Biosafety Manual

Purpose and Scope

The Biosafety Manual establishes procedures, work practices, and control measures to protect West Chester University staff, students, and the community from exposure to biological agents used in research and teaching laboratories.

West Chester University does not conduct work at biosafety levels higher than BSL-2. BSL-3 and BSL-4 work involves agents that have potential for aerosol transmission and causing serious human illness or death. BSL-3 and BSL-4 work is conducted in facilities specifically designed for containment of these agents, and West Chester University does not have any facilities that would meet these requirements.

This manual is intended to provide general guidelines that support the agent-specific procedures and guidelines developed by the principal investigator or lab manager.

- For purposes of this manual the term biological agent includes:
- Microorganisms (bacteria, fungi, and parasites)
- Viruses
- Prions and other infectious agents
- Cultured cells
- Human blood, unfixed tissues, and potentially infectious body fluids
- Recombinant and synthetic nucleic acid molecules
- Biological toxins
- Animals infected with human pathogens, and animals as sources of zoonotic diseases

Responsibilities

Environmental Health and Safety

- Provide guidance on safe handling of biological agents and overall management of the Biosafety program.
- Conduct periodic inspections of laboratories to assess biosafety issues and make recommendations for improvement.
- Respond to and investigate incidents involving biological agents.
- Coordinate biological waste disposal.

Principal Investigator (PI) / Lab Manager

- Provide guidance on safe handling of biological agents and overall management of the Biosafety program.
- Conduct periodic inspections of laboratories to assess biosafety issues and make recommendations for improvement.
- Respond to and investigate incidents involving biological agents.
- Coordinate biological waste disposal.

Laboratory Personnel and Students

- Work with biological agents as outlined in the procedures section of this document and in the laboratory SOPs.
- Use control measures such as biological safety cabinets and personal protective equipment to prevent exposure to biological agents and contamination of personnel and facilities.
- Report unsafe laboratory conditions, incidents or near misses involving exposure, releases outside of containment, or other biosafety issues to the PI or lab manager.

Procedures

Approval of Research Protocols

Institutional Animal Care and Use Committee (IACUC)

The IACUC approves the use of biological agents in animal models.

Biological Risk Assessment

The principal investigator (PI) or instructor is responsible for conducting a risk assessment before work begins and when any change is introduced that may change the hazard or risk level. The risk assessment process includes identifying the risk group, biosafety level, and hazards associated with manipulations and equipment.

Consider biological and non-biological hazards when conducting a risk assessment, including aerosol generation from equipment or spills, use of sharps, exposure to low and high temperatures, ultraviolet radiation, and physical hazards such as rotational energy.

A template for conducting a biological risk assessment can be found in Appendix A. The following resources are available assist in conducting a risk assessment:

- CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (6th Edition)
- APHL Risk Assessment Best Practices

Standard Microbiological Practices

Standard microbiological practices are safety procedures to prevent mucous membrane exposure, ingestion, inhalation, or a release of a biological agent and are required for all BSL-1 and BSL-2 laboratories.

Laboratory Hygiene

- Do not store or consume food or drinks in the laboratory. Do not use or store appliances for food or drink (coffee makers, refrigerator, microwave) in the laboratory.
- Do not touch the face or eyes or apply cosmetics in the laboratory.
- Keep personal items away from areas where biological materials are manipulated or stored, including cell phones.
- Wash hands with running water and soap for 20-30 seconds:
    - After removing gloves.
    - Before leaving work area.
    - Anytime gloves or hands have become contaminated.

Sharps Management

- Never throw a needle, syringe, scalpel, razor blade, broken glass, or any other sharp in the regular trash.

- Do not recap, bend, or shear needles before disposal.
- If needles must be recapped, only use a one-handed method.
- Dispose of needles, syringes, scalpels, and razor blades in a puncture-resistant sharps container.
- Do not overfill sharps containers. There is a fill line on sharps containers to limit filling the container to ¾ capacity.
- Do not handle broken glassware directly, use tongs, forceps, or a brush and dustpan. Dispose of broken glass in a sharps container or other rigid container.
- Substitute safer alternatives to sharps and glass labware whenever possible (i.e., plastic pipettes, retractable scalpels, etc.).

Aerosol and Splash Control

- Perform all procedures that present an aerosol or splash risk in a biosafety cabinet.
- Minimize quantities and unnecessary handling of biological agents when feasible.
- Use safe work procedures to minimize aerosols or splashes when centrifuging, blending, sonicating, or pipetting.

Personal Protective Equipment and Laboratory Attire

- Specific personal protective equipment (PPE) is selected based on the risk assessment. General PPE practices include:
- Wear disposable nitrile gloves when working with biological agents.
    - Change gloves when contaminated or when glove integrity is compromised.
    - Do not wash or reuse disposable gloves.
- Wear a lab coat to prevent contamination of personal clothing.
- Wear eye protection when performing procedures that have the potential to create aerosols or splashes.
- Restrain long hair or loose, dangling clothing to prevent contamination.

General Controls

Additional biosafety and biosecurity controls include:

- Control access to laboratories and keep doors locked when no one is working in the laboratory.
- Do not prop laboratory doors open. In addition to keeping the lab more secure, closed doors help maintain the negative pressurization of the room.
- Post universal biohazard symbol with biosafety level and contact information for responsible person at entrance of laboratory.
- Do not bring animals or plants not associated with the work being performed into the laboratory.
- Implement an integrated pest management program.

Decontamination

- Decontamination methods include sterilization and disinfection. Sterilization procedures kill all microorganisms, and the most common method is steam sterilization (autoclaving). Disinfection eliminates or reduces microorganisms from objects and surfaces. Disinfection uses chemical disinfectants, such as 10% bleach or 70% ethanol.

- Use a disinfectant appropriate for agent. Not all disinfectants work for all agents. (See Appendix B for commonly used laboratory disinfectants.)
- Use freshly prepared disinfectant.
- Decontaminate work surfaces after completion of work and after a spill or splash.
- Decontaminate equipment prior to repair, maintenance, or removal from laboratory.
- Decontaminate cultures, stocks, and other potentially infectious materials before disposal.

Information and Training

All laboratory personnel must receive information and training necessary to minimize exposures and prevent injuries and illnesses:

- Train laboratory personnel on the potential hazards of the agents they will be working with, how to perform manipulations of infectious agents, the necessary controls and work practices to minimize exposures, and how to respond to exposures or spills.
- Train laboratory personnel when agents, equipment, procedures, or policies change.
- Provide laboratory personnel with information regarding the routes of exposure and the health effects associated with the agent(s). Personal health status may affect an individual's susceptibility to infection and/or ability to receive immunizations or prophylactic interventions. Encourage individuals with conditions that predispose them to increased risk for infection to seek guidance and counseling at the Student Health Center or Occupational Health Center.

Additional BSL-2 Practices

In addition to following the Standard Microbiological Practices, additional controls are required for BSL-2 work. The following additional work practices are required for BSL-2 work:

- Control access to the laboratory while work is being conducted.
- Provide laboratory personnel applicable and appropriate medical surveillance, and offer immunizations, if available, for agents they are working with.
- Perform work in certified biosafety cabinets (BSCs).
    - Biosafety cabinets are certified annually by an outside vendor.
    - Any work that cannot be performed in a BSC must be assessed and approved by the PI or lab manager.
    - Protect vacuum lines with liquid disinfectant traps and in-line HEPA filters. (See diagram in BSC section.)
- Decontaminate equipment that is used with BSL-2 agents routinely.
- Provide laundering services for re-usable lab coats.
- Report all incidents to the principal investigator and EHS immediately. Exposures or potential exposures are evaluated at the Occupational Health Center.
- Require laboratory personnel to demonstrate proficiency in standard microbiological practices and techniques for working with agents requiring BSL-2 containment.
- Post the biohazard warning symbol on all equipment that comes into contact with biological agents and on door to laboratory.

BSL-2 Facilities

BSL-2 laboratories must have the following elements:

- Self-closing and lockable doors
- Handwashing sink located near the exit
- Eyewash station
- Accessible and non-porous surfaces for cleaning and disinfection
- No carpets or rugs
- No fabric chairs
- Space between benches, cabinets, and equipment
- Inward flow of air (negative pressurization) is recommended
- Positioning of BSCs to prevent airflow disruptions from room air supply and away from high traffic areas

Biosafety Cabinets (BSCs)

Biosafety cabinets are the primary means of aerosol containment when working with biological agents. BSCs are designed to provide personnel, environmental, and product protection when used appropriately. BSCs are equipped with HEPA (high efficiency particulate air) filters to provide a clean working environment and prevent contamination of the laboratory environment.

Class II Type A1 & A2

- Recirculating BSCs that exhaust 30% of the HEPA filtered air back into the room.
- Cannot be used with chemicals.

Class II Type B1 & B2

- Connected to building exhaust system.
- Type B1 cabinets exhaust 70% of HEPA filtered air through building exhaust. The remaining 30% of filtered air is returned to the cabinet work area.
  - Small amounts of chemicals can be used in the back half of the cabinet.
- Type B2 cabinets exhaust 100% of HEPA filtered air through building exhaust.
  - Small amounts of chemicals can be used in cabinet.

BSC Operation

Before Use

- Raise the front sash to 8 or 10 inches as indicated on cabinet frame.
- Turn on BSC and fluorescent light and let run for 5-10 minutes.
- Wipe cabinet surfaces with disinfectant.
- Check magnehelic gauge to ensure it is within acceptable range.
- Place all necessary supplies in cabinet (pipettes, tips, waste bags, etc.).

During Use

- Arrange work surface from “clean” to “dirty” from left to right.
- Do not block front, side, or rear air grilles with materials.
- Avoid frequent motions in and out of the cabinet as this disrupts airflow balance and compromises containment.

After Use

- Leave cabinet running for 5-10 minutes after use.
- Empty cabinet of all research materials.
- Wipe cabinet surfaces with disinfectant.

BSC Certification and Decontamination

BSCs are certified by a third-party certification vendor managed by EHS. BSCs are certified:

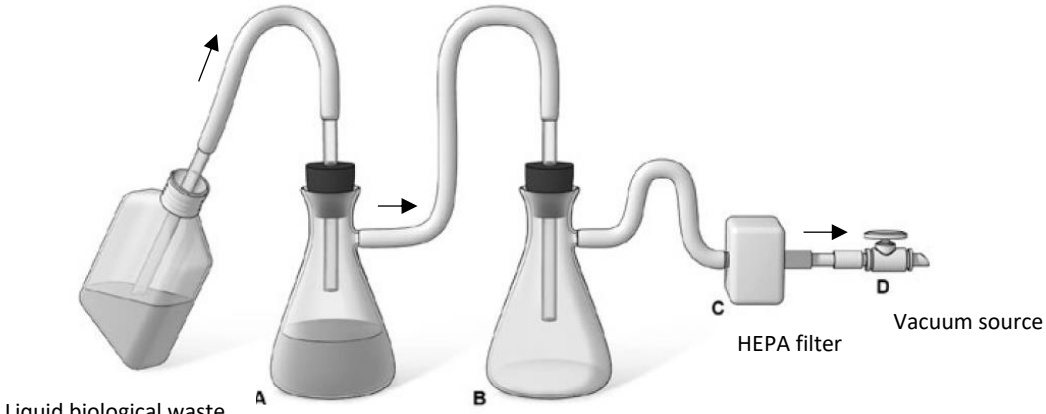
- Annually
- When a new cabinet is installed
- When a cabinet is moved
- When a cabinet is repaired

BSCs must be professionally decontaminated by the third-party certification vendor before moving the cabinet or before the cabinet is disposed of. Notify EHS prior to moving or disposing of a BSC.

Vacuum Line Protection

Protect vacuum lines with liquid disinfectant traps and in-line HEPA filters to protect central building vacuum system and the personnel who service this equipment.

The following diagram shows an example of vacuum system protection during aspiration of infectious fluids. The suction flask (A) is used to collect the contaminated fluids into a suitable disinfectant solution, the right flask (B) serves as a fluid overflow , an in-line HEPA filter (C) is used to protect the vacuum system (D) from aerosolized microorganisms. (Diagram adapted from *Biosafety in Microbiological and Biomedical Laboratories*, 6th edition.)



Ultraviolet (UV) Lights

UV lights are not recommended to decontaminate the BSC. UV lights are only effective if they are cleaned weekly to remove dust/dirt and checked periodically with a meter to ensure proper wavelength emission.

If UV lights are installed, they must be turned off whenever the room is occupied to protect from eye and skin burns.

Open Flames in BSC

Do not use continuous open flames (Bunsen burner) inside a BSC. Flames create temperature variations that cause turbulence that can disrupt the cabinet air flow patterns, possibly compromising containment. In addition, the heat generated from the flame may damage the HEPA filters or cause a fire. Use an alternative sterilizer, such as:

- Bacti-Cinerator
- Electric Bunsen Burner
- Glass Bead Sterilizer
- Fireboy Safety Bunsen Burner
- Argos StarFire Bunsen Burner

Biological Waste Management

Biological waste includes the following:

- Microbiological cultures and stocks
- Human blood, blood products, and cell cultures
- Any item used in recombinant DNA work
- Pathological wastes, including human tissues and organs
- Research animal waste, including contaminated carcasses, blood, secretions, excretions, and bedding
- Used sharps, including hypodermic needles, syringes (with or without needle), Pasteur pipettes, scalpel blades, blood vials, needles with attached tubing, culture dishes, suture needles, slides, cover slips, and broken glassware or plasticware that have been used in the manipulation of biological agents
- Waste created during the manipulation of biological agents, including media, serum, agar, consumables, gloves, etc.

Biological waste is managed by EHS. Contact EHS for disposal containers and to arrange for waste pick-up. Proper biological waste practices include:

- Place sharps in properly labeled sharps container or other leak-proof, puncture-resistant lidded container.
    - All syringes (with or without needles), needles, scalpels, and razor blades must be discarded in a sharps container
    - Do not fill sharps container above ¾ full
    - Do not recap syringes and scalpels prior to disposal
    - Do not autoclave chemically contaminated sharps. Label with “Chemical Contaminated Sharps DO NOT AUTOCLAVE.”
- Decontaminate liquid waste with a bleach solution and dispose of down the drain with copious amounts of water. Contact EHS for restrictions for drain disposal of other disinfectants.
    - Collect solid waste as follows:
    - Collect solid waste in biohazard bag.
    - When full, close and tape bag, and place in cardboard biohazard box.
    - Label the box with the date, type of waste, room number where waste was generated, and faculty name.

    - Contact EHS for pick-up.
- Do not discard any biological waste in the regular waste stream.
- Do not discard any item that can puncture a trash bag in the regular waste stream, including micropipette tips, serological pipets, and swabs/sticks. If non-infectious, place these items in a glass disposal box lined with a clear plastic bag.

Reviewed: ***May, 2022***

Appendix A: Biological Risk Assessment Template

Laboratory Contact Information	
PI Name and Contact Info (Email/ Cell Phone)	
Laboratory Location (Building/Room Number)	

Characteristics of the Agent	
Agent Name	
Risk Group (based on NIH definition).	☐**RG-1:** not known to be associated with human disease in healthy individuals ☐**RG-2:** known to be associated with human disease that is rarely serious, preventative or therapeutic interventions are typically available ☐**RG-3:** known to be associated with serious or lethal human disease, preventative or therapeutic interventions may or may not available
Agent Type	☐Bacteria ☐Protozoa ☐Prion ☐Virus ☐Archaea ☐Parasite ☐Algae ☐Human cells (primary and established cell lines or blood) and/ or human tissues ☐Human bodily fluids (saliva, urine, feces, CSF, etc.) ☐Non-human mammalian cells or tissues ☐Non-human non-mammalian cells or tissues ☐Recombinant Nucleic Acid Molecules
Agent/Strain/ Family and Source Information	
Permit Requirements	Are there any special permits/authorizations required for this agent? ☐Yes ☐No
Pathogenicity, Virulence, Infectious Dose (attenuated/standard/ more virulent, environmental stability, etc.)	

Biological Risks Associated with Agent	
Incubation Period (From exposure to onset of symptoms)	

Signs and Symptoms of Disease		
Host Range		
Routes of Exposure	☐Direct Contact ☐Mucous Membranes ☐Vertical Transmission ☐Aerosols/Inhalation ☐Contaminated Fomites	☐Percutaneous ☐Broken Skin ☐Animal Bites ☐Ingestion ☐Other - specify:

Laboratory Hazards and Handling Guidelines		
Recommended Laboratory BSL	☐BSL-1 ☐BSL-2 ☐BSL-2+ (BSL-2 with BSL-3 practices)	
Laboratory Hazards	☐Aerosol-generating procedures (centrifugation, sonication, high pressure systems, vortexing, tube cap popping) ☐Handling of sharps (needles and syringes, scalpels, microtome blades, broken glass, razor blades, etc.) ☐Splash-generating activities (pipetting, shaking incubators, liquid cultures) ☐Equipment contamination ☐Exposed skin/uncovered wounds ☐Other (specify):	
Prior known Laboratory Acquired Infections (LAIs)	☐Yes ☐No Prior LAIs documented:	
Risk Mitigation Options **(Potential alternative options to working with this agent)**		
Required Training	☐Bloodborne Pathogens ☐Radiation Safety ☐Laboratory Safety/Chemical Hygiene	☐Respiratory Protection ☐Other (Specify):
Lab Engineering Controls	☐Impervious bench top ☐Chemical fume hood ☐Centrifuge with lid, safety cups, other safety features	☐Biological Safety Cabinet - specify type: ☐Use of safety-engineered sharps - describe: ☐Other -specify:

Personal Protective Equipment (PPE)	☐Eye protection (specify): ☐Gloves (specify): ☐Lab coat- disposable, with cinch cuffs ☐Lab coat- cloth with cinch cuffs (no open cuffs) ☐Disposable solid-front lab gown ☐Protective Suit ☐Respirator (specify) ☐Shoe covers ☐Scrubs	☐Booties ☐Sleeve covers ☐Hair nets ☐Bonnets ☐Face shields ☐Safety Glasses ☐Goggles ☐Surgical masks

Decontamination and Disposal	
Disinfectants Appropriate for Equipment/ Benchtop	
Biological Safety Cabinet Decontamination	
Biohazardous Waste Decontamination	
Decontaminated biohazardous waste disposal	
Sharps Disposal	

Accidental Exposure and Spill Procedures	
Spills outside of biosafety cabinet	
Spills inside of biosafety cabinet	
Mucous membrane exposure	
Other exposures	
Incident Reporting	

Occupational Health	
Immunizations	☐Available ☐Not available
Prophylaxis (describe):	
Post-Exposure Treatment Options (Include contraindications for pre- or post-exposure prophylaxis)	
At-Risk Personnel (High-risk populations)	

Biosafety Level Containment Requirements	
Personal Hygiene	
Standard Microbiological Practices	
Special Practices	
Waste Guidance	

Transportation and Storage of Agent	
Transport of Agent	☐Transporting between laboratory rooms or buildings: ☐Transporting from off-campus or to an off-campus location:
Storage of Agent	

Other Hazards and Risk Mitigation	
Chemical Hazards	
Temperature Hazards	
Mechanical/Physical Hazards	
Other Hazards	

Appendix B: Disinfectant Selection

Disinfectant selection is based on several factors:

- What is the target organism that you wish to inactivate?
- What are the physical characteristics of the surface which will be disinfected? (porous surfaces may absorb disinfectants, some disinfectants may corrode metal surfaces)
- How long will the contact time be between the disinfectant and the target organism? (high concentrations of biological organisms may require longer contact times)

Types of Disinfectants

The following list of disinfectants, their efficiencies, contact times and recommended dilutions are general guidelines, please follow specific manufacturer's recommendations if available.

Quaternary Ammonium Compounds are commonly used in floor cleaning solutions. Quaternary ammonium compounds are effective in inactivating most vegetative bacteria, fungi, and lipid containing viruses. Quaternary ammonium compounds are NOT effective when used to disinfect Mycobacterium tuberculosis (TB), bacterial spores, and many viruses such as HBV.

- Recommended Contact Time: 10 minutes
- Recommended Working Dilution: 0.1-2.0%
- Recommended for: Cleaning optical instruments and administrative areas in the vicinity of a laboratory.

Ethanol is commonly used on equipment whose surfaces are susceptible for corrosion if other disinfectants are applied. Ethyl alcohol is effective in inactivating most vegetative bacteria, fungi, and lipid containing viruses. Ethanol is NOT effective when used to disinfect HBV, Mycobacterium tuberculosis (TB) and bacterial spores.

- Recommended Contact Time: 10 minutes
- Recommended Working Dilution: 70-85%
- Recommended for: Stainless steel surfaces. CAUTION: Do not use 70% ethanol to clean a Class II, type A recirculating biosafety cabinet. The vapors from ethanol are flammable and the lower explosive limit (LEL) for ethanol is easily attained.

Phenolics are commonly used to decontaminate surfaces such as lab bench tops. Phenolics are effective in inactivating vegetative bacteria, fungi, TB, lipid containing viruses and have some effect on HBV. However, phenolics will not inactivate bacterial spores.

- Recommended Contact Time: 10 minutes
- Recommended Working Dilution: 1.0-5.0%
- Recommended for: An alternative to bleach as a broad-spectrum disinfectant for bench tops, floors, and metal surfaces. Phenolics will not corrode metal surfaces as readily as bleach

Iodine-containing compounds or iodophors are commonly used to decontaminate metal surfaces or equipment. Iodophors are effective in inactivating vegetative bacteria, fungi, TB and lipid containing viruses and have some effect on HBV. However, iodophors will not inactivate bacterial spores.

- Recommended Contact Time: 10 minutes
- Recommended Working Dilution: 25-1600 ppm, 0.47%
- Recommended for: Biosafety cabinets, bench tops, floors, and lab equipment.

Chlorine (hypochlorite) compounds are effective in inactivating vegetative bacteria, fungi, lipid and non-lipid viruses, Coxiella burnetii and TB. Chlorine compounds have some effect in inactivating bacterial

spores. *Note: Bleach is not stable at dilute concentrations. Working dilutions of sodium hypochlorite should be made at least weekly from a stock solution.*

- Recommended Contact Time: 30 minutes
- Recommended Working Dilution: 500 ppm (1:10 dilution of household bleach and water)
- Recommended for: Floors, spills (inactivating liquid specimens), bench tops and contaminated clothing. Do not use bleach on electronic equipment, optical equipment, or unpainted stainless steel. Undiluted bleach and other disinfectants must not go down the drain.

Paraformaldehyde and formaldehyde are often used to decontaminate large pieces of laboratory equipment, such as biosafety cabinets. The approved biosafety cabinet contractor will use paraformaldehyde to decontaminate your biosafety cabinet prior to changing the HEPA filters.

Paraformaldehyde/formaldehyde will inactivate vegetative bacteria, fungi, lipid and non-lipid viruses, HBV, TB, Coxiella burnetii, and bacterial spores.

Paraformaldehyde and formaldehyde are toxic and must be used in a fume hood with appropriate personal protective equipment. Do not use paraformaldehyde or formaldehyde in the lab to decontaminate equipment.

The following table from the Iowa State University Center for Food Security and Public Health provides a summary of disinfectants and their characteristics:

Characteristics of Selected Disinfectants

This table provides general information for each disinfectant chemical classes. Antimicrobial activity may vary with formulation and concentration. Always read and follow the product label for proper preparation and application directions.

Disinfectant Category	Alcohols	Alkalis	Aldehydes	Oxidizing Agents: Halogens: Chlorine	Oxidizing Agents: Halogens: Iodine	Oxidizing Agents: Peroxygen Compounds	Phenols	Quaternary Ammonium Compounds
Common Active Ingredients	ethanol, isopropanol	calcium hydroxide, sodium carbonate, calcium oxide	formaldehyde, glutaraldehyde, ortho-phthalaldehyde,	sodium hypochlorite (bleach), calcium hypochlorite, chlorine dioxide	povidone-iodine	hydrogen peroxide/ accelerated HP, peracetic acid, potassium peroxymonosulfate	ortho-phenylphenol, orthobenzylpara-chlorophenol	benzalkonium chloride, alkyldimethyl ammonium chloride
Sample Trade Names*			*Synergize®*	*Clorox®, Wysiwash®*		*Rescue®, Oxy-Sept 333®, Virkon-S®*	*One-Stroke Environ®, Pheno-Tek II®, Tek-Trol®, Lysol®*	*Roccal-D®, DiQuat®, D-256®*
Mechanism of Action	Precipitates proteins; denatures lipids	Alters pH through hydroxyl ions; fat saponification	Denatures proteins; alkylates nucleic acids	Denatures proteins	Denatures proteins	Denature proteins and lipids	Denatures proteins; disrupts cell wall	Denatures proteins; binds phospholipids of cell membrane
Characteristics	• Fast acting • Rapid evaporation • Leaves no residue • Can swell or harden rubber and plastics	• Slow acting • Affected by pH • Best at high temps • Corrosive to metals • Severe skin burns; mucous membrane irritation • Environmental hazard	• Slow acting • Affected by pH and temperature • Irritation of skin/ mucous membrane • Only use in well ventilated areas • Pungent odor • Noncorrosive	• Fast acting • Affected by pH • Frequent application • Inactivated by UV radiation • Corrodes metals, rubber, fabrics, • Mucous membrane irritation	• Stable in storage • Affected by pH • Requires frequent application • Corrosive • Stains clothes and treated surfaces	• Fast acting • May damage some metals (e.g., lead, copper, brass, zinc) • Powdered form may cause mucous membrane irritation • Low toxicity at lower concentrations • Environmentally friendly	• Can leave residual film on surfaces • Can damage rubber, plastic; non-corrosive • Stable in storage • Irritation to skin and eyes	• Stable in storage • Best at neutral or alkaline pH • Effective at high temps • High concentrations corrosive to metals • Irritation to skin, eyes, and respiratory tract
Precautions	Flammable	Very caustic	Carcinogenic	Toxic gas released if mixed with strong acids or ammonia			May be toxic to animals, especially cats and pigs	
Bactericidal	+	+	+	+	+	+	+	+
Virucidal	±[a]	+	±	+	+	+	+	+ Enveloped
Fungicidal	+	+	+	+	+	±	+	+
Tuberculocidal	+	±	+	+	+	±	+	–
Sporicidal	–	+	+	+	±	+	–	+
Factors Affecting Effectiveness	Inactivated by organic matter	Variable	Inactivated by organic matter, hard water, soaps and detergents	Rapidly inactivated by organic matter	Rapidly inactivated by organic matter	Effective in presence of organic matter, hard water, soaps, and detergents	Effective in presence of organic matter, hard water, soaps,and detergents	Inactivated by organic matter, hard water, soaps and anionic detergents

+ = effective; ± = variable or limited activity; – = not effective a - slow acting against nonenveloped viruses (e.g., norovirus)

*Disclaimer: The use of trade names serves only as examples and does not in any way signify endorsement of a particular product.

References: Fraise AP, Lambert PA et al. (eds). *Russell, Hugo & Ayliffe's Principles and Practice of Disinfection, Preservation and Sterilization*, 5th ed. 2013. Ames, IA: Wiley-Blackwell; McDonnell GE. *Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance*. 2007. ASM Press, Washington DC. Rutala WA, Weber DJ. Healthcare Infection Control Practices Advisory Committee (HICPAC). 2008. Guideline for disinfection and sterilization in healthcare facilities. Available at: *http://www.cdc.gov/hicpac/Disinfection_Sterilization/toc.html*; Quinn PJ, Markey FC et al. (eds). *Veterinary Microbiology and Microbial Disease*. 2nd ed. 2011. West Sussex, UK: Wiley-Blackwell, pp 851-889.

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