

## **MODE OF ACTION**

Being impermeable to folic acid, many bacteria must rely on their ability to synthesise folate from PABA, Pteridine, and glutamate in contrast the mammalian in cells cannot synthesise folic acid and must obtain preformed folate as a vitamin in their diet. The sulphonamides are structurally similar to PABA, the sulphonamides competitively inhibit dihydropteroate synthetase, the enzyme that catalyses the incorporation of PABA. Into dihydrofolic acid. The folic acid is required for pure and D.N.A synthesis which without it bacteria growth is inhibited.

**ANTIBACTERIA SPECTUM:** sulphonamides have a broad- spectrum of activity against both gram- positive and gram negative bacteria, and some protozoa (coccidia, Neospora, Toxoplasm), riicketsiae.

**RESISTANCE:** is common in animals isolated and usually exhibit cross-resistance to the whole group. Resistance occur gradually and may be due to plasmid transfer or random mutation resulting in decrease affinity of the bacterial dihydropteroate synthetase for the sulphas, decrease uptake, increased PABA synthesis by bacteria.

### **Sulphonamides Classes :**

**Long acting** examples - sulphamethoxyridazine

- sulphamethoxine
- sulphadoxine

Peak plasma levels are attained in 2-6hours.

**Note:** These are not well absorbed orally others that are insoluble are called the (**enteric or gut-active**) sulphonamides.

- Phythalylsulphathiazole

- Succinyl sulphathiazole
- Sulpha-bromethazine
- Sulphaquinoxaline
- Salsalazine
- Sulphacetamide

These are used orally and parenterally to treat variety of conditions, including local lesions such as foot rot or podo-dermatitis and systemic disease such as **actinobacillosis, mastitis, metritis, colibacillosis, polyarthrits** and respiratory infections.

**Clinical Uses:**

*Sulphadimidine* is favoured as it maintains effective blood levels for 24 hours following one intravenous injection.

**Sulphadoxine** is most advantages in goats because only a moderate dose is required every 24 hours.

*Sulphonamides* are used in urinary tract infections because only few are water soluble.

*Sulphafurazole* is important to note that **Sulphafurazole** is also called (sulphisoxazole). These soluble **Sulphonamides** are rapidly excreted in the urine in 24 hours in an unchanged fom for these reason, they are used to treat urinary tract infections, particularly active against *proteus, coliforms*, and *Psuedomonas* species.

**Sulphanamides** are used in topical uses e.g. *Silver sulphadiazine* is used topically to avoid colonization by *Pseudomonas* species.

**Today in Clinical Practice.**

The development of other antimicrobial agents has reduced the importance of sulphonamide in Veterinary Practice. Sulphadimidine and sulphasalazine are the two that still

retain their uses in urinary tract infections and chronic inflammatory bowel disease and colitis in dogs and cats.

### **MISCELLANEOUS ANTIBACTERIAL AGENTS: NITROFURANS, HYDROXYQUINOLONES AND NITROIMIDAZOLES**

**Chemotherapy:** The use of chemical compounds in the treatment of infectious and neoplastic diseases. The chemotherapeutic drugs include antibacterial, antiprotozoal, antifungal, anthelmintic, ectoparasitic, antiviral and antineoplastic compounds. Antimicrobial therapy is based on the selective toxicity of a drug for invading organisms without harming host's cells as there are biochemical differences between microorganisms, animals and man.

There are several types of antimicrobials employed in veterinary medicine to treat specific infectious diseases which are excreted unchanged in high concentrations into the urine and are effective in the treatment of acute urinary tract infections. By contrast, urinary tract antiseptics are totally synthetic drugs that exert bacterial activity in the urine. They concentrate in renal tubules and are rapidly excreted from the urine unchanged.

#### **Classes are:**

1. Nitrofurans
2. Hydroxyquinolones
3. Nitroimidazoles

#### **NITROFURANS:**

- These are a group of closely related, synthetic, antimicrobial drugs with bacteriostatic activity against Gram positive and Gram negative bacteria, some protozoa and fungi. These include *Salmonella* spp, *Giardia* spp, Trichomonads, Amoeba and some *Coccidia* spp.
- Compared with other antimicrobial agents, their potency is not particularly great.

- They are yellowish compounds that must be protected from light, otherwise they deteriorate and turn brown.
- Absorption is complete after oral administration and is rapidly excreted in the urine.
- They are more active in acidic environment e.g acidic urine therefore not effective systemically. It is a common practice to administer a urinary acidifier with nitrofurans to promote drug ionization when treating UTI.
- Resistant mutants are rare and clinical resistance emerges slowly.
- They show cross resistance but not with other antibacterials.
- Given p/o or topical (not administered parenterally)

**Mechanism of action:** The nitrofurans are reduced to highly reactive intermediates which inhibit various enzymes including those involved in carbohydrate metabolism. Also block the initiation of translation thereby interfering with gene expression (DNA). Selective toxicity appears to arise from the relative ability of host and bacterial cells to reduce the drug and the speed with which they are cleared from the host's cells.

**N.B:** Bacteria reduce nitrofurans more rapidly than host's cells.

**Adverse Effects:** They have a narrow safety margin.

GIT disturbances include vomiting, intestinal bleeding, diarrhoea.

CNS involvement- peripheral nerve damage, excitement, convulsion, hypersensitivity.

Allergic skin rashes, depressed spermatogenesis and poor weight gain can also occur.

Some nitrofurans are carcinogenic, and their future use is in doubt.

Nitrofurans include nitrofurantoin, furaltadone, nifurprazine, nitrofurazone, nifuratel, furazolidone and nifuraldezone.

### **1. Nitrofurantoin:**

Has the least activity.

**Indication:** Treatment of urinary and respiratory tract infections. Susceptible bacteria include *E.coli*, *Aerobacter aerogenes*, *Klebsiella*, *Enterobacter*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus pyogenes* (horses and small animals). *Streptococcus faecalis* are usually resistant.

**Pharmacokinetics:** Rapidly and completely absorbed and eliminated by the kidneys, mainly by tubular secretion (40% in the unchanged form). Serum concentration is low and little unbound drug is available for diffusion into tissues. Plasma T<sub>1/2</sub> is only 20 mins.

**Dose:** Dogs/cats - 2-4mg/kg p/o tid for 4-10 days

Calves, foals - 4.4mg/kg initially, then 2.2mg/kg p/o tid for 5 days

Adult horses- 500mg/gm of feed.

It is a common practice to co-administer a urinary acidifier to promote drug ionization when using nitrofurantoin.

## 2. Nitrofurazone:

**Indication:** Treatment of enteric infections in poultry, cattle and pigs; avian coccidiosis, bovine mastitis and metritis. Sometimes used as in-feed medication for control of swine necrotic enteritis due to *Salmonella choleraesuis*.

**Pharmacokinetics:** Slightly soluble in water.

Readily absorbed with peak serum concentration occurring within 1-2hrs.

Penetrates blood brain barrier and attains therapeutic concentration in abscesses and empyema fluid.

Excretion is by renal and biliary routes.

**Dose:** 0.05% in feed for 7days, 0.2% in antibacterial ointment and powder for wound dressing.

### **3. Furazolidone:**

Has the greatest activity

**Indications:** Control of intestinal colibacillosis, salmonellosis, giardiasis and coccidiosis in chickens, turkeys, rabbits, calves and swine.

**Dose:** pigs-10-20g/tonne of feed; calves 10-12mg/kg bid 5-7days.

**NB:** Prolonged use may give rise is resistant strains of *Salmonella* and in calves, sufficient drug may be absorbed to cause encephalitis manifesting as staggers and hyperaesthesia.

### **4. Furaltadone:**

**Indication:** To control infections due to *Salmonella* species, *Mycoplasma gallisepticum* and caecal coccidiosis.

**Dose:** 0.04% in drinking water and 500mg per quarter intramammary infusion in treatment of bovine mastitis.

### **5. Nifuraldezone:**

For bacterial enteritis in calves.

### **6. Nifurprazine:**

Used topically as an antibacterial.

**NB:** Because of their mutagenic potential, the nitrofurans have been banned as feed additives in many countries including Nigeria.

## **8-HYDROXYQUINOLONES:**

- They are a group of synthetic compounds with antibacterial, antifungal and antiprotozoal activity.
- They have been widely and injudiciously used in humans for the prophylaxis and treatment of nonspecific diarrhoea, traveller's diarrhoea, dietary indiscretion etc.
- They are active against *Entamoeba*, *Giardia*, *Trichomonas*, dermatophytes, and *Candida*.

**Classes:** Iodochlorhydroxyquinolone (Quiniodochlor or Clioquinol), Diiodohydroxyquinolone (Iodoquinol), Broxyquinolone and Hydroxyquinolone.

**Pharmacokinetics:** Absorption from the intestine is variable.

- Least absorbed (10-30%) and probably safest is Iodoquinol.

**Route:** p/o or topical. Topical application of quiniodochlor has been used for dermatophytosis. Also as vagina cream for monilial and *Trichomonas vaginitis*.

**NB:** 8-hydroxyquinolones cause convulsion in cats and an iatrogenic disease in human known as subacute myelo-optic neuropathy (neurotoxic when used for prolonged periods).

**Dose:** Horses-1g/44.5kg p/o sid using decreasing dosage to end medication.

### **5-NITROIMIDAZOLES:**

- A group of synthetic drugs that have a broad spectrum activity against protozoa (trichomonads, amoebae and giardia) and bacteria (anaerobic cocci and bacilli).
- They are imidazole heterocycles with a nitro group
- The prototype is metronidazole.
- Others are dimetridazole, niradazole, lipronidazole, flunidazole, tinidazole, ronidazole and nimorazole.

**Mode of action:** A ferredoxin linked metabolite disrupts DNA synthesis in protozoa and bacteria.

**Metronidazole:**

- Active against bovine trichomoniasis, rabbit coccidiosis, canine giardiasis and obligate anaerobic bacteria but not facultative anaerobes, obligate aerobes or microaerophilic bacteria other than *Campylobacter fetus* or *Corynebacterium vaginalis*.
- It is bactericidal at concentration equal to or slightly higher than the minimum inhibitory concentration.

**Indication:** Amoebiasis, giardiasis, trichomoniasis, balantidiasis

To prevent infection after colonic surgery

Adjunct to radiotherapy of solid tumours.

**Mode of action:** Unclear, it is probably first reduced and then binds to DNA causing loss of the helical structure, strand breakage and impairment of DNA function.

**Pharmacokinetics:** Oral bioavailability varies from 50-99%. If given with food, absorption is enhanced in dogs due to increased bile secretion that helps to dissolve the drug. Peak blood levels occur within 1-2hrs, distribution is rapid and wide because the drug is highly lipid soluble. It is metabolized in the liver to glucoronide and several oxidation products that may darken the urine. Both metabolized and unchanged drug are excreted in the urine and faeces in 24hrs. It penetrates the blood brain barrier. Elimination  $T_{1/2}$  is 3-5hrs in dogs and horses. Biotransformation is extensive and excretion of parent drug and metabolites occur by both renal and biliary routes.

**Dose:** Dogs 44mg/kg p/o followed by 44mg/kg qid 5-7 days.

Canine giardiasis - 25mg/kg p/o, i/v or s/c bid

Equine trichomoniasis - 20mg/kg/day by slow i/v infusion



Bovine trichomoniasis - 75mg/kg i/v bid

Topical => 5% ointment plus urethral douche

To irrigate wounds and infected hoof => 1% solution for 5-7days.

When treating birds or rodents, metronidazole is added to drinking water.

For the treatment of amoebiasis, it is usually administered with a luminal amoebicide.

**Adverse effects:** May induce GIT disorders- nausea, vomiting and abdominal cramps. High doses in dogs may produce neurological disturbances characterized by tremor, weakness, muscle spasm, ataxia and convulsion. Reversible bone marrow depressions and reddish urine discoloration have been reported.

## **ANTISEPTICS, DISINFECTANTS AND GROWTH PROMOTERS**

### **A Good Antiseptic/Disinfectant must be;**

- i. chemically stable
- ii. non staining with agreeable colour and odour
- iii. active against all microbes – bacteria, protozoa
- iv. active even in the presence of blood, pus, exudates and excreta (though action is reduced)
- v. able to spread through organic films and enter folds/ crevices
- vi. cheap
- vii. rapid in action and exert sustained protection
- viii. non-irritating to tissues, should not delay healing
- ix. non-absorbable, produce minimum toxicity if absorbed
- x. non-sensitizing (no allergy)
- xi. compatible with soaps and other detergents
- xii. non destructive to applied surfaces.

### **Uses of Antiseptics/Disinfectants**

- Pre-operative: In surgery for the antiseptics of the surgical area, surgeon's hands, surgical instruments and apparel.
- Home and farm premises
- Water treatment/ purification
- Public health sanitation: in disease outbreaks to reduce the spread of disease through transport vehicles etc.
- Treating local infection e.g skin abrasion and animal husbandry procedures e.g sheeps teat dips or in farrowing houses.
- Preservation of food and drugs

**Factors affecting activity:**

- Temperature and pH
- Period of contact
- Nature of micro organism
- Size of inoculum
- Presence of blood, pus and other organic matter

**Therapeutic index of an antiseptic is defined by comparing the concentration at which it acts on micro organisms with that which produces local irritation, tissue damage or interference with healing.**

**CLASSIFICATION**

Antiseptics/Disinfectants could be classified into:

1. Phenols and derivatives e.g Chloroxylenol, phenol, cresol
2. Oxidizing agents e.g Hydrogen peroxide, potassium permanganate
3. Halogens and halogen containing compounds e.g Iodine, chlorine
4. Biguanides e.g Chlorhexidine
5. Quaternary Ammonium compounds e.g cetrimide
6. Soaps e.g Na and K
7. Alcohols e.g ethanol
8. Aldehydes/Alkylating agents e.g formaldehyde, glutaraldehyde
9. Acids and Alkalis e.g boric acid, acetic acid
10. Silver salts e.g silver sulfadiazine

11. Dyes e.g Gentian Violet
12. Furan derivatives e.g nitrofurazone

### **Phenols and derivatives**

**Phenol/carbolic acid:** Phenolic-type antimicrobial agents have long been used for their antiseptic, disinfectant, or preservative properties, depending on the compound. Although they are often referred to as “general protoplasmic poisons,” they have membrane-active properties which also contribute to their overall activity. Phenol induces progressive leakage of intracellular constituents, including the release of  $K^+$ , the first index of membrane damage. It is bacteriostatic at <1% and bactericidal/fungicidal at 1-2%. 5% solution kills anthrax spores in 48hrs. Oral ingestion and extensive application to skin can cause systemic toxicity - renal damage and convulsions. It is incorporated at concentration of 0.5% in lime wash for walls, as preservative at 0.5% strength in various drugs for injection, vaccines and sera and a concentration of 3-4% is used for chemical sterilization of surgical instruments. Not used as antiseptic because it is corrosive and carcinogenic especially for dogs and cats.

**Phenol coefficient:** Since phenol is one of the oldest disinfectants, it is customary to express the antiseptic activity of a new agent in relation to phenol. The effectiveness of a disinfectant is usually tested by finding a dilution which has the same effect as 1% solution of phenol on the test organism. If the disinfectant killed the organism at a conc. of 0.1%, it has a phenol coefficient of 10.

**Cresol/cresylic acid:** It is methyl-phenol, more active (3-10x) and less damaging to tissues. Used for disinfection of utensils and hands.

**Bis-Phenols:** These are hydroxy-halogenated derivatives of two phenolic groups connected by various bridges. In general, they exhibit broad-spectrum efficacy but have little activity against *P. aeruginosa* and moulds and are sporostatic toward bacterial spores. Triclosan and hexachlorophene are the most widely used biocides in this group, especially in antiseptic soaps and hand rinses. Both compounds have been shown to have cumulative and persistent effects on the skin.

**Hexachlorophene:** Hexachlorophene's (2,2'-dihydroxy-3,5,6,3',5',6'-hexachlorodiphenylmethane) primary action is to inhibit the membrane-bound part of the

electron transport chain. It has a Phenol coefficient of 125. Widely used in surgical scrub routine and as medicated/ deodorant soap (solid and liquid) at a concentration of 0.5-2%.

**Halophenols:** Chloroxylenol (4-chloro-3,5-dimethylphenol; *p*-chloro-*m*-xylenol) is the key halophenol used in antiseptic or disinfectant formulations. Chloroxylenol is bactericidal, but *P. aeruginosa* and many moulds are highly resistant.

### **Oxidizing agents /Peroxygens**

**Hydrogen peroxide** ( $H_2O_2$ ): It is a widely used biocide for disinfection, sterilization, and antiseptics. It is a clear, colorless liquid that is commercially available in a variety of concentrations ranging from 3 to 90%.  $H_2O_2$  is considered environmentally friendly, because it can rapidly degrade into the innocuous products, water and oxygen. Although pure solutions are generally stable, most contain stabilizers to prevent decomposition.  $H_2O_2$  demonstrates broad-spectrum efficacy against viruses, bacteria, yeasts, and bacterial spores. In general, greater activity is seen against gram-positive than gram-negative bacteria; however, the presence of catalase or other peroxidases in these organisms can increase tolerance in the presence of lower concentrations. Higher concentrations of  $H_2O_2$  (10 to 30%) and longer contact times are required for sporicidal activity, although this activity is significantly increased in the gaseous phase.  $H_2O_2$  acts as an oxidant by producing hydroxyl free radicals ( $\cdot OH$ ) which attack essential cell components, including lipids, proteins, and DNA. It has been proposed that exposed sulfhydryl groups and double bonds are particularly targeted. Used for septic wounds, purulent wounds and cavities difficult to access.

**Peracetic acid:** Peracetic acid (PAA) ( $CH_3COOOH$ ) is considered a more potent biocide than hydrogen peroxide, being sporicidal, bactericidal, virucidal, and fungicidal at low concentrations (<0.3%). PAA also decomposes to safe by-products (acetic acid and oxygen) but has the added advantages of being free from decomposition by peroxidases, unlike  $H_2O_2$ , and remaining active in the presence of organic loads. Its main application is as a low-temperature liquid sterilant for medical devices, flexible scopes, and hemodialyzers, but it is also used as an environmental surface sterilant.

**Potassium permanganate:** Occurs as purple crystals, highly water soluble. Acts by oxidation of bacterial protoplasm. Used for gargling, douching and irrigating wounds (1:4,000-1:10,000). Action is slow and high concentration cause burns hence its use is declined.

## Halogen-Releasing Agents

Chlorine- and iodine-based compounds are the most significant microbicidal halogens used in the clinic and have been traditionally used for both antiseptic and disinfectant purposes.

**Chlorine-releasing agents (CRAs):** The most important types of CRAs are sodium hypochlorite, chlorine dioxide, and the *N*-chloro compounds such as sodium dichloroisocyanurate (NaDCC), with chloramine-T being used to some extent. Sodium hypochlorite solutions are widely used for hard-surface disinfection (household bleach) and can be used for disinfecting spillages of blood containing human immunodeficiency virus and parvovirus.

**Chlorine:** Used mainly for water purification and to disinfect inanimate objects. Available in form of sodium and CaHCl (chlorinated lime) or at times  $\text{Na}_2\text{CO}_3$  is added to produce Dakin's solution or addition of Boric acid to give Edinburgh University's Solution (Eusol). The solution could also be made slightly alkaline (Milton's solution).  $\text{Cl}_2$  exerts its antimicrobial effect in form of undissociated hypochlorous acid. This acid is formed when  $\text{Cl}_2$  is dissolved in  $\text{H}_2\text{O}$  and it precipitates proteins.

**Chlorine demand of water:** Organic matter greatly reduces the activity of  $\text{Cl}_2$ . The amount of  $\text{Cl}_2$  bound to organic matter and thus not available for antimicrobial activity is called the  $\text{Cl}_2$  demand. The demand of relatively pure water is low and the addition of 0.5ppm of  $\text{Cl}_2$  is sufficient for disinfection of this water. Grossly polluted water will need 20ppm and above of  $\text{Cl}_2$  for effective antibacterial action.

$\text{Cl}_2$  is being replaced by chloramines or chlorophors which are organic chlorides in which  $\text{Cl}_2$  is bonded weakly with  $\text{N}_2$ . They include chloramine -T, Dichloramine-T, Chlorazodin and Halozone. A 2% solution or powdered form of chloramine-T is used for irrigating wounds. 0.2-0.5% solution is recommended for mouthwash and irrigation of bladder and urethra. Chlorazodine is used for irrigating infected wounds, halozone in tablet form is used for purification of small quantity of water. 15-20mg is suitable for 500ml of water. 4-8mg in 1litre of  $\text{H}_2\text{O}$  will sterilize the  $\text{H}_2\text{O}$  in 15-60mins unless a large quantity of organic matter is in it.

**Iodine and Iodophors:** Although less reactive than chlorine, iodine is rapidly bactericidal, fungicidal, tuberculocidal, virucidal, and sporicidal. Although aqueous or alcoholic (tincture)

solutions of iodine have been used for 150 years as antiseptics, they are associated with irritation and excessive staining. In addition, aqueous solutions are generally unstable. In solution, at least seven iodine species are present in a complex equilibrium, with molecular iodine ( $I_2$ ) being primarily responsible for antimicrobial efficacy. These problems were overcome by the development of iodophors (“iodine carriers” or “iodine-releasing agents”); the most widely used are povidone-iodine and poloxamer-iodine in both antiseptics and disinfectants. Iodophors are complexes of iodine and a solubilizing agent or carrier, which acts as a reservoir of the active “free” iodine. Although germicidal activity is maintained, iodophors are considered less active against certain fungi and spores than are tinctures.

Similar to chlorine, the antimicrobial action of iodine is rapid, even at low concentrations, but the exact mode of action is unknown. Iodine rapidly penetrates into microorganisms and attacks key groups of proteins (in particular the free-sulfur amino acids cysteine and methionine), nucleotides, and fatty acids, which culminates in cell death.

### **Aldehydes**

**Glutaraldehyde:** Glutaraldehyde is an important dialdehyde that has found usage as a disinfectant and sterilant, in particular for low-temperature disinfection and sterilization of endoscopes and surgical equipment and as a fixative in electron microscopy. Glutaraldehyde has a broad spectrum of activity against bacteria and their spores, fungi, and viruses. 1-2% glutaraldehyde in 70% isopropanol is used in surgery.

**Formaldehyde:** Formaldehyde is a monoaldehyde that exists as a freely water-soluble gas. Formalin is an aqueous solution containing 34 to 38% (wt/wt) formaldehyde with methanol to delay polymerization and used for anatomical prep. Its clinical use is generally as a disinfectant and sterilant in liquid or in combination with low-temperature steam. Formaldehyde is bactericidal, sporicidal, and virucidal, but it works more slowly than glutaraldehyde.

**o-Phthalaldehyde:** OPA is a new type of disinfectant that is claimed to have potent bactericidal and sporicidal activity and has been suggested as a replacement for glutaraldehyde in endoscope disinfection. OPA is an aromatic compound with two aldehyde groups.

### **Acids and Alkalis**

**Boric acid:** Has a weak antiseptic effect. Used in irrigating delicate tissues e.g eye conjunctiva. Also as a stabilizer in Chlorine releasing agents.

**Benzoic acid:** Used as food preservative and fungicide.

Others are lactic acid and salicylic acid.

Alkalis include NaOH (caustic soda/soda lime), Na carbonate/ washing soda, CaO (quick/hydrated lime). Used to disinfect animal pens, building, vehicles etc.

### **Alcohols**

Although several alcohols have been shown to be effective antimicrobials, ethyl alcohol (ethanol), isopropyl alcohol (isopropanol) and *n*-propanol (in particular in Europe) are the most widely used. Alcohols exhibit rapid broad-spectrum antimicrobial activity against vegetative bacteria (including mycobacteria), viruses, and fungi but are not sporicidal. They are, however, known to inhibit sporulation and spore germination, but this effect is reversible. Because of the lack of sporicidal activity, alcohols are not recommended for sterilization but are widely used for both hard-surface disinfection and skin antisepsis. Lower concentrations may also be used as preservatives and to potentiate the activity of other biocides. Many alcohol products include low levels of other biocides (in particular chlorhexidine), which remain on the skin following evaporation of the alcohol, or excipients (including emollients), which decrease the evaporation time of the alcohol and can significantly increase product efficacy. In general, isopropyl alcohol is considered slightly more efficacious against bacteria and ethyl alcohol is more potent against viruses; however, this is dependent on the concentrations of both the active agent and the test microorganism. For example, isopropyl alcohol has greater lipophilic properties than ethyl alcohol and is less active against hydrophilic viruses (e.g., poliovirus). Generally, the antimicrobial activity of alcohols is significantly lower at concentrations below 50% and is optimal in the 60 to 90% range.

Little is known about the specific mode of action of alcohols, but based on the increased efficacy in the presence of water, it is generally believed that they cause membrane damage and rapid denaturation of proteins, with subsequent interference with metabolism and cell lysis. This is supported by specific reports of denaturation of *Escherichia coli* dehydrogenases and an increased lag phase in *Enterobacter aerogenes*, speculated to be due to inhibition of metabolism required for rapid cell division.

### **Soaps**

Hard soap (Na oleate obtained from reaction of vegetable oil and NaOH) and soft soap (K oleate obtained from reaction of vegetable oil and frequently coloured with chlorophyll). They have cleansing and antibacterial action but are not too efficient as they are active largely against Gram +ve organisms so should be combined with stronger antibacterial agents e.g alcohol.

### **Quaternary Ammonium Compounds**

Surface-active agents (surfactants) have two regions in their molecular structures, one a hydrocarbon, water-repellent (hydrophobic) group and the other a water-attracting (hydrophilic or polar) group. Depending on the basis of the charge or absence of ionization of the hydrophilic group, surfactants are classified into cationic, anionic, nonionic, and ampholytic (amphoteric) compounds. Of these, the cationic agents, as exemplified by quaternary ammonium compounds (QACs), are the most useful antiseptics and disinfectants. They are sometimes known as cationic detergents. QACs have been used for a variety of clinical purposes (e.g., preoperative disinfection of unbroken skin, application to mucous membranes, and disinfection of noncritical surfaces). In addition to having antimicrobial properties, QACs are also excellent for hard-surface cleaning and deodorization.

**Benzalkonium chloride:** used as a 1% solution for skin, wound or burn dressing. 1% aq solution in 0.2% Na nitrate is used to preserve sterilized instruments and to prevent rust.