

Control of Infection

Asepsis

- **Asepsis** is the state of being free from disease-causing contaminants (such as bacteria, viruses, fungi, and parasites).

Antisepsis

- Prevention of infection by inhibiting or arresting the growth and multiplication of germs (infectious agents). Antisepsis implies scrupulously clean and free of all living microorganisms.

Antiseptics

- **Antiseptics** (from Greek *αντί* - *anti*, "against" + *σηπτικός* - *septikos*, "putrefactive") are antimicrobial substances that are applied to living tissue/skin to reduce the possibility of infection, sepsis, or putrefaction

- **Some common antiseptics**

- [Alcohols](#)

- Most commonly used are [ethanol](#) (60–90%), [1-propanol](#) (60–70%) and 2-propanol/[isopropanol](#) (70–80%) or mixtures of these alcohols. They are commonly referred to as "surgical alcohol". Used to disinfect the skin before injections are given, often along with iodine ([tincture of iodine](#)) or some [cationic surfactants](#) ([benzalkonium chloride](#) 0.05–0.5%, [chlorhexidine](#) 0.2–4.0% or [octenidine dihydrochloride](#) 0.1–2.0%).

- [Quaternary ammonium compounds](#)

- Also known as *Quats* or QAC's, include the chemicals [benzalkonium chloride](#) (BAC), [cetyl trimethylammonium bromide](#) (CTMB), [cetylpyridinium chloride](#) (Cetrim, CPC) and [benzethonium chloride](#) (BZT). Benzalkonium chloride is used in some pre-operative skin disinfectants (conc. 0.05–0.5%) and antiseptic towels. The antimicrobial activity of Quats is inactivated by [anionic surfactants](#), such as soaps. Related disinfectants include [chlorhexidine](#) and [octenidine](#).

- [Boric acid](#)

- Used in suppositories to treat [yeast infections](#) of the [vagina](#), in eyewashes, and as an antiviral to shorten the duration of [cold sore](#) attacks. Put into creams for burns. Also common in trace amounts in eye contact solution.

- [Brilliant Green](#)

- A triarylmethane dye still widely used as 1% ethanol solution in Eastern Europe and ex-[USSR](#) countries for treatment of small wounds and [abscesses](#). Efficient against [gram-positive](#) bacteria.

- [Chlorhexidine Gluconate](#)

- A biguanidine derivative, used in concentrations of 0.5–4.0% alone or in lower concentrations in combination with other compounds, such as alcohols. Used as a skin antiseptic and to treat inflammation of the gums ([gingivitis](#)). The microbicidal action is somewhat slow, but remanent. It is a [cationic surfactant](#), similar to Quats.

- [Hydrogen peroxide](#)

- Used as a 6% (20 Vols) solution to clean and deodorize wounds and [ulcers](#). More common 3% solutions of hydrogen peroxide have been used in household first aid for scrapes, etc. However, even this less potent form is no longer recommended for typical wound care as the strong oxidization causes scar formation and increases healing time. Gentle washing with mild soap and water or rinsing a scrape with sterile saline is a better practice.

- [Iodine](#)

- Usually used in an [alcoholic](#) solution (called [tincture of iodine](#)) or as [Lugol's iodine](#) solution as a pre- and post-operative antiseptic. No longer recommended to disinfect minor wounds because it induces scar tissue formation and increases healing time. Gentle washing with mild soap and water or rinsing a scrape with sterile saline is a comparatively better practice. Novel iodine antiseptics containing [povidone-iodine](#) (an [iodophor](#), complex of [povidone](#), a water-soluble [polymer](#), with triiodide anions I³⁻, containing about 10% of active iodine) are far better tolerated, don't negatively affect wound healing, and leave a deposit of active iodine, thereby creating the so-called "remnant," or persistent, effect. The great advantage of iodine antiseptics is its wide scope of antimicrobial activity, killing all principal pathogens and, given enough time, even [spores](#), which are considered to be the most difficult form of microorganisms to be inactivated by disinfectants and antiseptics.

- [Mercurochrome](#)

- Not recognized as safe and effective by the U.S. [Food and Drug Administration](#) (FDA) due to concerns about its [mercury](#) content. Other obsolete organomercury antiseptics include bis-(phenylmercuric) monohydrogenborate (Famosept).

- [Manuka Honey](#)

- Recognized by the U.S. [Food and Drug Administration](#) (FDA) as a medical device for use in wounds and burns. Active +15 is equal to a 15% solution of phenol.

- [Octenidine dihydrochloride](#)

- A [cationic surfactant](#) and bis-(dihydropyridinyl)-decane derivative, used in concentrations of 0.1–2.0%. It is similar in its action to the Quats, but is of somewhat broader spectrum of activity. Octenidine is currently increasingly used in continental Europe as a QAC's and chlorhexidine (with respect to its slow action and concerns about the [carcinogenic](#) impurity 4-chloroaniline) substitute in water- or alcohol-based skin, mucosa and wound antiseptic. In aqueous formulations, it is often potentiated with addition of [2-phenoxyethanol](#).

- [Phenol](#) (carbolic acid) compounds

- Phenol is germicidal in strong solution, inhibitory in weaker ones. Used as a "scrub" for pre-operative hand cleansing. Used in the form of a powder as an antiseptic baby powder, where it is dusted onto the [navel](#) as it heals. Also used in [mouthwashes](#) and throat lozenges, where it has a [painkilling](#) effect as well as an antiseptic one. Example: [TCP](#). Other phenolic antiseptics include historically important, but today rarely used (sometimes in dental surgery) [thymol](#), today obsolete [hexachlorophene](#), still used [triclosan](#) and sodium 3,5-dibromo-4-hydroxybenzenesulfonate (Dibromol).

- [Sodium chloride](#)

- Used as a general cleanser. Also used as an [antiseptic mouthwash](#). Only a weak **antiseptic** effect, due to [hyperosmolality](#) of the solution above 0.9%.

- [Sodium hypochlorite](#)

- Used in the past, diluted, neutralized and combined with [boric acid](#) in Dakin's solution.

- [Calcium hypochlorite](#)

- Used by Semmelweis, as "[chlorinated lime](#)", in his revolutionary efforts against childbed fever.

- [Sodium bicarbonate](#) (NaHCO₃)

- has antiseptic and disinfectant properties.[3][4]

- [Terpenes](#)

- are the main type of compound found in essential oils, and some have reasonably strong antibacterial, antifungal and antiviral properties. For example [Terpinen-4-ol](#) is found in [Tea tree oil](#).

Desinfection

- **Disinfectants** are substances that are applied to non-living objects to destroy microorganisms that are living on the objects. Disinfection does not necessarily kill all microorganisms, especially not resistant bacterial spores; it is less effective than sterilisation, which is an extreme physical and / or chemical process that kills all types of life. Disinfectants are different from other antimicrobial agents such as antibiotics, which destroy microorganisms within the body, and antiseptics, which destroy microorganisms on living tissue. Disinfectants are also different from biocides — the latter are intended to destroy all forms of life, not just microorganisms.

- **Disinfectants**

- [Alcohols](#), usually [ethanol](#) or [isopropanol](#), are sometimes used as a disinfectant, but more often as an [antiseptic](#) (the distinction being that alcohol tends to be used on living tissue rather than nonliving surfaces). They are non-corrosive, but can be a fire hazard. They also have limited residual activity due to evaporation, which results in brief contact times unless the surface is submerged, and have a limited activity in the presence of organic material. Alcohols are most effective when combined with purified water to facilitate diffusion through the cell membrane; 100% alcohol typically denatures only external membrane proteins.^[9] A mixture of 70% ethanol or isopropanol diluted in water is effective against a wide spectrum of bacteria, though higher concentrations are often needed to disinfect wet surfaces.^[10] Additionally, high-concentration mixtures (such as 80% ethanol + 5% isopropanol) are required to effectively inactivate lipid-enveloped viruses (such as HIV, hepatitis B, and hepatitis C).^{[10][11][12]} Alcohol is, at best, only partly effective against most non-enveloped viruses (such as hepatitis A), and is not effective against fungal and bacterial spores.^{[9][11]}

- **[edit] Aldehyding**

- [Aldehydes](#), such as [formaldehyde](#) and [glutaraldehyde](#), have a wide microbicidal activity and are [sporocidal](#) and [fungicidal](#). They are partly inactivated by organic matter and have slight residual activity.

- Some bacteria have developed resistance to glutaraldehyde, and it has been found that glutaraldehyde can cause asthma and other health hazards, hence [ortho-phthalaldehyde](#) is replacing glutaraldehyde.^[citation needed]

- **[edit] Oxidizing agents**

- [Oxidizing agents](#) act by oxidizing the cell membrane of microorganisms, which results in a loss of structure and leads to cell [lysis](#) and death. A large number of disinfectants operate in this way. [Chlorine](#) and [oxygen](#) are strong oxidizers, so their compounds figure heavily here.
- [Sodium hypochlorite](#) is very commonly used. Common household [bleach](#) is a sodium hypochlorite solution and is used in the home to disinfect drains, [toilets](#), and other surfaces. In more dilute form, it is used in swimming pools, and in still more dilute form, it is used in drinking water. When pools and drinking water are said to be chlorinated, it is actually sodium hypochlorite or a related compound—not pure chlorine—that is being used. Chlorine partly reacts with proteinaceous liquids such as blood to form non-oxidizing N-chloro compounds, and thus higher concentrations must be used if disinfecting surfaces after blood spills.^[13]
- Other hypochlorites such as [calcium hypochlorite](#) are also used, especially as a swimming pool additive. Hypochlorites yield an aqueous solution of [hypochlorous acid](#) that is the true disinfectant. Hypobromite solutions are also sometimes used.
- [Chloramine](#) is often used in drinking water treatment.
- [Chloramine-T](#) is antibacterial even after the chlorine has been spent.
- [Chlorine dioxide](#) is used as an advanced disinfectant for drinking water to reduce waterborne diseases. In certain parts of the world, it has largely replaced chlorine because it forms fewer byproducts. [Sodium chlorite](#), [sodium chlorate](#), and [potassium chlorate](#) are used as precursors for generating chlorine dioxide.
- [Hydrogen peroxide](#) is used in [hospitals](#) to disinfect surfaces and it is used in solution alone or in combination with other chemicals as a high level disinfectant. [Hydrogen peroxide vapor](#) is used as a [medical sterilant](#) and as room disinfectant. Hydrogen peroxide has the advantage that it decomposes to form oxygen and water thus leaving no long term residues, but hydrogen peroxide as with most other strong oxidants is hazardous, and solutions are a primary irritant. The vapor is hazardous to the respiratory system and eyes and consequently the OSHA permissible exposure limit is 1 ppm (29 CFR 1910.1000 Table Z-1) calculated as an eight hour time weighted average and the [NIOSH](#) immediately dangerous to life and health limit is 75 ppm.^[14] Therefore, engineering controls, personal protective equipment, gas monitoring etc. should be employed where high concentrations of hydrogen peroxide are used in the workplace. Hydrogen peroxide is sometimes mixed with [colloidal silver](#). It is often preferred because it causes far fewer [allergic](#) reactions than alternative disinfectants. Also used in the food packaging industry to disinfect foil containers. A 3% solution is also used as an antiseptic. However, recent studies have shown hydrogen peroxide to be toxic to growing cells as well as bacteria; its use as an [antiseptic](#) is no longer recommended.^[citation needed] (((VHP is one of the chemicals approved for decontamination of anthrax spores from contaminated buildings, such as occurred during the 2001 anthrax attacks in the U.S.[3] It has also been shown to be effective in removing exotic animal viruses, such as avian influenza and Newcastle disease from equipment and surfaces.)))
- Accelerated Hydrogen Peroxide, also known as AHP, is a globally patented technology for cleaning, disinfection and sterilization. AHP is a synergistic blend of commonly used safe ingredients, that when combined with low levels of hydrogen peroxide, dramatically increase its germicidal potency and cleaning performance.^[15] The inert ingredients, which include surfactants, wetting agents and chelating agents, are listed on the United States Environmental Protection Agency's (EPA) and Health Canada Inerts lists in addition to the US Food and Drug Administration (FDA) Generally Regarded as Safe (GRAS) List. The benefits and efficacy of AHP have been validated by third party clinical studies conducted by scientific organizations and third party researchers that are recognized by government regulatory agencies in Canada, the U.S and Europe. The evidence available suggests that products based on Accelerated Hydrogen Peroxide, apart from being good germicides, are safer for humans and benign to the environment.^[16]
- [Iodine](#) is usually dissolved in an organic solvent or as [Lugol's iodine](#) solution. It is used in the [poultry](#) industry. It is added to the birds' drinking water. Although no longer recommended because it increases both scar tissue formation and healing time, [incture of iodine](#) has also been used as an antiseptic for skin cuts and scrapes.
- [Ozone](#) is a gas that can be added to water for sanitation.
- [Peracetic acid](#) is a disinfectant produced by reacting hydrogen peroxide with acetic acid. It is broadly effective against microorganisms and is not deactivated by [catalase](#) and [peroxidase](#), the enzymes that break down hydrogen peroxide. It also breaks down to food safe and environmentally friendly residues (acetic acid and hydrogen peroxide), and therefore can be used in non-rinse applications. It can be used over a wide temperature range (0-40°C), wide [pH](#) range (3.0-7.5), in [clean-in-place](#) (CIP) processes, in [hard water](#) conditions, and is not affected by protein residues.

- [Potassium permanganate](#) (KMnO₄) is a red crystalline powder that colours everything it touches, through a strong oxidising action. This includes staining "stainless" steel, which somehow limits its use and makes it necessary to use plastic or glass containers. It is used to disinfect [aquariums](#) and is also widely used widely in community swimming pools to disinfect ones feet before entering the pool. Typically, a large shallow basin of KMnO₄/water solution is kept near the pool ladder. Participants are required to step in the basin and then go into the pool. Additionally, it is widely used to disinfect community water ponds and wells in tropical countries, as well as to disinfect the mouth before pulling out teeth. It can be applied to wounds in dilute solution.
- [Hexachlorophene](#) is a phenolic that was once used as a germicidal additive to some household products but was banned due to suspected harmful effects.
- [Thymol](#), derived from the herb thyme, is the active ingredient in the only 100% botanical disinfectant with an EPA registration (#74771-1), Benefect. Registered as "broad spectrum," or hospital-grade, it is also the only disinfectant with a green certification, Environmental Choice.
- **[edit] Quaternary ammonium compounds**
- [Quaternary ammonium compounds](#) ("quats"), such as [benzalkonium chloride](#), are a large group of related compounds. Some concentrated formulations have been shown to be effective low level disinfectants. Typically quats do NOT exhibit efficacy against difficult to kill non-enveloped viruses such as Norovirus, Rotavirus or Polio. Newer synergous, low alcohol formulations are highly effective broad spectrum disinfectants with quick contact times (3–5 minutes) against bacteria, enveloped viruses, Pathogenic Fungi and Mycobacteria. Unfortunately, the addition of alcohol or solvents to quat based disinfectant formulas results in the products drying much more quickly on the applied surface which could lead to ineffective or incomplete disinfection. Quats are biocides which also kill algae and are used as an additive in large-scale industrial water systems to minimize undesired biological growth.
- **[edit] Other**
- The [biguanide polymer polyaminopropyl biguanide](#) is specifically bactericidal at very low concentrations (10 mg/l). It has a unique method of action: the polymer strands are incorporated into the bacterial cell wall, which disrupts the membrane and reduces its permeability, which has a lethal effect to bacteria. It is also known to bind to bacterial DNA, alter its transcription, and cause lethal DNA damage.^[17] It has very low toxicity to higher organisms such as human cells, which have more complex and protective membranes.
- High-intensity shortwave [ultraviolet light](#) can be used for disinfecting smooth surfaces such as dental tools, but not porous materials that are opaque to the light such as wood or foam. Ultraviolet light fixtures are often present in [microbiology](#) labs, and are activated only when there are no occupants in a room (e.g., at night).
- Common [sodium bicarbonate](#) (NaHCO₃) has disinfectant properties.^{[18][19]}
- **[edit] Measurements of effectiveness**
- One way to compare disinfectants is to compare how well they do against a known disinfectant and rate them accordingly. Phenol is the standard, and the corresponding rating system is called the "[Phenol coefficient](#)". The disinfectant to be tested is compared with phenol on a standard microbe (usually [Salmonella typhi](#) or [Staphylococcus aureus](#)). Disinfectants that are more effective than phenol have a coefficient > 1. Those that are less effective have a coefficient < 1.
- A less specific measurement of effectiveness is the [EPA](#) classification into either *high*, *intermediate* or *low* level of disinfection.^[20] High-level disinfection kills all organisms, except high levels of bacterial spores, and is effected with a chemical germicide cleared for marketing as a sterilant by the [FDA](#). Intermediate-level disinfection kills mycobacteria, most viruses, and bacteria with a chemical germicide registered as a "tuberculocide" by the EPA. Low-level disinfection kills some viruses and bacteria with a chemical germicide registered as a hospital disinfectant by the EPA.^[21]

Sterilisation

- **Sterilization** (or **sterilisation**) is a term referring to any process that eliminates (removes) or kills all forms of life, including transmissible agents (such as [fungi](#), [bacteria](#), [viruses](#), spore forms, etc.) present on a surface, contained in a fluid, in medication, or in a compound such as biological culture media. Sterilization can be achieved by applying the proper combinations of [heat](#), [chemicals](#), [irradiation](#), [high pressure](#), and [filtration](#).

Dry heat sterilisation

- Hot air
- Circulation
- 160, 170 or 180 °C
(60, 30, 20 min)

Hot steam sterilisation

- Autoclave

Vacuum

Steam – pressure

Autoclaves commonly use steam heated to 121–134 °C (250–273 °F). To achieve sterility, a holding time of at least 15 minutes at 121 °C (250 °F) or 3 minutes at 134 °C (273 °F) is required.

Cold sterilisation

- Irradiation
- Special gas

No in dental surgery