Selection and Use of Chemical Disinfectants

Alcohols (ethanol, isopropanol)
Ethanol or isopropanol in concentrations of 70% - 95% are good general-use disinfectants. They are most effective against lipophilic viruses, less effective against non-lipid viruses, and ineffective against bacterial spores. Because of their quick evaporation rate, it may be difficult to achieve sufficient contact time.

Chlorine compounds (household bleach – 5.25% sodium hypochlorite)
Chlorine-containing solutions have universal disinfectant activity. With proper concentration and sufficient contact times, hypochlorite solutions can be considered chemical sterilants since they will inactivate bacterial spores. The downside is that chlorine compounds are quickly inactivated by excess organic materials and are corrosive to metals and tissues. Consequently their use in labs has some limitations.

In solutions of 50-500 ppm available chlorine, they are effective against vegetative bacteria and most viruses. Bacterial spores require concentrations of 2500 ppm with extended exposure time. Household bleach (5.25% sodium hypochlorite) diluted 1:100 with water yields a disinfectant solution containing to 525 ppm available chlorine; a 1:10 dilution yields 5000 ppm available chlorine. Since the free chlorine is inactivated by light and air, disinfectant chlorine solutions are best made fresh before use.

Formalin
Formalin is a 37% solution of formaldehyde gas in water. Diluted to 5% formaldehyde it is an effective disinfectant; at 0.2% - 0.4% it can inactivate bacteria and viruses. Unlike chlorine, formalin does not corrode stainless steel. It has a pungent, irritating odor; exposures must be limited due to its toxicity and carcinogenicity.

Glutaraldehydes
These agents are closely related to formaldehyde but seem to be more biologically active. Glutaraldehydes are effective against all types of bacteria, fungi, and viruses. With sufficient contact time they kill bacterial spores. While glutaraldehyde vapors are less irritating than formaldehyde (formalin), they remain irritating to the eyes, mucous membranes, and upper respiratory tract. Exposures should be minimized by confining use to a properly functioning chemical fume hood.

Phenols
Phenol solutions have been used for many years as a disinfectant. Their usefulness in laboratories is limited, however, because they leave a sticky residue on surfaces following treatment. Concentrated phenol is a highly toxic, corrosive substance that is easily absorbed through the skin. Use of appropriate personal protective equipment is essential.

Please see the following tables for helpful information on selection of chemical disinfectants for use on specific biological agents.

Hazardous Characteristics of Chemical Disinfectants

Disinfectant	**Significant Characteristics**									
Liquid	Effective Shelf Life >1week[1]	Corr	Flam	Residue	Inactivated by organic Matter	Compatible For Optics[2]	Skin Irritant	Eye Irritant	Respiratory Irritant	Toxic[3]
Quat. Ammon. Cpds	Y				Y	Y	Y	Y		Y
Phenolic Cpds	Y	Y		Y			Y	Y		Y
Chlorine Cpds		Y		Y	Y		Y	Y	Y	Y
Iodophor	Y	Y		Y	Y		Y	Y		Y
Ethyl Alcohol	Y		Y					Y		Y
Isopropyl Alcohol	Y		Y					Y		Y
Formaldehyde	Y			Y			Y	Y	Y	Y
Glutaraldehyde	Y			Y		Y	Y	Y	Y	Y

[1] Protected from light and air.
[2] Usually compatible, but consider interference from residues and effects on associated materials such as mounting.
[3] By skin or mouth, or both. See manufacturer’s literature and the Material Safety Data Sheet.

Inactivation Properties of Chemical Disinfectants

Disinfectant		Practical Requirements		Inactivates				
Liquid	Use Dilution	Contact Time		Vegetative Bacteria	Lipoviruses	Nonlipid Viruses	Mycobacteria	Bacterial Spores
		Lipovirus	Broad Spectrum					
Quat. Ammno. Cpds	0.1% - 2.0%	10	NE	Y	Y			
Phenolic Cpds	1.0% - 5.0%	10	NE	Y	Y	[1]		
Chlorine Cpds	500 ppm [2]	10	30	Y	Y	Y	Y	Y [3]
Iodophor	25 – 1600 ppm [2]	10	30	Y	Y	Y		
Ethyl Alcohol	70% - 85%	10	30	Y	Y	[1]		
Isopropyl Alcohol	70% - 85%	10	30	Y	Y	[1]		
Formaldehyde	0.2% - 8.0%	10	30	Y	Y	Y	Y	Y
Glutaraldehyde	2%	10	30	Y	Y	Y	Y	Y

NE = not effective
[1] Variable results dependent on virus
[2] Available halogen (1:100)
[3] Bacterial spores require 5000 ppm available chlorine (1:10)

Applicability of Chemical Disinfectants for Common Surfaces

Disinfectant	**Potential Applications**									
Liquid	Work Surface	Dirty Glassware	Large Area Decon	Portable Equip. Surface	Portable Equip. Penetrating	Fixed Equip. Surface	Fixed Equip. Penetrating	Optical & Electronic Instruments	Liquids for Discard	Books Papers
Quat. Ammno. Cpds	Y	Y		Y		Y				
Phenolic Cpds	Y	Y		Y		Y				
Chlorine Cpds	Y	Y		Y		Y			Y	
Iodophor	Y	Y		Y		Y				
Ethyl Alcohol	Y	Y		Y		Y				
Isopropyl Alcohol	Y	Y		Y		Y				
Formaldehyde	Y	Y		Y		Y				
Glutaraldehyde	Y	Y		Y		Y				

Decontamination Methods for Prions

The safest and most unambiguous method for ensuring that there is no risk of residual prion infectivity is to discard and destroy contaminated materials by incineration. Instruments that will be reused should be kept moist between the time of exposure to prions and subsequent decontamination and cleaning.

Current research indicates that inactivation of prions may be achieved by applying one of the following methods:

Liquid Wastes

- Mix with NaOH for a final concentration of 1.0 N NaOH and hold for 24 hours. Neutralize and dispose of down the drain or hold for chemical waste disposal.
- Autoclave at 132^{o}C for 4½ hours and dispose of down the drain.

Heat Resistant Instruments

- Soak in 2.0 N NaOH for 1 hour (or 1.0 N NaOH for 2 hours). Rinse and autoclave autoclave at 134^{o}C for 1 hour.
- Immerse in 1.0 N NaOH and autoclave at 121^{o}C for 30 min. Clean and rinse.
- Soak in 1.0 N NaOH (or full-strength household bleach) for 1 hour. Rinse and place open pan, covering with water if desired. Autoclave at 121^{o}C for 1 hour.
- Immerse in 1.0 N NaOH and boil for 10 min. Clean and rinse.
- Immerse in full-strength household bleach (or 1.0 N NaOH) for 1 hour. Clean and rinse.
- Autoclave at 132^{o}C for 4½ hours.

Surfaces and Heat Sensitive Instruments

- Flood with 2.0 N NaOH or full-strength household bleach and let stand for 1 hour. Mop up and rinse with water.
- Clean with 1.0 N NaOH allowing a 5 minute contact time, followed by a wipedown with 1.0 N HCl. Rinse with water.
- Where surfaces cannot tolerate the proceeding methods, thorough cleaning will remove most infectivity by dilution and some additional benefit may be derived from the use of one or another of the partially effective methods listed in the table below.

Dry Materials, Dry Waste, Sharps

- Heat in porous load autoclave at 134^{o}C for 1 hour.
- Autoclave at 132^{o}C for 4½ hours.
- Identify container with label reading “Prion-Contaminated– For Incineration Only”. Arrange for pick-up and final destruction by incineration.

Contaminated Skin Surfaces and Splashes to the Eye

- Swab skin with 1.0 N NaOH for 5 minutes. Rinse with copious amounts of water.
- Eyes are rinsed with copious amounts of water or saline *only*.

Ineffective or Sub-Optimal Prion Disinfection Methods

Chemical Disinfectants	Gaseous Disinfectants	Physical Processes
Ineffective Alcohol Ammonia β-propiolactone Formalin Hydrochloric acid Peracetic acid Phenolics Sodium dodecyl sulfate (SDS) (5%) **Variably or Partially Effective** Chlorine dioxide Glutaraldehyde Guanidinium thiocynate (4 M) Iodophores Sodium dichloro-isocynaurate Sodium metaperiodate Urea (6 M)	**Ineffective** Ethylene oxide Formaldehyde	**Ineffective** Boiling Dry heat (<300°C) **Variably or Partially Effective** Autoclaving at 121°C for 15 minutes Boiling in sodium dodecyl sulfate (SDS) (3%)