# 17

# Chemistry in Daily Life

## 17.1 Chemistry in Human Health

Chemistry influences almost every aspect of human life and most important aspect is medicines used for human health. Airl pollution, hereditary disorders, accidents, bacterial infections, etc. are reasons, for diseases in human beings. Various medicines are used for treatment and prevention of diseases. Medicines used in different fields of medical sciences like Ayurved, Unani, etc., are either naturally occuring or synthesized materials by chemists. Use of chemicals for therapeutic effect is called chemotherapy.

Drugs are chemicals of low molecular masses, which interacts with biomolecules like carbohydrates, lipids, proteins, nucleic acids, etc., that involves in various biological processes and produce a useful biological response. These useful responses are used in diagnosis and treatment of diseases in human beings and living organism.

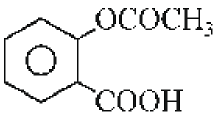
A doctor selects suitable medicine according to the symptoms of the disease. Classification of medicines/ drugs is useful for their selection. Medicines can be classified on the basis of various criteria like pharmacological effect, chemical strucuture, target molecules, etc.

### 17.1.1. Analgesics

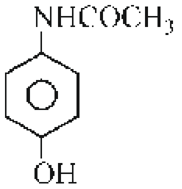
Chemicals used for getting relief or reduce pain are called analgesics. These are neural activating drugs/ medicine. These are classified into two types :

(i) **Non Narcotic drugs :** These are non-habit forming chemicals or analgesics. These drugs also have effect such as reducing fever (antipyretics).

Examples : Aspirin, Paracetamol, etc. are non narcotic drugs.



aspirin
(2-acetoxy benzoic acid)

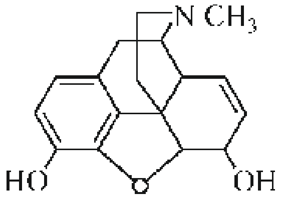


paracetamol
(4-acetamino phenol)

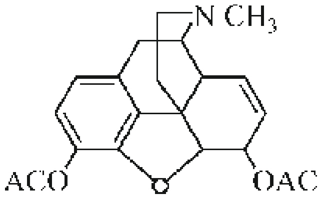
Aspirin should not be taken empty stomach. On hydrolysis aspirin form salicylic acid, which produce ulcers in the walls of stomach.

(ii) **Narcotic Drugs :** In case of acute and unbearable pain, these analgesic drugs are used, which cause sleep and unconsiousness. These are called Narcotic drugs or analgesic. These are habit forming drugs.

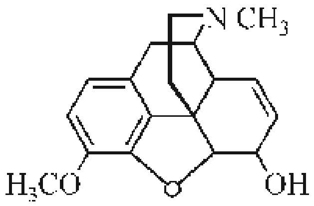
Example :- Morphine, codeine, Heroin etc.



morphine



heroin

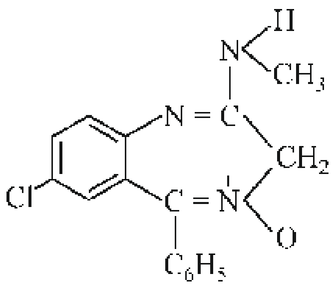


codeine

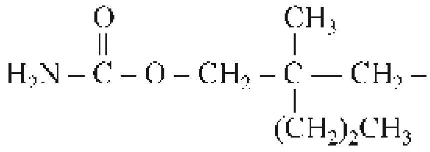
### 17.1.2 Tranquillizers :

The chemical compound, used for diagnosis and treatment of mental diseases, are called tranquillizers. These are neurologically active drugs and have effect on central nervous system. These give relief from anxiety, stress, irritability, excitement, etc. They have a hypnotic effect, so these are the common constituents of sleeping pills.

**Example :** Maprobamate, equanil, chlordiazepoxide, etc.

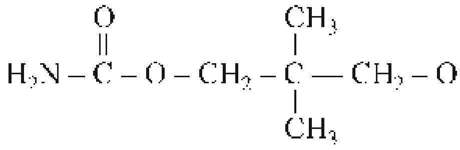


chlordiazepoxide



$$H_2N-\overset{\overset{\displaystyle O}{\|}}{C}-O-CH_2-\underset{\underset{\displaystyle (CH_2)_2CH_3}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}-CH_2-O-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2$$

meprobamate

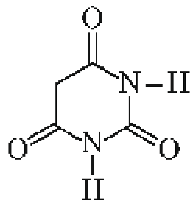


$$H_2N-\overset{\overset{\displaystyle O}{\|}}{C}-O-CH_2-\underset{\underset{\displaystyle CH_3}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}-CH_2-O-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2$$

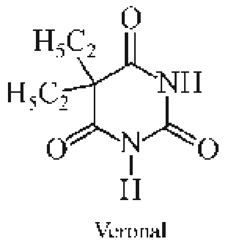
equanil

**Barbiturates :** Derivatives of barbituric acid are an important class of tranquilizers. These cause sleep i.e. these are sleep producing agents.

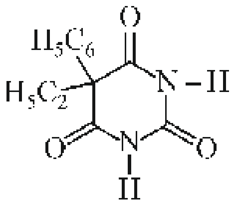
**Example :** Varonal, luminal, Saconal etc.



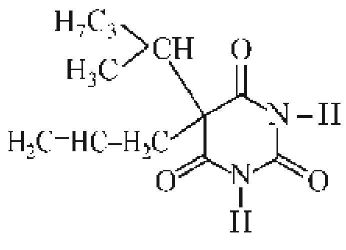
barbituric acid



Veronal



luminal



seconal

### 17.1.3 Antimicrobials

The chemicals which tends to prevent or kill growth of microbes or like bacteria, virus, fungi, etc. are called anti microbials.

Many diseases in human beings and animals may be caused by a variety of microorganisms such as bacteria, virus, fungi and pathogens. On the basis of nature of microbes, a variety of antimicrobials are used to destroy or prevent their growth. For bacteria, fungi, viruse and parasites, antibacterial, antifungal agents, antivirus agents and antiparasitic drugs are used, respectively.

Microorganisms are very small in size. These can be observed under microscope only. Many substances are secreted in body, which destroys these microorganisms but if there is any problem in secretion of these substances, then these microorganism cause diseases by infecting tissues. The diseases caused by these microorganisms can be controlled by three methods :

(i) Use of such medicines which destroy micro organisms present in the body. These medicines are called bactericidal.

(ii) Use of such medicines which stops the growth of microorganism. These are known as antibacterial drug.

(iii) By increasing immunity in the body.

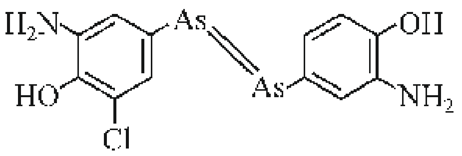
Antibiotic and Antiseptics are antimicrobial drugs/ medicines.

### 17.1.4 Antibiotic

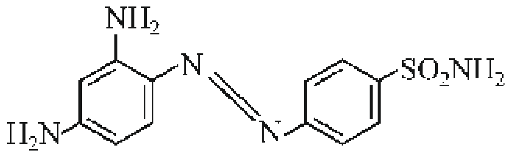
Antibiotics are drugs produced by bacteria, and fungus and are used to kill or prvent the growth of microorganisms by intervening in their metabolic processes. These type of compounds can also be synthesized which can work as antibiotics. So in other words, antibiotics are the chemicals synthesized partially or wholly, which inhibit the growth of micro organisms or destroy them by intervening in their metabolic processes.

Firstly, in nineteenth centuary, a German Bacterio-logist Paul Ehrlich synthesized "arsphenamine" also known as "Salvarsan", for the treatment of syphilis.

In the year 1932, one more antibiotic "Prontosil" was prepared. The structure of "prontosil" is simillar to the structure of "Salvarsan". In prontosil, there is –N=N– bond in place of –As = As –.



salversan



prontosil

The reactivity of "Prontosil" is shown by a group p-amimo benzene sulphonamide (-$C_6H_4SO_2NH_2$) present in it. Thus the sulpha drugs were discovered and a large range of sulphonamide analogues were synthesized.

In 1929 Alexander Fleming discovered antibiotic from the fungus Penicillium Notatum and named it Penicillin. It took thirteen years for separation and isoloation of penicillin for medical text. Fleming was given Nobel prize in medical science for this discovery in 1945.

**Antibiotics are of two types :**

**(1) Bactericidal antibiotics :** These have killing effect on microbes. For example : Pencillin, Ofloxacin, amino glycosides, etc.

**(2) Bacteriostatic antibiotics :** These have a inhibitory effect on microbes.

**For example :** Chloramphenicol, Erythromycin, tetracycline, etc.

Bacteria are of two types-gram positivie and gram negative. The range of bacteria that is affected by a certain antibiotic is expressed as its "Spectrum". On this basis, antibiotic can be divided into three types-

**(i) Broad Spectrum Antibiotics :** Antibiotic which kill or inhibit a wide range of Gram positive and Gram negative bacteria are said to be broad spectrum antibiotics.

**Example :** Ampicillin, amoxicillin, etc.

**(ii) Narrow Spectrum Antibiotics :** These are effective against Gram positive or Gram negative bacteria.

**(iii) Limited Spectrum Antibiotics :** These are effective against a single organism or disease.

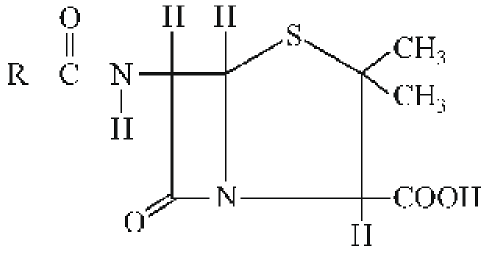
**Example :** Penicillin G.

With the help of antibiotics, many infectious diseases can be cured. These are highly specific in nature and its small amount is effective against micro organism. Some of the important antibiotics are -

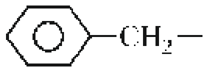
### (A) Penicillin :

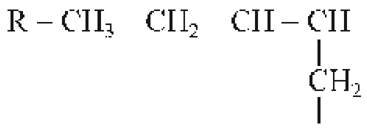
Total six naturally occuring penicillins are separated. Penicillin G is mostly used. Ampicillin and amoxicillin are synthetic modifications of penicillins.

Penicillin is used for treatment of Pneumonia, Bronchitis. It is absolutely essential to test the patients for sensitivity to penicillin before it is administered because some person have allergy with this.



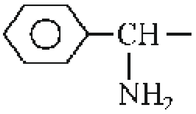
general structure of penicillin

Penicillin G : R = 

Penicillin P : 

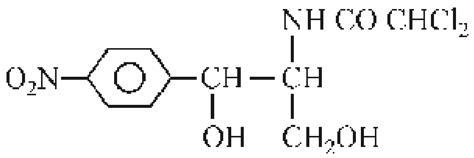
$R-CH_3 \quad CH_2 \quad CH-\underset{|}{\overset{}{CH}}$ $\;\; CH_2$

Penicillin K : $R = CH_3-(CH_2)_6-$

ampicillin : 

### (B) Chloramphenicol :

It is also known as chloromycetin. It is used in treatment of dysentery, Pneumonia, acute fever, typhoid, etc.



structure of chloramphenicol

#### (C) Streptomycin –

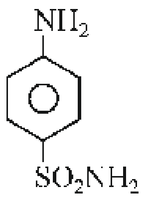
It is used in the treatment of tuberculosis. It is a broad spectrum antibiotic. It is also used in treatment of mental disease and Pneumonia.

#### (D) Tetracyclines –

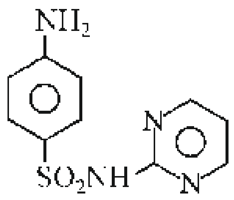
The main antibiotic of this group are iromycine, teramycine. Iromycine is used in treatment of eye infection and teramycin is used in the treatment of typhoid.

#### (E) Sulpha Drugs –

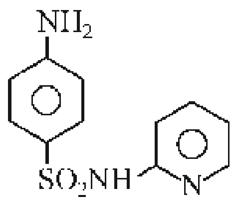
These are sulphonamides and its derivatives. These are used in treatment of diseases caused by Cocoi infection. For example - Sulfadiazine, Sulfaguanidine, Sulfapyridine, Sulfathiazole, etc.



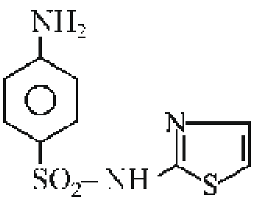
sulfanilamide (aminobenzene sulphonamide)



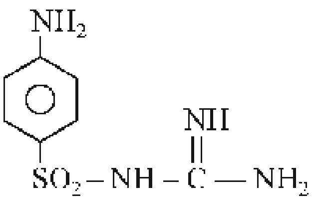
sulfadiazine



sulfapyridine



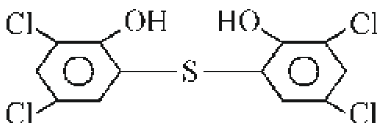
sulfathiazole



sulfaguanidine

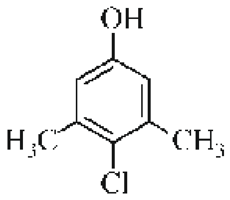
### 17.1.5 Antiseptics–

Chemicals which are used either to kill or stop the growth of harmful microorganism and not affect living tissues, are called antiseptics. Antiseptics are applied to the living tissues such as cut or wounds in skin. Antiseptics are used to reduce the odours produced by bacterial decay. These are mixed in mouth wash, deodorant, toothpaste, tooth powder and face powder. Bithionol is mixed in soap to add antiseptic property in it.

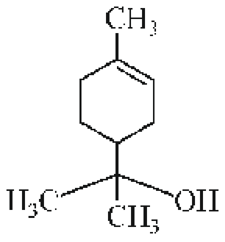


Bithionol

Iodine is a strong antiseptic. Tincture of iodine is a 2-3% solution of iodine in a mixture of alcohol and water. Dettol is a commonly used antiseptic, which is a mixture of chloroxylenol and terpineol.



chloroxylenol

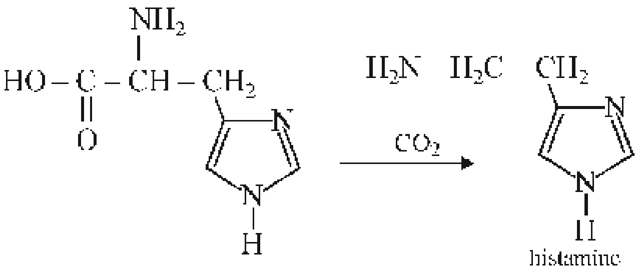


terpeneol

Dilute aqueous solution of Boric acid is a mild antiseptic for eyes.

### 17.1.6 Antihistamines or Anti allergic Drugs :

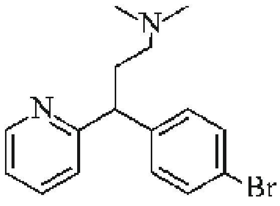
The chemicals which are used for the treatment of allergy are known as antihistamines or anti allergic drugs. The allergy is due to a chemical called histamine which is present in skin, lungs, tissues of liver and blood. Histamine is produced by decarboxylation of α-amino acid histidine.



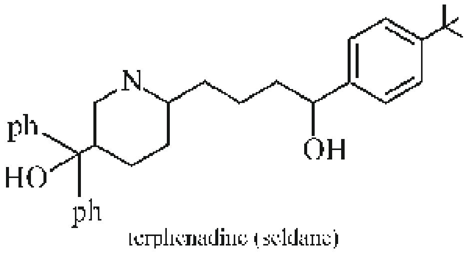
histidine

histamine

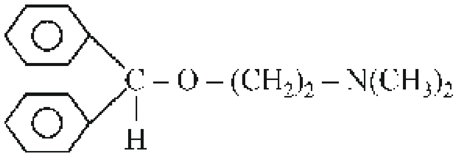
As anti allergic drugs are used against histamine, these are also called antihistamines. These drugs provide relief from rashes on the body, itching, irritation, conjuctivitis, Rhinitis (swelling in mucous membrane of nose), sneezing, running nose, itching in eyes, nose and throat. These are used in the form of tablets or solution. The name and strucutre of some important antihistamines are given below :



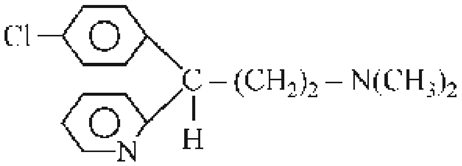
brompheniramine



terphenadine (seldane)



diphenyl hydramine



chlorpheniramine

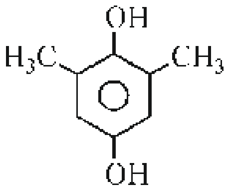
There are some side effects of taking antipistamines like unconsciousness, sleep etc. Therefore, these drugs should be taken in adequate amount as prescribed by doctor.

### 17.1.7 Antifertility Drugs

Chemicals which are used for preventing fertilization are called as antifertility drugs.

These chemicals are designed to solve the problems arises due to increased population. To Control increased population, birth control pills are most commonly used. Birth control pills contain a mixture of estrogen and progesterone derivatives. These control the female menstrual cycle and ovulation. Norethindrone is an example of synthetic progesterone derivatives, most widely used as antifertility drug. Thynylestradiol (Novestrol) is a derivative of estrogen, which is used in combination with progesterone derivatives.

Fluoro derivatives of aromatic hydrocarbons are used as antifertility drugs is laboratory. Antifertility chemicals are also found in soyabeans, oil of peas, seeds of carrot, etc. For example- Metaxylohydroquinone is found in oil of peas.



metaxylohydroquinone

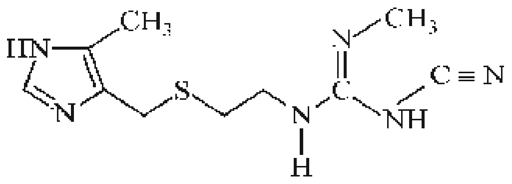
Other important antifertility chemicals are Rutin, cyproterone, hexamethyl phosphoramide, etc.

The most common method to take these antifertility chemicals is to use as birth control pills but the use of these chemicals for long time have some side effects like-overblooding during menstrual cycle, infertility, gain of weight, etc.

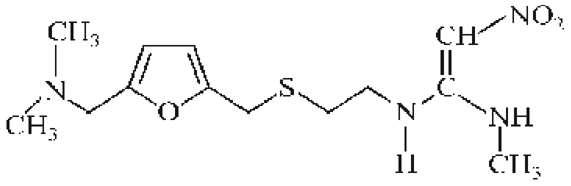
### 17.1.8 Antiacids

The chemicals which are used to reduce the acidity of stomach are known as antiacids. Mostly the use of tea, coffee, pickel, allopathy medicines in excess, leads excessive secretion of hydrochloric acid in gastric Juice of stomach. If the level of pH droped in stomach it causes ulcers in stomach which is harmful for life. Antiacids are salts which have basic nature- for example- milk of magnesia (magnesium hydroxide), magnesium carbonate, magnesium trisilicate, aluminium hydroxide Jel, sodium bicarbonate, aluminium phosphate, etc. Excessive sodium hydrogen carbonate can make the stomach alkaline and trigger the production of even more acid. Thus, two antiacid drugs are designed namely-cimetidine and ranitidine, which are helpful in treatment of acidity.

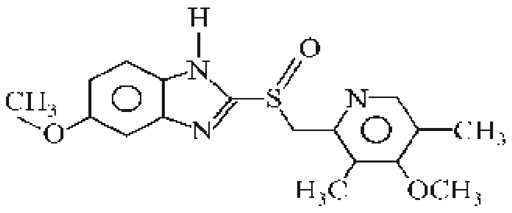
Recently omeprazole and lansoprazole are also synthesized which are used as antiacids. These medicines prevent the formation of extra acid is stomach. Structure of some antiacids are as follows :



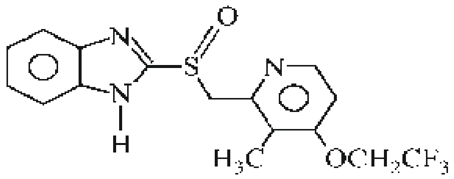
cimetidine



ranitidine (zantac)



omeprazole



lansoprazole

## 17.2 Dyes

### Dyes and Pigments :

The organic compounds which impart color to food products, different fibers, paper, and walls and are stable towards sunlight are called as dyes. In ancient period dyes were obtained from trees, plants and animals to dye various substances especially the fibers. There is no difference between pigments and dyes as application point of view. The main difference is that the dyes are generally soluble to water or some other solvents but pigments are insoluble in water or any other solvent. The pigment dyes to any substance by coagulation, which makes a layer on the dying substance. In other words the dye gives color to the substance by absorbing while the pigment colors the substance by making a layer on it.

There are some difference between dyes and pigments given below:

### General Characteristics of Dyes :

Dyes are coloring matter that bind in some way to a substrate which is generally a fabric or fiber and are fast to sunlight and washing with detergent. Thus for a coloring substance, it must fulfill following conditions :

(1) It must have proper color.

(2) It must be capable of being fixed to cloth by direct or 'indirect' method.

(3) It must be fast to light, and

(4) It must be resistant to action of water, dilute acids or bases, various organic solvents used

| Property | Dyes | Pigments |
|---|---|---|
| (1) Solubility | Soluble in various solvents | Insoluble in water and most of the solvents. |
| (2) Light sensitivity | Colors are faded in sunlight and slowly become dull | These are almost not affected by sunlight. |
| (3) Numbers | There are a large number of dyes and classified in various classes | There are very little number of pigments and need not to classify them. |
| (4) Product resistance | These are lesser resistant for example highly affected by solvents | These are very resistant for example these not effected by solvents. |
| (5) Chemical Composition | These are generally organic substances | These are inorganic compounds or heavy poison metals. |
| (6) Stability | These are not much stable i.e. slowly the substance becomes dull | These are very much stable. |
| (7) Ignition | These are highly inflammable | These are not inflammable. |

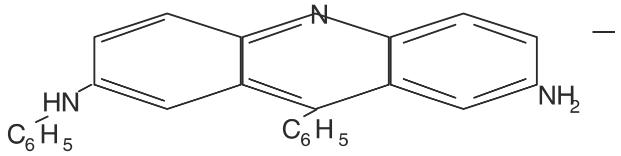
in dry-cleaning etc.

When white light falls on a substance it may be totally reflected and the substance well appear white. If the light is totally absorbed by the substance, it will appear black, while partially absorbed or partially reflected then the substance will have a color of reflected light. If only a single band is absorbed then the color of the substances will be the 'complementary color' of the absorbed light band. Actually a substance does not reflect only are one band of wave length but a mixture of these. The visible color is complementary to the color absorbed. Thus a substance may appear red either because it absorbs all other wavelengths except the wavelength corresponding to red light (605-750) or because it absorbs blue – green a substance appear to be violet, means it absorbed its complementary green color.

The relation between color absorbed and the visible or complementary color visualized with respect to a given range of wavelength is given in following table :

| Wave length absorbed (nm or mμ) | Color absorbed | Visible or complementary color |
|---|---|---|
| 400-435 | Violet | Yellow – green |
| 435-480 | Blue | Yellow |
| 480-490 | Green – Blue | Orange |
| 490-500 | Blue – Green | Red |
| 500-560 | Green | Purple |
| 560-580 | Yellow – green | Violet |
| 580-895 | Yellow | Blue |
| 595-605 | Orange | Green – blue |
| 605-750 | Red | Blue – green |

Thousand of compounds absorb the visible light which may be considered as coloring substances but about 1500 of them are stable coloring compounds which are practically useful and are synthesized at industrial level. Most probably, the first useful color was synthesized in 1856 by W.H. Perkin at the age of 18 years only. He synthesized a violet color from impure aniline in which the main component was N-phenyl phenosafranin.



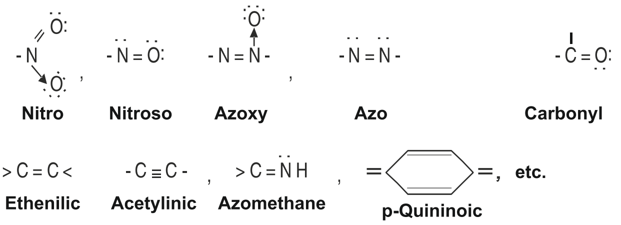
**(N-Phenyl Phenosafranin)**

## Structural Features of a Dye :

There must be a relation between color and constitution of the compounds having the same physical and chemical properties. For example benzene is a colorless compound but its isomer flavin is a colourful compound. Grabe and Liebermann in 1868 pointed out that unsaturation was important for producing colour and that reduction of coloured compounds always resulted in the formation of colourless products.

In 1876 O.N. Witt, in his "Chromophore-auxochrome theory" brougth forth the importance of unsaturation in the appearance of colour. This concept is known as 'Witt Theory'. He pointed out that :-

1. The colour of organic compound is mainly due to the presence of unsaturated groups which is known as chromophores (Greek; chromo for colour and pherein for to bear). These chromophoric groups are responsible to give colour to an organic compounds. Some important chromophores are as follows :-



(2) Compounds containing the chromophoric groups were named as chromogens. The intensity of the colour increases with increase in the number of chromophores in a chromogen. It was observed that some chromophores produce colours themselves like - NO, $NO_2$, -N=N- etc. For example :-

| Chromogen | Chromophore | Colour |
|---|---|---|
| Nitrobenzene | $-NO_2$ | Yellow |
| Azobenzene | -N = N- | Red |

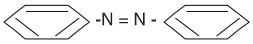
Similarly a single alkenic double bond is not sufficient to produce colour but if a number of them are present in conjugation then colour may develop, for example in $C_6H_6 - (CH = CH)_n - C_6H_6$, the color depends of the number n.

$n = 0, 1, 2$ (Colorless)
$n = 3$ (Yellow)
$n = 5$ (Orange)
$n = 7$ (Copper Bronze)
$n = 11$ (Black violet)

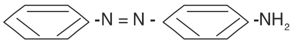
(3) Certain groups, which by themselves fail to produce color, have an important effect on the color of the chromogens. Such groups are termed as 'auxochromes (Greek, ausein means to increase)' they are either acidic or basic in nature and they increase the intensity of the color. They make a chromophore a dye by fixing it to the fabric either by association or by salt formation. Such groups are as follows:

$- \ddot{\underset{..}{O}}H$ , $- \ddot{\underset{..}{O}}R$ , $- \ddot{N}H_2$ , $- \ddot{N}HR$ , $- \ddot{N}R_2$ $- \ddot{\underset{..}{X}}:$ , $- \ddot{S}H$ , $\ddot{\underset{..}{S}}R$

It can be explained as that for example, azobenzene is a colorless compound. If an $- NH_2$ group is attached to its para position it becomes p-amino azobenzene, which is a yellow colored compound.



Azobenzene
(colourless)



p-Aminoazobenzene
(yellow)

Here $- N = N -$ is chromophoric group and $- NH_2$ is auxochrome group in the molecule.

Thus, according to witt the color of organic molecules are explained due to the presence of two types of groups – chromophores and auxochromes – in the molecule. The greater the number of chromophores, preferably in conjugation, deeper will be its colour.

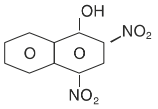
Recently two theories called valence bond theory and molecular orbital theory have been designed to explain the relation between colour and constitutions.

### Classification of dyes according to application:

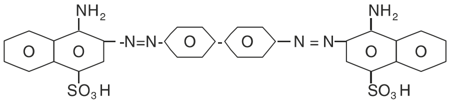
Dyes may be classified according to the method of their application to color fiber, cloth, leather, food material and other substances. The major classes according to the method of application of dyes are as follows :

### (i) Direct Dyes :

These dyes are substantive to cotton and other cellulosic fibers. These are applied from hot water solution in which they form a colloidal solution due to their high molecular weight and are absorbed on the fiber. They are used directly to the fiber so they are called direct direct dyes – and used to dying cotton, silk, wool etc directly. For example Martius yellow, Congo red etc.



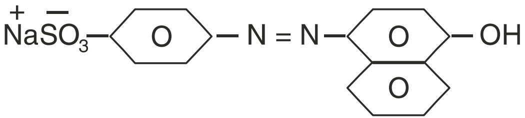
**Martius yellow**



**Congo red**

### (ii) Acid dyes :

They are the sodium salts of sulphonic acid and nitrophenols are applied from an acidic bath. Acid dyes, dye wool and silk directly due to the interaction of the polar acidic groups of the dye with the basic groups of the fabric. For example orange –I



**Orange –I**

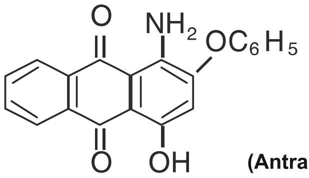
### (iii) Basic Dyes :

These are generally salts of hydrochloric acids and the colour in these is due to the cationic part of the compound. These are used in basic medium. Like acid dyes, basic dyes are also used for dying woolen and silk fibers. These dyes are also used in the dyeing of nylon, polyester etc. Examples are aniline yellow, malachite green etc.

**(Aniline Yellow)**

### (iv) Disperse Dyes:

Synthetic fibers like nylon, terilene, polyesters can be dyed from a colloidal aqueous solution of azo or anthraquinone dyes that have low molecular weight, lack polar groups and are fiber soluble. The dyes are usually applied in the form of a fine dispersion of the dye in a soap solution in the presence of stabilizing agent, for example antraquinone dyes.



(Antraquinone Dyes)

### (v) Fiber Reactive Dyes:

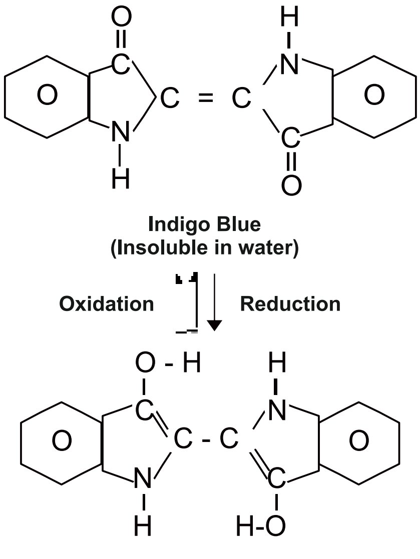
These are dyes having simple structures that react with the fiber to form dyes of excellent light and wash – fastness. They are colored acid chlorides that react with the –OH groups of cellulosic fibers or – $NH_2$ groups of proteinous fibers to form ester or amide linkages. For example vinyl sulphone derivatives are reactive dyes.

### (vi) Ingrain Dyes :

This type of dyes are synthesized on the fiber in the solution at the time of dyeing only, these are called as azoic dyes. Fibers are first dipped into any amine or phenol solution and them of adding mixture of diazonium salts at low temperature. The coupling reaction takes places and dyes are produced. These are also called ice dyes due their application at low temperature conditions. Some important examples are para red, aniline black etc.

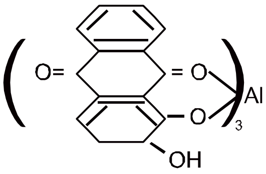
### (vii) Vat Dyes :

They are insoluble in water and hence cannot be applied directly. However on reduction with sodium hypo sulphite they are converted to water or alkali soluble where they form white or colorless compounds known as 'leuco – compounds.' The fibers are dipped in this colorless leuco compound which is readily absorbed by any animal or vegetable fiber. After dyeing with the leuco base the cloth or fibers are exposed in air to oxidize. After oxidation air there develop color on the cloth. For example in indigo blue.



### (viii) Mordant Dyes :

These dyes do not dye a fiber directly but are used in conjugation with a mordant (Latin, mordant means to bite) by a suitable metal ion. The mordant for acidic dyes is usually a metal hydroxide and for basic dyes, it is tannin (tannic acid). The mordant gets attached to the fiber and these combine with the dye to form an insoluble compiles which is called 'lake'. Thus, in strictly speaking the term mordant dye is reserved for such dyes as can form coordination chelate complexes with metal ions. Formation of these complexes increases the complexity of the dye and consequently its absorbability by the fiber also increases. A very important characteristic of these class of dyes is that they can give different colours with different metals. For example alizarin gives pink color with aluminum hydroxide while it gives blue color with barium hydroxide.



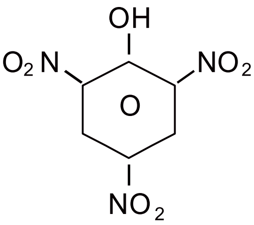
Alizarin - Al, (pink)

## Classification of Dyes according to their structures :

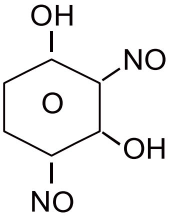
This classification is useful actually for chemists. This system is based on the chromphoric of dyes which differs so remarkably that is often very difficult to classify them into a particular group. Thus, in many cases the same dye can be classified in two or more groups. Nevertheless main classes of dyes as per their chemical constitution are as follows :

### (i) Nitro and Nitroso Dyes :

These are the earliest known synthetic dyes which contain nitro or nitroso groups in their molecules. These are generally poly nitro derivative of phenols. These have the nitro group as chromophore and hydroxyl or the amino group as auxochrome. Examples are fast green, Picric acid etc.



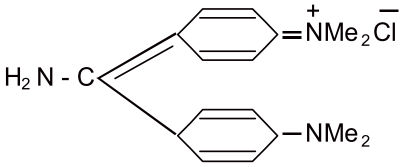
**(Picric acid)**



**(Fast Green-O)**

### (ii) Diphenylmethane Dyes:

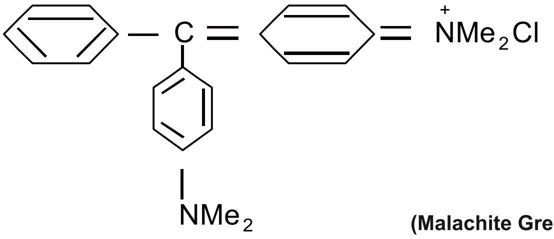
These dyes possess a basic diphenylmethane skeleton. Auramine-O is an important dye in this series which is useful in dyeing silk, paper, leather etc.



**(Auramine-o)**

### (iii) Triphenylmethane Dye :

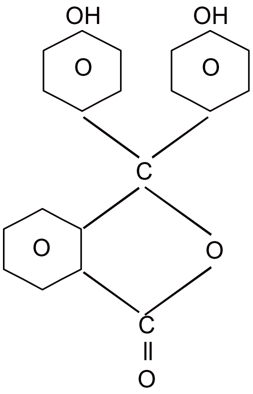
These dyes have basic triphenylmethane skeleton. Malachite green, rosaniline (Magenta or fuchsine), pararosaniline, crystal violet, aurin etc. are the main dyes in this series. These are very useful dyes which dye the wool and silk directly while the dying of cotton can be done after mordant it with tannin.



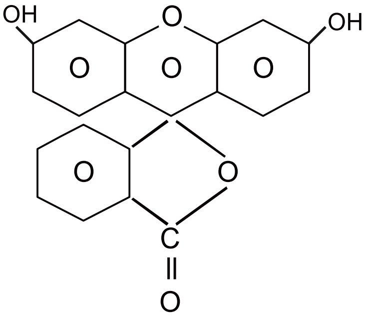
**(Malachite Green)**

### (iv) Phthalene and Xanthene Dyes :

They can be synthesized by condensing phenols with phthalic anhydride in the presence of dehydrating agent. Phenolphthalene is the most important member in this series. Phenolphthalene remain colorless in natural or in acidic medium but color changes to pink in alkaline solution. Fluorescene is one of other important members which is a xanthene derivative.



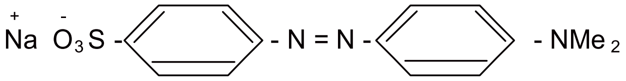
**(Phenolphthalene)**



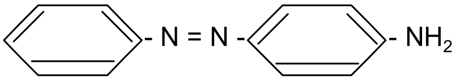
**(Fluorescein)**

### (v) Azo Dyes :

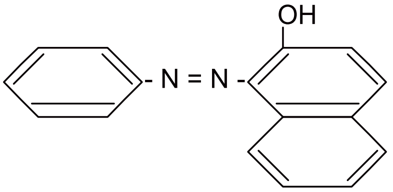
They constitute the single largest group of dyes having almost complete range of colours. These are characterized by the presence of azo (-N=N-) group. In addition they contain sulphonic acid group and hydroxyl or amino groups. The sulphonic acid group gives water solubility. Methyl orange, Aniline yellow, Sudan – I are given here as examples:



(Methyl Orange)



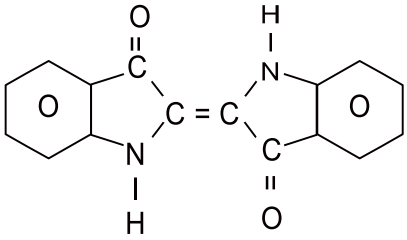
(Aniline Yellow)



(Sudan - I)

### (vi) Indigo Dyes :

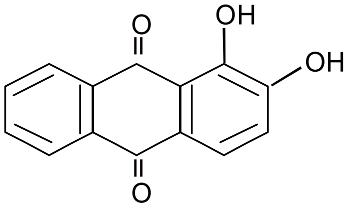
The oldest known organic dye is indigo or indigo tin. It was first prepared and used in India some four or five thousand years ago. It was obtained from the Indigofera plant species. The farmers of Bengal were forced to grow these plants in their farms by British government. It became the reason of dissociation of Bengal in 1906 by the famous farmer's movement in Indian history.



### (vii) Anthraquinone Dyes :

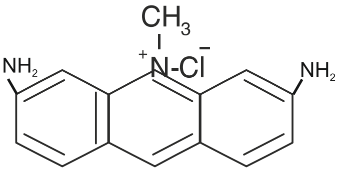
These dyes are the derivatives of anthraquinone. Alizarin is very important dye in this series which is obtained from madder roots. Alizarin is the best known mordant as it is polygenetic yielding different colours with different metal ions.

### (viii) Heterocyclic Dyes :



+ $Al^{+3}$ (Pink)
+ $Fe^{+3}$ (Black Violet)
+ $Cr^{+3}$ (Brown Violet)
+ $Ba^{+2}$ (Blue)
+ $Mg^{+2}$ (Violet)

In these compounds there is at least one heterocyclic aromatic ring is present. It is also a very large range of dyes which is in developing state. Acriflavin is one of example in this series which have various applications also, other than the dyeing.



(Acriflavin)

## 17.3 Chemicals in food

1. **Preservation–** These are the chemical substances which are added to the food materials to prevent their spoilage and to retain their nutritive value for long peroids. These preservatives prevent the rancidity of food and inhibit the growth or kill the micro-organisms.

The following properties should exists in a chemical preservative :

(i) reactive in least quanity.
(ii) effective up to long time.
(iii) does not decreases the ability of food material.
(iv) does not have harmful effect on edibles.

Examples of chemical food preservatives are :

**(i) Sodium benzoate–** It is commonly used preservative and its 0.06% to 0.1% concentrated solution is used in fruit juice, gem, gelly, etc.

**(ii) Sorbate–** These are salts of sorbic acid. Food materials prepared from milk preserved by the addition of sorbate.

**(iii) Potassium metabisulphite–** By the addition of potassium metabisulphite in food material, $SO_2$is evolved which preserve the food.

$$K_2S_2O_5 \longrightarrow K_2SO_3 + SO_2$$

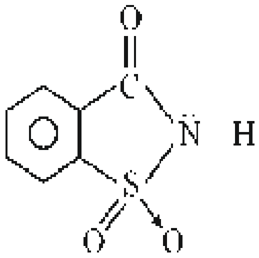
**(iv) Parabens–** These are alkyl para hydroxy benzoate which are used for the preservation of soft drinks, ketchup, etc.

**(v) Propionate–** These are ethyl and phenyl ester of propionic acid and used for the preservation of bread, cakes and biscuits.

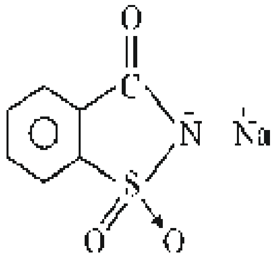
### 17.3.2 Artificial sweeteners–

These are the chemical compounds which give sweetening effect to the food and enhance its odour and flavour.

**(i) Saccharin–** O-sulpho benzoic amide is known as saccharin. It is insoluble in water but its sodium salt is soluble in water. It is about 600 times more sweeter than sucrose. It pass through the human body unmetabolised i.e., without producing any calories so used by diabetic patients.

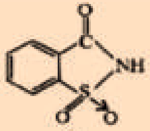
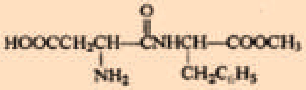
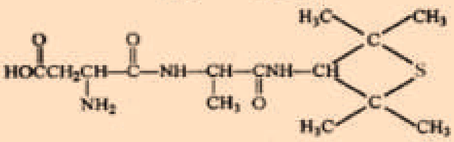
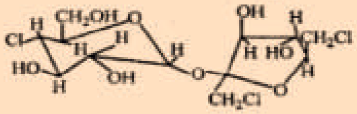


O-sulpho benzimide
(insoluble in water)

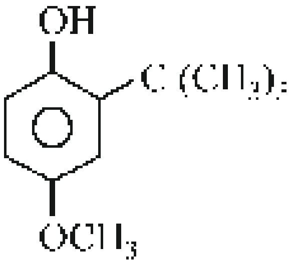


sodium salt of saccharin
(soluble in water)

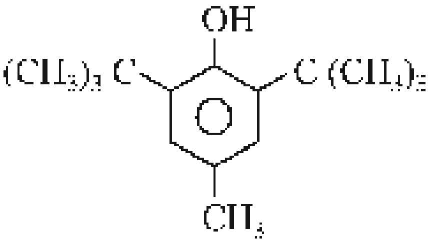
Some available aritficial sweeteners listed in the table.

| Name | Structural formula | Sweetness compared to sucrose |
|---|---|---|
| Saccharin |  | 600 |
| Aspartame |  $HOOCCH_2\underset{NH_2}{CH}-\overset{O}{\overset{\parallel}{C}}NH\underset{CH_2C_6H_5}{CH}-COOCH_3$ | 100 |
| Alitame |  | 2000 |
| sucralose |  | 600 |

**3. Antioxidants–** The foods which contain substances like unsaturated oils and fats undergo deterioration on storage because of atmospheric oxygen. To prevent their spoilage, certain chemical substances are added which prevent their oxidation. These are called antioxidants. Thus antioxidants are chemical substances which prevent oxidation and subsequent spoilage of the food. The structures of antioxidents are–



2-tert butyl hydroxy anisole
(BHA)



2,6-di tert.butyl hydroxy toluene
(BHT)

### 17.3.4 Food colour–

These are the chemical substances which are used for imparting colour to the food and increase the eye appeal and compliment a definite flavour.

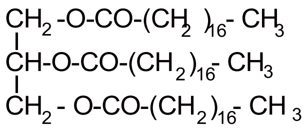
**Example :**

**(i) Tartrazine–** Yellow in colour.

**(ii) 1, 4-di-p-toluidino anthraquinone (PTA)–** Green in colour. Generally, food colours are harmful for childrens and asthama patients.

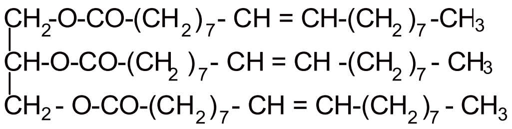
## 17.4 Detergents

**Soap :** The soaps are sodium or potassium salts of higher fatty acids like stearic acid, palmitic acid, oleic acid etc. Esters of glycerol having high molecular weight carboxylic acids are called oil and fat. These are also called as glyceroids because they are esters of glycerol and fatty acids. Palmitic, stearic are saturated acid which are soft solids at room temperature whereas oleic acid, linolenic acids are unsaturated and their triglyceroids are called oil because these are liquid at room temperature. Sodium salts of these acids are called hand soap whereas their potassium salts are called soft soap. Formation process of soap is known as sponification. Various seeds are pressed by mechanical methods to give oil. Extraction methods also used to produce oil or fat from seeds. Animals are the sources of fat. The structures of oil and fat are shown as bellow:



$$\begin{array}{l} CH_2\text{-}O\text{-}CO\text{-}(CH_2)_{16}\text{-}CH_3 \\ | \\ CH\text{-}O\text{-}CO\text{-}(CH_2)_{16}\text{-}CH_3 \\ | \\ CH_2\text{-}O\text{-}CO\text{-}(CH_2)_{16}\text{-}CH_3 \end{array}$$

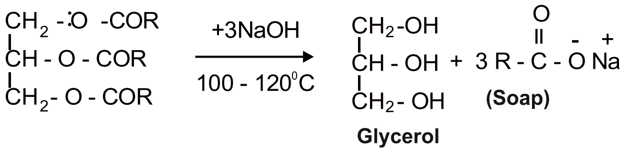
**(Glycerol tristearate) - Fat**



$$\begin{array}{l} CH_2\text{-}O\text{-}CO\text{-}(CH_2)_7\text{-}CH=CH\text{-}(CH_2)_7\text{-}CH_3 \\ | \\ CH\text{-}O\text{-}CO\text{-}(CH_2)_7\text{-}CH=CH\text{-}(CH_2)_7\text{-}CH_3 \\ | \\ CH_2\text{-}O\text{-}CO\text{-}(CH_2)_7\text{-}CH=CH\text{-}(CH_2)_7\text{-}CH_3 \end{array}$$

**(Glycerol trisoliate) - Oil**

When oils and facts are heated with a solution of NaOH or KOH, they break down to sodium or potassium salts respectively. This process of making soap by the hydrolysis of fats and oils with alkalis is called saponification. As follows



$$\begin{array}{l} CH_2\text{-}O\text{-}COR \\ | \\ CH\text{-}O\text{-}COR \\ | \\ CH_2\text{-}O\text{-}COR \end{array} \xrightarrow[100 - 120^{\circ}C]{+3NaOH} \begin{array}{l} CH_2\text{-}OH \\ | \\ CH\text{-}OH \\ | \\ CH_2\text{-}OH \end{array} + 3R\text{-}\overset{\overset{O}{\|}}{C}\text{-}\overset{-}{O}\overset{+}{Na}$$

It is clear that one mole of oil or fat reacts with three mole of NaOH to give soap. In this process a mixture of soap and glycerine is produced which is called 'lye'. The soap is separated from this solution by the addition of common salt, (NaCl). Due to common ion effect, the glycerol is recovered from the solution as it is very useful chemical used in drugs, cosmetics, explosives and paints. Now soap is mixed with desired colours, perfumes and chemicals of medical importance. It is then cast into desired shape for use.

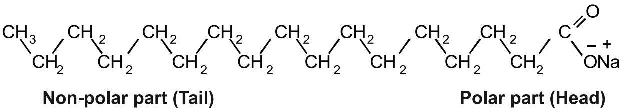
### Cleansing action of soaps and detergents :

The cleaning action of soap and detergents follows the same principle. Soap and detergents consist of two parts :

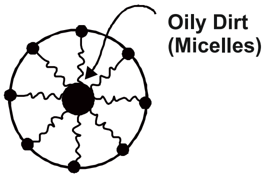
(i) A non-polar part which consists of long chain hydrocarbon part. It is called non-polar tail. This part is insoluble in water but soluble in oil and grease. This is also called water repelling or hydrophobic part.

(ii) An ionic part which consists of carboxylate ion (in case of soap) or sulphonates or sulphates (in case of detergents). This is called polar head. It is soluble in water but insoluble in oil or grease. The ionic part is called water attracting or hydrophilic part.

For example in sodium stearate :$(C_{17}H_{35}\ CO\overset{-}{O}\overset{+}{Na})$



The dirt in the cloth is due to the presence of dust particles in fat or grease which stick to the cloth. When a soap or detergent is dissolved in water, the molecules gather together as clusters called micelles. When the dirty cloth is dipped in soap or detergent solution, the soap and dirt particles come in contact with each other. The non polar tails of the soap begin to dissolve in non-polar oil or grease, while the polar head part remains directed in water as shown in figure :



As more and more soap particles enter the grease, each fat or oil particles is surrounded by a number of negatively charged ends. Since the similar charges repel each other, the oil or grease droplets break off into small globules of oil. In this manner, the grease particles can be completely broken up and it forms emulsion of grease confined in dirt and water. As a result, the cloth gets free from the dirt and the droplets are washed away with water.

### Detergents :

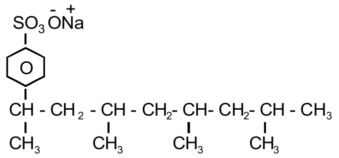
These are obtained from derivatives of long chain hydrocarbons and sulphuric acid. These are invented in 1920. These are synthetic compounds having almost similar structure as soaps. These are also called 'soapless soap' because though they behave like soaps but they are not sodium salt of fatty acids. These are better clearing agents because they do not form insoluble calcium and magnesium salts with hard water. Soaps are the salts of weak acid and strong base so their solutions are alkaline in nature. On the other hand the detergents are salts of strong acid like sulphuric and strong base like sodium hydroxide, so that their solutions are neutral in nature. It is because of that part detergents are less harmful to colours and fabrics.

Detergents are salts of hydrocarbon sulphuric acid with long chain and sodium hydroxide as shown below :

$CH_3\text{-}(CH_2)_{10}\text{-}CH_2\text{-}O\text{-}SO_2\text{-}ONa$

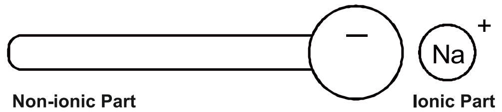
Sodium Dodecylsulphonate (Dreft)

Similarly,



(Sodium p- (1, 3, 5, 7) - tetra methyl octyl benzene sulphonate)
(Necalone or Sandamerse)

In such type of molecules the head is ionic part which is water soluble like soaps and the tail in non-ionic part which is insoluble. The cleaning action is similar as the soaps.



### Differences between Soaps and Detergents:

The applications of soap and detergents are same as to clean the cloth or dirty substances where the dirt is accumulate by dust particles in fat or grease which stick to the cloth. The cleaning action is also same as the soaps. There are following differences :

(i) Soaps are made by weak acids (like stearic acid) and strong base hydroxide, so they do hydrolysis and their water solution become alkaline.

$$\underset{\text{(Soap - a salt)}}{R\text{-}CO\overset{-}{O}\,\overset{+}{Na}} + H_2O \rightleftharpoons \underbrace{\underset{\text{(Non-ionic)}}{R - COOH} + \underset{\text{(Ionic)}}{\overset{+}{Na} + \overset{-}{OH}}}_{\text{(Basic Solution)}}$$

While in detergents both the acid and bases are strong, so that there do not occur hydrolysis and their solution remains neutral.

$$Ar - SO_2\overset{-}{O}\ \overset{+}{Na} + H\ \ O \rightleftharpoons \underbrace{\underset{\text{(Strong acid)}}{Ar - SO_2 - OH} + \underset{\text{(Strong base)}}{NaOH}}_{\text{Neutral Solution}}$$

Thus, due to alkaline nature the soap requires more water to complete removal of dirt and the excess soap from the cloth. Alkaline nature also harmful to fabric and colours of the cloths. On the other hand, detergents are less harmful for fabric and colours of cloth due to their neutral nature.

(ii) Soap cannot be used in hard water as they produce precipitates with $Ca^{+2}$, $Mg^{+2}$, $Fe^{+2}$, $Fe^{+3}$ etc which are present in hard water. Thus, the cloths become more dirty when these are washed by soaps in hard water because the particles of these precipitates stick on the cloth.

$$2R - CO\overset{-}{O}\ \overset{+}{Na} + Ca^{+2} \xrightarrow{H_2O} (R\text{-}COO)_2\,Ca + 2Na^{+}$$

on the other hand the detergents do not form any precipitate with $Ca^{+2}$, $Mg^{+2}$ etc.

(iii) Detergents may be used to convert hard water in to soft water because if detergents are added with polyphosphates in hard water they form some insoluble salts which settle down in to the surface of water.

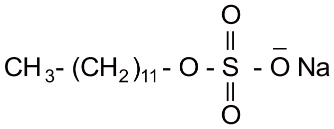
(iv) Soaps are biodegradable. Therefore they do not cause any pollution problems but detergents are not biodegradable so they cause pollution problems. Detergents may be used as lubricants.

### Types of Detergents :

The detergents may be classified in three types depending upon the nature of surface active groups:

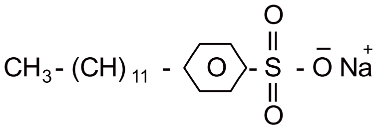
#### (i) Anionic Detergent :

Sodium salts of alkyl or aryl sulphonic acids are taken in this type and these are mostly used detergents. In these detergents the head part is anionic, for example sodium lauryl sulphonate, sodium p-dodecyl benzene sulphonate etc.



$$CH_3-(CH_2)_{11}-O-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-\bar{O}\,Na$$

(Sodium lauryl sulphonate)



(Sodium p-dodecyl benzene sulphonate)

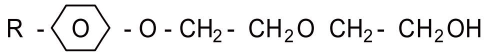
#### (ii) Cationic Detergents :

The cationic detergents are those which have cationic head. These are mostly acetates, chlorides or bromides of quaternary amines. For example:

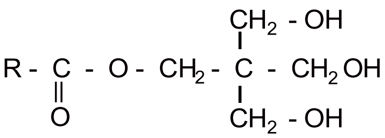
$$R-(CH_2)_n-\overset{+}{N}(CH_3)_3\,\bar{Cl}$$

#### (iii) Non – ionic detergents :

These detergents are non–ionic like the esters of high molecular masses. However, these contain polar groups which can form hydrogen bonding with water. For example :



Similarly, esters of poly hydroxyl alcohols are also non–ionic detergents. For example pentaarythrilol mono alkanoate –



$$R-\underset{\underset{O}{\|}}{C}-O-CH_2-\overset{\overset{CH_2-OH}{|}}{\underset{\underset{CH_2-OH}{|}}{C}}-CH_2OH$$

## 17.5 Insect repellents

An insect repellent is a substance applied to skin clothing or other surfaces which discourages insects from landing and climbing on that surface.

### 17.5.1 Pheromones and sex attractants

Insect communicate with each other and with their environment by means of organic chemicals secreted in very minute amounts. These substances are called pheromones (Greek words pherin means 'to transfer' and hormone means 'to excite'). Thus, the chemical substances secreated by one individual of a species that brings forth a response to another individual of the same species is called pheromone.

Insect pheromones are generally classified by the response they elicit. These are

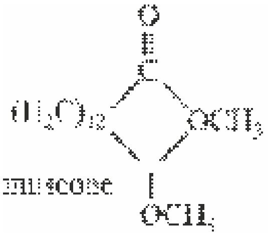
(i) Alarm pheromones which spread alarm.

(ii) Sex attractants which help the different sexes of the same species to find one another.

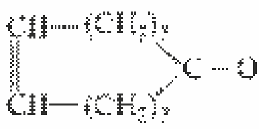
For example, a pheromone secreted by one bee helps alert other bees to the location of a food source.

You must have seen a line of ants, all following the same invisible trail across a floor. This is because one ant has found a food source and had laid down a chemical, a trail of pheromone on its return to the nest. Other ants then follow this chemical trail back to the food source. Insects also use pheromones exclusively to attract members of opposite sex for mating.

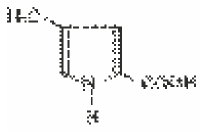
Cevatones in found in pheromones emitted by tiger and cat. The structures of pheromones are-



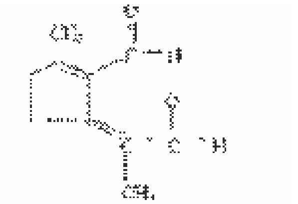
muscone



civetone



trail pheromone



defence pheromone of [illegible]
[illegible]

## 17.6 Rocket propellants

We know that many satellites have been launc-hed by different countries for space research. India launched her first successful statellite Vehicle SLV-3. These use chemical substances which on ignition provide thrust for the rocket to move forward. These substances are called **rocket propellants.**

### Properties of Rocket Propellants

1. Rocket propellents are in both solid and liquid states.
2. These have a combination of an oxidiser and fuel.
3. Highly flammable so that passage of hot gases through the nozzle of the rocket motor provides the necessary thrust for the rocket to move forward.
4. The chemical combination should be very fast.

### Types of Rocket propellants

Depending upon the physical state, propellants can be classfied as –

(a) Solid propellants
(b) Liquid propellants and
(c) Hybrid propellants

### (a) Solid propellants

The solid propellants are mixtures of solid fuel and a solid oxidiser. These are further divided into two classes–

**(i) composite propellants**– These are solid propellants which use polymeric binder such as polyurethane of polybutadiene as a fuel and a solid oxidiser such as ammonium perchlorate, nitrate or chlorate. The performance of these propellants can be increased by using some additives such as finely divided magnesium or aluminium metals along with the fuel.

**(ii) Double base propellants**– These are solid propellants which are mainly formed by nitroglycerine and nitrocellulose.

The main disadvantage of solid propellants is that these propellants once ignited will continue burning with predetermined rate. These cannot be regulated.

### (b) Liquid propellants

These consist of an oxidizer such as liquid oxygen, nitrogen tetroxide ($N_2O_4$) or nitric acid and a fuel such as kerosene, alcohol, hydrazine or liquid hydrogen. These are further classified as:

**(i) Monopropellants**– The propellants in which a single chemical compound acts as fuel as well as oxidizer are called monopropellants. For example, hydrazine, nitromethane, methyl nitrate, hydrogen peroxide, etc. Except hydrazine, the other compounds contain both the oxidizer and the fuel elements in the same molecule.

**(ii) Bipropellants**– These are propellants in which the fuel and oxidiser are stored separately but are allowed to combine at the time of combustion. For example, kerosene and liquid oxygen.

### Examples of Propellants used in Different Rockets

1. Saturn booster rocket of American space programme used a mixture of kerosene and liquid oxygen as the propellant in the initial stage whereas liquid oxygen and liquid hydrogen were used as propellant in high altitudes.
2. Russian rockets such as Proton used a liquid propellan consisting of kerosene and liquid oxygen.
3. The Indian satellite SLV-3 and ASLV used composite solid propellants.
4. The rocket PSLV use solid propellant in the first and third stages and liquid propellant in second and fourth stages. The liquid propellant consist of $N_2O_4$ and unsymmetrical dimethyl hydrazine (UDMH) and $N_2O_4$ and monomethyl hydrazine (MMH), respectively.

## 17.7 Advanced Materials

### 17.7.1 Carbon Fibres

Carbon fibres are new type of high strength materials. These are prepared by he controlled pyrolysis of synthetic fibres or asphalt and pitch materials. Some of the common precursors for carbon fibres are :

(i) Several types of acrylic polymers with small variations in their composition have been used for the production of carbon fibres. The general composition contains a minimum of 85% acrylonitrile and reamining other monomers such as methyl methacrylate, methyl acrylate, vinyl acetate, vinyl chloride and other mono vinyl compounds. These polymers are regarded as the most important and promising for the manufacture of carbon fibres becasue of their high degree of molecular orientation, high melting and boiling points and larger yield of the carbon fibres. These give carbon fibres with good mechanical properties. The basic principle in the conversion of acrylic polymer into carbon fibres are the treatment of the fibres in an oxidizing atmosphere at temperature in the range 200-300 ºC. The oxidized fibres are then carbonized to about 1000ºC and further heated to about 3000ºC depending of required tensile strength.

(ii) Cellulose is the second most important raw material for large scale production of carbon fibres. The commonly used cellulosic fibres for producing carbon fibres are textile grade rayon, regenerated cellulose, viscose rayon.

(iii) Certain fractions of asphalt and pitch materials are also converted to carbon fibres. The most common types of pitches are those obtained from petroleum asphalt, coal tar and polyvinyl chloride. The carbon fibres are made by heat treatment, spining followed by stabilization and carbonization processes.

(iv) Carbon fibres have also been obtained from aromatic polymers such as phenolic polymers, phenol formaldehyde resin, poly acenaphthalene, polyacryl ether, certain polyamides, etc. These substances have advantages such as easy cyclization into graphite structrue, easy removal of non-carbon atoms and a greater carbon yield.

(v) Carbon fibres have also been prepared from certain coal extracts obtained by digesting coal at higher temperatures and under high pressure with a high boiling solvent.

It may be noted that the significant factors in getting high yield of carbon fibres are : the nature of the polymer precursor, the nature of degradation process, the tendency for the precursor for cyclization and nature of stabilizing pre treatment to prevent melting or fusion of the fibre.

The basic principles involed in the conversion of polyacrylonitrile firbres into carbon fibres are :

(i) Treatment of fibres in the oxidizing atmosphere at the temperature in the range 200-300 ºC. This treatment converts thermoplastic fibre into non-plastic cyclic compound capable of withstanding high temperature present in the subsequent processes.

(ii) The oxidized fibres are then carbonized to about 1000 ºC in an inert atmosphere with a slow heating rate in order to avoid damage to high degrees of molecular order present in the fibre. During the carbonization process, non carbon elements are removed as volatiles (i.e. $H_2O$, HCN, $NH_3$, CO, $CO_2$, $N_2$, etc.). The rate of heating in the early stages of carbonization is generally low so that the release of volatiles does not damage the fibre. Most of the volatiles are evolved below 1000ºC.

(iii) The carbonized product is further heated to about 2500ºC to improve the ordering and orientation of the direction of the fibre axis. This process is called graphitization and improves the mechanical properties of the fixed carbon fibre.

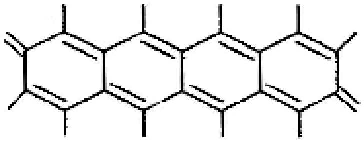
The carbon fibres consist of long chains of carbon atoms. Their structure shows resemblances to graphite but in place of extended sheets, the layers consist of ribbons parallel to the axis of fibre. The strong in plane bonds, resembling those in graphite give the fibre very high tensile strength. These have high toughness and low weight.

### 17.7.2 Applications of carbon fibres

(i) The carbon fibres have applications in high technology sector which includes aerospace and nuclear engineering.

(ii) These find applications in general engineering and transportation sector which includes engineering components such as bearings, gears, brake disks, cams, fan blades and other friction related products, etc. and automobile bodies.

(iii) These are also used in sports articles such as golf club shafts, fishing rods, telescoping casting rods for canal fishing, ski poles, cricket bats, tennis and badminton racquets, bicycle frames and racing cars. The structures of carbon fiber can be expressed as follows :



## Exercise Questions

### Very Short Answer Questions :

1. What do you mean by saponification?
2. What do you mean by soft and hard soaps?
3. What do you mean by detergents?
4. What is the meaning of biodegradable and non – biodegradable detergents?
5. Give an example of cationic detergent.
6. What are chromophores? Give some examples.
7. What are auxochromes? Give some examples.
8. What are mordant dyes? Give an example.
9. What are triphenylmethane dyes? Give an example.
10. What do you mean by vat dyes? Give an example.

### Short Answer Questions :

1. What are soaps? Give an example.
2. What are the differences between soaps and detergents?
3. What are micelles? Explain the cleaning action of soaps.
4. What do you mean by soapless soap? Explain with examples.
5. Explain the anionic, cationic and non – ionic detergents with suitable examples.
6. Phenolphathalene is which kind of dye? Give its structure.
7. Give the structures of these dyes –
   (i) Methyl orange
   (ii) Fluorecein
   (iii) Alizarin
8. What are the differences between dyes and pigments?
9. Discuss the characteristics of dyes.
10. Write a short note on:
    (i) Direct dyes
    (ii) Disperse dyes
    (iii) Ingrain dyes

### Large Answer Questions :

1. What is soap? How these are synthesized? Discuss the cleaning action of soaps.
2. What are detergents? Classify these and explain the cleaning action of detergents.
3. Discuss the Witt theory of color and constitution of dyes.
4. Classify the dyes on the basis of their utilization?
5. Classify the dye on the basis of their constitution.
6. What are analgesics? Give two examples.
7. Define Antiacids with two examples.
8. What do you mean by antibiotics? How these were discovered ? Give uses of streptomycin and chloramphenicol.
9. Write short notes on the followings.
   (a) Antihistamines (b) sulfa drugs.
10. Write an example of broad, narrow, and limited spectrum antibiotics.
11. Who discovered antibiotic drug?
12. Explain the difference between narcotic and non-narcotic analgesics with examples.
13. Why a diabetic patient need artificial sweetner ?
14. Give an example of food preservative.
15. Write the structures of water soluble and insoluble forms of saccharine.
16. Write the three properties of chemical preservative.
17. Give example of single liquid propellant.
18. Write short notes of followings-
    (a) Insect repellent.
    (b) Carbon fibres.