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DISINFECTANTS AND ANTISEPTICS

INTRODUCTION AND CLASSIFICATION

DISINFECTANTS AND ANTISEPTICS

- **Sterilizing Agents**-- kill everything (e.g. heat, radiation)
- **Disinfectants**-- kill most things. Too strong for living tissues (e.g. lysol, NH_3)
- **Antiseptics**-- milder in action. Can be used topically, but not ingested. (e.g. alcohol, iodine)

■ Medicines with an antimicrobial activity are divided into two groups:

1 – non-selective antimicrobial agents, causes most destructive effect on the *majority of microorganisms* (***antiseptics and disinfectants***).

2 - selective antimicrobial drugs (***chemotherapeutic agents***).

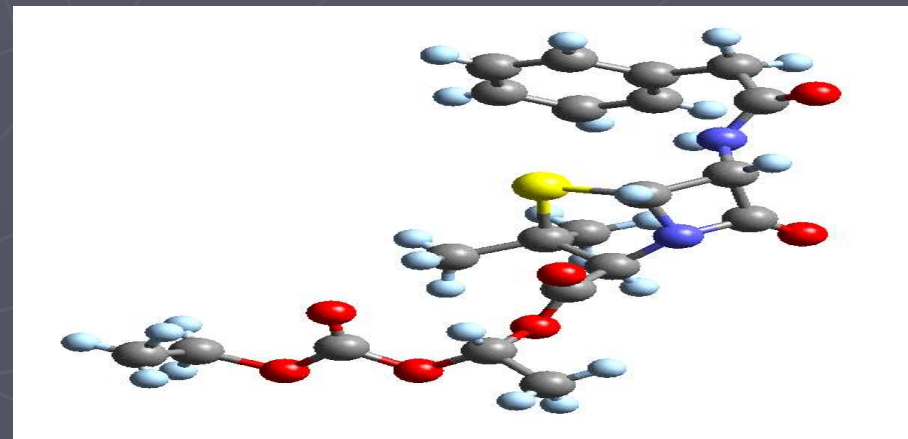
ORIGINS OF ANTISEPTICS

Joseph Lister (1827 - 1912)

- Realised that deaths from operations mostly occurred from infection contracted during the operation as a result of unclean practices.
- He started using Carbolic acid (phenol) during operations to maintain aseptic conditions with significant improvements.
- Like Semmelweiss he initially encountered opposition, but use of his methods by the Germans during the Franco-Prussian war in 1870 provided his major breakthrough and over the next 10 years, the practise of aseptic surgery became accepted.

Antimicrobials could be

- ▶ narrow-spectrum and effective only against a limited variety of pathogens or broad-spectrum, affecting many different types of pathogens
- ▶ bactericidal if they kill the susceptible bacteria or bacteriostatic if they inhibit the growth of bacteria



Antiseptics and disinfectants

- a group of drugs that are able to inhibit the growth, development or leads to death of microorganisms in the environment surrounding the patient or on the surface of the body.

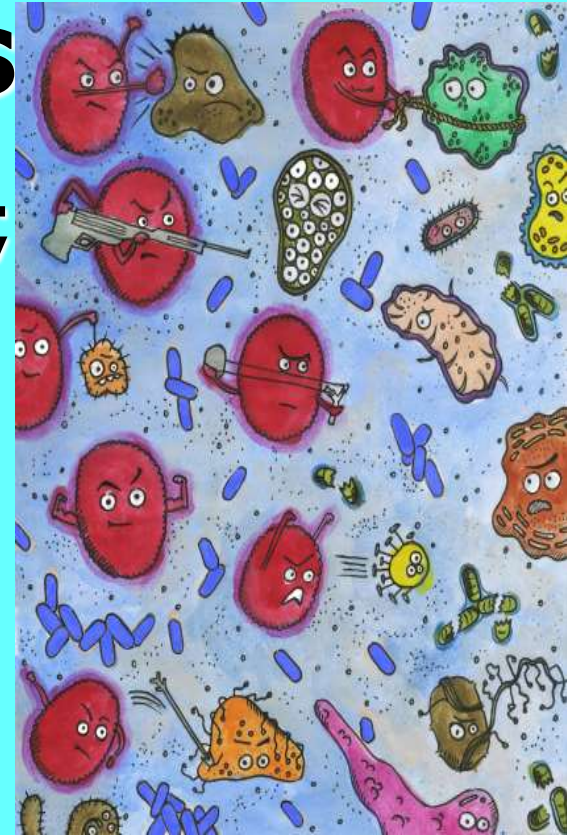
Antiseptics - (anti- *against*; *septicus* - putrid). This is a group of medicines that are used to eliminate pathogens in the wound (skin, mucous membranes) in the gastrointestinal tract and urinary tract. Causes bacteriocidal or bacteriostatic effect depending on the concentration.

Disinfectants - used for disinfection of medical instruments, utensils, facilities, equipment, etc. Disinfection - a complex of measures aimed at prevention of infection in the wound (in the body as a whole) or to prevent the spread of infection.

- *Draw a sharp line between antiseptics and disinfectants is not always possible, because many substances used in low concentrations as antiseptics, and higher - for disinfection.*

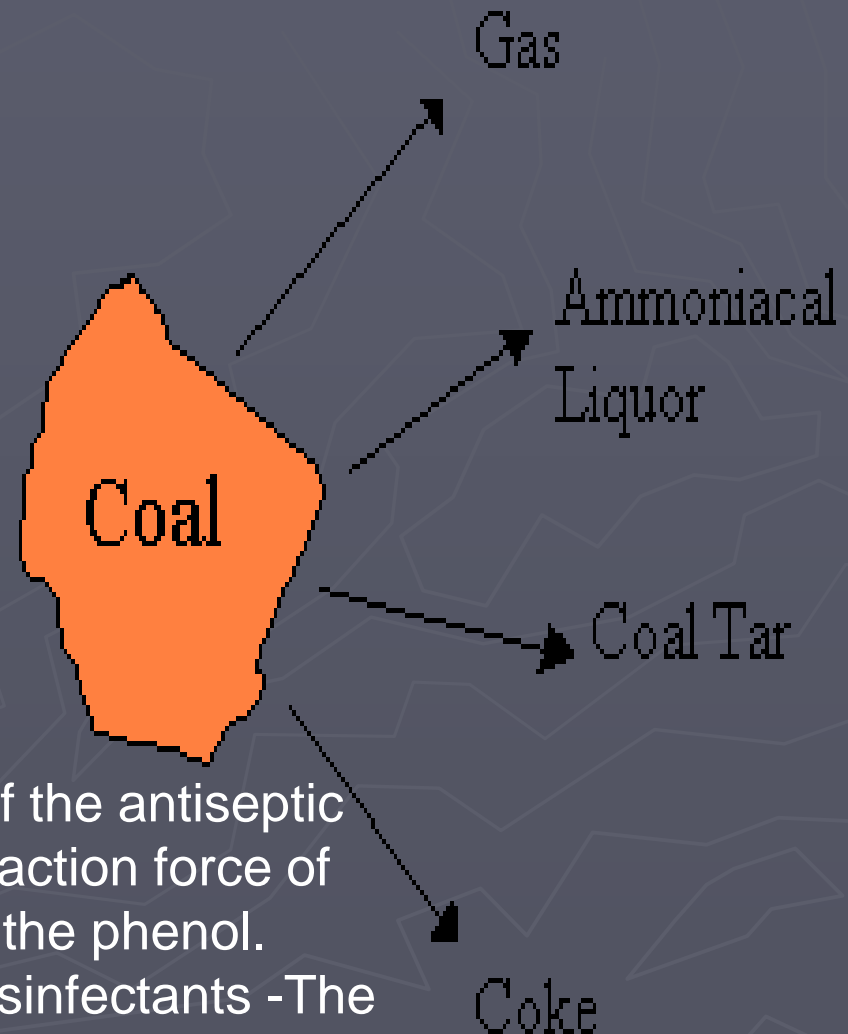
Requirements for antiseptics and disinfectants

- Must have a broad spectrum of action;
- Rapid onset of action;
- Should have a small latency period;
- Should have a high activity;
- Must be chemically resistant;
- High availability and low cost;
- Lack of local irritant or allergic effects on tissues;
- Minimal absorption from the place of their application;
- Low toxicity.



Sources of antiseptics

- ▶ **Early antiseptics were probably vegetable extracts**
 - Many spices contain antibacterial agents
- ▶ **Essential oils extracted from plants often have antibacterial properties**
- ▶ **Lister used carbolic acid which chemically is a solution of phenol**
 - Phenol was originally extracted from coal tar.
 - Coal tar preparations are still used today in therapeutic soaps and shampoos.



- To characterize the antimicrobial activity of the antiseptic agents used **phenol ratio** which indicates action force of the antimicrobial agent in comparison with the phenol.
- The difference between antiseptics and disinfectants -The objectives of their application.

Classification of Antiseptics and Disinfectants (according chemical structure)

I. Inorganic substances

1. Halogens:

- Iodine (2%, 3%, 5% alcohol solution)
- Iodinolum
- Ioddicerinum
- Povidon-Iod (Betadinum)
- Iodophorm
- Lugol's solution
- Chloramine B
- Chlorhexidine bigluconate
- Pantocidum (Halazone)

2. Oxidizing agents:

- Hydrogen peroxide
- Potassium permanganate

3. Acids and alkalis:

- Boric acid
- Salicylic acid
- Solution of ammonia

4. Metallic salts:

- Hydrargyri dichloridum
- Hydrargyri amidochloridum
- Silver nitrate
- Copper sulfate
- Zinc sulfate
- Zinc oxide



Classification continuation

II. Organic substances

1. Aldehydes:

- Formaldehyde (Formalinum)
- Glutaraldehyde
- Hexamethylenetetraminum (Methenamine)

2. Alcohols:

- Spiritus aethylicus (Ethyl alcohol)

3. Phenol derivatives:

- Phenol (Phenolum purum, Carbolic acid)
- Cresol (Tricresolum)
- Resorcinol
- Thymol
- Benzylbenzoat

4. Dyes:

- Methylene blue
- Brilliant green (Viride nitens)
- Etacridin lactate

5. Detergents:

- Aethonium
- Decamethoxin
- Roccal
- Dimexid

6. Tar, resins, products of petroleum:

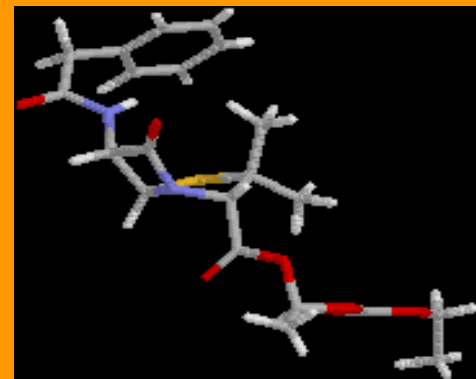
- Pix liquida Betulae (Birch tar)
- Ichthyolum
- Liniment by Vishnevsky

7. Nitrofurane derivatives:

- Nitrofurazone (Furacilinum)

8. Antiseptics from medicinal plants:

- Chlorophylliptum
- Novoimaninum



Halogens

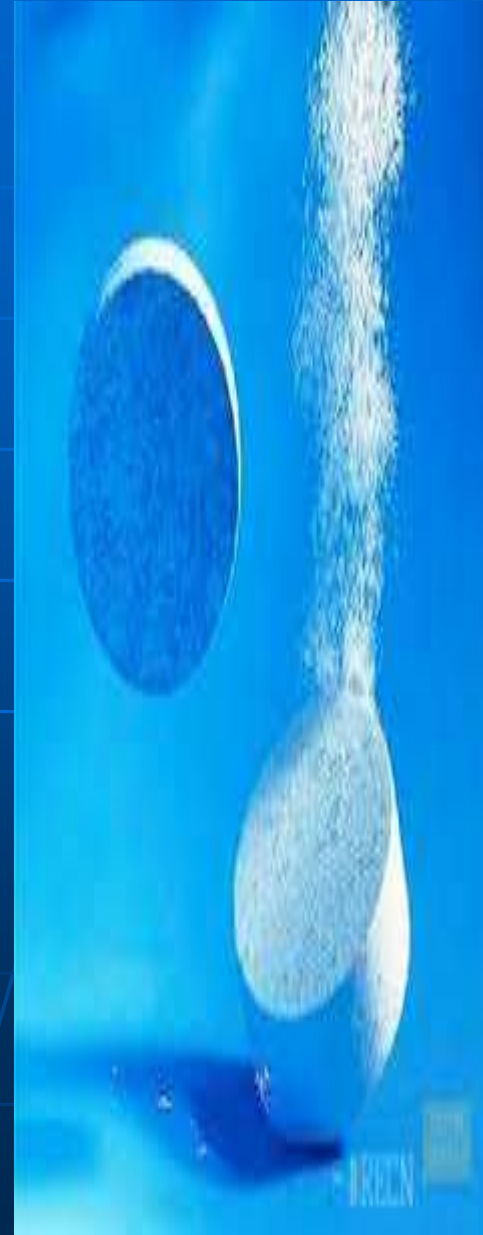
Chlorine

- Discovered in 1774 by a Swede, C.W. Scheele
- It is a pale green, toxic, reactive gas
- It is a powerful irritant and toxin
 - Used as a gas warfare agent in WWI
 - very nasty, inflicting lifelong damage on those who survived
 - The damaged lungs were possibly a factor in the 1918 flu pandemic
- Solution of chlorine in water is both a powerful bleach and disinfectant
 - Semmelweis had used chloride of lime as an antiseptic

Halogens

The mechanism of antimicrobial action

- Denaturation of proteins of the protoplasm of microbial cells by reacting with the **amino group of the proteins**, displacing **hydrogen**.
- Denatured protein loses its activity.
- In the **presence of organic substances** halogen's **antimicrobial effect decreases**.



Iodines



- Iodine - active bactericidal element.
- At a dilution of 1: 20 000 - kill vegetative forms of bacteria for 1 min,
- the dispute - 15 min.
- Alcoholic solution of Iodine 5% (5 g of Iodine, KI -2g, ethyl alcohol 95% 100ml)
- An irritant and a distraction action
- INDICATIONS: Disinfection of the surgical field, disinfection of wounds, the surgeon's hands, in myositis, neuralgia.
- Iodine is partially absorbed into the blood from the skin and exhibits resorptive effects, especially in children.
- SIDE EFFECT: Chemical burns, dermatitis.

Halogens (Iodine)

- **LUGOL'S SOLUTION (Iodine-1 part, 2 part -KI, water-17 part)**
- INDICATION: Mucos lubrication in pharynhitis and larynhitis.
- **IODDICERINE (Iodine, dimethyl sulfoxide, glycerol)**
- Fungicidal, antimicrobial, antiviral, antinecrotic, antioxidant effect.
- **!!!The most active Iodine preparation!!!**
- Doesn't irritate tissue, does not cause pain reaction, deeply penetrates into the tissue.
- INDICATION: Inflammatory infection (purulent wounds, infectious ulcers, sore throats, tonsillitis, pulpitis, otitis, pyoderma, erosion of the mucous membranes, mastitis, candidiasis, inflammatory diseases of the genital organs).
- Topically in the form of tampons, turundul, napkins, irrigation, washing.

Halogens (Chlorine disinfectants)

CHLORINE - active bactericidal element is active in the undissociated form of HOCl when Cl dissolved in water at neutral and acidic pH.

- Bleach - not less than 32% of free Cl. Antimicrobial action - fast, but not for long
- INDICATIONS: 0.2-0.5% sol. for the disinfection of premises, infective patients discharge (pus, sputum, urine, feces).
- Corrosive to metals.

CHLORAMINE B - 25-29% active Cl.

- INDICATION: eye wash, hand disinfection, douching (0.25-0.5%), treatment of purulent wounds, burns, pustular skin diseases (0.5-2%). Disinfection of premises, health products and non-metallic tool, selection of patients (1.5%).
- Deodorizing properties.
- 4-8mg CHLORAMINE B is able to sterilize 1 liter of water for 15-60 min. (Pantocid), if the water contains a lot of organic substances.



Halogens

CHLORHEXIDINE BIGLUCONATE (Bisdiguanidine derivative).

- Has the properties of chlorine and detergent compounds.
- Capable of damaging the plasma membrane of microorganisms.
- Strong antibacterial and fungicidal action.
- Bactericidal activity against GR+, Gr- bacteria, active against Treponema, gonococci, trichomonas, Proteus.

INDICATIONS: disinfection of the surgical area, the surgeon's hands, tools, burn surfaces, septic processes, prevention of sexually transmitted diseases. In the form of a tabl. - in infectious and inflammatory diseases of the mouth and throat. 0.2% solution inhibits the formation of plaque and effective in treating gingivitis.

SIDE EFFECTS: Dry hands, itchy skin, dermatitis.

- **!!!Can not be used in conjunction with IODINE!!!**
- **CHLORHEXIDINE** is often used as an active ingredient in mouthwash pastes to reduce dental plaque and oral bacteria.
- It have an immediate **bactericidal action** and a prolonged **bacteriostatic action** due to adsorption onto the pellicle-coated enamel surface.

Oxidizing agents

■ HYDROGEN PEROXIDE

- It is available as 30% and 3% solution. More common 3% solutions is used.



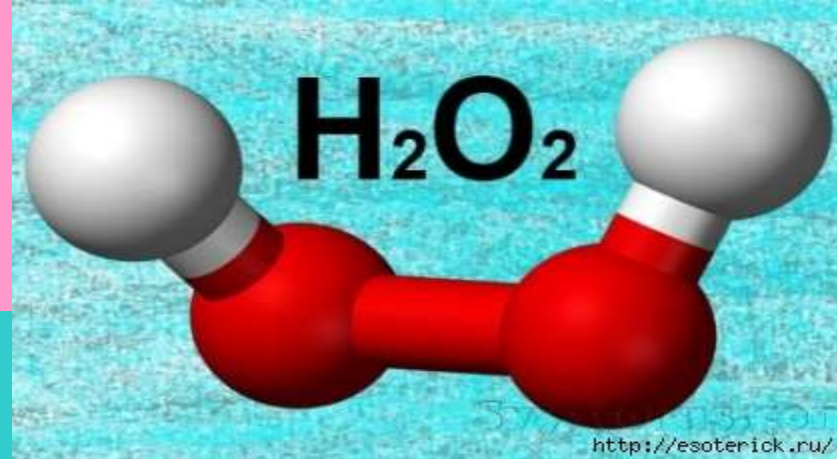
It is decomposed with release of **molecular form of oxygen** that is responsible for antimicrobial effect

- Releasing oxygen makes foam that cleans and deodorizes putrid wounds and ulcers.

- Catalases present in tissues speeds decomposition and foaming of hydrogen peroxide

- Hydrogen peroxide is used in treatment of infected wounds and to stop small bleeding.

Hydrogen peroxide



Indications:

- rinsing the mouth and throat, for the treatment of wounds that are infected with anaerobic microflora. Concentrated solutions (20-30%) is indicated for the treatment of warts, lichen planus.

Side effects:

- burn mucosa. Not used in deep wounds, and not introduced into a body cavity - **may cause embolism.**

Potassium permanganate

- $2\text{KMnO}_4 + \text{H}_2\text{O} = 2\text{KOH} + 2\text{MnO}_2 + 3\text{O}_2$
It liberates **oxygen in atomic form**.
- Highly water soluble, used in 1:4000-1:10000 solution.
- Higher concentrations cause burns and blistering.
- It promotes rusting.

Clinical uses:

- Gargling, douching, irrigating cavities, urethra and wounds.
- Stomach wash in alkaloid poisoning.
- In a 2-5% solution is used for burns, bites of mosquitoes and snakes, for quick healing of wounds.
- Disinfection of water.



Heavy metal compounds.

- Their mechanism of action is the **blocking of sulfhydryl, carboxyl and amino groups** of proteins and enzymes of microorganisms.
- Metal ions are formed by dissociation of the salts, interaction with these active biosubstrates functional groups cause their **denaturation**.
- At a deeper penetration of the substance in the tissue causes irritated cells and nerve endings effect, and the extreme manifestation of a **cauterizing** effect of metal salts.
- **(Pb, ... Al, Zn, Cu, Ag, ... Hg)** In such sequence an increases antimicrobial activity. As antiseptics most active are metal salts on the right side of the row.

Heavy metal compounds.

- With prolonged use of salts of heavy metals can be **cytotoxic effect** due to the inhibition of thiol enzymes in the tissues.
- **Symptoms of poisoning with salts of heavy metals:** a chemical burn of GIT mucosa, the weakening of cardiac activity, collapse, kidney and liver damage.
- **In cases of poisoning:** gastric lavage with water, tea solution with activated carbon, Unithiol.

Inside: milk, raw eggs, Unithiol or Tetacin calcium, Sodium thiosulfate. **Symptomatic treatment:** cardiac glycosides, sympathomimetic, plasma expanders, vasoconstrictors, narcotic analgesics.



Acids and alkalis

- **Acids: boric acid, salicylic** - *Shift the pH to the acid side* → *protein denaturation of microbial cell protoplasm*. Since proteins of the skin and mucous membranes forming dense, insoluble albuminates, that is providing **anti-microbial, anti-inflammatory, antifungal effects**.
- In high concentrations **cauterize tissue (coagulative necrosis)!**
- **Boric acid:** used for washing and rinsing of the mucous membranes of the mouth, diaper rash, acute and chronic otitis media, colitis, pyoderma, pediculosis.
- **Side effect:** It penetrates through the skin and mucous membranes, especially in children, cumulates. With long-term use in patients with impaired renal function develops **acute and chronic poisoning** (nausea, vomiting, diarrhea, skin rashes, confusion consciousness, convulsions, oliguria, sometimes shock.
- **Salicylic acid:** Weak antiseptic, irritant, low concentrations (1-3%) –keratoplastic, in high (5% -10%) - keratolytic effect.
- **Application:** Oily seborrhea, acne, eczema, psoriasis, ichthyosis, warts, corns, etc.

Alkalis

- Alkalines: NaHCO_3 , sodium tetraborate, sol. of ammonia.
- **NaHCO_3 , sodium tetraborate** - melted mucin, a softening effect. Inflammatory exudate pH shifts to the alkaline side reduces the manifestations of inflammation.
- **10% ammonia solution** exhibits antiseptic effect, manifests cleaning properties, dissolves fat. Given these properties, it is suggested for **washing hands before surgery** (25 ml solution of ammonia diluted in 5 liters of water).
- Inhalation to stimulate the respiratory center.

Organic antiseptics

Group of (aromatic) phenol, resorcinol, thymol, tar, ichthyol, benzylbenzoate.

- **Phenol (carbolic acid):** 3-5% solution for disinfection of furniture, household items, hospital linen, patients discharge.
- 0.25-1% - sometimes in skin diseases accompanied by itching.
- 0.1-0.5% - conservation of serum and suppository.
- Readily absorbed through intact skin and mucous membranes, **causing intoxication** (short-term stimulation of the CNS, respiratory depression and cardiac activity, decrease in body temperature, damage of parenchymal organs).



Organic compounds

Phenols

Resorcinol

- In small doses has keratoplastic property in the more annoying - keratolytic.
- Used for the treatment of skin diseases (eczema, seborrhea), fungal infections (2-5% solutions, 5-20% ointment, paste).

Birch tar

- Has: antimicrobial, keratoplastic, keratolytic and irritant effect.
- Is used to treat a number of skin diseases and scabies.
- Is one of the components of balsamic liniment of Vishnevskiy

Group of aldehydes and alcohols

- PREPARATIONS: **FORMALDEHYDE SOLUTION, LIZOFORM, ETHYL ALCOHOL, HEXAMETHYLENETETRAMINE (METHENAMINE)**

Formaldehyde solution (Formalin)

- Has antimicrobial (vegetative forms and spores) and deodorizing effects.
- MECHANISM OF ACTION: dehydration of microbial cells protoplasm proteins causing its destruction.
- Is used as a disinfectant and deodorant, skin treatment with sweating (0.5-1%), disinfection tools (0.5%). For the preservation of anatomical objects.

Aldehydes and alcohols (Formaldehyde)

- **If inhaled formaldehyde** - tearing, coughing, shortness of breath, agitation.
- **In oral poisoning** - pain in the mouth, behind the sternum, in epigastric region, hematemesis, thirst, loss of consciousness, cyanosis, coma.
- **Emergency in poisoning:** Inhalation of water vapor, oxygen saturation, gastric lavage 2.3% sol. of Ammonium chloride.
- **Inward enter:** 2-3 tbsp. of activated carbon, 100 ml of 30% solution of magnesium sulfate.
- **In severe poisoning** - forced diuresis, s/c 1 ml 0.1% solution of Atropine sulfate, Promedol, inward - Codeine in tabl.

Ethyl alcohol

- Bactericidal activity starts with alcohol 20% and increases with concentration. On the spore form does not affect.
- High concentrations of alcohol in the protein environment form dense protein aggregates.
- 70% - it is more deeply penetrates into the deeper layers of the epidermis of the skin, sebaceous and sweat glands, provides a high antiseptic effect (antimicrobial strength of 70% is equal to 3% phenol sol.).
- Application: disinfection of hands and operating field (70%).
- Sterilization of surgical instruments (90-96%).
- Disinfection of the skin before injection (70%).
- Alcohol compresses for children (20%), adults (40%).
- For the preparation of medicaments.

Group of dyes

*Ethacridine lactate (rivanol),
Brilliant green,
Methylene blue*

- Antimicrobial activity of this group falls in the protein environment
- The most sensitive Gr + bacteria, cocci.



Ethacridine lactate (rivanol):

- used in surgery, gynecology, urology, ophthalmology, dermatology. For washing of fresh and infected wounds, cavities (pleura, peritoneum), bladder, uterus.

Brilliant green

(1-2% water and alcohol sol.):

- for the treatment of skin with scratches, pyoderma, blepharitis, and others.

Methylene blue:

- used internally for urinary tract infections (cystitis, urethritis).
- I/V 1% sol. 50-100 ml in case of **poisoning with hydrocyanic acid or salts (in large doses translates hemoglobin to methemoglobin which comes into contact with a non-toxic form of cyanide complex cyanmethemoglobin).**
- When administered I/V in small doses (0.1-0.15 ml/kg 1% sol.) contrary methylene blue restores methemoglobin in the hemoglobin **(with nitrite poisoning, aniline, and others.)**

Nitrofuran derivatives (furacillin, furazolidone)

- **Spectrum of action:** Gr-, Gr + bacteria (staphylococci, streptococci, dysentery bacillus, intestinal coli, Salmonella paratyphi, the causative agent of gas gangrene, etc.) and protozoa (Trichomonas, Giardia).
- **Pharmacodynamic:** influenced microbes reductase, there is a restoration of the nitro group and their transformation into toxic products for cells (inhibition of the respiratory chain, the destruction of the microbial wall).
- In the presence of pus does not lose effectiveness.
- **Apply** for external treatment of wounds, skin, mucous membranes, wash serous and joint cavities, otitis media, conjunctivitis and others. Eye diseases and orally for the treatment of bacterial dysentery.

Detergents

- **Detergents** - a substances with a high surface activity.
- Show antiseptic and cleansing action.
- Distinguish anionic and cationic **detergents**.
- **Anionic detergents** include ordinary soaps (**sodium or potassium salts** of fatty acids).
- As antiseptics mainly used cationic surfactants: **benzalkonium chloride, cetylpyridinium chloride, miramistim**.
- **Benzalkonium chloride** has antibacterial, antiprotozoal and spermicidal action (spermicidal effect develops in two stages: first - the destruction of the flagellum, and then - the gap of the sperm head, which makes it impossible to fertilization).
- Used for treatment of skin, mucous membranes, wounds, rinsing the bladder, urethra, and for contraception in women.