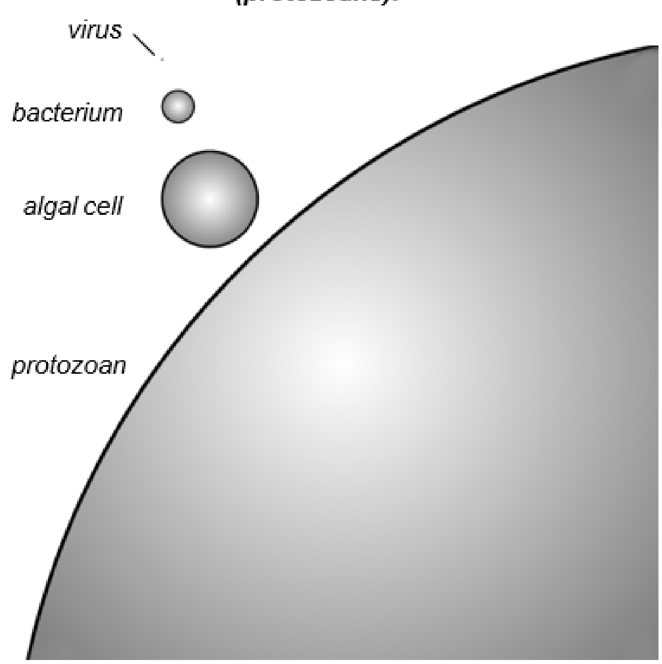
Viruses come in a wide variety of shapes but they are most remarkable for their tiny size. They are smaller than other microorganisms by a factor of 1,000 or more.

MICROBIAL SLIMES

Slimes are thick, sticky masses found in various equipment. Slimes form around the gelatinous excretion of certain bacteria but include a combination of bacteria, fungi, algae, and floating debris.

Temperatures between 100–110 F are optimum for the production of bacterial slime. Slimes can be troublesome in any water system.

Although there is huge diversity and overlap in size, microbes generally range from around 100 nanometers (viruses) to 250 micrometers or more (protozoans).



MANAGING MICROORGANISMS

A combination of methods is needed for most microbial pest control programs. The challenge lies in selecting the proper methods to achieve the desired control level. Available methods include:

- Prevent their entry
- Keep materials and surfaces clean so that microbes have nothing to feed on
- Keep materials and surfaces dry so that microbes will not have enough moisture to multiply
- Keep temperature low enough or high enough so that microbes either cannot grow or are killed
- Use chemical agents

Nonchemical control

Prevention of entry. Walls and other physical barriers can he used to prevent microbes from entering certain areas. Special procedures may reduce the number of organisms brought into a critical area by people, equipment and supplies:

- Require employees to wear clothing cleaned by the institution (not street clothes)
- Require employees to change shoes or put on shoe covers when entering critical areas
- Require employees to wear hair covers and face masks
- Keep equipment and supplies clean
- Use a combination of recirculating, filtered air and positive pressure in “clean” areas.

Scrubbing. Usually done with water and a chemical agent, such as soap or detergent, scrubbing removes dirt and other matter that contains microbes.

Air Filtration. Aerosols are particles dispersed and floating in the air. They include microorganisms, dandruff, dust, smoke particles, liquid droplets, etc. Two types of filter materials are used to remove aerosols from the air: fibrous mats and membrane filters. The fibrous mat is the most common, especially when large volumes of the air must be handled. Membrane filters are becoming more important in critical applications.

Fluid filtration. Filtration is the only way to make some biological and pharmaceutical fluids sterile and particle-free. This method involves forcing a mixture of fluids and solids through a porous medium which traps all particles and microorganisms larger than the pore size of its surface.

pH. The acidity or alkalinity of water may promote corrosion in a water system and may encourage the growth of microorganisms. Bacteria prefer neutral conditions (pH 6.5-7.5). Fungi are more common in slightly acid conditions (pH 5-6).

Boiling. Boiling can be used to disinfect objects. It kills fungi, most viruses, and most vegetative forms of bacteria in a few minutes. Bacterial spores may resist boiling for many days.

Steam. Applying saturated steam under pressure (autoclaving) is widely used to sterilize materials; when properly done, it is considered very reliable. Time and temperature may vary, depending on the size of the load and type of material. Autoclaving for 15 minutes at 121°C (250°F) is an accepted minimum standard.

Dry heat. Any material that withstands the required temperature can be satisfactorily treated using heat alone. Gas or electric ovens with thermostats are generally used, some may have fans to circulate the hot air. Exposure to a temperature of 160°C (320°F) for two hours or 170°C (338°F) for one hour generally achieves sterilization.

Incineration is another form of dry heat sterilization. Incinerators work by completely burning microorganisms, for example, direct flaming forceps, etc.

Radiation. Artificially produced ultraviolet (UV) radiation is used in many ways for microbial control. UV radiation kills vegetative cell bacteria, but usually not fungal and bacterial spores. UV radiation does not penetrate well; therefore, it may not kill microorganisms which are either in clumps or covered by dust and other debris. Because of this fact, UV radiation has limited usefulness. Gamma and x-rays are also biocidal, but such application is quite specific and is not widely useful today for economic reasons.

Chemical control

Nonchemical methods do not always give adequate control of microorganisms. Therefore, antimicrobial pesticides are often necessary. Use them only where they are needed and where they can be used safely. Select and use them so they work with other methods whenever possible. Be careful not to harm yourself or the environment. Remember, chemicals often will not give adequate control unless they are used in combination with other methods.

SECTION 3
ANTIMICROBIAL PESTICIDES

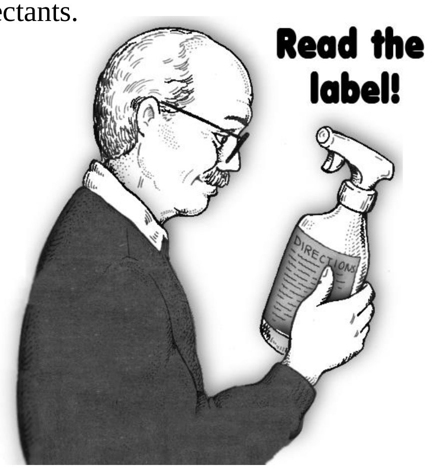
Choosing the right antimicrobial agent is not easy; literally thousands of disinfectants, sanitizers, preservatives and sterilants are registered with the Environmental Protection Agency (EPA) and the State of Vermont.

The EPA registers and regulates antimicrobial pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). To obtain registration, manufacturers of antimicrobial products must meet the basic standards, the foremost being:

- that the product will not cause unreasonable adverse effects to human health or the environment, and
- that product labeling and composition comply with the requirements of FIFRA. Full details on antimicrobial registration, labeling, and data requirements are in 40 CFR Parts 152, 156, and 158.

Antimicrobials can be grouped by the type and the degree of control they provide. Read the label to find out what an antimicrobial agent will do and what it will not do. Antimicrobial agents work in one or more of the following ways. Some products accomplish all of these depending on the application rate:

- Kill microorganisms by contact. The names of these products usually include the suffix -cide or -cidal, for example, bactericide, fungicidal.
- Interfere with multiplication or growth of the microorganisms. The names of these products usually include the suffix -stat or -static, for example, fungistatic, bacteriostat.
- Reduce the number of microorganisms but not eliminate all the microorganisms on a treated surface. These products are sanitizers and disinfectants.



CHEMICAL GROUPS

In order to tell which chemical group an antimicrobial formulation belongs, you must interpret the chemical names listed on the label as *active ingredients*. The most common antimicrobial agents are in one of the following chemical groups:

- Halogens
- Heavy metals
- Phenolic derivatives
- Quaternary ammonium compounds
- Organo-sulfur compounds
- Alcohols
- Aldehydes
- Oxiranes

Halogens

The halogens are chlorine, bromine, iodine and fluorine. Some are used in antimicrobial agents. They are powerful oxidizing agents and must be applied only to materials able to withstand their strong chemical activity.

Chlorine - Household bleach (calcium or sodium hypochlorite), chlorine gas, or other chemicals that release chlorine (sodium dichloro-s-trazinetrione) are common antimicrobial agents used on surfaces or objects that are not damaged by the oxidizing and bleaching activity. Chlorine is used to treat drinking water, swimming pools, water-cooling towers, and dairy and food processing equipment. These chemicals are also used by laundries and paper manufacturers.

Chlorine dioxide - This product is used to a limited extent in water treatment to eliminate odor and taste problems. It is applied extensively in the pulp and paper industry for bleaching purposes.

Iodine - Both iodine itself and chemical combinations (polyethoxy polypropoxy polyethoxy ethanol iodine complex) that release iodine are used to treat surfaces or objects not damaged by staining or by the strong chemical action. Products used for surface treatment are usually special iodine preparations that minimize staining.

Heavy metals

Certain metal salts have strong antimicrobial activity even when diluted. Some (mercury, arsenic) have limited usefulness because they are highly toxic to humans and other living creatures. Modern day usage of these products is strictly controlled and for the most part, entirely banned.

Mercury - Salts of mercury are used to treat inanimate surfaces, but use is limited because of the toxic residues they leave. Mercurial formulations are used as preservatives for leather (phenyl-mercuric acetate), paper, pulp, paints (phenyl-mercuric oleate), and adhesives (phenylmercuric hydroxide).

Silver - Silver compounds that kill harmful bacteria have been used for many years as antiseptics and disinfectants. Colloidal silver is sometimes used in water filters. Antibacterial silver nanoparticles are now popular in consumer products, but they may also kill a significant number of beneficial bacteria.

Copper - Soluble salts of copper are antimicrobial agents. Their use is limited because they break down so quickly in the environment. Copper sulfate is used to control algae in swimming pools and other waters. More stable copper compounds control fungi and mildew in paint formulations (copper-8-quinolinolate).

Zinc - Zinc oxide is widely used as a mold inhibitor in paint.

Arsenic - Organic arsenicals are used to preserve plastics (oxybisphenoxarsine).

Tin - Organic tin compounds are used as preservatives for paint films (bistributyltin oxide), plastics (tributyltin linoleate), and textiles (tributyltin acetate) and as fungal control agents (tributyltin oxide). They exhibit a synergistic effect with quaternary ammonium compounds to provide a good overall microbiocide in industrial water-cooling systems.

Phenolic derivatives

Many synthetic chemicals related to phenol (carbolic acid) are in formulations used for sanitizing and disinfecting (orthobenzyl para-chlorophenol, ortho-phenylphenol). These formulations are for treating equipment and surfaces such as floors and walls. They also are used as preservatives for textiles, leather and paints. Some are corrosive and must be handled with care. Chlorinated phenols identified here are also formulated with other antimicrobial chemicals for use as slimicides in the manufacture of paper and in water-cooling towers.

Quaternary ammonium compounds

These compounds, widely known as *quats*, are related to detergents. They have weak to strong antimicrobial activity against selected groups of microorganisms, and they penetrate well. They are used to disinfect room surfaces, laundry and other materials. Quats have long chemical names, for example, alkyl (60%C^{14}, 30%C^{15}, 5%C^{12}, 5%C^{18}) dimethyl ethylbenzyl ammonium chloride, and methyldode-cylbenzyltrimethyl ammonium chloride.

Some formulations are used as algaecides in swimming pools and in industrial cooling water systems.

Organo-sulfur compounds

Although some of these products exhibit a noticeable “sewer gas” odor, compounds such as the sodium and potassium salts of dimethyldithiocarbamate are widely used as bacterial and fungal control agents in recirculating cooling water systems,

One of the most widely applied products of this class, methylene bis-thiocyanate, is an effective algal and bacterial control even in the presence of organic matter and oils in recirculating cooling water systems.

Alcohols

Ethyl and isopropyl alcohols - Ethyl and isopropyl alcohols in concentrations of 60-95% have bactericidal action. Methyl alcohol is not widely used for disinfection because it is toxic and is a weak bactericide. Alcohol preparations are used on equipment and other materials not damaged by their solvent action. Alcohols are flammable and must be handled with care.

Glycols - Formulations of single or mixed glycols (such as triethylene glycol) can be applied as fine aerosols or mists. They are used to temporarily reduce bacterial numbers in the air of enclosed spaces.

Aldehydes

Formaldehyde - Gaseous formaldehyde can he used as a sporicide and disinfectant in enclosed areas (such as rooms or small chambers), but it penetrates poorly. Maintain high humidity (70% or more) for effective results.

Glutaraldehyde - Hospitals and dental offices use glutaraldehyde formulations to disinfect and sterilize medical equipment.

Oxiranes

Ethylene Oxide - Ethylene oxide (EO) is an effective and widely used gas to sterilize medical supplies that may otherwise be damaged by heat. Some ethylene oxide products are flammable and explosive–read the label! EO is also available as a nonflammable mixture. Use EO in equipment with adequate control measures.

FORMULATIONS

In an antimicrobial product, chemicals that are effective against microorganisms are called active ingredients. Each of these will be named on the container label.

Few products contain only active ingredients. They also contain other chemicals called inert ingredients. The latter chemicals are added to make the product more stable; safer and easier to handle, measure and apply; or to make it effective for other uses, such as cleaning.

The mixture of active and inert ingredients is called the formulation. Some formulations are ready to use just as you purchase them. Other formulations must be diluted with water. The label directions tell you how to use each formulation. Many antimicrobial agents are used for more than one purpose. Each use may require a different concentration. Be sure the solution you prepare is in the correct concentration for the job you need to do. Follow the label directions carefully.

Concentrated liquids - Water-based concentrates are very common. The formulation often contains more than one active ingredient, as well as several inert ingredients. A typical concentrated liquid is prepared for use by adding the recommended volume of the concentrate to the stated amount of water to form a diluted solution. Read the label to determine the correct dilution and whether to add water to the product, or the product to water.

For water treatment uses (slimicides for paper mills, algaecides for cooling towers, disinfectants for drinking water) a measured amount of concentrate is normally added directly to the system.

Soluble solids - Dry formulations, such as powders and granules, are also quite common. Some contain 100% active ingredient, and some are mixtures. In most cases, these formulations must be dissolved before using. The proper solvent is specified on the label.

For water treatment, the directions may say either to add the dry product directly at a point in the system where there is good mixing, or to prepare a liquid concentrate before adding it to the system.

Granules, pellets or briquets for water treatment: release the active ingredient slowly over a long period of time. These formulations provide a simple way to treat circulating systems, such as cooling towers or swimming pools.

Suspensions/dispersions - Suspensions or dispersions are either finely divided solid particles in a liquid or droplets of one liquid in another (emulsions). Either type of formulation will separate unless it is well mixed before and during use.

Aerosols - An aerosol is a suspension of fine particles or droplets in air. Fog or mist-generating machines can be used to produce aerosols to treat large enclosed areas. Pressurized or non-pressurized packaged aerosol formulations may be solutions or emulsions. A direction to shake well before using is a reminder to get a well-mixed suspension before applying the spray.

Gases - Gaseous antimicrobial pesticides are used to disinfect and sterilize where other agents cannot he used or where the use of a gas is dictated by the need. Gases may be supplied in pressurized containers, or they may be solids or liquids that are sprayed, heated or evaporated to produce the active gases.

Ethylene oxide and its mixtures are supplied in pressurized cylinders. Formaldehyde may be purchased as a powder (paraformaldehyde) to be heated or as a spray solution.

Ozone gas is generated by ozone generators to disinfect potable water and to treat certain waste streams. Its purpose is to avoid the residual chloramines that result from normal chlorination of water and wastewater effluent. Neither the generator nor the gas is registered, but the generators are regulated as devices.

Gaseous agents are always used in unoccupied, enclosed spaces. Special precautions are required to insure that they will work well and not harm the applicator or other people. Pay close attention to all label instructions. Temperature and relative humidity requirements are sometimes critical. Be sure to note the types of materials that the product may be used to treat and any required post-treatment procedures.

CHOOSING ANTIMICROBIAL AGENTS

Types of microorganisms - The types of microorganisms to be controlled will vary. Some are very resistant to specific chemicals, while others are easily killed. No one chemical kills all types of microorganisms under all conditions. Read the product label to learn what each chemical agent can do.

Number of microorganisms - The number of microorganisms present may affect the speed at which they can be killed. A larger number of microbes may require longer exposure to the antimicrobial agent (see label directions). Where there are large numbers of microorganisms, as in fecal or other organic contamination, do not expect microbial agents to work. Clean the area before the antimicrobial agent is applied, even though the label may not say so.

Age and condition of organisms - Older microbial cells are more resistant to antimicrobial agents than younger cells. All antimicrobial agents work best when microorganisms are actively multiplying or dividing. Most agents have little or no effect on microbial spores.

In general, articles or materials exposed to soil or dust and kept dry have large numbers of bacterial and fungal spores. Similar items in the presence of water and organic materials such as urine, protein, carbohydrates and cellulose contain large numbers of actively growing bacteria and fungi.

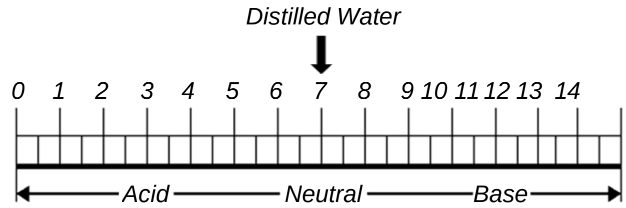
Nature of surface - Porosity, smoothness, oiliness and other surface characteristics may affect the action of antimicrobial agents. Remember, the antimicrobial agent must contact the microorganisms to be effective.

Concentration - The amount of antimicrobial agent you apply influences its effectiveness. Follow label directions for properly diluting the product for use at the prescribed concentration.

Contact time - Chemical agents vary in activity. Some have an effect within a few seconds; others may take hours. However, if the antimicrobial agent does not contact the microbial cell, it will be ineffective. Always follow the label directions.

Hardness of water - The hardness of water depends on the amount of calcium, magnesium and other chemicals present. Hardness may interfere with the killing power of some antimicrobial agents because these products may react with the calcium and magnesium hardness ions. Therefore, the label may set a hardness limit for the diluting water (expressed in parts per million of calcium carbonate). Determine the hardness of your local water supply by contacting municipal water supply officials or your local public health authority.

In circulating cooling water systems, solids suspended in water such as dust, dirt, mineral salts and organic contaminants can dramatically affect the quantity of certain biocides required to produce the desired control. Quaternary ammonium compounds are easily absorbed by the surfaces of these contaminants, and chlorine is quickly consumed by the organic particulates.



On the pH scale, 7 is neutral, less than 7 is acidic, more than 7 is alkaline. Altering pH by a whole number changes the acidity ten-fold, e.g., a solution of pH 5 is 100 times more acidic than distilled water (pH 7). Some antimicrobials are strong acids and bases capable of causing severe injury.

Acidity/alkalinity (pH) - Antimicrobial agents and slimicides work best at some optimum level of acidity or alkalinity. Read the label to determine if an adjustment to the pH will help the disinfectant work better.

Composition and amount of soil on surfaces - The presence of organic matter interferes with the activity of most chemical agents. In hospitals, surfaces may be contaminated with blood, pus, tissue debris, sputum, urine or feces. In food preparation areas, fats or oils may be present. Because the organic matter protects the microorganism, it reduces and may completely stop the killing power of antimicrobial agents. Thus, the label may require very dirty materials to be exposed to a higher concentration of an antimicrobial agent for a longer time, or it may require the surface to be cleaned before the antimicrobial agent is applied. The surface to be disinfected must be clean in order for the disinfectant to work effectively. If it is not heavily soiled, clean and disinfect at the same time, but be sure the product is designed for this combined use. If the antimicrobial agent does not contact the microbes, it is ineffective.

Moisture or humidity - Antimicrobial agents are ineffective without water or moisture. Either the relative humidity of the treated areas must be high, or water must be present in or on the material to be treated.

Temperature - With many antimicrobial agents, there is a relationship between the rate of action and an increase in temperature. Generally, the agents are more effective as the temperature is increased.

SECTION 4
MOLD REMEDIATION & WATER DAMAGE RESTORATION

HEALTH EFFECTS

Adverse effects to health and well-being is an important reason for preventing indoor mold growth and for remediating existing problems. Typical indoor exposures to mold rarely present health risks but some molds do produce allergens and mycotoxins. Reactions to significant mold exposure may include:

Asthma and Allergies. Inhaling or touching molds can trigger asthma attacks in persons who are allergic (sensitized) to molds. Allergic reactions may be immediate or delayed, and they may be produced whether the mold is dead or alive. Allergic responses include hay fever-type symptoms, such as sneezing, runny nose, red eyes, and skin rash (dermatitis). Exposure to mold or mold spores may cause previously non-sensitive individuals to become sensitive, and repeated exposure may increase sensitivity.

Hypersensitivity Pneumonitis. Hypersensitivity pneumonitis may develop following either short-term (acute) or long-term (chronic) exposure to molds. The disease resembles bacterial pneumonia and is uncommon.

Irritant Effects. Mold exposure can cause irritation of the eyes, skin, nose, throat, and lungs, and sometimes creates a burning sensation in these areas.

In mold relmediation, the primary function of personal protective equipment (PPE) is to prevent exposure to mold and mold spores by inhalation, ingestion and contact with the skin or eyes.

Opportunistic Infections. People with weakened immune systems (immune-compromised or immune-suppressed individuals) may be more vulnerable to infections by molds. *Aspergillus fumigatus*, for example, has been known to infect the lungs of immune-compromised individuals. These individuals inhale the mold spores which then start growing in their lungs. *Trichoderma* has also been known to infect immune-compromised children.

Healthy individuals are usually not vulnerable to opportunistic infections from airborne mold exposure. However, molds can cause common skin diseases, such as athlete's foot, and other infections such as yeast infections.

Mold Toxins (Mycotoxins). Molds can produce toxic substances called mycotoxins. More than 200 mycotoxins have been identified; many more are unknown. Some molds produce several toxins, others only produce toxins under certain environmental conditions. Certain molds known to produce mycotoxins are commonly found in moisture-damaged buildings. However, the presence of mold in a building does not necessarily mean that mycotoxins are present or of concern.

Although some mycotoxins clearly affect human health, little information is available for many others. Nevertheless, it seems obvious that we should avoid exposure to molds and mycotoxins, including inhalation, ingestion, and skin contact. Symptoms attributed to inhaling mycotoxins include:

- mucous membrane irritation
- skin rash
- nausea
- immune system suppression
- acute or chronic liver damage
- acute or chronic central nervous system damage
- endocrine effects, and cancer

MOLD PREVENTION

Molds may grow when excessive moisture or water accumulates indoors, particularly when a moisture problem remains uncorrected. Ignoring maintenance only contributes to more problems. While it is impossible to eliminate all molds and mold spores, controlling moisture can control indoor mold growth.

In buildings, moisture problems may be linked to improper maintenance and design of heating/ventilating/air-conditioning (HVAC) systems, roof leaks, water runoff from landscaping or gutters, unvented appliances, or tight construction that allows little ventilation.

Quick response and moisture control are the keys to mold control. When water leaks or spills occur indoors, a prompt response (within 24 - 48 hours) and thorough clean-up, drying, and/or removal of water-damaged materials will prevent or limit mold growth. To help avoid indoor mold growth:

- Perform regularly scheduled building and HVAC inspections and maintenance, including filter changes.
- Keep HVAC drip pans clean, flowing properly, and unobstructed.
- Repair plumbing and structural leaks, and any other moisture problem as quickly as possible.
- If you see condensation or moisture collecting on windows, walls or pipes–ACT QUICKLY to dry the wet surface and reduce the moisture/water source. Mold will usually not grow if wet areas are dried within 24-48 hours.
- Cover cold surfaces, such as cold-water pipes, with insulation.
- Do not paint or caulk moldy surfaces. Clean up the mold and dry the surfaces before painting.
- Prevent condensation by:
  1 - increasing surface temperature–insulate and/or increase air circulation. Use fans as needed.
  2 - reducing the moisture level in the air–repair leaks, increase ventilation (if outside air is cold and dry), or dehumidify (if outdoor air is warm and humid). Maintain indoor relative humidity below 70% (ideally between 30 and 50 percent relative humidity).
- Vent cooking areas and bathrooms according to local code requirements. Vent appliances to the outside if they produce moisture, including clothes dryers, dishwashers, stoves, and kerosene heaters.
- Provide adequate drainage around buildings; slope the ground away from building foundations. Follow all local building codes.

REMEDIATION PLAN

Remediation includes both the identification and correction of the conditions that permit mold growth, as well as the steps to safely and effectively remove mold damaged materials. Remediation plans may vary greatly depending on the size and complexity of the job, and may require revision as new facts are discovered. However, one thing remains constant–the remediation plan's highest priority is to protect the health and safety of the building occupants and remediators.

After correcting water or moisture infiltration, the prompt removal of contaminated material and structural repair is the primary response to mold contamination in buildings. In all situations, the underlying cause of water accumulation must be fixed, or mold growth will reoccur. Emphasis should be placed on preventing contamination through proper building and HVAC system maintenance and prompt repair of water damaged areas.

Effective communication with building occupants is an essential component of all large-scale remediation efforts. The building owner, management, and/or employer should notify occupants in the affected area(s) of the presence of mold. Notification should include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to mold exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures.

Every remediation plan should include

- An assessment of the extent of the mold or moisture problem and the type of damaged materials.
- Proper methods for containing and removing moldy building materials.
- Steps to permanently correct the water or moisture problem.
- A choice, if required, of an effective biocide.
- Use of the appropriate personal protective equipment (PPE).
- A schedule of work that may include the temporary relocation of some or all of the building occupants.

Sampling for mold

In most cases, if visible mold growth is present, sampling is unnecessary. There are no standards for acceptable levels of mold in buildings, and the lack of a definitive correlation between exposure levels and health effects makes interpreting sample data difficult, if not impossible.

However, sampling may help identify the source of contamination. Air sampling can compare the levels and types of mold spores found inside the building with those found either outside or in another location in the building. Sampling may show a higher concentration of the same species of mold when the HVAC is operating than when it has been turned off. Negative results would indicate other sources of mold growth or dissemination. But if you know you have a mold problem, it is more important to spend time and resources removing the mold and solving moisture problems than to do extensive testing. For additional information on air sampling, refer to *Bioaerosols: Assessment and Control* published by the American Conference of Governmental Industrial Hygienists (http://www.acgih.org/).

Mold sampling in the case of sewage contamination is irrelevant because a biocide must be used in these cases.

Hidden mold

Hidden mold may be indicated if a building smells moldy but there is no obvious source, or if there has been water damage and building occupants are reporting health problems. Mold may be hidden on the inside of dry wall, wallpaper, or paneling, the top side of ceiling tiles, the underside of carpets and pads, areas inside walls around pipes (with leaking or condensing pipes), the surface of walls behind furniture (where condensation forms), inside ductwork, and in roof materials above ceiling tiles (due to roof leaks or insufficient insulation), etc.

Investigating hidden mold problems is difficult and requires caution; it may require containment if the investigation might disturb sites of mold growth. For example, removal of wallpaper can lead to a massive release of spores if there is mold growing beneath the paper.

Remediation equipment

There are various types of equipment useful in mold assessment and remediation. Some of the more common items include:

Moisture meters. Moisture meters can measure and monitor moisture levels in building materials. They may be used to monitor the progress of drying damaged materials. These are direct reading devices with a thin probe that is inserted into the material to be tested or pressed directly against the surface of the material. Moisture meters can be used on carpet, wallboard, wood, brick, and concrete.

Humidity gauges or meters. Humidity meters are used to monitor indoor relative humidity.

Humidistat. A humidistat is a control device that can be connected to an HVAC system and adjusted so that if the humidity level rises above a set point, the HVAC system will automatically turn on and reduce the humidity below the established point.

Boroscope. A boroscope is a hand-held video camera on the end of a flexible “snake” that allows users to see potential mold problems inside walls, ceiling plenums, crawl spaces, and other tight areas. No major drilling or cutting of dry wall is required.

HVAC system filter. High-quality filters must be used in a HVAC system during remediation because conventional HVAC filters are not effective in filtering particles the size of mold spores. Consult an engineer for the appropriate filter efficiency for your specific HVAC system, and consider upgrading your filters. A filter with a minimum efficiency of 50 - 60% or a rating of MERV 8, as determined by *Test Standard 52.2* of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, may be appropriate.

Remember to change filters as appropriate, especially following any remediation activities. Remove filters in a manner that minimizes the reentry of mold and other toxic substances into the workplace. Under certain circumstances, it may be necessary to wear appropriate protective equipment while performing this task.

Personal protective equipment (PPE)

Any remediation work that disturbs mold spores and releases them into the air increases the degree of respiratory exposure. The primary function of personal protective equipment is to prevent the inhalation and ingestion of mold and mold spores and to avoid mold contact with the skin or eyes.

Skin and eye protection. Gloves protect the skin from contact with mold, as well as from potentially irritating cleaning solutions. Long gloves that extend to the middle of the forearm are recommended. The glove material should be selected based on the type of substance/chemical being handled. If you are using a biocide such as chlorine bleach, or a strong cleaning solution, you should select gloves made from natural rubber, neoprene, nitrile, polyurethane, or PVC. If you are using a mild detergent or plain water, ordinary household rubber gloves may be used.

To protect your eyes, use properly fitted goggles or a full-face piece respirator. Goggles must be designed to prevent the entry of dust and small particles. Safety glasses or goggles with open vent holes are not appropriate when mold may be airborne.

Respiratory protection. Respirators protect cleanup workers from inhaling airborne mold, contaminated dust, and other particulates that are released during the remediation process. Either a half mask or full-face air-purifying respirator can be used. A full-face respirator provides both respiratory and eye protection. Respirators used to provide protection from mold and mold spores must be certified by the National Institute for Occupational Safety and Health (NIOSH). More protective respirators may be selected and used if toxic contaminants such as asbestos or lead are encountered during remediation.

As specified by the Occupational Safety and Health Administration (OSHA) in *29 CFR 1910.134 - Respiratory Protection,* individuals who use respirators must be properly trained, have medical clearance, and be properly fit tested before they begin using a respirator. In addition, use of respirators requires the employer to develop and implement a written respiratory protection program, with worksite- specific procedures and elements.

Protective clothing. While conducting building inspections and remediation work, individuals may encounter hazardous biological agents as well as chemical and physical hazards. Consequently, reusable or disposable PPE is recommended to minimize cross-contamination between work areas and clean areas, to prevent the transfer and spread of mold and other contaminants to street clothing, and to eliminate skin contact with mold and potential chemical exposures.

Disposable PPE should be discarded after use; usually placed into impermeable bags and discarded as ordinary construction waste. Appropriate precautions and protective equipment for biocide applicators should be selected based on the product label requirements. Always READ THE LABEL before using any antimicrobial product!

It is a violation of Federal (EPA) law to use a biocide in any manner inconsistent with its label direction.

Cleanup methods

The purpose of mold remediation is to correct the moisture problem, and to remove moldy and contaminated materials to prevent human exposure and further damage to building materials and furnishings. Porous materials that are wet and have mold growing on them may have to be discarded because molds can infiltrate porous substances and grow on or fill in empty spaces or crevices. This mold can be difficult or impossible to remove completely.

As a general rule, simply killing the mold, for example, with biocide is not enough. The mold must be removed, since the chemicals and proteins, which can cause a reaction in humans, are present even in dead mold.

A variety of cleanup methods are available for remediating damage to building materials and furnishings caused by moisture control problems and mold growth. The specific method or group of methods used will depend on the type of material affected.

Wet vacuum. Wet vacuums are vacuum cleaners designed to collect water from floors, carpets, and hard surfaces where water has accumulated. They should not be used to vacuum porous materials, such as gypsum board. Wet vacuums should be used only on wet materials, as spores may be exhausted into the indoor environment if insufficient liquid is present.

The tanks, hoses, and attachments of these vacuums should be thoroughly cleaned and dried after use since mold and mold spores may adhere to equipment surfaces.

Damp wipe. Mold can generally be removed from nonporous surfaces by wiping or scrubbing with water and detergent. It is important to dry these surfaces quickly and thoroughly to discourage further mold growth. Instructions for cleaning surfaces, as listed on product labels, should always be read and followed.

HEPA vacuum. HEPA (High-Efficiency Particulate Air) vacuums are recommended for final cleanup of remediation areas after materials have been thoroughly dried and contaminated materials removed. HEPA vacuums also are recommended for cleanup of dust that may have settled on surfaces outside the remediation area. Care must be taken to assure that the filter is properly seated in the vacuum so that all the air passes through the filter. When changing the vacuum filter, remediators should wear respirators, appropriate personal protective clothing, gloves, and eye protection to prevent exposure to any captured mold and other contaminants. The filter and contents of the HEPA vacuum must be disposed of in impermeable bags or containers in such a way as to prevent release of the debris.

Disposal of damaged materials. Building materials and furnishings contaminated with mold growth that are not salvageable should be placed in sealed impermeable bags or closed containers while in the remediation area. These materials can usually be discarded as ordinary construction waste. It is important to package mold-contaminated materials in this fashion to minimize the dispersion of mold spores. Large items with heavy mold growth should be covered with polyethylene sheeting and sealed with tape before being removed from the remediation area. Some jobs may require the use of dust-tight chutes to move large quantities of debris to a dumpster strategically placed outside a window in the remediation area.

Antimicrobial pesticides. The use of antimicrobial pesticides (biocides), such as chlorine bleach, is not recommended as a routine practice during mold remediation, although there may be instances where professional judgment may indicate its use (for example, when immuno-compromised individuals are present). In most cases, it is not possible or desirable to sterilize an area, as a background level of mold spores comparable to the level in outside air will persist. However, the spores in the ambient air will not cause further problems if the

COMMON INDOOR ANTIMICROBIAL PRODUCTS

Antimicrobial	Action[1]	Advantages	Disadvantages
Alcohols	B, F, V	non-staining; not irritating; non-corrosive	inactivated by organic matter; highly flammable; not effective against spores
Aldehydes (formaldehyde)	B, F, V, S**	inexpensive; not affected by organics	irritating; slow penetration rate; toxic
Chlorine dioxide		Extremely toxic; not recommended for treating occupied areas	
Gluteraldehydes;	B, F, V, S**	not affected by organics; not corrosive; less toxic than aldehyde	irritating; expensive; slow penetration
Hydrogen peroxide	B, F, V, S**	stable at low concentrations	corrosive; degrades in heat and ultraviolet light; expensive
Hypochlorites (bleach)	B, F, V, S**	inexpensive	toxic; corrosive; inactivated by organic matter; removes color from fabrics; dissolves protein fibers (wool, silk); NEVER mix with ammoniated detergent (releases chlorine gas)
Iodophors (iodine compounds)	B, F, V, S**	stable; residual action	inactivated by organic matter; expensive; irritating
Ozone		Extremely toxic; not recommended for treating occupied areas	
Phenolics	B, F, V	inexpensive; residual action; considered effective against vegetative (growing) bacteria and fungi	toxic; irritating; corrosive; not effective against spores
Quaternary Ammonia Compounds	B*, F, V*	inexpensive; relatively non-toxic; odorless; non-corrosive; stable	inactivated by organic matter; limited efficacy; not considered sporicidal

[1]Action Key

B = Bactericide — *** Limited effectiveness**
S = Sporicide — **** Requires prolonged contact time**
F = Fungicide
V = Virucide

moisture level in the building has been corrected.

Biocides are toxic to animals and humans, as well as to mold. If you choose to use disinfectants or biocides, always ventilate the area, using outside air if possible, and exhaust the air to the outdoors. When using fans, take care not to extend the zone of contamination by distributing mold spores to a previously unaffected area. Never mix chlorine bleach solution with other cleaning solutions or detergents that contain ammonia because this may produce highly toxic vapors and create a hazard to workers. Always, read and follow product label precautions and use appropriate PPE. It is a violation of Federal (EPA) law to use a biocide in any manner inconsistent with its label directions.

ANTIMICROBIAL PESTICIDES

Since most antimicrobials are irritants, improper application can actually cause additional problems when the area is reoccupied. If biocides are required, mix and apply according to manufacturer directions, ensure adequate contact time and ventilation.

Antiseptics and germicides - Used to prevent inflection and decay by inhibiting the growth of microorganisms. Because these products are used in or on living humans or animals, they are considered drugs and are thus approved and regulated by the Food and Drug Administration (FDA).

Disinfectants - One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a disinfectant when it destroys or irreversibly inactivates infectious or other undesirable organisms, but not necessarily their spores. EPA registers three types of disinfectant products based upon submitted efficacy data: limited, general or broad spectrum, and hospital disinfectant.

Sanitizers - One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a sanitizer when it reduces but does not necessarily eliminate all the microorganisms on a treated surface. To be a registered sanitizer, the test results for a product must show a reduction of at least 99.9% in the number of each test microorganism over the parallel control.

Sterilizers or sporicides - One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a sterilizer when it destroys or eliminates all forms of bacteria, fungi, viruses, and their spores. Because spores are considered the most difficult form of a microorganism to destroy, EPA considers the term sporicide to be synonymous with sterilizer.

Biocides in ventilation systems

The EPA cautions against using disinfectants and sanitizers in ventilation systems. These products have not been evaluated for exposure risks to building occupants or applicators. Consequently, disinfectants and sanitizers should not be used in HVAC systems *unless* the product contains directions specific to this application.

Biocides can be used in HVAC condensate pans and/or coils to prevent microbial growth. Such procedures should be part of the building's HVAC preventive maintenance plan.

Fumigating a building for mold remediation, i.e., using gaseous chlorine dioxide or ozone, is not recommended. There is insufficient data on the efficacy of such wholesale sanitizing. Further, the chemicals themselves are highly toxic and may cause harm if used inappropriately.

MOLD REMEDIATION GUIDELINES

This section presents remediation guidelines for building materials that have or are likely to have mold growth. The guidelines are designed to help construct a remediation plan. They are based on the size of the area impacted by mold contamination, and designed to protect the health of cleanup personnel and other workers during remediation. Please note that these are guidelines; some professionals may prefer other remediation methods, and certain circumstances may require different approaches or variations on the approaches described below. If possible, remediation activities should be scheduled during off-hours when building occupants are less likely to be affected.

Although the level of personal protection suggested in these guidelines is based on the total surface area contaminated and the potential for remediator or occupant exposure, professional judgment always should play a part in remediation decisions. The guidelines are based on the size of the affected area to make it easier for remediators to select appropriate techniques; they are not based on research that shows a specific method is required. The remediation manager should rely on professional judgment and experience to adapt the guidelines to particular situations. When in doubt, caution is advised.

Level I - Small Isolated Areas

10 sq. ft or less

Ceiling tiles, small areas on walls, etc.

- Remediation can be conducted by the regular building maintenance staff as long as they are trained on proper clean-up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA *Hazard Communication Standard* (29 CFR 1910.1200).
- Respiratory protection is recommended. Respirators must be used in accordance with the OSHA *Respiratory Protection Standard* (29 CFR 1910.134). Gloves and eye protection should be worn.
- The work area should be unoccupied. Removing people from spaces adjacent to the work area is not necessary, but is recommended for infants (less than 12 months old), persons recovering from recent surgery, immune-suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
- Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
- Contaminated materials that cannot be cleaned should be removed from the building in a sealed impermeable plastic bag. These materials may be disposed of as ordinary waste.
- The work area and areas used by remediation workers for egress should be cleaned with a damp cloth or mop and a detergent solution.
- All areas should be left dry and visibly free from contamination and debris.

Level II - Mid-Sized Isolated Areas

10-30 sq. ft.

Individual wallboard panels, etc.

- Remediation can be conducted by the regular building maintenance staff. Such persons should receive training on proper clean-up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA *Hazard Communication Standard* (29 CFR 1910.1200).
- Respiratory protection is recommended. Respirators must be used in accordance with the OSHA *Respiratory Protection Standard* (29 CFR 1910.134). Gloves and eye protection should be worn.
- The work area should be unoccupied. Removing people from spaces adjacent to the work area is not necessary, but is recommended for infants (less than 12 months old), persons recovering from recent surgery, immune-suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
- Surfaces in the work area that could become contaminated should be covered with a secured plastic sheet(s) before remediation to contain dust/ debris and prevent further contamination
- Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
- Contaminated materials that cannot be cleaned should be removed from the building in a sealed impermeable plastic bag. These materials may be disposed of as ordinary waste.
- The work area and areas used by remediation workers for egress should be HEPA vacuumed and cleaned with a damp cloth or mop and a detergent solution.
- All areas should be left dry and visibly free from contamination and debris.

Level III - Large Isolated Areas

30 –100 sq. ft.

Several wallboard panels, etc.

Industrial hygienists or other environmental health and safety professionals with experience performing microbial investigations and/or mold remediation should be consulted prior to remediation activities to provide oversight for the project.

If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the mold is heavy (blanket coverage as opposed to patchy), it is recommended that the remediation procedures for Level IV be followed.

The following procedures may be implemented depending upon the severity of the contamination:

- It is recommended that personnel be trained in the handling of hazardous materials and equipped with respiratory protection. Respirators must be used in accordance with the OSHA *Respiratory Protection Standard* (29 CFR 1910.134). Gloves and eye protection should be worn.
- Surfaces in the work area and areas directly adjacent that could become decontaminated should be covered with a secured plastic sheet(s) before

MOLD REMEDIATION CONTAINMENT

PROCEDURE or ACTION	CONTAMINATED AREA, ft^2			HVAC[1]
	< 10	10-100	>100	
Remove occupants from work area.[2]	✓	✓	✓	✓
Remove occupants from adjacent areas.[2]			✓	✓
No containment needed.	✓			
Seal off work area with 6-mil polyethylene sheeting (i.e., critical barrier).[3] Seal seams.		✓	✓ double poly	✓
Seal off all supply and return air ducts and doors into/out of the contained area.		✓	✓	
Secure ventilation system.			✓	✓
Place work area under negative pressure using exhaust fan(s) equipped with HEPA filters. Exhaust air outside.		✓	✓	✓[4]
Use airlocks into/out of the work area.			✓	✓[4]
Establish decontamination room outside of the enclosure.			✓	✓[4]
Use dust suppression methods (misting) on any material or object to be removed, cut, or discarded.	✓	✓	✓	✓
Dispose of contaminated material and cleaning rags per Disposal guidelines.	✓	✓	✓	✓
Mop or wipe down area after cleaning/removal is complete.	✓	✓	✓	✓
After damp wiping, clean the same area with a HEPA-filtered vacuum		✓	✓	✓
Visually inspect work area for cleanliness (no dust).	✓	✓	✓	✓
Conduct clearance sampling before removing containment.			✓	✓

[1] HVAC = heating, ventilation, and air-conditioning system.

[2] Consult occupational medicine physician. Some occupants may be removed based on medical conditions such as recent surgery, chronic lung disease, immunosuppression, etc.

[3] Cover area with poly sheeting from ceiling to floor. Tape (or otherwise attach) poly to the framing or room perimeter. Tape all seams shut. Provide slit entry with covering flap. Maintain high negative pressure using HEPA filtered fan. Block supply and return vents

[4] If contaminated area is >30 ft^2

remediation to contain dust/ debris and prevent further contamination.

- Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
- The work area and areas directly adjacent should be unoccupied. Removing people from spaces near the work area is recommended for infants, persons having undergone recent surgery, immuno-suppressed individuals, or people with chronic inflammatory lung diseases. (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
- Dust suppression methods, such as misting (not soaking) surfaces prior to mediation, are recommended.
- Contaminated materials that cannot be cleaned should be removed from the building in sealed impermeable plastic bags. These materials may be disposed of as ordinary waste.
- The work area and surrounding areas should be HEPA vacuumed and cleaned with a damp cloth or mop and a detergent solution.
- All areas should be left dry and visibly free from contamination and debris.

Level IV - Extensive Contamination

greater than 100 contiguous sq. ft. in an area

Industrial hygienists or other environmental health and safety professionals with experience performing microbial investigations and/or mold remediation should be consulted prior to remediation activities to provide oversight for the project.

The following procedures may be implemented depending upon the severity of the contamination:

- Personnel trained in the handling of hazardous materials and equipped with full face respirators with HEPA cartridges.
- Disposable protective clothing covering entire body including both head and shoes; and gloves.
- Containment of the affected area.
- Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and other openings).
- The use of an exhaust fan with a HEPA filter to generate negative pressurization; and airlocks and decontamination room.
- If contaminant practices effectively prevent mold from migrating from affected areas, it may not be necessary to remove people from surrounding work areas. However, removal is still recommended for infants, persons having undergone recent surgery, immune-suppressed people, or people with chronic inflammatory lung diseases. (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
- Contaminated materials that cannot be cleaned should be removed from the building in sealed impermeable plastic bags. The outside of the bags should be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. These materials may be disposed of as ordinary waste.
- The contained area and decontamination room should be HEPA vacuumed and cleaned with a damp cloth or mopped with a detergent solution and be visibly clean prior to the removal of isolation barriers.

SEWAGE CONTAMINATION

Sewage may contaminate a building if it is present in flood waters, or when septic lines back-up. Although sewage water will certainly contribute to indoor mold problems, the major concern is more immediate: sewage contains chemicals, pathogens, and organic debris that may become lodged in porous building materials such as wood, paper, gypsum, concrete and brick- or stone-work. Fungi and bacteria from the sewage may become established in these materials and pose a chronic health hazard to building inhabitants.

Damage to structures from water containing sewage requires prompt remediation. This is especially true if several days pass while a sewage leak is repaired or flood waters recede. Not only does this allow ample time for organic matter to penetrate the structure but high indoor humidity following water damage maintains an ideal climate for further microbial growth.

Sewage remediation

Work quickly

- Begin remediation as soon as possible in order to minimize the potential for microbial growth.

Use PPE

- Evacuate building occupants until water, sewage and sludge have been removed, and the area has been treated with disinfectants.
- During initial clean-up, workers should wear hard hats, organic vapor HEPA respirators, rubber gloves, splash goggles, coveralls and boots. Workers should avoid tracking contamination into unaffected areas.

- An area for decontaminating PPE and equipment should be provided. All equipment must be cleaned and disinfected after use. Wash-water must be collected and disposed of properly.

Remove water and sewage and disinfect

- Use a wet extraction system to completely remove sewage as well as the water used for cleaning. Dispose of this waste in a properly operating sewer system.
- Remove heavier deposits including sludge, mud and organic matter with shovels, septic pumps, wet vacuums, etc.
- Use a pressure washer with a disinfectant solution to clean hard, porous materials.
- Following application, recover excess disinfectant solution using a wet vac or other extraction method.

Dry area as quickly as possible

- Ventilate area; increase air flow as much as possible. Rapid drying is essential for success. Use HVAC systems, fans, and dehumidifiers to reduce the indoor humidity to 40% relative humidity as quickly as possible. Monitor humidity with a hygrometer or a psychrometer.

Remove contaminated materials and disinfect

- Remove and dispose of porous, contaminated structural material including wood, carpet, wall covering, porous wallboard, insulation, and other items with the potential for supporting mold growth.
- Clean and disinfect, or replace semi-porous building materials made of vinyl, linoleum, wood, painted drywall and plaster.
- Very absorbent materials may be damaged beyond a reasonable degree of restoration. Place non-restorable material in plastic bags and dispose of them in a proper waste-disposal facility.
- Remove contaminated furniture and other portable items off-site; clean and apply a disinfectant or dispose of them. Soaps and detergents, work well with most organic matter.
- Once the area and contaminated items are clean of all organic contamination, make a second application of disinfectant.
- Insure that the type of personal protective equipment provided during disinfection meets label requirements.

WHEN IS REMEDIATION FINISHED?

- You must have identified and completely corrected the source of the water or moisture problem.
- Mold removal should be complete. Visible mold and moldy odors should no longer be present. Note that some mold damage areas may have permanent, cosmetic stains.
- Visiting the site after remediation should show no signs of moldy or musty odors, water damage, or mold growth.
- Building occupants should be free from mold-related health complaints or physical symptoms.
- If you have concerns or questions call the EPA Indoor Air Quality Information Clearinghouse at 800)-438-4318.

For more information on mold related issues including mold cleanup, moisture and condensation control, and humidity issues visit:

EPA Indoor Air Quality
Information Clearinghouse
www.epa.gov/mold

GLOSSARY

AEROBIC: living or occurring only in the presence of oxygen, as certain microorganisms.

AEROSOL: small liquid or sold particle, which can remain suspended in air for some time.

ALGA: any of the numerous groups of chlorophyll-containing, mainly aquatic eukaryotic organisms ranging from microscopic single-celled forms to multicellular forms 100 feet or more long, distinguished from plants by the absence of true roots, stems, and leaves and by a lack of nonreproductive cells in the reproductive structures

ALGAECIDE: A chemical agent that kills algae.

ALLERGEN: a substance (such as a mold spore) that can elicit an excessive immune response (allergic reaction) such as hay fever, rashes, sinusitis, or asthma symptoms.

AMPLIFIER: An item (material, substrate, etc.) that supports the active growth and proliferation (increase in numbers) of mold.

ANAEROBIC: living in the absence of air or free oxygen.

ANTIFOULANT: A chemical agent that prevents growth of organisms on underwater structures.

ANTIMICROBIAL AGENT/PESTICIDE: Any substance or mixture of substances intended for preventing, destroying, repelling or mitigating pest microorganisms on direct contact; a microbiocide.

ANTISEPTICS AND GERMICIDES: Used to prevent inflection and decay by inhibiting the growth of microorganisms. Because these products are used in or on living humans or animals, they are considered drugs and are thus approved and regulated by the Food and Drug Administration (FDA).

APR : Air purifying respirator

BACTERIA: ubiquitous single-celled organisms, spherical, spiral, or rod-shaped and appearing singly or in chains. Various species are involved in fermentation, putrefaction, infectious diseases, or nitrogen fixation.

BACTERICIDE: A chemical agent that kills bacteria, but not ordinarily bacterial spores.

BACTERIOSTAT: A chemical agent that inhibits the growth of bacteria, without killing.

BIOCIDE: Substance or chemical that kills organisms such as molds.

BIOAEROSOL: Airborne particles or matter of biological origin (derived from a live or formerly living organism). For example, mold spores or fragments of a mold growth that are suspended in the air.

BIODISPERSANT: A chemical compound added to recirculating water within a cooling tower system to penetrate and break down biofilm, which may be present on the wetted surfaces of the cooling tower system.

BIOFILM: A surface layer of microorganisms and other organic matter. It is usually combined with particulate matter, scale and products of corrosion.

“-CIDE” or “-CIDAL”: A suffix that means “to kill.”

CLEANING: The science and practice of controlling contaminants by locating, identifying, containing, removing and disposing of unwanted substances from the environment.

COLONY: A uniform mass of cells all derived from a single cell and which is growing on a solid surface. A colony is usually the smallest unit of mold that can be observed with the naked eye.

CONTAINMENT: Barriers, seals, air-locks, negative air filtration systems and other methods used to control the movement of airborne materials or agents and avoid secondary contamination. For example, plastic sheeting used to enclose a work area to prevent disturbed mold particles from drifting from the containment zone into adjacent or connected areas.

CONTAINMENT BARRIER: polyethylene sheeting (or other nonpermeable materials) used to completely seal off work area to prevent the airborne distribution of contaminants to areas outside the containment zone.

DEODORIZER: A chemical agent that prevents the formation of odors by acting upon microorganisms.

DETERGENT: A cleaning agent. Detergency refers to the ability to remove soil.

DETERGENT DISINFECTANT: A product that is both a cleaner and a disinfectant.

DISINFECTANT: One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a disinfectant when it destroys or irreversibly inactivates infectious or other undesirable organisms, but not necessarily their spores.

DISINFECTION: The elimination and destruction of microorganisms, which may allow for survival of some resistant organisms (e.g., bacterial endospores or fungal spores).

ENCLOSURE: The practice of attaching a rigid and durable barrier to building components, with all edges sealed for the purpose of permanently enclosing contaminants.

EPA: Environmental Protection Agency

FUNGUS: Fungi are neither animals nor plants and are classified in a kingdom of their own. Fungi include molds, yeasts, mushrooms, and puffballs. In this document, the terms fungi and mold are used interchangeably. Molds reproduce by making spores. Mold spores waft through the indoor and outdoor air continually. When mold spores land on a damp spot indoors, they may begin growing and digesting whatever they are growing on. Molds can grow on virtually any organic substance, providing moisture and oxygen are present. It is estimated that more than 1.5 million species of fungi exist.

FUNGICIDE: Substance or chemical that kills fungi.

FUNGISTAT: A product that inhibits the growth of fungi, without killing.

GENUS: A biological level of classification directly above the species level. In the practice of naming mold, the genus is indicated first and is capitalized (e.g., Aspergillus is the genus of the mold named, Aspergillus fumigatus). There often are many different species within a single genus. The plural form is genera.

GERMICIDE: See “Disinfectant.”

HEPA: High Efficiency Particulate Air. Capable of removal and capture of 99.97 % of dispersed particles greater than or equal to 0.3 microns in size. See the Dept. of Energy standard DOE-STD-3020-97 for details.

HEPA-FILTERED VACUUM: A high-efficiency particulate air filtered vacuum with a properly installed filter capable of collecting and retaining particulate matter 0.3 microns or larger at an efficiency rate of 99.97%.

HIDDEN MOLD: Mold growth on building materials or assemblies of building components that are obscured from the view of an observer within building spaces normally intended for occupancy. Common examples include contamination beneath carpeting or padding, behind fixed cabinetry or shelving units, in spaces above a drop ceiling, in air handling or distribution systems, or within a wall cavity.

HYPERSENSITIVITY: Great or excessive sensitivity

HYPERSENSITIVITY PNEUMONITIS: (aka extrinsic allergic alveolitis). A syndrome characterized by inflammation of the lungs, caused by inhalation of certain allergens. Typically occurs in the occupational setting following the repeated inhalation of very high levels of an allergen(s), including mold allergens (e.g., farmer’s lung).

IAQ: Indoor Air Quality

INCINERATE: Flame, burn or reduce to ashes.

LIMITED DISINFECTANT: Effective against one major group of microorganisms, such as gram positive bacteria or gram negative bacteria.

METABOLITE: A chemical produced by the metabolism of a living organism; produced by enzymatic action.

MICROBE: a microorganism, including types of fungi and bacteria that are usually not visible to the naked eye. Indoor biological contamination can include other microbes in addition to mold, and this may affect the remediation strategy.

MICROBIOCIDE: An antimicrobial agent.

MICRON: A unit of measure equal to one millionth (10-6) of a meter; also known as a micrometer and written as "m". Approximately equal to 1/25,000 inch.

MILDEWCIDE: A chemical agent that kills mildew (a fungus that causes decay).

MOISTURE CONTENT: The mass of moisture held in a material, relative to the material. Measured as the mass of water as a percentage of the dry mass of a material. Expressed as a percentage [(wet mass – dry mass) (100)]/(dry mass), or in terms of mass of water over material volume. Moisture content can be measured in the field using a moisture meter that is appropriate and calibrated for the material. Different moisture content values can be tolerated, depending on the material, before mold growth occurs.

MOLD: Molds are a group of organisms that belong to the kingdom Fungi. In this document, the terms fungi and mold are used interchangeably. There are over 20,000 species of mold.

mVOC: Microbial volatile organic compound, a chemical made by a mold which may have a moldy or musty odor.

MYCOTOXIN: A harmful substance produced by a fungus, which affects the structural or functional integrity of cells or tissues. Mycotoxins are usually found in the spores, filamentous structures, and/or the surrounding growth material.

MYCOLOGIST: A microbiologist who studies or has expert knowledge of fungi.

NADCA: National Air Duct Cleaners Association. Trade group that publishes the standard Assessment, Cleaning, and Restoration of HVAC Systems (ACR-2002).

NEGATIVE PRESSURE: An atmosphere created in an enclosure such that the air pressure within the enclosure is less that that outside the enclosure resulting in the tendency for airborne particles to be drawn in rather than out.

NIOSH: National Institute for Occupational Safety and Health

ODTS: Organic Dust Toxic Syndrome (same disease as humidifier fever; also referred to as silo unloader's disease and pulmonary mycotoxicosis). Illness characterized by chest tightness, flu-like symptoms, and possibly other symptoms following a single very heavy microbial exposure (including mold). Such extreme conditions are rarely found in homes, schools, or offices.

OSHA : Occupational Safety and Health Administration

PAPR: Powered air purifying respirator

PATHOGENIC: A microbe capable of causing disease by direct contact, typically through infection. The molds most often regarded as pathogenic are those most frequently known to cause opportunistic fungal infections, primarily among immune-compromised individuals (e.g., *Aspergillus fumigatus*). A microbe that produces toxins that cause disease in the absence of the microbe is not defined as pathogenic.

PHENOL COEFFICIENT: The ratio of the concentration of the product and the concentration of phenol required to kill certain bacteria in a specified time.

POROUS: Strictly defined, porous refers to the ability of a material to allow fluids to pass through (permeability to liquids or gases). For the purposes of this document, porous materials are items that absorb moisture (liquid water or humidity). Examples include wood products, paper products, fabric, carpet and pad, plasterboard, drywall, insulation, and ceiling tiles. In contrast, non-porous materials include Formica, vinyl, plastic, glass, some tile, metal and many other similar hard surfaced durable or sealed materials.

PPE: Personal Protective Equipment

PRESERVATIVE: A chemical agent or process that prevents deterioration of materials.

PROPAGULE: Particles that are capable of germinating and producing a colony (for example, mold spores or fragments of hyphae).

PROTECTIVE CLOTHING: garments worn by workers to keep gross contamination from contacting skin surfaces and reaching underlying clothing layers.

PROTOZOAN: any of a diverse group of eukaryotes, of the kingdom Protista, that are primarily unicellular, existing singly or aggregating into colonies, are usually nonphotosynthetic, and are often classified further into phyla according to their capacity for and means of motility, as by pseudopods, flagella, or cilia.

RELATIVE HUMIDITY (RH): A ratio quantifying the actual amount of water present in air to the maximum amount of water that air (at the same temperature) is capable of holding; this ratio is expressed as a percentage. Warmer air has a greater capacity to hold water in the vapor form than does cooler air.

REMEDIATE: Fix

REMEDIATION: The spectrum of measures intended to correct a problem and restore the environment to a useable state. For the purposes of this document, MDH regards mold remediation as any combination of activities which: a) remove indoor mold growth and mold-contaminated materials, b) eliminate and prevent excess moisture that allows growth, and c) rebuild or refurnish.

SANITATION: The process of reducing the number of organisms to safe levels as determined by public health requirements.

SANITIZER: One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a sanitizer when it reduces but does not necessarily eliminate all the microorganisms on a treated surface. To be a registered sanitizer, the test results for a product must show a reduction of at least 99.9% in the number of each test microorganism over the parallel control.

SENSITIZATION: Repeated or single exposure to an allergen that results in the exposed individual becoming hypersensitive to the allergen. :

SLIMICIDE: A chemical preparation that prevents, inhibits or destroys biological slimes composed of combinations of microorganisms.

SPECIES: The next most specific level of biological classification below genus. In the practice of naming mold, the species follows the genus and its first letter is always written in the lower case (e.g., fumigatus, in Aspergillus fumigatus).

SPORE: Molds reproduce by means of spores. Spores are microscopic; they vary in shape and size (2-100 micrometers). Spores may travel in several ways—they may be passively moved (by a breeze or waterdrop), mechanically disturbed (by a person or animal passing by), or actively discharged by the mold (usually under moist conditions or high humidity).

SPORICIDE: A chemical agent that destroys bacterial spores as well as vegetative forms of microorganisms.

“STAT” or “STATIC”: A suffix that means to stop growth of microorganisms without destruction.

STERILE: The condition of being free from all forms of life, especially microorganisms.

STERILIZATION: The process of effecting the complete destruction or removal of all forms of life.

STERILIZE: Kill or inactivate all microorganisms and destroy viruses.

STERILIZER (AKA SPORICIDE): One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a sterilizer when it destroys or eliminates all forms of bacteria, fungi, viruses, and their spores. Because spores are considered the most difficult form of a microorganism to destroy, EPA considers the term sporicide to be synonymous with "sterilizer."

STERILANT: A chemical agent intended to destroy all forms of life, including viruses, bacteria and fungi, and their spores, on inanimate surfaces.

SURFACTANT: A substance that, when dissolved in water, lowers the surface tension of the water and increases the solubility of organic compounds.

TAXONOMY: An orderly system for classifying and naming living organisms based upon how closely groups or individuals are related. See also GENUS and SPECIES.

TOXIC: Toxic refers to the inherent ability of a substance to cause harm to living cells or biological tissues.

TOXIGENIC: An organism that can produce one or more toxins. Examples of fungi that can produce toxins under certain conditions include the certain species of Aspergillus, Penicillium, Fusarium, Trichoderma, Memnoneniella, and Stachybotrys chartarum (note other species may also produce toxins).

USE-DILUTION METHOD: A laboratory test that measures whether a disinfectant product kills test bacteria on a standard hard surface.

VIABLE: Able to reproduce under appropriate conditions (the opposite of non-viable). Some mold testing methods only detect molds that will grow on the specific culture medium used--molds that are non-viable or don't grow on that medium will be missed. Some mold spores can remain viable for many years.

VIRUCIDE: A chemical product that destroys viruses.