4 CHAPTER

CHEMISTRY IN EVERYDAY LIFE

Objectives

- Drugs and Medicines
- Chemicals in Food
- Soaps and Detergents

DRUGS AND MEDICINES

Substances of low molecular masses of about 100 to 500u that interact with macro-molecular targets to produce biological response are called drugs. Biomolecules like carbohydrates, proteins, nucleic acids, lipids, etc., react with drugs. These are the chemicals that are used in diagnosis.

4.1.1 Classification of drugs and medicines

Drugs are used for modifying physiological systems or pathological states for the benefit of the receipient. Drugs that produce biological response therapeutically and that are useful in diagnosis, prevention and treatment of diseases are called medicines. Use of chemicals for therapeutic action is called chemotherapy. An ideal drug has to satisfy the following conditions :

a) It must act efficiently at the expected site, that is, it should be localised.

b) It should not be toxic and should not injure the host tissues and cells.

c) It should have tolerable side effects.

Use of chemicals for treatment of diseases is called chemotherapy

Chemotherapy is the branch of science in which chemical substances are used for treatement of diseases. Drugs are classified on the basis of pharmacological effect molecular targets, chemical structure and on the basis of drug action.

Drugs are classified based on pharmacological effect of the drugs. It is useful for doctors because it provides them the whole range of drugs available for the treatment of a particular type of problem. For example, analgesics have pain killing effect, antiseptics kill or arrest the growth of microorganisms.

Drugs are classified based on molecular targets. Drugs usually interact with biomolecules such as carbohydrates, lipids, proteins and nucleic acids. These are called target molecules or drug targets. Drugs possessing some common structural features may have the same mechanism of action on targets. The classification based on molecular targets is the most classification for medicinal chemists.

On the basis of chemical structure, drugs are classified as glycosides, enols, amines, alcohols, amino acids, etc. Drugs with similar structural features have same mechanism of action and exert similar activity.

On the basis of drug action or therapeutic action, drugs are divided as follows :

Drug producing biological response that is used in diagnosis is called medicine

Analgesics are body pain relievers. Alkaloids are narcotic drugs. They cause depression of central nervous system. They act as strong analgesics.

Antipyretics are body temperature reducers in fever condition. Antimalarials are malarial fever reducing substances.

Antimicrobials kill or stop the growth of microorganisms that cause disease.

Antiseptics kill microorganisms or prevent the growth of microorganisms.

Antibiotics are microorganism killing substances.

Tranquilizers are medicines used in the management of psychoses and neuroses.

Antihistamines interact with natural action of histamine and prevent acidity.

Antacids remove the excess acid in stomach and maintain the normal pH.

4.1.2 Drug–target interaction

Enzymes as drug targets : Proteins which perform the role of biological catalysts in the body are called enzymes. For understanding the interaction between a drug and an enzyme, it is important to know how enzymes catalyses the reaction.

Catalylic action of enzymes : In the catalylic activity, enzymes perform two major functions. The first function of an enzyme is to hold the substrate for a chemical reaction. Active sites of enzymes hold the substrate molecule in a suitable position, so that it can be attacked by reagent effectively. Substrates bind to the active site of the enzyme through a variety of interactions such as ionic bonding, hydrogen bonding, van der Waals interaction as shown in Fig 4.1.

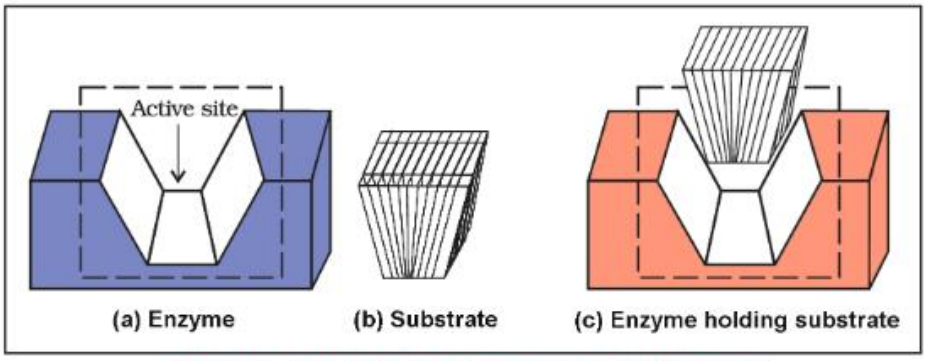


Fig 4.1 (a) Active site of an enzyme (b) Substrate (c) Substrate held in active site of the enzyme

The second function of an enzyme is to provide functional groups that will attack the substrate and carry out chemical reaction.

Drugs compete with natural substrate for their attachment on the active sites of enzyme are called competitive inhibitors

Drug – enzyme interaction : Drugs which can block the binding site of the enzyme and prevent the bonding of substrate, or can inhibit the catalytic activity of the enzyme are called enzyme inhibitor. Drugs inhibit the attachment of substrate on active site of enzymes in two different ways. Some drugs compete with the natural substrate for their attachment on the active sites of enzymes as shown in Fig 4.2. Such drugs are called competitive inhibitors. If the bond formed between an enzyme and an inhibitor is a strong covalent bond and cannot be broken easily, then the enzyme is blocked permanently. The body then degrades the enzyme - inhibitor complex and synthesis the new enzyme.

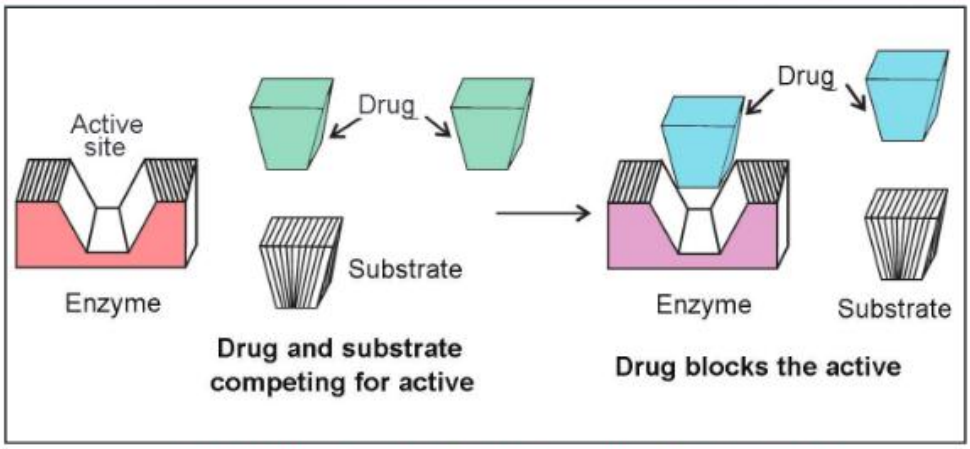


Fig 4.2 Drug and substrate competing for active site

Some drugs do not bind to the enzymes active site but bind to a different site of enzyme which is called allosteric site. This binding of inhibitor at allosteric site changes the shape of the active sites in such a way that substrate cannot recognise it.

Receptors are proteins that are crucial to body's communication process

Receptors as drug targets : Receptors are proteins that are crucial to body's communication process. Majority of these are embedded in cell membrane. Receptor proteins are embedded in the cell membrane in such a way that their small part possessing active site projects out of the surface of the membrane and opens on the outside region of the cell membrane as shown in Fig 4.3.

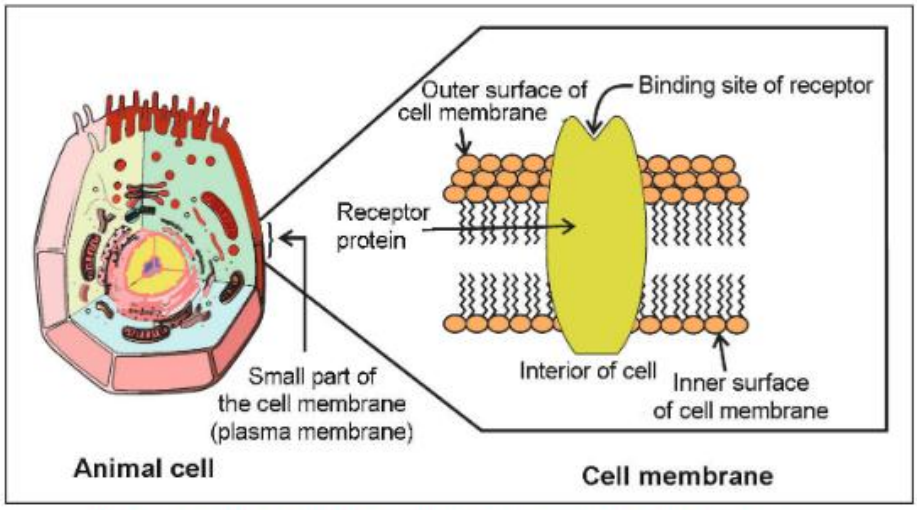


Fig 4.3 Active receptor embedded in animal cell membrane

Chemical messengers communicate between neurons

In the body, message between two neurons and that between neurons to muscles is communicated through certain chemicals known as chemical messengers. These are received at the binding sites of receptor proteins. To accommodate a messenger, shape of the receptor site changes. This brings about the transfer of message into the cell. Thus, chemical messenger cgives message to the cell without entering the cell as shown in Fig 4.4.

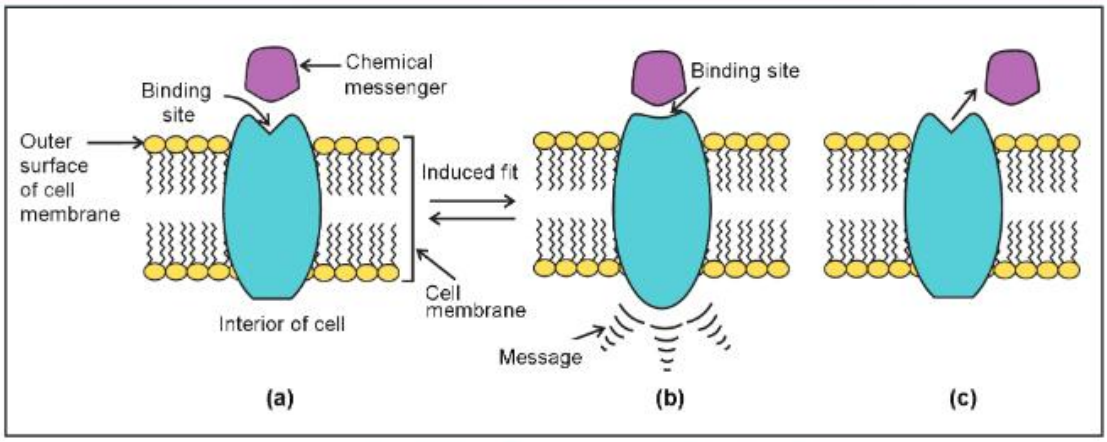


Fig 4.4 (a) Receptor receiving chemical messenger (b) Shape of the receptor changed after attachment of messenger (c) Receptor regains structure after removal of chemical messenger.

Drugs that bind to the receptor site and inhibit its natural function are called antagonists

There are a large number of different receptors in the body that interact with different chemical messengers. These receptors show selectivity for one chemical messenger over the other because their binding sites have different shape, structure and amino acid composition.

Drugs that bind to the receptor site and inhibit its natural function are called antagonists. There are useful when blocking of message is required. These are other types of drugs that mimic the natural messenger by switching on the receptor, these are called agonists. These agonists are useful when there is lack of natural chemical messenger.

4.1.3 Narcotic analgesics

Analgesics reduce pain or abolish pain without causing disturbances to nervous system like mental confusion, impairment of consciousness, incoordination, paralysis etc. Analgesics are of two types. These are narcotic analgesics and non-narcotic analgesics.

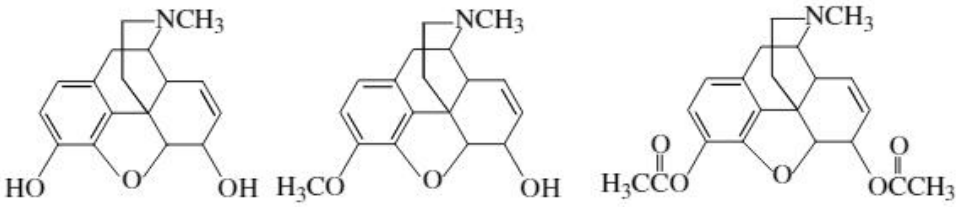
Narcotic drugs are most potent and clinically useful agents that cause depression of central nervous system. These are strong analgesics.

The term narcotic means drowsiness. The narcotic drugs means dependance producing drugs. Narcotic drugs are addictive drugs. The narcotic analgesics tend to produce euphoria. This is a feeling of being happiness and is an important factor in their addictive property.

Morphine, heroin and codeine are narcotic drugs

The examples of narcotic drugs are morphine, heroin, papaverine, thebaine and codeine. The structures of some of these drugs are given below. Morphine and related drugs are obtained from 'opium poppy' and are called opioids or opiates. Morphine and its related compounds may not alter the sensation of pain but they modify the emotional reactions to pain, that is, pain may be present but may not be perceived as painful.

These analgesics are chiefly used for the relief of post operative pains, cancer pains, cardiac pains and in child birth.



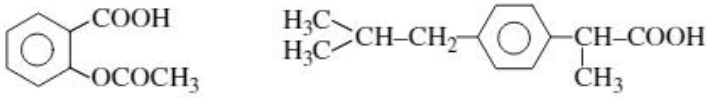
Morphine Codeine Heroin

Morphine, codeine and their homologues when administered in medicinal doses relieve pain and produce sleep. Morphine has pharmacological uses like check diarrhoea, ease dypsnea, supress cough and induce sleep in the presence of pain.

These analgesics are cheifly used for the relief of postoperative pain, cardiac pain, pains of terminal cancer and in child birth.

4.1.4 Non–narcotic analgesics

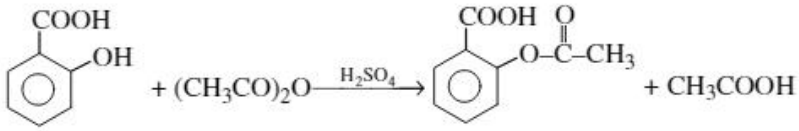
Aniline, aminophenol analogues and salicylates are also used as analgesics. These are non-narcotic analgesics. They have no addictive property. These analgesics are recommended for headache, backache and such mild pains. Aspirin and ibuprofen are important examples of non-narcotic analgesics. The structures of these non–narcotic drugs are given here.



Aspirin Ibuprofen

Acetylation of salicylic acid gives aspirin

Aspirin : Aspirin is chemically acetyl salicylic acid. It is prepared by the acetylation of salicylic acid with acetic anhydride.



Aspirin has antinflammatory, antipyretic and analgesic action

Prostaglandins stimulate inflammation in the tissues and cause pain. Aspirin inhibits the synthesis of prostaglandin. Aspirin has antiblood clotting action. Therefore aspirin is used to prevent heart attacks. Aspirin prevents platelet function.

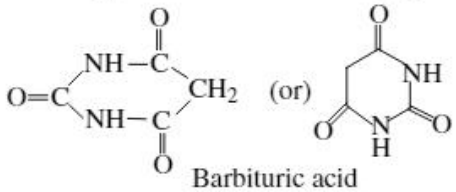
Aspirin is used as anti–inflammatory medicine, analgesic and also as antipyretic. Aspirin gives relief from headache, muscular pains, bodyache and also from fever due to cold. Aspirin finds use in the prevention of heart attacks, because of its anti-blood clotting action.

4.1.5 Tranquilisers

Tranquilizers and analgesics are neurologically active drugs. These affect the message transfer mechanism from nerve to receptor. Drugs that exert a quieting effect accompanied by relaxation and rest are called sedatives. Drugs that induce sleep are called hypnotics.

Sedatives may or may not induce sleep, but hypnotics induce sleep. Same drug taken in small doses acts as sedative but in large amounts acts as hypnotic. However, a sedative need not be a hyptonic and a hypnotic need not be a sedative. potassium bromide is a good sedative but not a hypnotic. Thiopentanol sodium is a powerful hypnotic but not a sedative.

Barbituric acid is malonyl urea. Some derivatives of barbituric acid are important tranquilizers. Barbiturates are hypnotics. These are sleep producing agents.



Barbituric acid

Drug used for treatment of mental stress is called tranquiliser

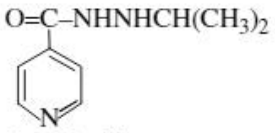
The drugs used for treatment of stress and mental disesases are called tranquilisers. These are divided as major tranquilisers and minor tranquilisers. Major tranquilisers are used for treatment of psychoses and minor tranquilisers are used for treatment of neuroses.

Tranquilisers relieve anxiety, stress, fatigue, irritability and excitement. They induce a sense of well being. Tranquilisers exert their action on the lower brain areas to produce emotional calmness and relaxation. Tranquilisers are also used as muscle relaxants, antihypertensive, antiemetic and antipileptic agents. Tranquilisers are psychotherapeutic drugs.

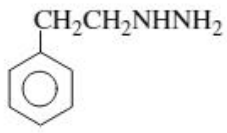
Adrenaline increases the blood pressure

Lower concentrations of nor-adrenaline in blood results in depression

Adrenal gland secrets the two harmones, adrenaline and nor–adrenaline into the blood stream. Adrenaline increases the blood pressure, strengthens the heart rate and widens the passages of the lungs. All these prepare the animal to take a fight or flee. Nor–adrenaline transmits impulses from one end of nerve fibre to the next. If the level of nor–adrenaline is low, the signal sending activity also would be low. This leads to depression. Iproniazid and phenalzine (nardil) are two drugs that inhibit the catalytic degradation activity of nor–adrenaline by enzymes and then the neuro transmitter is slowly metabolised. Iproniazid and phenalzine are antidepressant drugs. The structures of these drugs are given below.

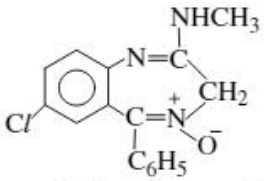


Iproniazid

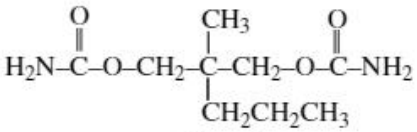


Phenalzine

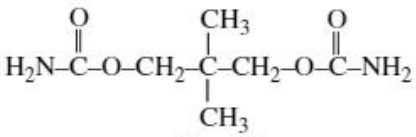
Chlorodiazepoxide and meprobamate are mild tranquilizers. These drugs relieve tension. Equanil is another tranquilizer used in controlling depression and hypertension.



Chloro diazepoxide

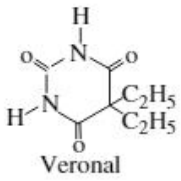


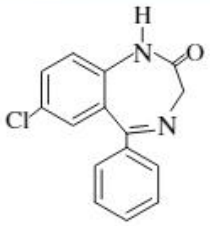
Meprobamate



Equanil

Derivatives of barbituric acid viz., veronal, amytal, nembutal, luminal and seconal constitute an important class of tranquilizers. These derivatives are called barbiturates. Barbiturates are hypnotic, i.e., sleep producing agents. Some other substances used as tranquilizers are valium and serotonin.


Veronal


Valium


Serotonin

4.1.6 Antimicrobials

The microbes that cause disease are called pathogens

The microorganisms like bacteria and viruses which can be seen only under microscope are called microbes. These microorganisms when they reach the tissues causes infection. Toxins produced by the microbes affect the tissues or organs of the host. Multiplication and invasion of the microorganism result in the destruction of normal cell metabolism. This results in disease. The microbes that cause disease are called pathogens.

In human beings and animals many diseases are caused by microorganisms. However body secretions either kill the microbes or inhibit their growth. Skin is impervious to microbes. These body secretions serve as antimicrobials. Lysozyme, fatty acids, lactic acid and hydrochloric acid are some antimicrobials. Antibiotics, antiseptics and disinfictants are antimicrobial drugs.

Antibiotic therapy is like setting one thief against the other

Antibiotics : Antibiotics are chemical compounds derived from a living organism that are capable of destroying the life of microorganisms. The process of opposing the life of one living organism by another is called antibiosis. An antibiotic is used either to abolish microorganism or some times to inhibit the growth of the microorganism. Antibiotic therapy is like setting one thief against the other.

Chemical substance produced by bacteria, fungi and mould which inhibits the growth or kill microorganism is called an antibiotic. It can also be produced completely or partially in chemical synthesis.

Microbial disease can be controlled by a drug that kills the microorganism in the body or that inhibits the growth of microorganism. An antibiotic should have the following properties :

a) It must be a product of metabolism.

b) It should be effective in low concentration.

c) It should antagonise the growth or survival of the microorganism.

d) It should be a synthetic substance produced as a structural analogue of naturally occurring antibiotic.

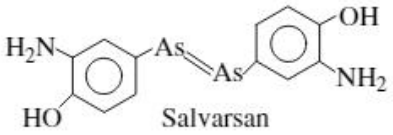
Antibiotic inhibits growth of the microorganisms

Penicillin, chloramphenicol, oflaxacin and sulphadiazene are some important examples of antibiotics.

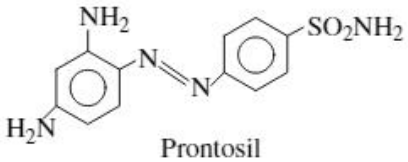
Paul Ehrlich investigated arsenic based structures in order to produce less toxic substances for the treatment of syphilis. He developed the medicine, arsphenamine, known as salvarsan for which he was awarded Nobel prize for medicine. Although salvarsan is toxic to human beings, its effect on the bacteria, spirochete which causes syphilis, is much greater than that on human beings. He worked on azodyes and noted that there is similarity in structures of salvarsan and azodyes. In place of –As=As– linkage in arsphenamine, there is –N=N– linkage in azodyes. He succeeded

Prontosil is first effective antibacterial agent known

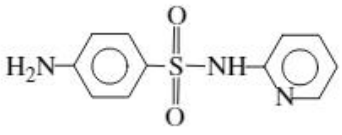
in preparing the first effective antibacterial agent, prontosil, which resembles in structure to the compound, salvarsan. Soon, it was discovered that in the body prontosil is converted to a compound called sulphanilamide, which is the real active compound. Thus, the sulpha drugs were discovered. One of the most effective sulpha drugs is sulphapyridine. The structures of these drugs are given below.



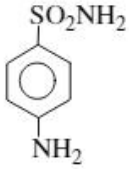
Salvarsan



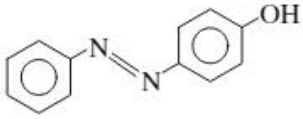
Prontosil



Sulphapyridine



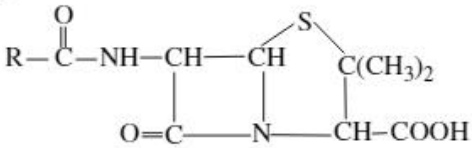
Sulphanilamide



Azo-dye

First antibiotic penicillin was discovered by Fleming

Penicillin : Alexander Fleming discovered penicillin from the mould, penicillium notatum. This is the first antibiotic discovered. The name penicillin is given to a mixture of natural compounds with the molecular formula $C_9H_{11}O_4N_2SR$. The basic general structure is given below.



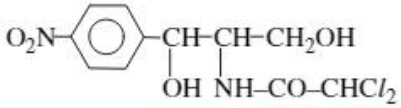
Antibiotics that kill microorganism are called bactericidal antibiotics and that inhibit the growth of microorganism are called bacteriostatic antibiotics. Penicillin, ofloxacin and aminoglycosides are bactericidal antibiotics. Erythromycin, tetracycline and chloramphenicol are bacteriostatic antibiotics.

The complete range of microorganisms attacked by an antibiotic is called broad spectrum antibiotic. Medicines effective against several different types of harmful microorganisms are called broad spectrum antibiotics. Chloramphenicol, tetracycline, vanomycin and ofloxacin are examples of broad spectrum antibiotics.

Ampicillin and amoxycillin are semi synthetic modifications of penicillin

The antibiotics that are effective mainly against Gram–positive or Gram–negative bacteria are called narrow spectrum antibiotics. If the antibiotics are effective against a single organism or disease, they are referred to as limited spectrum antibiotics. Penicillin G has a narrow spectrum. Ampicillin and amoxicillin are semi synthetic modifications of penicillin. They are broad spectrum antibiotics. Some patients are sensitive towards penicillin due to allergy.

Chloramphenicol : This antibiotic is rapidly absorbed from the gastrointestinal track and is given orally to the patients suffering from typhoid fever, acute fever and dysentery. Chloramphenicol is recommended for urinary infections, meningitis and pneumonia. It is a broad spectrum antibiotic. Chloramphenicol has the following structure.



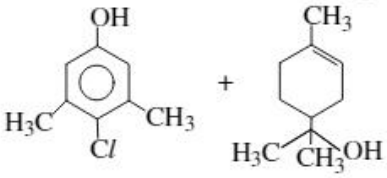
Ofloxacin and vancomycin are important broad spectrum, antibiotics. Dysidazirine is toxic towards certain strains or cancer cells. Streptomycin, another antibiotic is used for treatment of tuberculosis.

Antiseptics and disinfectants : Chemical compounds are used for killing or preventing the growth of microorganisms. These compounds when applied to living tissues like wounds, cuts, ulcers and diseased skin surfaces are called antiseptics. However when applied to inanimate objects like floors and drainage systems, they are called disinfectants. Antiseptics do not harm the living tissues. They can be applied to cuts and wounds. Disinfectants are harmful to living tissues and cannot be used on the skin.

The same substance in low concentration may be used as antiseptic and in high concentration as disinfectant.

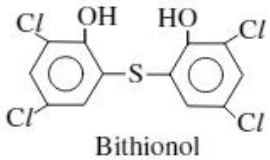
A 0.2% Solution of phenol is antiseptic, but 1% solution of phenol is disinfectant

A 0.2% Phenol solution is antiseptic but 1% phenol solution is disinfectant. Antiseptics are applied externally. They are not ingested. Dettol, bithional, tincture of iodine, iodoform and boric acid are antiseptics. Dettol is a mixture of chloroxylenol and terpineol. Bithional is also called bithionol. It is an antiseptic present in soaps. The structures of these two antiseptics substances are given below.



Chloroxylenol Terpineol

Dettol



Bithionol

Iodine is a powerful antiseptic. An alcohol–water solution containing 2 to 3% iodine is called tincture of iodine. Iodoform was used as antiseptic powder of wounds. A dilute soution of boric acid is antiseptic for eyes. Baby talcum powders contain the antiseptic boric acid. Other examples of antiseptics are furacene, soframycin, etc. Hydrogen peroxide is used as non–irritating strong antiseptic. A dilute solution of hydrogen peroxide is used as mouth wash.

Formalin is used as preservative for biological specimens

Aqueous solution of chlorine in 0.3 ppm concentration, SO_2 in lowest concentration and formalin are disinfectants. Formaldehyde is highly soluble in water. A 40% aqueous solution of formaldehyde is called formalin. It is a preservative for biological specimens.

4.1.7 Antacids and antihistamines

Antacids : The excess of acid in the stomach due to the action of histamine causes irritation, pain and inflammation. If the pain is severe it leads to ulcers. If ulcers are formed, the affected part of the stomach should be removed.

Substances that remove the excess acid in the stomach and rise the pH to the normal level in stomach are called antacids. Examples of antacids include magnesium hydroxide, aluminium hydroxide gel, sodium bicarbonate, magnesium carbonate, magnesium trisilicate and aluminium phosphate. Excess sodium bicarbonate causes the stomach alkaline and triggers the overproduction of acids. Metal hydroxides are better alternatives because of being insoluble and do not increase the pH above neutrality.

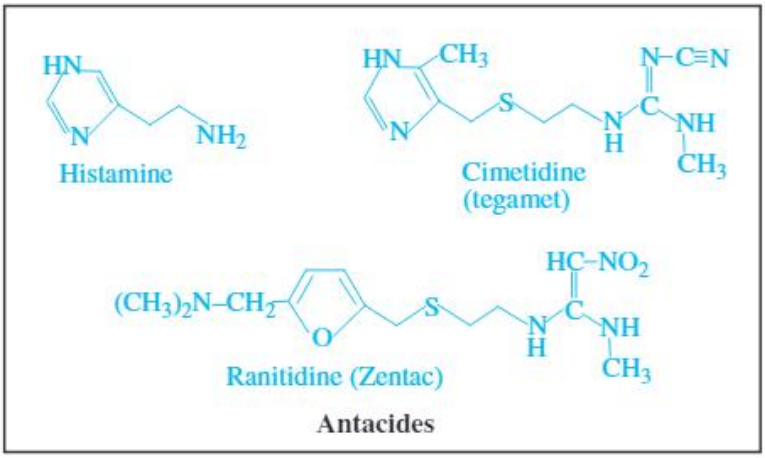
Excess of acids in stomach leads to ulcers

These antacids control the symptoms like inflammation in stomach. But they have no influence on the action of histamine which is responsible for acidity. Omeprazole and lansoprazole are also useful antacids. These prevent the formation of acid in the stomach.

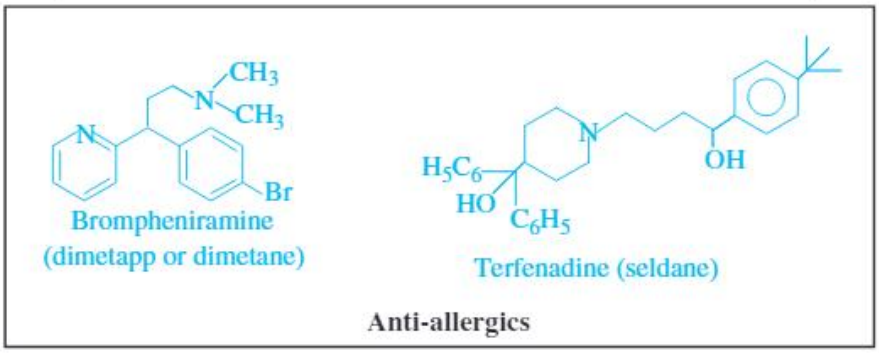
Antihistamine inhibits the action of histamine

Antihistamines : Histamine stimulates the secretion of pepsin and hydrochloric acid into the stomach. The excess of acid in the stomach causes inflammation in the body. Drugs that inhibit the action of histamine are called antihistamines.

Cimetidine was the largest selling antihistamine drug used for acidity until ranitidine was discovered. The structures of the antacids and anti-allergics are given below.



Antacides



Anti-allergics

The antihistamines bind to the sites of receptors in the stomach wall where histamine shows its effect. Antihistamines prevent the interaction of histamine and thus less amount of acid is produced in stomach.

Histamine is a potent vasodilator

Histamine is a potent vasodilator. It controls the smooth muscles in the bronchi and relaxes muscles in the walls of fine blood vessels. Histamine in the body causes allergic reactions like skin–rashes. It also causes nasal congestion associated with common cold and itching of eyes.

Antihistamines are also known as anti–allergic drugs as these are used to treat allergy. These drugs relieve sneezing, nasal discharge and itching of eyes, nose and throat. Antihistamine drugs used for allergy (dimetapp and terfenadine) do not effect the secreted acid in the stomach. The antihistamines cause side effects like retardation from work, drowsiness and impaired alertness.

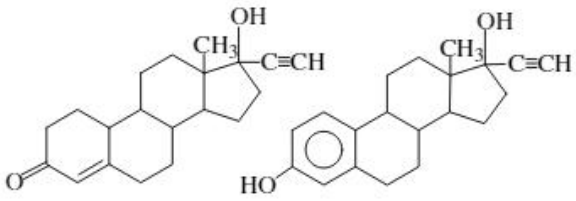
4.1.8 Antifertility drugs

Steroids are antifertility agents

Steroids are antifertility agents. These are used as oral contraceptives in birth control. These oral contraceptives form the active ingredients of the pill. It controls the female menstrual cycle and ovulation.

The birth control pill is a mixture of synthetic estrogen and progesterone derivatives.

The birth control pills contain generally norethindrone and ethynylestradiol. The structures of these drugs are given below.



Norethindrone Ethynylestradiol(Novestrol)

Norethindrone is an example of synthetic progesterone. Ethynylestradiol is estrogen derivative which is used in combination with progesterone derivative.

P.4.1 What is the structural difference between morphine and codeine? Why codeine is more versatile ?

Solution The phenolic –OH group of morphine is methylated in codeine.
The cosumption of codeine is more than that of morphine. This is because, analgesic activity and sedative effect of codeine are lower than those of morphine.

P.4.2 Aspirin is used to prevent heart attack and transient ischemic attacks. Comment.

Solution Aspirin has anti blood clotting action. So it is used to prevent heart attack.
Aspirin inhibits platelet function. So it is used prophylactically to minimise the incidence of myocardinal infraction and transient ischemic attacks.

P.4.3 A patient was suffering from urinary infection. What is the prescribed antibiotic ?

Solution Chloramphenicol is the prescribed medicine to the patient. It can be given orally to the patient as a tablet. This is because of rapid absorption by the gastrointestinal track.

P.4.4 What is the difference between disinfectants and antiseptics? Can the same chemcial be used for both the pruposes ?

Solution Chemical compounds are used for killing or preventing the growth of microorganisms. Compounds when applied to living tissues like wounds, cuts, ulcers and diseased skin surfaces are called antiseptics. However when applied to inanimate objects like floors and drainage systems, they are called disinfectants. Same chemical in low concentration may be used as antiseptic and in high concentration as disinfectants. 0.2% Phenol solution is antiseptic but 1% phenol solution is disinfectant.

P.4.5 What do you understand by mild tranquilizer? Give examples.

Solution Meprobamate and chlorodiazepoxide are mild tranquilizers and are suitable for relieving tension.

P.4.6 Is ranitidine an antacid or antihistamine? Can it be used for both purposes ?

Solution Ranitidine is an antihistamine. Ranitidine can also be used as an antacid because of the presence of –NH– group in its molecule.

P.4.7 What are antifertility drugs ?

Solution Steroids are antifertility agents.

They are used as oral contraceptive in birth control. They control the female menstrual cycle and ovulation.

EXERCISE - 4.1.1

1. Why do we need to classify drugs in different ways?
2. What happens when a drug is used in more than prescribed amounts?
3. What are analgesics? How are they classified? Give the preparation of codeine from morphine.
4. What are coal tar analgesics?
5. Discuss the preparation of aspirin. Write the necessary equation.
6. Why shoud not the medicines be taken without consulting doctors?
7. Name any two compounds that are derivatives of barbituric acid. Give their structures.
8. What are tranquilisers? Mention some derivatives of 2–phenylethylamine that act as tranquilisers.
9. What are antimicrobials? Give the general formulae and derivatives of penicillin.
10. What are antacids? Give examples.
11. What are antihistamines? Give examples.
12. Mention the active ingradients of the oral contraceptive pill. Write its structure.

CHEMICALS IN FOOD

Many chemical substances are added to food to improve its appeal and to preserve it. Main categories of food additives are

i) Food colours

ii) Flavours and sweeteners

iii) Fat emulsifiers and stabilising agents

iv) Flour improvers - antistaling agents and bleaches

v) Antioxidants

vi) Preservatives

vii) Nutritional supplements such as minerals, vitamins and amino acids.

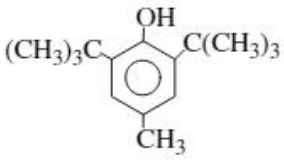
Food additives make the food attractive and palatable

The food additives make the food attractive and palatable. Most of them (categories i to vi) have no nutritive value. These are added either for ease in processing or for cosmetic purposes.

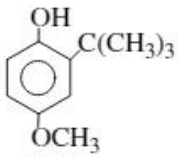
4.2.1 Antioxidants

Chemicals that retard the action of oxygen on food and preserve the food are called antioxidants. These arrest the aging process of the food by preventing the food from spoilage. These are sacrificial materials.

Antioxidants are more reactive towards oxygen than the food they protect. In the aging process of food, antioxidants reduce the involvement of free radicals. Butylated hydroxy toluene (BHT) and butylated hydroxy anisole (BHA) are familiar antioxidants. Their structures are given below.



BHT



BHA

Butylated hydroxy anisole when added to butter increases its storage from months to years. BHT and BHA are added in combination with citric acid or ascorbic acid to produce more active synergisic effect.

Sulphur dioxide and sulphites are used as antioxidants for wine, beer, sugar syrup, cut peeled vegetables and dried fruits.

4.2.2 Preservatives

Sodium benzoate is used as food preservative

At the harvest time, palatability and wholesomeness of many foods reach a peak. In the food processing units, from the production line, food comes with most apetizing appeal. On long standing it loses colour, flavour, apetitic appeal and texture. To delay these changes, preservatives are added to food. The food preservatives prevent the spoiling of food due to microbial growth. Certain organic acid derivatives are efficient preservatives, of which sodium benzoate (C_6H_5COONa) is an important and familiar food preservative. Salts of sorbic acid and propionic acid are also used as preservatives.

Sulphur dioxide in low concentration is used for sterlizing and preservation of squashes. Sodium benzoate of concentration, 0.06% to 0.1% is sufficient for the preservation of fruit juices and squashes. Potassium metabisulphite or sodium metabisulphite is used for the preservation of colourless food materials such as fruit juices, squashes, apples, liches and raw mango chutney.

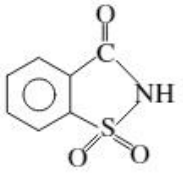
Edible colours added to the food to enhance their visual appeal. The colours used for food are essentially dyes. Food dyes add nothing to the nutritive value of food. Proper care must be taken that these added colours are safe for health.

4.2.3 Artificial sweeteners

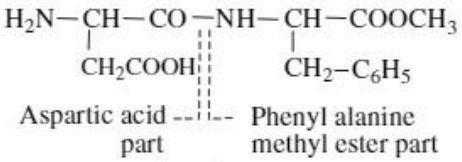
Saccharin was the first artificial sweetner

Sugar used in foods add calories to intake. Chemicals used in food in place of sugar or sucrose are called artificial sweeteners. The artificial sweeteners do not add calories to intake. Examples are saccharin, aspartame, alitame and sucralose.

Saccharin was the first popular artificial sweetener. It is 550 times more sweeter than cane sugar. Saccharin is useful to diabetic persons. Saccharin is orthosulpho–benzimide. It has the following structure.



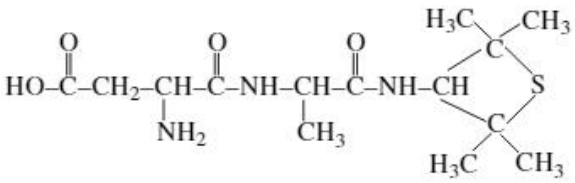
Aspartame is another most widely spread artificial sweetener. It is 100 times more sweeter than sucrose. Aspartame is unstable at cooking temperatures. This limits its use as a sugar substitute. It is used for cold foods and soft drinks. Aspartyl phenyl alanine methyl ester is called aspartame. It is a dipeptide and has the following structure. It is formed from aspartic acid and phenyl alamine.



Aspartame

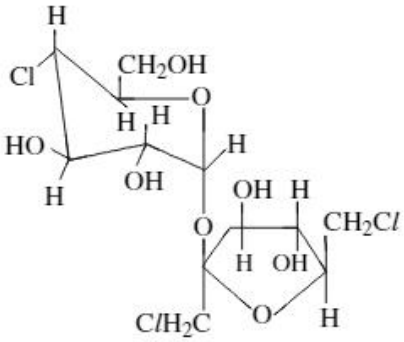
Alitame is 2000 times more sweeter than sucrose

Alitame is a high potency sweetner. It is 2000 times more sweeter than sucrose. Alitame is more stable than aspartame during cooking food, but the control of sweetness of food is difficult. Alitame has the following structure.



Sucralose is similar to sucrose in appearance and taste, but has no calorie addition

Sucralose is trichloro derivative of sucrose. Its appearance and taste are similar to that of sugar. It is 600 times more sweeter than sucrose. It has no calorie addition. Sucralose has the following structure.



P.4.8 Antioxidants are called sacrificial chemicals. Comment.

Solution Antioxidants retard the action of oxygen on food and preserve it.

Antioxidants are more reactive towards oxygen than the food materials they protect.

Hence antioxidants are called sacrificial chemicals.

P.4.9 Sodium benzoate is the most important food preservative. Suggest reason.

Solution When sodium benzoate is used as food preservative it is metabolised by the conversion into hippuric acid, which is finally excreated in the urine.

So, it is the most important food preservative.

P.4.10 What are artificial sweeteners ?

Solution Artificial sweeteners are the chemicals used in food in place of natural sugar or sucrose. Artificial sweeteners do not add calories to the intake.

P.4.11 Aspartame is less preferred than sucralose as sweetner. Why?

Solution Aspartame is not stable at cooking temperature but sucralose is stable. It is 160 times more sweeter than sucrose but sucralose is 550 times more sweeter than sucrose.

EXERCISE - 4.1.2

1. What are food preservatives? Give examples.
2. Synthetic food colours are not advisible. Why?
3. What are the advantages of artificial sweetening agents? Write the structures of alitame saccharine, sucralose and aspartame.

CLEANSING AGENTS

Water is most abundant and has high dissolving power. Natural waters contain large number of dissolved ionic substances. Due to the presence of ions Ca^{2+} and Mg^{2+} in water, it acquires hardness. The water sample is then called hard water.

4.3.1 Soaps

Soap is sodium salt of higher organic acids like stearic acid, oleic acid and palmitic acids. These are formed by heating fat or oil (i.e., glyceryl ester of fatty acid) with aqueous sodium hydroxide solution. This reaction is called saponification. Generally potassium soaps are soft to the skin than sodium soaps.

These can be prepared by using potassium hydroxide solution in place of sodium hydroxide. When soap is added to hard water, the cations, Ca^{2+} and Mg^{2+} cause the precipitation of soap. This precipitate adhers to cloth surface and decreases the ability of soap to remove the oil and grease from the fabric.

$$\begin{array}{l} CH_2\text{–}OCO\text{–}C_{17}H_{35} \\ | \\ CH\text{–}OCO\text{–}C_{17}H_{35} \\ | \\ CH_2\text{–}OCO\text{–}C_{17}H_{35} \end{array} + 3NaOH \longrightarrow \begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array} + 3C_{17}H_{35}COONa \quad (soap)$$

Soap is sodium salt of fatty acid like stearic acid

Only sodium and potassium soaps are soluble in water and are used for cleaning purposes. Toilet soaps are prepared by using better grades of fats and oils and care is taken to remove excess alkali. Colour and perfumes are added to make these soaps more attractive. Transparent soaps are made by dissolving the soap in ethanol and then evaporating the excess solvent. Soaps that float on water are made by beating tiny air bubbles before their hardening.

Rosin is added in making shaving soaps

If substances of medicinal value are added, they are called medicated soaps. Shaving soaps contain glycerol to prevent rapid drying. A gum called, rosin is added while making shaving soaps. It forms sodium rosinate which lathers well. Laundry soaps contain fillers like sodium rosinate, sodium silicate, and borax.

Soap chips are made by running a thin sheet of melted soap onto a cool cylinder and scraping off the soaps in small borken pieces. Soap granules are dried miniature soap bubbles.

Soap powders and scouring soaps contain some soap, a scouring agent (abrasive) such as powdered pumice or finely divided sand, and builders like sodium carbonate and trisodium phosphate. Builders make the soaps act more rapidly.

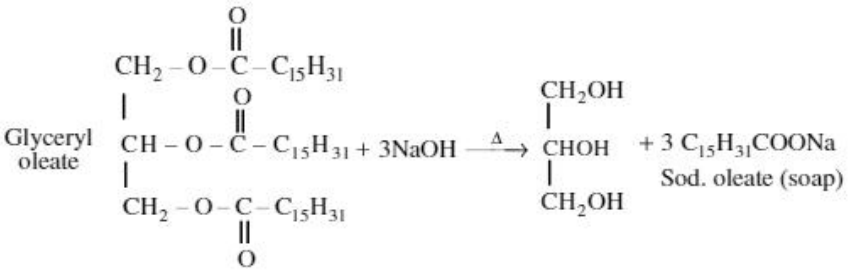
P.4.12 What is saponification reaction ?

Solution Soap is a sodium salt of higher organic fatty acid. The formation of soap from fat or oil with sodium hydroxide solution is called saponification.

Saponification reaction is chemically base hydrolysis of glyceryl ester of fatty acid.

P.4.13 Write the chemical equation for preparing sodium soap from glyceryl oleate.

Solution



P.4.14 What is the action of soap with hard water ?

Solution Soap is soluble in soft water. Hard water contains soluble Ca^{2+} and Mg^{2+} salts.

Soap reacts with these ions of hard water and precipitates calcium sterate and magnesium stearate.

4.3.2 Synthetic detergents

Synthetic detergents are the salts of fatty sulphonic acids. The anions of synthetic detergent does not precipitate in the presence Ca^{2+} and Mg^{2+} ions. So, the cleaning action of synthetic detergent is not affected by hard water.

Alkyl benzene sulphonate is anionic detergent

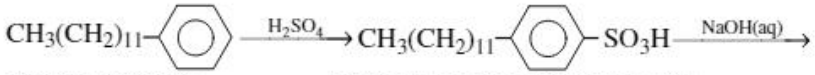
Detergents are classified into three types. They are anionic detergents, cationic detergents and non–ionic detergents. Each type of detergent has its specific use.

Anionic detergents : In the detergent, if the largest part of the molecule is anion, it is called anionic detergent. eg : Alkyl benzene sulphonate.

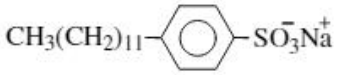
Long chain alcohols were used in the manufacture of anionic detergents. The long chain alcohol is treated with concentrated sulphuric acid to give alkyl hydrogen sulphate. This high molecular mass compound is treated with alkali to give the salt, which is the anionic detergent.

$$\underset{\text{Lauryl alcohol}}{CH_3{-}(CH_2)_{10}{-}CH_2OH} \xrightarrow{H_2SO_4} \underset{\text{Lauryl hydrogen sulphate}}{CH_3{-}(CH_2)_{10}{-}CH_2OSO_3H} \xrightarrow{NaOH\,(aq)}$$

$$\underset{\text{Sodium lauryl sulphate (detergent)}}{CH_3{-}(CH_2)_{10}{-}CH_2OSO_3^{-}Na^{+}}$$



Dodecyl benzene — Dodecyl benzene sulphonic acid



Sodium dodecyl benzene sulphonate

Anionic detergents are mostly used for household purpose. They are also used in toothpastes.

Soap when reacts with slightly acidic solution gives a precipitate of fatty acid Detergent in slightly acidic solution gives soluble alkyl hydrogen sulphate.

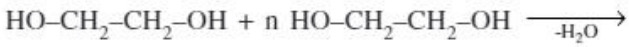
Cetyl trimethyl ammonium chloride is cationic detergent

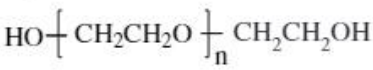
Cationic detergents : Cationic detergents are mostly acetates or chlorides or bromides of quaternary amines.

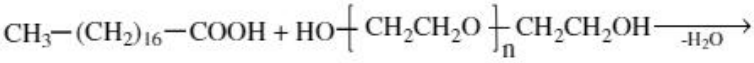
eg : Cetyl trimethyl ammonium bromide, formula : $CH_3\text{-}(CH_2)_{15}\text{-}N(CH_3)_3^+\ Br^-$.

Cationic detergents are more expensive than anionic detergents. So, cationic detergents are limited in use. Cationic detergents have germicidal properties and they are useful germicides. Cetyltrimethyl ammonium bromide is a popular cationic detergent and is used in hair conditioners.

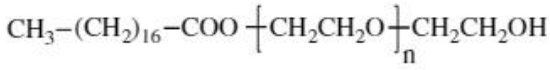
Non–ionic detergents : Liquid dish washing detergents are non–ionic detergents. The reaction of stearic acid with polyethylene glycol gives an ester, called non–ionic detergent. Polyethylene glycol is obtained from ethylene glycol and ethylene oxide.







Stearic acid — Polyethyleneglycol



Branched chain deteregents are non–biodegradable

The hydrocarbons used earlier for the manufacture of detergents were highly branched. When detergent molecules are associated, branched hydrocarbon chains stop bacteria from attacking and breaking the chains. The slow degradation and hence over accumulation of detergents in rivers and waterways causes pollution.

Detergents with straight chain of hydrocarbons are preferred over branched chain. This is because the branched chain deteregents are non–biodegradable. Now a days the branching was kept minimum in the manufacture of detergents. So, the unbranched chains of the detergent are readily attacked by bacteria. This results in easy bio–degradation of the detergent and prevents pollution in waterways.

P.4.15 What are synthetic detergents ? How many types are these detergents ?

Solution Synthetic detergents are the salts of fatty sylphonic acids. Cleaning action of synthetic detergent is not affected with hand water as detergent anion does not precipitate with calcium or magnesium ions present in hand water.

Synthetic detergents are mainly classified into three types :

(a) anionic detergents (b) Cationic detergents (c) non-ionic detergents

P.4.16 Detergents are advantageous over natural soaps. Explain.

Solution Naturally occurring water contains dissolved materials, especially ionic substances. The presence of Ca^{2+} and Mg^{2+} ions in water causes hardness to water. These ions of hard water produce a curdy white precipitate with soap.

This precipitate adhers to cloth and the ability of soap to remove grease and oil from fabric is decreased.

However, if detergent is used, its anions are not precipitated by Ca^{2+} and Mg^{2+} ions of hard water.

So, cleaning action of detergent is not influenced by hardwater. For this reason, detergents are advantageous than soaps.

P.4.17 The detergents used in olden days caused pollution in rivers and waterways. Comment.

Solution Earlier used detergents have great deal of branching in their hydrocarbon tails.

The detergent molecules associate with branched chain hydrocarbon tails. These side chains stop bacteria from attacking and breaking.

This results in slow degradation of detergent molecules and leads to the accumulation of detergent molecule. This causes pollution in rivers and waterways.

P.4.18 Stright chain of a hydrocarbon is preferred over branched chain as a detergent. Why ?

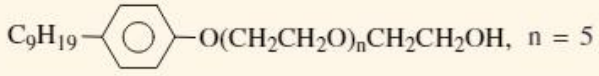
Solution Branched chain detergents are non–biodegradable. Unbranched hydrocarbon chain of a detergent is readily attacked by bacteria and hence is preferred.

EXERCISE - 4.1.3

1. What are soaps chemically?
2. Name different types of soaps. Write suitable examples.
3. What are soft soaps? How are they prepared?
4. Write the differences between soapes and detergents.
5. What are synthetic detergents? How are they better than soapes.
6. Can we use a detergent with hard water for the purpose of cleaning? Explain with suitable example.
7. What are the types of detergents? How are they prepared?
8. What are biodegradable detergents?
9. Branched chain detergents are non-biodegradable. Why?

1. Chemotherapy is the branch of science in which chemical substances are used for treatment of diseases.
2. On the basis of chemical strucutre, drugs are classified as glycosides, enols, amines, alcohols, amino acids, etc.
3. Analgesics are body pain relievers. Antibiotics are microorganism killing substances. Antacids remove the excess acid in stomach and maintain the normal pH.
4. Narcotic drugs are most potent and clinically useful agents that cause depression of central nervous system. These are strong analgesics.
5. Aspirin is used as antiinflammatory medicine, analgesic and also as antipyretic.
6. Drugs that exert a quieting effect accompanied by relaxation and rest are called sedatives.
7. The derivatives of barbituric acid are called barbiturates. They exert a depressant action on the cerebrospinal axis.
8. Valium is a tranquiliser. Serotonin and dopamine are very important neurotransmitters. Amphetamine is a powerful stimulant.
9. Class of chemicals used for the treatment of stress are called tranquilisers.
10. Antibiotics are chemical compounds derived from a living organism that are capable of destroying the life of microorganisms.
11. Compounds when applied to kill microorganisms in living tissues are called antiseptics. However when applied to inanimate objects like floors and drainage systems they are called disinfectants.
12. Formaldehyde is highly soluble in water. Its 40% aqueous solution is called formalin. It is a preservative for biological specimens.
13. Histamine is a potent vasodilator and stimulates the secretion of pepsin and hydrochloric acid in the stomach. Antihistamines stop the natural action of histamine.
14. Steroids are antifertility agents and are used asoral contraceptives in birth control.
15. Chemicals that retard the action of oxygen on food and preserve the food are called antioxidants. BHT, BHA, sulphite and sulphur dioxide are common on antioxidants.
16. The food preservatives prevent the spoiling of food due to microbial growth. Sodium benzoate is a familiar food preservative.
17. The colours used for food are essentially dyes. Tetrazine is a widely used food dye.
18. Chemicals used in food in place of sugar or sucrose are called artificial sweeteners.
19. Soap is a sodium salt of higher organic acids like stearic acid.
20. Synthetic detergents are very similar to the salts of fatty acids. Detergents are classified into anionic, cationic and non–ionic detergents.

EXERCISE - 4.2

1. Suggest examples and give structures of antiseptic, anaesthetic and insecticide.
2. Name three different classes of chemicals that can be called antimicrobials.
3. What are antidepressants? Give examples.
4. Write the structure of the antifertility drug that is used as 'morning after pill' in many countries.
5. Suggest two medicines that are both antacids and antihistamines.
6. Write the IUPAC name of the non-opiate drug that has antipyretic and analgesic propertes. Give its preparation.
7. Write the sequence of reagents required to prepare paracetamol from benzene.
8. Write the semisynthetic modifications of penicillin.
9. All hypnotics need not be barbiturates. Comment.
10. What are pathogens? What is the harm caused by them in our body? Suggest remedy for the cause.
11. Write the characteristic properties of antibiotics.
12. Write the structural formula of three narcotic analgesics.
13. Discuss the role played by adrenaline and nor–adrenaline.
14. What is the difference between the antacids metal hydroxides and cimetidine.
15. How the action of oxygen on food is reduced?
16. Differentiate between soap and detergent.
17. Distinguish between ionic and non–ionic detergents.
18. What are antioxidants? Give examples.
19. What are the characteristics of artificial sweeteners? Write examples.
20. Write the characteristics and examples of food preservatives and edible colours.
21. What is the use of BHT and BHA? Write their structural formulae.
22. What is saponification? Give one example along with equation.
23. What are non-biodegradable detergents? Write the consequences of using these detergents.
24.  , n = 5 to 10 is a non-ionic detergent molecule. Identify the functional groups present in it.