Learning objectives
What you should know
- What is asepsis and antisepsis
- The difference between sterilization and disinfection
- The main types of disinfectants
- The main methods of sterilization
- The main types of antiseptics

Definition of asepsis
(a=without + sepsis=infection)
Asepsis is a set of prophylactic methods used to prevent infection during surgery or any other invasive medical procedure.

Definition of antisepsis
(anti=against + sepsis=infection)
Antisepsis represents all methods used to fight infection by destroying and inhibiting the development of infectious agents.

Disinfection
Disinfection is the removal of many, but not all microorganisms. It is a process involving the reduction of contamination up to a level that cannot cause infection, but bacterial spores can survive. It is performed with disinfectants and is only used on non-living objects. Antiseptics are milder forms of disinfectants, which can be used externally on living tissues to kill microorganisms (e.g., on the skin surface or mucosae).

Disinfectants
- Propylene glycol and triethylene glycol
  o Can be used as aerosols or vapors which in sufficient concentrations disinfect air in hospital wards
- Aldehydes (formaldehyde and glutaraldehyde)
  o Are used as disinfectants. They have a strong bactericidal effect, also destroying fungi and certain spores.
- Chlorine and ozone
  o Are strong oxidants used for surface disinfection
- Quaternary ammonium compounds (benzalkonium chloride)
- Biguanide polymers (polyaminopropyl biguanide)
  - Are potent bactericides even in low concentrations.

**Sterilization**
Sterilization represents the removal of all microorganisms, including multiresistant bacterial spores. Sterile is an absolute term, which means the absence of all microorganisms.

**What can be sterilized**
- Gloves
- White coats, soft materials (compresses, sheets)
- Surgical instruments
- Syringes, other medical instruments

![Figure 1. Materials that can be sterilized](image)

**Sterilization methods**
Sterilization is carried out by
- Physical methods: heat, radiation, filtration
- Chemical methods: liquid or gaseous chemical agents

**Sterilization by physical methods**
*Heat* is the most effective and rapid sterilization method. High temperatures have a coagulating effect on proteins, destroying bacteria (including spores), viruses or fungi. Sterilization can be performed by dry or wet heat.

*Heat sterilization*: wet heat denatures proteins and the DNA helix and disintegrates the cell membrane.

*Autoclaving*
- Uses steam under pressure at a temperature higher than 121ºc and a pressure of 1 atmosphere for 30 minutes; with the increase of pressure, the duration of sterilization becomes shorter
It is used for textile materials; it can be used for metal instruments, but the instruments sterilized by this method deteriorate more rapidly; it cannot be used for plastic, rubber, endoscopic instruments

It is carried out with a special device termed autoclave; this ensures vapor heating at the necessary temperature, inside pressure, and circulation of overheating vapors

The materials to be sterilized are placed in special boxes that allow the passage of overheated steam; the most common type of such a box is the cylindrical container with perforated walls; a sliding metal band allows blockage of orifices after completion of sterilization

![Autoclave and Sterilization Container](image)

**Figure 2.** A. Autoclave. B. Sterilization container

- **Control of sterilization by autoclaving:**
  - Automated monitoring system of the device
  - Bacillus stearothermophilus spore strips
    - Resist to up to 121°C for about 12 minutes; the strips are introduced with the other materials to be autoclaved; after autoclaving, the strips are cultured on culture media; if sterilization has been effective, nothing grows on the media
  - Substances in the form of powders with a known melting point or substances that change their color at a certain temperature; these are introduced in tubes or small glass vials that are placed in containers with the materials to be sterilized.

**Radiation sterilization**

Industrial sterilization of disposable materials (sterile gloves, sterile white coats, drains, syringes, needles, collecting bags, etc.) Is carried out by irradiation with gamma rays or X rays.
Ultraviolet rays are used for sterilization of operating rooms.

**Filtration**

Fluids (water, glucose, physiological serum or other perfusable solutions) are sterilized by mechanical filtration. Filtration is carried out through porous materials (pores less than 20-50 nm in diameter), which allow small molecules, but not microorganisms, to pass.

![Figure 3. A. Principle of filtration. B. Filter for the obtaining of sterile water](image)

Modern operating rooms are equipped with air-conditioning systems which, in addition to optimal temperature and humidity, provide air filtration.

**Chemical sterilization**

**Plasma sterilization**

- Is a sterilization method at low temperature, Used for metal and non-metal instruments
- It is based on the action of ionized gases, which penetrate through the paper and nylon packaging bags and Induce alteration of proteins, lipids and nucleic acids by oxidoreduction processes
- Instruments are packaged in special bags (a wax paper side and a nylon side) and are exposed to the action of the ionized gas (nitrogen, oxygen or noble gases); the materials are sterile for two months, as long as the package is intact.
Ethylene oxide sterilization

- Ethylene oxide is a colorless, inodorous, inflammable gas, with a high capacity to penetrate rubber, plastic or paper; therefore, instruments and devices can be sterilized sealed in plastic foil (similarly to bags used for plasma sterilization).
- It is an effective method used for plastic, rubber or metal instruments, both at industrial scale and in hospitals or medical practices.
- Ethylene oxide has a very potent bactericidal action, destroying all microorganisms. However, it is irritant, and sterilized instruments are used only after 24-48 hours, in order to allow the residual substance to dissipate from the package of the sterilized materials.
- Instruments can be used for up to 2 Months after sterilization, provided the package has not been deteriorated.

Sterilization with liquid chemical agents

- Delicate instruments, which have optical and/or electronic components or plastic and rubber parts combined with metal parts, are sterilized by immersion in antiseptic solutions.
- The following solutions are used:
  - Glutaraldehyde
  - Formaldehyde
  - Phthalaldehyde
- There are various preparations of such substances, each having its own technical parameters (concentration, sterilization time) that should be respected
- After sterilization with these substances, the instruments are rinsed with sterile water

Antiseptics

- *Ethyl alcohol and other concentrated alcohols* are used on the skin surface; they are highly effective in inactivating HIV, hepatitis B and hepatitis C viruses.
  - Ethanol (70-100%) or isopropanol (> 70%) is used
- *Phenols* (phenol and chloroxylenol)
- **Boric acid** exists in the form of white crystals and is used as such or in 2-3% solutions, particularly for antisepsis of wounds infected with bacillus pyocyaneus. It also acts on sphaeceli, necrotic tissues and crusts, which it macerates, facilitating their removal.

- **Chlorhexidine** is a biguanide derivative used in 0.5-4% concentrations, alone or in combination with alcohols, as a skin antiseptic.

- **Hydrogen peroxide** (oxygenated water – 3% concentration) releases atomic oxygen, which acts as an oxygen radical, destroying bacterial membranes, proteins and nucleic acids. It is used for antisepsis of dirty wounds as a first component, in ulcers, etc. It also has a mild hemostatic effect.

- **Povidone-iodine (Betadine)** is an antiseptic with a wide antimicrobial spectrum (bactericidal, fungicidal, virucidal, protozoacidal), recommended for skin and mucosal disinfection, as well as wound treatment. The preparation contains active iodine as an antimicrobial agent. It is used as a solution, soap, ointment or in the form of vaginal ovules. It is
much less irritating, but much more active than organic iodine solutions (iodine tincture); it is practically the most widely used antiseptic in hospitals.

- **Chloramines** are organic chlorine compounds; in contact with the water, they form hypochlorous acid, which in turn releases active chlorine. They act on gram-negative bacilli and Koch’s bacillus. They are not active in an alkaline environment. They are used in solutions of various concentrations (0.2 to 5%) for irrigation of suppurating wounds and mucosal disinfection. They are also used to disinfect dishes, floors, trays and some materials.

### Assessment / self-assessment form

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