Overview

Antimicrobial agents are used to kill or inhibit the growth of harmful microbes. Products containing these chemicals are routinely relied upon to ensure food and drug safety, prevent hospital-acquired infections (HAIs), and treat drinking and wastewater, in addition to various other industrial, commercial, and residential applications. Use of antimicrobial agents has also received recent increased attention as an effective infection control measure against SARS-CoV-2, the virus that causes COVID-19, and guidance regarding cleaning and disinfection has been developed by various agencies in response to the COVID-19 pandemic. Despite their important public health role, antimicrobial agents may also represent occupational health risks under certain exposure scenarios if not used as recommended. This document is intended to provide (1) an overview on chemical-based antimicrobial agents and (2) an outline of a strategy to evaluate and manage workplace exposures to antimicrobial agents.

Background

Microbes, such as viruses, bacteria, and fungi, are ubiquitous in the environment. Controlling these microbes is critical for inhibiting the spread of infectious diseases, preventing contamination of food and consumer products, and stopping the decomposition of materials. Antimicrobial agents and biocides are terms often used interchangeably to describe chemicals and other agents used to intentionally kill or inhibit the growth of harmful microbes. Products containing these chemicals are routinely applied in various industrial and commercial settings, such as healthcare facilities, food processing plants, pharmaceutical production facilities, commercial transportation vehicles (e.g., aircraft, trains), wastewater treatment facilities, in addition to residences. The selection and use of chemical-based antimicrobial products is a multifaceted process that should take into consideration factors including (1) regulatory framework, (2) product categories, and (3) intended use and application.

REGULATORY FRAMEWORK

Within the United States (U.S.), products containing antimicrobial agents are regulated primarily through two federal laws: (1) Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and (2) Federal Food, Drug, and Cosmetic Act (FFDCA). These acts establish a regulatory framework intended to ensure the safe use of antimicrobial agents in various applications including, but not limited to, surface treatment, production of food, pharmaceuticals and cosmetics, agricultural uses, and food processing. The U.S. Environmental Protection Agency (EPA) and U.S. Food and Drug Administration (FDA) have been charged with regulating antimicrobial agents based on their intended applications. In general, products used on inanimate objects are regulated by EPA as antimicrobial pesticides under FIFRA, whereas products used in or on living animals or humans are regulated by FDA under FFDCA. Additionally, there are a few applications where the federal agencies co-regulate antimicrobial use. Table 1 provides an overview of the roles of the EPA and FDA in regulating antimicrobial agents.
## Table 1: Overview of Regulatory Framework for Antimicrobial Agents in the United States*

<table>
<thead>
<tr>
<th>Federal Agency</th>
<th>Jurisdictions</th>
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</table>
| **Environmental Protection Agency (EPA)** | > Pre- and/or post-harvest field use on crops  
> Consumer use on raw agricultural commodities (e.g., home gardens, home produce washes)  
> Post-harvest use (field washing) of raw agricultural commodities  
> Animal drinking water  
> Treatment of permanent or semi-permanent food contact surfaces (sanitizers)  
> Production of food contact articles (excluding food packaging where antimicrobial is intended to have an ongoing effect on the article’s food contact surface or in food that may contact the article)  
> Use on inanimate environmental surfaces |
| **Food and Drug Administration (FDA)** | > Use in and on processed food  
> Water processing in a food processing facility where the water is only a vehicle for transporting the antimicrobial agent to the processed food  
> Use in and on living human or animal  
> Use in and on cosmetics  
> Use in and on beverages  
> Use in and on drugs  
> Use in and on animal feed  
> Use on medical devices |
| **EPA/FDA Joint Responsibility** | > Treatment of raw agricultural commodities in a food processing facility  
> Water processing in a food processing facility to control a pest in the water  
> Food packaging production  
> Production of food contact articles other than food packaging; no intended effect on the surface of the article |

*Adapted from EPA¹

Additionally, the U.S. Consumer Product Safety Commission (CPSC) regulates soap products if they are (1) composed primarily of alkali salts and fatty acids, (2) these are the only ingredients that result in the product’s cleaning action, and (3) the product is labeled and marketed only for use as soap². However, many products commonly referred to as soaps contain other ingredients that result in the products being regulated by the FDA. For example, if a product is intended for moisturizing the skin, providing a pleasant smell, deodorization, or if it contains synthetic detergents, it is regulated by the FDA as a cosmetic. In addition, if a product is intended to prevent disease by killing germs or to treat skin conditions, it is regulated by the FDA as a drug. Nevertheless, such products regulated by the FDA as cosmetics or drugs are still permitted to use the term ‘soap’ on labeling³.

### PRODUCT CATEGORIES

Chemical-based antimicrobial products are categorized according to their efficacy and intended use. Products applied to environmental surfaces are commonly categorized as sanitizers, disinfectants, or sterilizing agents, depending on the degree to which the product is intended to kill or otherwise control certain classes of microbes. For example, if the concern is focused on the elimination of all bacterial spores, use of a disinfectant may not be appropriate if such product is not deemed effective against bacterial spores. Understanding the key terminology associated with the different categories of antimicrobial agents is an important step in ensuring that these products are used effectively. Table 2, on page 3, summarizes key terminology associated with antimicrobial agents based on guidance issued by the EPA⁴, FDA⁵, Centers for Disease Control and Prevention (CDC)⁶, and others⁷.

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Table 2: Key Terminology and Intended Uses for Antimicrobial Agents

<table>
<thead>
<tr>
<th>Term</th>
<th>Intended Uses</th>
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<tbody>
<tr>
<td>Antiseptics</td>
<td>&gt; Intended for use on living tissue, such as the skin</td>
</tr>
<tr>
<td></td>
<td>&gt; Not intended for use on environmental surfaces</td>
</tr>
<tr>
<td></td>
<td>&gt; Includes products such as hand sanitizers and antiseptic wipes</td>
</tr>
<tr>
<td>Cleaners</td>
<td>&gt; Remove foreign material (e.g., soil and organic matter) from a surface</td>
</tr>
<tr>
<td></td>
<td>&gt; Do not necessarily kill microbes, but may remove them and thus, lower their numbers</td>
</tr>
<tr>
<td></td>
<td>&gt; Often used prior to surface disinfection</td>
</tr>
<tr>
<td>Cleaner-disinfectant</td>
<td>&gt; Show efficacy as a disinfectant in the presence of organic matter</td>
</tr>
<tr>
<td>Disinfectants</td>
<td>&gt; Destroy or irreversibly inactivate infectious bacteria, fungi and viruses, but not necessarily bacterial spores, in the inanimate environment</td>
</tr>
<tr>
<td>Sanitizers</td>
<td>&gt; Reduce, but not destroy or eliminate, bacterial population in the inanimate environment to levels considered safe as determined by public health codes or regulations</td>
</tr>
<tr>
<td>Sterilants</td>
<td>&gt; Destroy or eliminate all forms of microbial life in the inanimate environment, including all forms of vegetative bacteria, bacterial spores, fungi, fungal spores, and viruses</td>
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</tbody>
</table>

While the EPA and FDA provide guidance for understanding their respective responsibilities, navigating the regulatory framework associated with antimicrobial agents can still be challenging. For example, a single antimicrobial agent may be used in a healthcare facility as a sanitizer on cafeteria tables, as a disinfectant on patient room surfaces, and as a sterilant for medical instrumentation, with the differences in products often being simply the concentration, contact times, and instructions for use. Under such scenarios, the products would be subject to regulations established by both the EPA and FDA. Understanding regulatory responsibilities can also be particularly challenging in the agricultural and food processing industries. As one example, the EPA regulates antimicrobial agents used on food contact services, whereas the FDA regulates such agents when used on food itself. Further, there are several instances (e.g., food packaging production) where the EPA and FDA have joint responsibility. Guidance may also be issued by other governmental agencies that are applicable to a specific setting or application of antimicrobial agents. For example, the CDC has developed recommendations for cleaning, disinfection, and sterilization in healthcare settings. The CDC has also developed guidance documents specific to SARS-CoV-2 for cleaning and disinfection of public spaces, workplaces, businesses, schools, and households. The World Health Organization (WHO) has also recently released guidance titled Cleaning and Disinfection of Environmental Surfaces in the Context of COVID-19, related to both healthcare and non-healthcare settings. In summary, antimicrobial product regulation, categorization, and use setting are connected, and all three aspects need to be understood and considered for appropriate antimicrobial product selection.

**USE AND APPLICATION METHODS**

Appropriate selection and use of antimicrobial products is essential for such products to achieve their intended effectiveness in controlling harmful microbes. Although some antimicrobial agents are very versatile depending on the concentration and contact time, other chemistries are more limited in the types of microbes that are affected. Thus, consideration should be given to the microorganism(s) targeted when selecting antimicrobial products. Common antimicrobial agents include hypochlorites, chlorine dioxide, peracetic acid (PAA), quaternary ammonium compounds (QACs), hydrogen peroxide, alcohols, and aldehydes. In addition to their antimicrobial efficacy, any given chemistry may have advantages (e.g., not corrosive, low acute toxicity, low cost, fast acting, environmentally friendly) and disadvantages (e.g., corrosive, flammable, explosion hazard, adverse health effects) that need to be considered when selecting the most appropriate and effective product. Further, practical factors such as ease of use and product stability may be important considerations.

The EPA has issued multiple lists of registered antimicrobial products considered to be effective for specific end uses, such as a sterilant for medical waste treatment, and against specific pathogens, such as hepatitis B, norovirus, and Mycobacterium tuberculosis. Recently, under the EPA’s Emerging Viral Pathogen Guidance for Antimicrobial Pesticides, the agency has issued List N: Disinfectants for Use Against SARS-CoV-2 that identifies disinfectant products that have met the agency’s efficacy criteria and are anticipated to be effective against SARS-CoV-2.

Beyond product selection, antimicrobial agents will only be effective insofar as they are properly used. For EPA-registered disinfectants, the agency approves the product label and such products are required by law to be used in accordance with their label. Product labels specify, among other critical information, the appropriate dilutions, application instructions, and contact times. All disinfectants registered by the EPA must have a registration number displayed on their label, which can be used to acquire additional product information through the EPA website.

In addition to the typical application methods of wiping or spraying, other disinfection methods - including fumigation, fogging, and electrostatic spraying - have been investigated. These methods provide unique challenges to ensure both disinfection effectiveness and prevention of exposures. For instance, fumigation and fogging may allow for the disinfectant chemical to come into contact with otherwise difficult to reach room locations. However, it may be challenging to ensure sufficient contact time on all surfaces to achieve adequate disinfection. Further,
such applications may require additional ventilation or modifications to the existing ventilation system in order to prevent or mitigate exposures. Limited information may also be available on the effectiveness of fumigation, fogging, or novel application methods. Nevertheless, in all instances, antimicrobial products should be used in accordance with their approved product labels and instructions for use.

**SUMMARY**

Antimicrobial agents are a primary method to control harmful microbes and protect public health, and are therefore common in many industries and settings. Numerous chemistries and products are available to the consumer for selection and the EPA has developed lists of disinfection products specific to certain microorganisms, including SARS-CoV-2. As part of the proper selection and use of such products, a thorough understanding of the regulatory framework, categorization, intended use, and application instructions is necessary. This knowledge will ultimately contribute to the effectiveness of the antimicrobial products.

**Understanding the Risks Associated with Occupational Exposure to Antimicrobial Agents**

Despite the benefits of antimicrobial agents, the intrinsic properties that allow them to kill microbes also represent health hazards and potential health risks for individuals who encounter them in various settings. In particular, workers who interact directly with antimicrobial agents, such as through the mixing or application of such chemicals, are likely to have increased opportunities for exposure. Other workers may have indirect exposures by being in the vicinity during application or through touching surfaces that have been treated with antimicrobial agents. In order to ensure that such exposures are controlled, and to protect the safety and health of all individuals, it is important to understand the hazards of the various antimicrobial agents and develop comprehensive occupational risk management plans.

Like any chemical or non-chemical hazard found in the workplace, a comprehensive occupational safety and health program should include precautions to ensure that workers are not encountering conditions that are jeopardizing their safety or health when antimicrobial agents are in use. Figure 1 provides a list of critical considerations to aid in ensuring that the health risks of occupational exposures to antimicrobial agents are characterized and controlled. These considerations align with the primary steps in the human health risk assessment framework. Overall, these considerations are intended to aid in (1) identifying the critical health hazards of a product, (2) determining the exposure profiles for the workforce of interest, (3) selecting appropriate exposure recommendations, and (4) controlling workplace exposures.

**Figure 1 – Key Considerations in Protecting Workers from Antimicrobial Agents**

<table>
<thead>
<tr>
<th>Hazard Analysis</th>
<th>What is the hazard potential of the antimicrobial agent?</th>
<th>What are the primary health effects?</th>
<th>At what concentrations can these effects occur?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure Assessment</td>
<td>Which workers are exposed?</td>
<td>What is the exposure route (inhalation, dermal, multiple routes)?</td>
<td>What is their exposure profile (magnitude, frequency, duration)?</td>
</tr>
<tr>
<td>Risk Characterization</td>
<td>What is the metric by which risk is determined?</td>
<td>Are there occupational exposure limits (OELs) or other health-based exposure limits (HBEL) for agent(s) of interest?</td>
<td>Can an OEL or HBEL recommendation be established?</td>
</tr>
</tbody>
</table>
HAZARD ANALYSIS

A hazard analysis is conducted to characterize the type, nature, and severity of adverse health effects associated with exposures to a specific chemical or agent of concern. This process includes reviewing toxicology and epidemiology data, in addition to information pertaining to the physiochemical properties of a specific chemical. The Occupational Safety and Health Administration’s (OSHA) Hazard Communication Standard requires employers to maintain Safety Data Sheets (SDS), which include the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) hazard statements as well as chemical composition and toxicological information, among other relevant information. For chemicals, such as antimicrobial agents that are specifically designed to destroy or control harmful microbes, conducting a hazard analysis is a critical first step in ensuring the safety and health of workers.

To illustrate the usefulness of a hazard analysis, Table 3 provides a list of chemicals routinely used as antimicrobial agents and some of their associated adverse health effects. Exposures to these antimicrobial agents are associated with a wide range of adverse health effects including sensory irritation, corrosivity, and systemic toxicity (e.g., central nervous system (CNS) depression). These effects exhibit a threshold dose (exposure)-response indicating that (1) there is a dose below which no response is anticipated and (2) that severity of response increases with greater doses above the threshold. For these reasons, it is important to characterize not only the potential adverse health effects associated with a specific antimicrobial agent, but also the dose or concentration at which they occur. Antimicrobial products are often commercially available in concentrated solutions that are intended to be diluted and applied based on manufacturer product instructions. The concentrated and diluted solutions may exhibit different health effects based on the concentration of the active ingredient, and other factors such as exposure duration and frequency. For example, dermal contact with diluted solutions of glutaraldehyde may cause mild to moderate irritation, while concentrated solutions may cause corrosion. The outputs of a hazard analysis aid in (1) identifying workers at elevated health risk and (2) selecting risk management practices aimed at controlling exposures.

Table 3: Common Antimicrobial Agents and Potential Health Effects

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Potential Health Effects</th>
</tr>
</thead>
</table>
| Alcohols (ethanol, isopropanol) | > Central nervous system (CNS) depression  
> Dermal, ocular, and respiratory irritant  
> Acute respiratory failure at high concentrations  
> Developmental and reproductive toxicity (DART) |
| Aldehydes (glutaraldehyde, ortho-phthalaldehyde) | > Dermal and respiratory irritant  
> Dermal and respiratory sensitization (asthma)  
> Eye irritation and damage  
> Skin corrosion |
| Chlorine compounds [chlorine dioxide and hypochlorites (bleach)] | > Dermal and respiratory irritant  
> Eye irritation and damage  
> Acute lung damage (pulmonary edema)  
> Bronchitis |
| Phenolics (2-Phenylphenol, phenol) | > Dermal and respiratory irritant  
> Eye irritation and damage  
> Skin corrosion  
> DART |
| Peracetic acid (PAA) | > Sensory irritant  
> Dermal irritant |
| Hydrogen peroxide | > Dermal and respiratory irritant  
> Eye irritation and damage  
> Acute lung damage (pulmonary edema)  
> Skin corrosion |
| Quaternary ammonium compounds (QACs) | > Dermal and respiratory irritant  
> Eye irritation and damage  
> Skin corrosion  
> DART |

EXPOSURE ASSESSMENT

Exposure assessment is the process of characterizing the exposure profile(s) for chemicals. An understanding of the exposure profiles for antimicrobial agents allows for determinations to be made regarding the acceptability of those exposures and what controls may need to be put in place. Further, the potential exposures may be a determining factor in the selection of antimicrobial products, if it is determined that an alternative product would result in more acceptable exposures.

The exposure profile includes the route (e.g., inhalation, dermal), magnitude (i.e., concentration), frequency, and duration of exposures. As such, numerous exposure profiles likely exist within a given facility, even for the same antimicrobial agent. For example, a worker mixing a concentrated chemical in a storage room will likely have a different exposure profile than a worker spraying the same chemical on environmental surfaces in a large production area. Exposure profiles should not only be considered for the workers potentially exposed directly to antimicrobial agents, but also for others who may have indirect exposure such as from chemical residues on surfaces. Antimicrobial product handling and use instructions provided within the label and SDS are designed to eliminate exposures or control exposures to acceptable levels. Nevertheless, characterization of the exposure profiles allows for determination of the effectiveness of those work practices and controls in a particular workplace as well as allows for appropriate determinations regarding risk.

Characterizing the concentration of exposure may be particularly challenging for certain chemicals for which available exposure information is limited and that lack routine monitoring methodologies. In addition, some chemicals exist in solution with other chemicals, meaning that occupational risk management plans need to address both chemicals. For example, by its inherent chemistry, PAA is always found in solution with acetic acid and hydrogen peroxide. While sampling methods have been developed for the determination of air concentrations of both PAA and hydrogen peroxide, such methods can be complex and are limited in their ability to sample for extended durations. For such chemicals, it may be necessary to formulate occupational risk management plans based on conservative assumptions regarding exposures and an understanding of the chemistry.

RISK CHARACTERIZATION

The purpose of a risk characterization is to integrate information assembled from the hazard analysis and exposure assessment to determine the nature and magnitude of risk. For non-cancer effects, such as those anticipated with antimicrobial agents, including irritation, corrosivity, or systemic effects, the historical approach has been to compare health-based exposure limits (HBELs) against measured or estimated exposures. In the case of occupational risk assessments, these guidance values are typically represented by occupational exposure limits (OELs). Selection of the appropriate OEL for an antimicrobial agent is dependent on both the hazard potential of the chemical of interest and the exposure profile of workers. For example, in situations where workers are performing short duration tasks, use of a time-weighted average OEL may not be appropriate. Instead, the selection of a short-term exposure limit would allow for the characterization of exposures in a way that is more representative of the task.

Many chemicals do not have OELs and may require the use of alternative approaches to characterize risk. For example, HBELs developed for consumer or environmental uses, such as derived no effect levels (DNELs) or acute exposure guideline levels (AEGs), may be adapted to serve as occupational exposure recommendations. This process should be performed with caution to ensure that the resulting recommendations are health protective for workers and based on the latest available scientific information on the chemical. Another approach is occupational exposure banding (OEB) that sets exposure limit ranges based on hazard information without requiring full analyses of the data, as is done for OEL derivation. The National Institute for Occupational Safety and Health (NIOSH) has developed an OEB decision logic intended “to characterize chemical hazards so that timely, well-informed risk management decisions can be made for chemical substances that lack OELs.”

Application of this process results in chemicals being placed in hazard-based categories that communicate the potential health concerns. Overall, the risk characterization is intended to integrate the collected information and help inform risk management decisions on how to protect workers from the hazards of exposures to antimicrobial agents. It is an iterative process that can be updated as new data and recommendations are developed.

20ECHA. Guidance on Derivation of DNEL/DMEL from Human Data, DRAFT, Rev.2.1
Implications for Risk Management

Antimicrobial agents are the primary method for controlling the spread and growth of harmful microbes, including bacteria, fungi, and viruses. The selection and use of these products is complex and may be difficult to navigate due to the regulatory framework, which includes distinct terminology, labeling requirements, and multiple other factors. It can be expected that, with the increased awareness of viruses and other harmful microbes due to the COVID-19 pandemic, the use of antimicrobial agents will only increase, including potentially for industries and settings either where antimicrobial agents were previously not used or where use was limited. The misapplication or excessive use of antimicrobial products may result in workers being overexposed and experiencing unacceptable levels of health risks. Occupational safety and health professionals will play a critical role in both managing exposure and potential health risks associated with antimicrobial agents, as well as educating the growing number of workers, employers, and others who will likely be involved in the selection and use of these chemicals.

Numerous approaches have been developed for this purpose and can be readily applied to controlling workplace exposures for antimicrobial agents. The hierarchy of controls emphasizes the use of a systematic approach to implement feasible and effective control solutions such as (1) eliminating or substituting the hazard, (2) engineering controls intended to isolate workers from the hazard, (3) administrative controls that modify worker interaction with the hazard, and (4) the use of personal protective equipment (PPE). Figure 2 provides an overview of the hierarchy of controls including their relative effectiveness. Regardless of the approach that is applied to control workplace exposures to antimicrobial agents, it is necessary to do so according to occupational safety and health regulations, including those promulgated by OSHA. Relevant OSHA regulations pertaining to antimicrobial agents include those establishing OELs for specific chemicals and the Hazard Communication Standard.

Although the focus of this paper is on chemical-based antimicrobial agents, non-chemical-based antimicrobial agents and alternative technologies have been introduced in recent decades in response to multiple factors including increased focus on (1) product stewardship and sustainability efforts, (2) public and environmental health concerns associated with traditional antimicrobial agents and their application methods, and (3) scientific and technological advancements. For example, ultraviolet (UV-C) irradiation is routinely used to disinfect water and surfaces. Although it is often advertised as an alternative to chemical-based antimicrobial agents, the usefulness of UV-C in controlling harmful microbes must be weighed with its potential health risks, which include damage to the skin, eyes, and immune system. In addition, the use of UV lamps to irradiate surfaces may result in the generation of ozone from interactions with nitrogen oxides. Another example is the application of antimicrobial agents through fumigation or fogging. Historically, the use of these application methods has been questioned due to concerns about their efficacy because of the potential for limited contact (or kill) time and residues of deposited antimicrobial agents on surfaces. For example, the WHO does not recommend the use of fumigation or wide-area spraying to control spread of COVID-19. From an occupational health standpoint, use of these methods may result in increased exposures via the inhalation route and dermal contact with residues. Despite the differences of these alternative agents and application methods, the same occupational risk management framework described in this document can be used to evaluate the associated health effects, the dose-response relationship, exposure levels, and characterization of the risk.
Conclusion

Antimicrobial agents are essential tools in controlling harmful microbes and protecting public health. Use of antimicrobial products is common in numerous industries and their use is expected to grow with the heightened awareness surrounding COVID-19. As such, it is and will continue to be necessary that individuals charged with selection or use of antimicrobial products have a thorough understanding of the many relevant aspects of such products. These include the regulatory framework, product categories, and intended use and application. Further, the established risk assessment framework can be employed in order to characterize the risks associated with antimicrobial products and make informed decisions to protect worker health and safety.

RESOURCES

- American Industrial Hygiene Association (AIHA) https://www.aiha.org

- Centers for Disease Control and Prevention (CDC) https://www.cdc.gov/
  - Infection Control: Disinfection and Sterilization https://www.cdc.gov/infectioncontrol/guidelines/disinfection


- National Institute for Occupational Safety and Health (NIOSH) https://www.cdc.gov/niosh
  - Control Banding: https://www.cdc.gov/niosh/topics/ctrlbanding/default.html
  - Hierarchy of Controls: https://www.cdc.gov/niosh/topics/hierarchy/default.html

- NIOSH Pocket Guide to Chemical Hazards: https://www.cdc.gov/niosh/pocketguide/default.html
- Occupational Exposure Banding: https://www.cdc.gov/niosh/topics/control.html

> National Academy of Science (NAS)

> National Toxicology Program (NTP) https://ntp.niehs.nih.gov

- Occupational Safety and Health Administration (OSHA) https://www.osha.gov
  - Chemical Hazard and Toxic Substances: https://www.osha.gov/dsg/hazardoustoxicsubstances/control.html


- U.S. Environmental Protection Agency (EPA) https://www.epa.gov
  - Antimicrobial Pesticide Registration: https://www.epa.gov/pesticide-registration/antimicrobial-pesticide-registration
  - Emerging Viral Pathogen Guidance for Antimicrobial Pesticides: https://www.epa.gov/pesticide-registration/emerging-viral-pathogen-guidance-antimicrobial-pesticides
  - List N. Disinfectants for Use Against SARS-CoV-2: https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2
  - Pesticide Product and Label System: https://ofmpub.epa.gov/apex/pesticides/?p=PPLS:1
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