

## *Disinfectants and antiseptics*

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## *Disinfectants and antiseptics*

- These agents exhibit little or no selective toxicity.
- Most of them are toxic not only for microbial parasites but also for cells.
- They may be used topically to reduce microbial population in inanimate environment.

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## Definitions

- **Disinfectant:** A substance that kills microorganisms in the inanimate environment.
- **Antiseptic:** Substances that inhibit bacterial growth both in vitro and in vivo when applied to the surface of living tissue under suitable conditions of contact.

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**Table 50–2.** Commonly used terms related to chemical and physical killing of microorganisms.

<b>Antisepsis</b>	Application of an agent to living tissue for the purpose of preventing infection
<b>Decontamination</b>	Destruction or marked reduction in number or activity of microorganisms
<b>Disinfection</b>	Chemical or physical treatment that destroys most vegetative microbes or viruses, but not spores, in or on inanimate surfaces
<b>Sanitization</b>	Reduction of microbial load on an inanimate surface to a level considered acceptable for public health purposes
<b>Sterilization</b>	A process intended to kill or remove all types of microorganisms, including spores, and usually including viruses with an acceptable low probability of survival
<b>Pasteurization</b>	A process that kills nonsporulating microorganisms by hot water or steam at 65–100 °C

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## *Ideal disinfectant*

Ideally disinfectants should be:

- Lethal to microorganisms in high dilution
- Noninjurious to tissues or inanimate substances
- Inexpensive
- Stable, nonstaining, odorless
- Rapid-acting even in the presence of foreign proteins, exudates or fibers.

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## *Alcohols*

- Aliphatic alcohols are antimicrobial in varying degree by denaturing protein.
- **Ethanol** in 70% concentration is bactericidal in 1-2 minutes at 30 °C but less effective at lower and higher concentration.
- **Isopropanol 90%** along with **ethanol 70%** are the most satisfactory general antiseptics for skin surfaces however they have no effect on spores.

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### *Alcohols (continued)*

- Better agents are now available for sterilizing instruments.
- Aerosols of 70% alcohol with 1  $\mu\text{m}$  size droplets may be effective disinfectants for mechanical respirators.

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### *Aldehydes*

- **Formaldehyde** in concentration of 1-10% effectively kills microorganisms and their spores in 1-6 hours. It acts by combining with and precipitating protein. It is too irritating for use on tissues but widely used as a disinfectant for instruments.
- It is used in 37% formaldehyde in methyl alcohol by mass solution added to prevent polymerization.
- **Methenamine** taken orally releases formaldehyde into acidic urine.

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### *Aldehydes (continued)*

- **Glutaraldehyde** as a 2% alkaline solution in 70% isopropanol (pH 7.5-8.5) serves as a lipid disinfectant for instruments and for some prosthetic materials.
- It kills viable microorganisms in 10 minutes and spores in 3-10 hours, but the solution is unstable, and tissue contact must be avoided.

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### *Acids*

- **Boric acid** 5% in water or as powder can be applied to skin lesions, but is toxic.
- Esters of benzoic acid (**parabens**) are used as antimicrobial preservatives of some drugs.

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### **Acids (continued)**

- **Acetic acid** 1% can be used in surgical dressings as a topical antimicrobial agent. 0.25-2% acetic acid is used as an antimicrobial agent, in external ear and for irrigation of lower urinary track. It is particularly effective against aerobic Gram-negative bacteria such as *Pseudomonas*.
- **Salicylic**, and **undecylenic** and other fatty acids can serve as antifungicides on the skin.

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### **Halogens and halogen containing compounds**

- **Iodine:** 1:20000 solution of iodine kills bacteria in 1 minute and spores in 15 minutes. Tincture of iodine contains 2% iodine and 2.4% sodium iodide in alcohol.
- It is the most powerful antiseptic for intact skin, but not commonly used because of serious hypersensitivity reactions, irritant effects and its staining of clothing and dressings.

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## *Iodophores*

- **Iodophores (povidine-iodine):** They are iodine complexes and release free iodine as the solution is diluted.
- Iodophores retain the activity of iodine. They kill vegetable bacteria, fungi and lipid containing viruses. They may be sporocidal upon prolonged exposure.
- Iodophores are less irritating and less likely to produce skin hypersensitivity than tincture of iodine.

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## *Chlorine*

- Chlorine is a strong oxidizing agent and universal disinfectant that is most commonly provided as a 5.25% **sodium hypochlorite** solution.
- Thus 1:10 dilution provides 5000 ppm of available chlorine; this concentration is recommended for disinfection of blood spills.

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## Chlorine (continued)

- Less than 5 ppm kills vegetative bacteria whereas 5000 ppm is necessary to kill the spores. It can also kill *Mycobacteria* (1000-10000 ppm) and vegetative fungal cells (100 ppm), and fungal spores (500 ppm).
- Because chlorine is inactivated by blood serum, feces and protein containing materials, surfaces, should be cleaned before use.
- Alternative chlorine-releasing compounds include **chlorine dioxide** and **chloramineT**.

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## Chlorhexidine

- Chlorhexidine is a cationic biguanide with very low water solubility.
- It is active against vegetative bacteria, and *Mycobacteria* and has moderate activity against fungi and viruses.
- It strongly absorbs to bacterial membranes causing leakage of small molecules and precipitation of cytoplasmic proteins.

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### ***Chlorhexidine (continued)***

- It is most effective against Gram-positive cocci and less active against Gram-positive and Gram-negative rods.
- It has formulations 2-4%.
- Oral activity is low because of poor absorption.
- It has neurotoxicity when applied topically in middle ear surgery and neurosurgery.

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### ***Phenolics***

- Phenol itself is no longer used because of its corrosive effect on tissues, its toxicity upon absorption and its carcinogenic effect.
- Derivatives which has diminished adverse effects are used such as **o-phenylphenol**, **o-benzyl-p-chlorophenol** and **p-tertiary-amyphenol**.
- Detergents are often added to formulations to clean and remove organic material that may decrease the activity of a phenolic compound.

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### ***Phenolics (continued)***

- Phenolic compounds disrupt cell wall and membranes, precipitate proteins, and inactivate enzymes.
- They are bactericidal, fungicidal and capable of inactivating lipophilic viruses. They are not sporicidal.
- Phenolic compounds are used for hard surface decontamination in hospitals and laboratories.

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### ***Peroxygen compounds***

- Hydrogen peroxide and peracetic acid have high killing activity and a broad spectrum against bacteria, spores, viruses, and fungi when used in appropriate concentration.
- 10-25% concentrations of hydrogen peroxide are sporicidal.

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### *Peroxygen compounds (continued)*

- Peracetic acid is more active than hydrogen peroxide as a bactericidal and sporicidal agent.
- Concentrations of 250-500 ppm are effective against broad range of bacteria in 5 minutes. Bacterial spores are inactivated by 500-30000 ppm.
- Only slightly increased concentrations are necessary in the presence of organic matter.
- Enteroviruses require 2000 ppm for 15-30 min. for inactivation.

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### *Heavy metals*

- Heavy metals, principally **mercury** and **silver** are rarely used as disinfectant the moment.
- **Silver sulfadiazine** slowly releases silver and is used to suppress bacterial growth in burn wounds.

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## Disinfectants

Table 50-1. Activities of disinfectants.

	Bacteria				Viruses		Other		
	Gram-positive	Gram-negative	Acid-fast	Spores	Lipophilic	Hydrophilic	Fungi	Amebic Cysts	Prions
Alcohols (isopropanol, ethanol)	HS	HS	S	R	S	V	—	—	R
Aldehydes (glutaraldehyde, formaldehyde)	HS	HS	MS	S (slow)	S	MS	S	—	R
Chlorhexidine gluconate	HS	MS	R	R	V	R	—	—	R
Sodium hypochlorite, chlorine dioxide	HS	HS	MS	S (pH 7.6)	S	S (at high conc)	MS	S	MS (at high conc)
Hexachlorophene	S (slow)	R	R	R	R	R	R	R	R
Povidone, iodine	HS	HS	S	S (at high conc)	S	R	S	S	R
Phenols, quaternary ammonium compounds	HS	HS	±	R	S	R	—	—	R
Strong oxidizing agents, cresols	HS	MS to R	R	R	S	R	R	R	R

Key: HS, highly susceptible; S, susceptible; MS, moderately susceptible; R, resistant; V, variable; —, no data.

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## Sterilants

- Pressurized steam (autoclaving) at 120 °C for 30 minutes has been the basic method for sterilizing instruments and decontaminating materials.
- If autoclaving is not possible **ethylene oxide** is used, but this agent is explosive, mutagen and carcinogen.

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*Thank you...*

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