Chemical disinfectants, antiseptics and preservatives


Dsinfectant was first introduced by **Joseph Lister** who introduced "carbolic acid" (phenol) in the 1880's. Today disinfectants are widely used in the health care, food and pharmaceutical sectors to prevent unwanted microorganisms from causing disease.

Disinfection is the process of removing microorganisms including pathogenic ones from the surface of inanimate objects. The British Standards Institution further defines disinfection as not necessarily killing all microorganisms, but reducing them to a level acceptable for a defined purpose, for example, a level which is harmful neither to health nor to the quality of perishable goods.

Disinfectants are substances that are applied to non-living objects to destroy microorganisms.

Comparison of disinfectant with other methods:

With sterilization method:

Disinfection does not necessarily kill all microorganisms, especially resistant bacterial spores; it is less effective than sterilization, which is an extreme physical and/or chemical process that kills all types of life.

With antibiotics and antiseptics:

Disinfectants are different from other antimicrobial agents such as antibiotics, which destroy microorganisms within the body, and antiseptics, which destroy microorganisms on living tissue. Antiseptics are the chemicals applied to skin and mucous membranes, therefore as well as having adequate antimicrobial activity they must not be toxic or irritating for skin. Antiseptics are mostly used to reduce the microbial population on the skin before surgery or on the hands to help

prevent spread of infection by this route. Antiseptics are often lower concentrations of the agents used for disinfection

With biocides:

Disinfectants are also different from biocides — the latter are intended to destroy all forms of life, not just microorganisms. Disinfectants work by destroying the cell wall of microbes or interfering with the metabolism.

Preservative

Preservatives are included in pharmaceutical preparation to prevent microbial spoilage of products and to minimize the risk of consumer acquiring an infection .

Properties:

A perfect disinfectant

- Would offer complete and full microbiological sterilization, without harming humans and useful forms of life,
- Inexpensive,
- Non-corrosive
- Complete compatible with other ingredients
- Stable on storage
- No offensive odour, colour and tasteble
- Readily miscible with water

Choice of the antimicrobial compound depends on:

- properties of the chemical agent
- microbiological challenge
- intended application
- environmental factors
- toxicity of the agent.

The choice of disinfectant to be used depends on the particular situation. Some disinfectants have a wide spectrum (kill many different types of microorganisms), while others kill a smaller range of disease-causing organisms but are preferred for other properties (they may be non-corrosive, non-toxic, or inexpensive).

Table 17.1 Levels of disinfection attainable

	Disinfection level		
	Low	*Intermediate*	*High*
Microorganisms killed	Most vegetative bacteria Some viruses Some fungi	Most vegetative bacteria including *M. tuberculosis* Most viruses including hepatitis B virus (HBV) Most fungi	All microorganisms unless extreme challenge or resistance exhibited
Microorganisms surviving	*M. tuberculosis* Bacterial spores Some viruses and prions	Bacterial spores Prions	Extreme challenge of resistant bacterial spores Prions

Low-level disinfectants

Used to treat non-critical instruments and devices

Quaternary ammonium compounds	0.4% to 1.6% (low)

Intermediate-level disinfectants

Used for cleaning surface or instruments without bacterial spores and highly resilient organism

Alcohol (ethyl, isopropyl)	70% to 95% (intermediate)
Phenolic compounds	0.4% to 5.0% (intermediate/low)
Iodophor compounds	30 to 50 ppm of free iodine/L (intermediate)

High-level disinfectants

Used for items involved in invasive procedures.

Heat	
Moist heat	75°C to 100°C for 30 min (high)
Liquid	
Glutaraldehyde	2% (high)
Hydrogen peroxide	3% to 25% (high)
Formaldehyde	3% to 8% (high/intermediate)
Chlorine dioxide	Variable (high)
Peracetic acid	Variable (high)
Chlorine compounds	100 to 1000 ppm of free chlorine (high)

Classification

1. Alcohols
2. Phenols
3. Aldehydes
4. Dyes
5. Surface active compounds
6. Halogens
7. Metals
8. Guanidine and amidines
9. Furan derivatives

10 Quinoline and isoquinoline

1: Alcohol

Ethanol and isopropanol are used for disinfection and antisepsis they are bactericidal against vegetative form including mycobacterium species but are not sporocidal.

- 100% ethanol ineffective, presence of water is essential for its activity concentration between 60 to 95% solution show bactericidal activities.
- 70% solution is mostly employed for disinfection of skin cleaning instruments or surfaces.
- 90% solution is effective against viruses including HIV.

- Isopropanol:

Has greater bactericidal activity than ethanol but it is twice as toxic and is less effective against viruses in mechanism of action of alcohol is protein denaturation

- Alcohol as a preservative:

- Benzyl alcohol: 2% solution show preservative activity
- Chlorobutanol:0.5% preservative activity in injections and eye drops
- Phenyl ethanol: 0.25 to 0.5%
- phenoxy ethanol:1%
- bronopol:0.01 to 0.1%

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2. Phenols

Phenols used as disinfectant including phenol, xylenol, cresol.

Mechanism: Phenolic disinfectants destruct the cytoplasmic membrane resulting in leakage of bacterial cellular constituents

Uses

Phenol is used as standard against which other germicides are comparing. They are added to multidose injections also added to gurgles and mouth washes and in ear drops.

Disadvantages:

They are caustic in nature.

Cause systemic toxicity

Cresol:

It is obtained from coal tar. It is more bactericidal than phenol but disadvantages are same as phenol. It is also less soluble in water.

Lysol:

Soap sollubalised formulation of cresol BP 1968. It is useful as disinfectant. Its disadvantage is its caustic nature 2 to 5% solution of Lysol is recommended for disinfection of contaminated surfaces.

3: Aldehydes

They have antimicrobial and sporocidal activity. Important members are formaldehyde, glutaraldehyde, orthophthaldehyde.

Formaldehyde:

It is used in liquid or gas form and is used for decontamination of isolators safety cabnets and rooms.

Disadvantages:

It is highly toxic and carcinogenic.

Formulation:

Formaline 37-40% solution of formaldehyde use to preserve tissues.

However it is further diluted for disinfectant ability.

Glutaraldehyde

It is sporocidal and tuberocidal activity its 2% or greater solution is used for sterilization of medical and surgical materials that cannot be sterilized by other method.

Orthophthaldehyde

Recent addition to aldehyde group have high level of disinfectant activity have high excellent antimicrobial activity and have several advantages over glutaraldehyde because not have caustic nature and not irritant

4: Dyes

Triphenyl methane dyes:

Crystal violet brilliant green and malachite green are triphenyl methane dyes use to stain bacteria they also have bacteriostatic and fungistatic activity so are applied topically for infection treatment however due to their possible carcinogenisity they are rarely used

The acridine dyes:

The acridine dyes acriflavine and aminacrine they are used for skin disinfection and for treatment of infected wounds or burns however they are slow acting and have only bacteriostatic effect.

5:Surface active compounds or surfactants

Sub groups:

Anionic Soaps have slightly antibacterial activity

Cationic Citrimide have bacteriocidal activity

Non ionic Sorbitol esters they are divide of any antibacterial activity

Amphoteric or ampholytic, Tego compounds have bacteriocidal and fungicidal activity.

Mechanism of action. They damage cytoplasmic membrane and cause leakage of cytoplasmic compounds.

6:Halogens

In halogens chlorine and iodine are important disinfecting agents formulary preparations include iodine tincture, liquid chlorine, dakins solution.

Dakins solution

It is an antiseptic solution that contains Na hypocholrite and is prepared by passing cholorine through a solution of sodium hydroxide or sodium carbonate,.

7:Metals

Metal as disinfectant include mercury silver and copper compounds.

Mercury compounds

Mercuric chloride is highly toxic so is rarely used.

Phenyl mercuric compounds are used as disinfectant

Silver compounds silver nitrate solution used to treat eye infections

Copper compounds used as fungicide and algicide

8:Furan derivatives

It include nitrofurazone it has antibacterial activity its formulation include creams ointments solutions and ear drops.

9:Quinoline and isoquinoline derivatives

8 hydroxy quinoline, it has fungicidal and bactericidal activity

10:Guanidine and amidine

Guanidine disinfectant is chlorhexidine which is bactericidal against wide range of gram positive and gram negative bacteria . However it is ineffective against acid fast bacteria and bacterial spores and viruses.

Main annidine disinfectant is dibromopropamidine it is used in eye drops and antiseptic creams Preservatives

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Organic acids

Benzoic acid

It is used alone or in combination with preservatives in pharmaceuticals in 0.05- 0.1%

It is effective at low concentration .

Sorbic acid

I t is widely used as preservative. Effective at pH 4 or above.

Used as preservative in gums, mucilages, and syrups.

Ester group

Ester of Parahydroxybenzoic acid (Parabens).

Good preservative activity at high pH 7-8. However optimum activity at low pH

Preservative in Emulsions, Creams, and lotions

Home disinfectants

The most cost-effective home disinfectant is chlorine bleach (typically a >10% solution of sodium hypochlorite), which is effective against most common pathogens, including disinfectant-resistant organisms such as tuberculosis (mycobacterium tuberculosis), hepatitis B and C, fungi, and antibiotic-resistant strains of staphylococcus and enterococcus. It has disinfectant action against some parasitic organisms.

The benefits of chlorine bleach include its inexpensive and fast acting nature. However it is harmful to mucous membranes and skin upon contact, has a strong odour; is not effective against *Giardia lamblia* and *Cryptosporidium*; and combination with other cleaning products such as ammonia and vinegar can generate noxious gases like chlorine. The best practice is not to add anything to household bleach except water. As with most disinfectants, the area requiring disinfection should be cleaned before the application of the chlorine bleach, as the presence of organic materials may inactivate chlorine bleach.

The use of some antimicrobials such as triclosan, is controversial because it may lead to antimicrobial resistance. The use of chlorine bleach and alcohol disinfectants does not cause antimicrobial resistance as it denatures the protein of the microbe upon contact.