Chemistry plays very important role in our every day life from the starting, it has been in the service of mankind. Our daily needs of food, clothing, shelter, potable water, medicines etc. are in one or the other manner connected with chemical compounds, processes and principles. We always owe a debt to chemists for their important contributions for giving us life saving drugs, synthetic fibres, synthetic detergents, variety of cosmetics, preservatives for our food, fertilizers, pesticides etc. There is no aspect of our life that is not affected by the developments in chemistry. Thus the mankind owes much to chemistry because it has improved the quality of life.

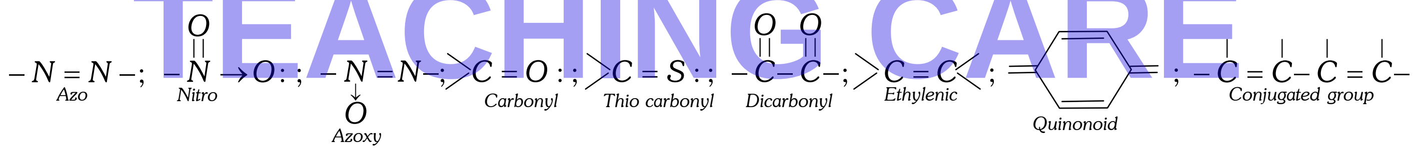
Dyes.

Dye is a natural or synthetic colouring matter which is used in solution to stain materials especially fabrics. All the coloured substances are not dyes. A coloured substance is termed as a dye if it fulfils the following conditions,

- It must have a suitable colour.
- It can be fixed on the fabric either directly or with the help of mordant.
- When fixed it must be fast to light and washing, *i.e.*, it must be resistant to the action of water, acids and alkalies, particularly to alkalies as washing soda and soap have alkaline nature.

(1) **Theory of Dyes :** A dye consists of a chromophore group and a salt forming group called **anchoric group. In 1876, Otto witt** put forth a theory as to correlate colour with molecular structure (constitution). The theory is named '**The Chromophore Auxochrome Theory**' and its main postulates are,

(i) The colour of the organic compounds is due to the presence of certain multiple bonded groups called **chromophores**. Important chromophores are,



[Chromophore-Greek word, Chroma = *colour*, Phorein = *to bear*].

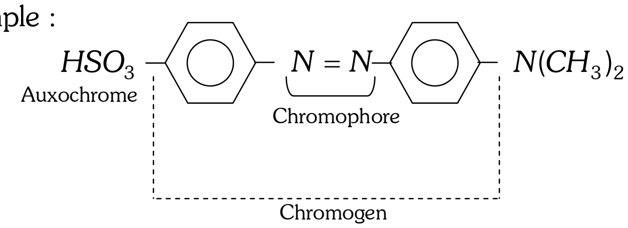
The presence of chromophore is not necessarily sufficient for colour. To make a substance coloured, the chromophore has to be conjugated with an extensive system of alternate single and double bonds as exists in aromatic compounds.

The chromophore part of the coloured substance (dye) absorbs some wavelengths from white light and reflects back the complementary colour. A coloured compound having a chromophore is known as **chromogen**.

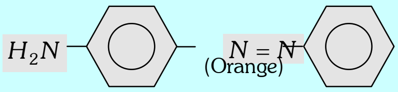
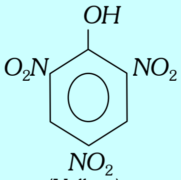
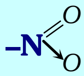
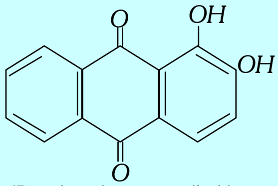
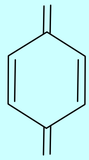
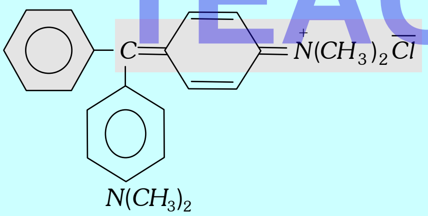
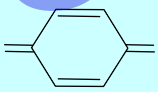
(ii) Certain groups, while not producing colour themselves, when present along with a chromophore in an organic substance, intensify the colour. Such colour assisting groups are called **auxochromes** (Greek word, Auxanien = *to increase*; Chrome = *colour*), i.e. they make the colour deep and fast and fix the dye to the fabric. The auxochromes are acidic or basic functional groups. The important auxochromes are,

Acidic :	$-OH$ Hydroxy	$-SO_3H$ Sulphonic	$-COOH$ Carboxylic
Basic :	$-NH_2$ Amino	$-NHR$ Alkylamino	$-NR_2$ Dialkylamino

Example :



Examples :

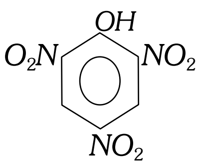
Dye	Chromophore	Auxochrome
p-Aminoazobenzene 	**– N = N –**	**– NH_2**
Picric acid  (Yellow)		Error! Not a valid link.**– OH**
Alizarin  (Purple solution in alkali)		**– OH**Error! Not a valid link.
Malachite green 		$-N(CH_3)_2$

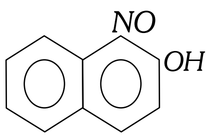
However, Otto witt chromophore-Auxochromo concept fails to explain the colour of certain dye stuffs like indigo.

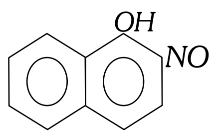
(2) **Classification of Dyes :** Dyes are classified to their chemical constitution or by their application to the fibre.

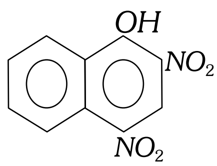
(i) ***Classification of dyes according to their chemical structure***

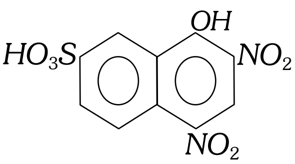
(a) *Nitro and Nitroso dyes* : These dyes contain nitro or nitroso groups as the chromophores and *–OH* as auxochrome. A few example are,

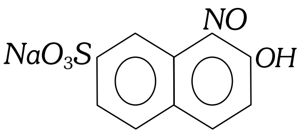

Picric acid
(2 : 4 : 6-Trinitrophenol)


1-Nitroso-2-naphthol
(Gambine-*Y*)

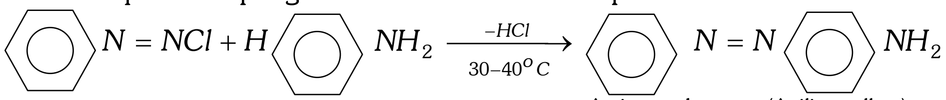

2-Nitroso-1-naphthol
(Gambine-*R*)


Martius yellow

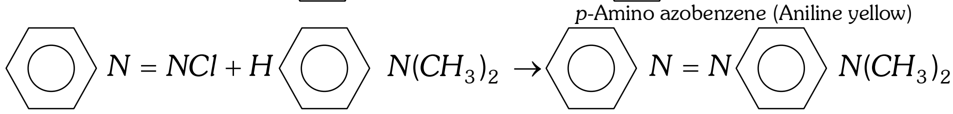

Naphthol yellow-S


Naphthol green-B

(b) *Azo dyes* : The azo dyes contain one or more azo groups – *N*=*N*–, as the chromophore. Azo dyes constitute the largest and most important group of synthetic dyes. These can be prepared by diazotising an aromatic amine and subsequent coupling with a suitable aromatic phenol or amine.

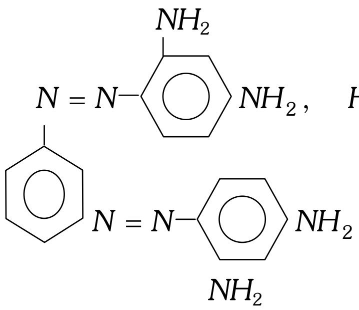


p-Amino azobenzene (Aniline yellow)

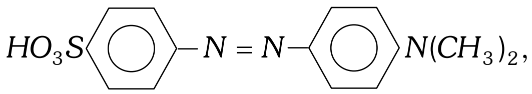


p-Dimethyl amino azobenzene (Butter yellow)

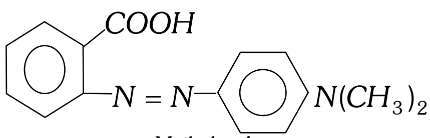
The important azo dyes are the following,



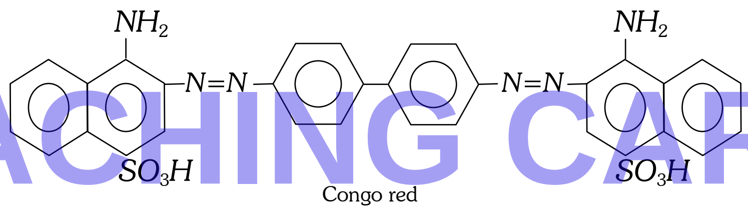
Bismark brown



Methyl orange



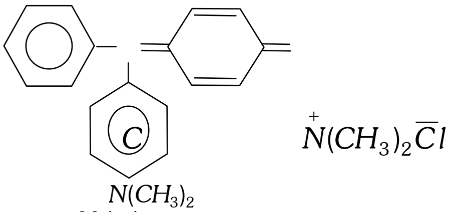
Methyl red



Congo red

Azo dyes are highly coloured. Azo dyes can be further divided into acid, basic, direct, ingrain or developed dyes, etc., on the basis of mode of application.

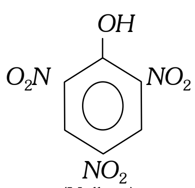
(c) *Tri aryl methane dyes* : In these dyes, the central carbon is bonded to three aromatic rings. One of which is in the quinonoid form (the chromophore). Malachite green is the typical example of this class.



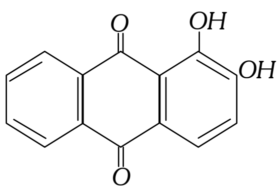
Malachite green

Rosaniline and crystal violet are other two important dyes of this class.

(d) *Anthraquinone dyes* : Para quinonoid chromophore is present in these anthracene type dyes. Alizarin is a typical anthraquinone dye.

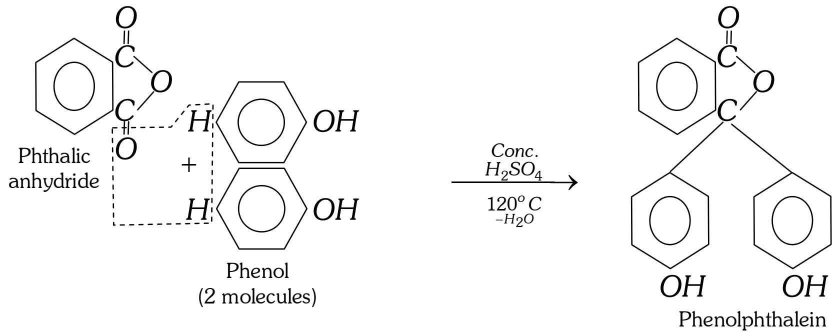


(Yellow)

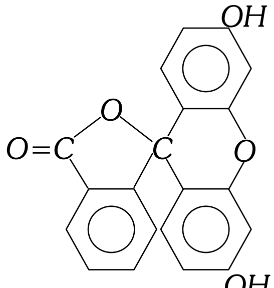


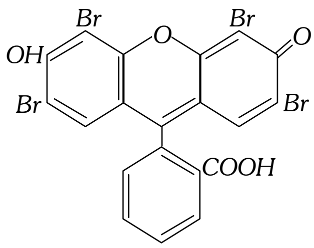
Alizarin

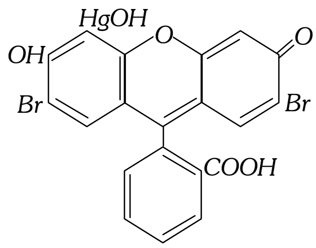
(e) *Phthaleins* : Products obtained by condensation of phthalic anhydride with phenols in presence of dehydrating agents like conc. H_2SO_4 or anhydrous zinc chloride are called phthaleins.



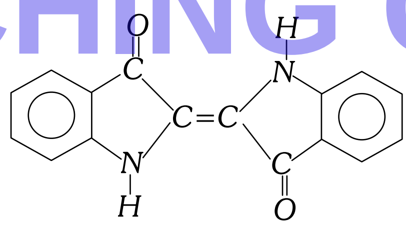
The other important dyes of this class are,


Fluorescein

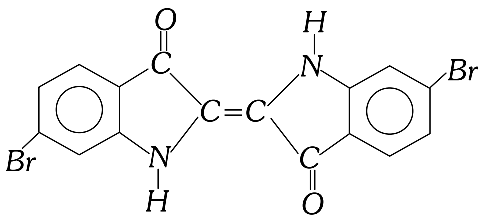

Eosin


Mercurochrome

(f) *Indigo dyes* : These dyes contain the carbonyl chromophore. Indigo is the oldest known dye.


Indigo (Dark blue crystalline powder)

Another indigo dye is royal blue in colour which is dibromo derivative of indigo. It is called Tyrian blue.

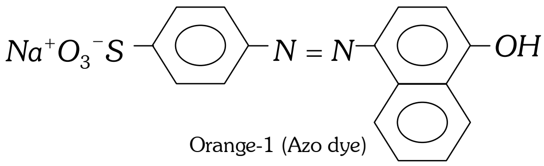

Tyrian purple

Note : ✹ *Common 'Neel' used as a blueing agent in laundary to remove yellowish tint on white clothes or in whitewashing is not indigo. It is ultramarine blue – an inorganic complex silicate of aluminium and sodium with about 13% sulphur.*

(ii) ***Classification of dyes according to their application***

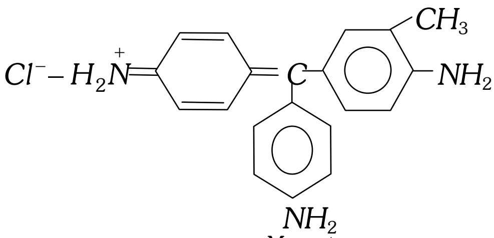
(a) *Direct dyes* : Direct dyes can be directly applied to the fibre, both animal and vegetable, by dipping in hot aqueous solution of the dye. *These dyes are most useful for those fabrics which can form hydrogen bonds*, *i.e.*, for cotton, rayon, wool, silk and nylon. Martius yellow and congo red act as direct dyes. Examples : Marius yellow, congo red.

(b) *Acid dyes* : These are usually salts of sulphonic acids and can be applied to wool, silk and nylon. The presence of sulphonic acid group makes them water soluble. These dyes are applied from an acidic bath. The polar acidic groups interact with the basic groups of the fabric. Orange-1 is an excellent acid dye.



Orange-1 (Azo dye)

(c) *Basic dyes* : These are the hydrochlorides or zinc chloride salts of colour bases having basic groups. These dyes react with anionic sites present on the fabric to attach themselves. These dyes colour fibres of nylons and polyesters. Aniline yellow. Magenta (Rosaniline) and Malachite green are the examples of basic dyes.



Magenta

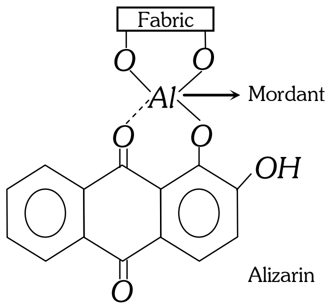
Note : ✸ *Acid and basic dyes are actually direct dyes.*

(d) *Mordant dyes* : These dyes have no natural affinity for the fabric and are applied to it with the help of certain additional substances known as mordants. A mordant (Latin mordere = *to bite*) is any substance which can be fixed to fabric and reacts with the dye to produce colours on fabric. Three types of mordants are commonly used,

• Acidic mordants like tannic acid which are used with basic dyes.

• Basic mordants such as metallic hydroxides or albumin which are used with acidic dyes.

• Metallic mordants like salts of aluminium, chromium, iron, tin, etc., which are used with acidic dyes.

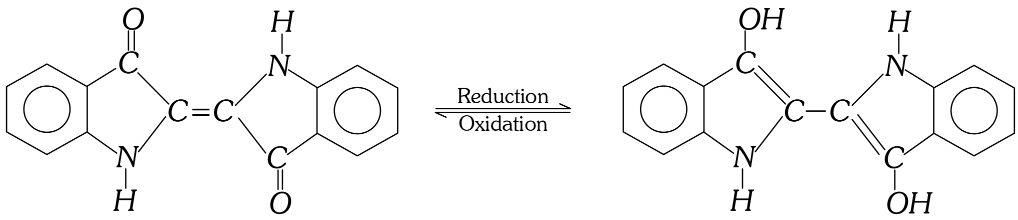


Coordination compound of Alizarin with Al^{3+}

Actually the mordant forms an insoluble coordination compound between the fabric and the dye and binds the two. Alizarin is a typical mordant dye. It gives different colours depending on the metal ion used. For example, *with* Al^{3+}, *alizarin gives a rose red colour; with* Ba^{2+}, *a blue colour; with* Fe^{3+}, *a violet colour and with* Cr^{3-}, *a brownish red colour.*

The process of mordant dyeing consists in impregnating the fabric with mordant in presence of wetting agent followed by soaking of the fabric into the solution of dye.

(e) *Vat dyes* : These dyes are insoluble in water and cannot be applied directly. These dyes on reduction with sodium hydrosulphite ($NaHSO_3$) in a vat form a soluble compound which has great affinity for cotton and other cellulose fibres. The cloth is soaked in the solution of a reduced dye and then hung in air or treated with oxidants like perboric acid. As a result, the colourless compound is oxidised to insoluble dye which is now bound to the fabric. *The colourless and reduced state of the dye is called the Leuco base.* The common examples of vat dyes are indigo and tyrian purple. These are mostly used on cotton.



Indigo
(Blue, water insoluble)

Indigo-white, Leucobase
(Colourless water insoluble)

(f) *Ingrain dyes* (developed dyes) : Ingrain dyes are those which are synthesised directly on the fabric. Examples of this type are azo dyes. The fabric is immersed in the solution of coupling reagent (usually a phenol or naphthol). Then it is dipped in the solution of suitable diazonium salt. Both react to form the dye whose molecules are adsorbed on the surface of fabric. The ingrain dyeing is particularly suitable for cotton fabrics.

(g) *Disperse dyes* : These dyes are used to colour synthetic fabrics such as nylon, orlon, polyesters and cellulose acetate which have tightly packed structures. The dyes are dispersed in a colloidal form in water. The fabric is immersed in the colloidal dispersion of the dye when fine dye particles are trapped within the polymer structure of the fabric. Examples of this type are monoazodye and anthraquinone dye.

Drugs and Chemotherapy.

Drugs may be a single chemical substance or a combination of two or more different substances. An ideal drug should satisfy the following requirements,

- When administrated to the ailing individual or host, its action should be localised at the site where it is desired to act. In actual practice, there is no drug which behaves in this manner.
- It should act on a system with efficiency and safety.
- It should have minimum side effects.
- It should not injure host tissues or physiological processes.
- The cell should not acquire resistance to the drug after sometime.

Very few drugs satisfy all the above requirements. Each drug has an optimum dose, below which it has no action and above this level it becomes a poison.

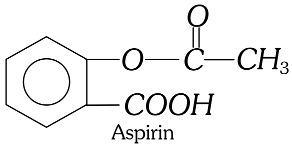
The term *chemotherapy*, which literally means chemical therapy or chemical treatment was coined in 1913 by ***Paul Ehrlich***, the father of modern chemotherapy. **He defined chemotherapy as the use of chemicals (drugs) to injure or destroy infections micro-organisms without causing any injury to the host**.

Further growth of cancerous cells in the body is arrested by chemotherapy. Chemotherapy has developed into a vast subject today and efforts are being continuously made to search new drugs as to free human beings from various types of diseases. Chemicals (drugs) used in chemotherapy are usually classified according to their action.

(1) **Antipyretic :** Antipyretic is a drug which is responsible for lowering the temperature of feverish body. The central nervous system, especially the hypothalamus, plays an important role in maintaining the balance between the heat production and heat loss in order to regulate the body temperature. Hypothalamus is, thus, known as the *thermostat* of the body.

The antipyretic drug helps to reset the thermostate at normal temperature. Heat production is not inhibited but heat loss is increased by increased peripheral blood flow which increases the rate of perspiration. This causes body to lose heat and subsequently lowers the body temperature.

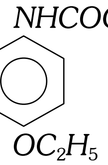
Aspirin is an important antipyretic. The other antipyretics are phenacetin, paracetamol, novalgin and phenyl butazone.



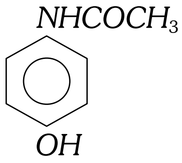
Aspirin
(Acetyl salicylic acid)

Aspirin should not be taken empty stomach. Some persons are allergic to aspirin. The usual allergic reaction is rashes on skin, lowering of blood pressure, profuse sweating, intense thirst, nausea and vomitting. Calcium and sodium salts of aspirin are more soluble and less harmful.

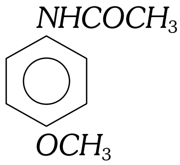
The derivatives of *p*-aminophenol are used as antipyretic. The main limitation of these derivatives is that they may act on red blood cells and thus, they may be harmful in moderate doses. The important derivatives are,



Phenacetin
(4-Ethoxy acetanilide)

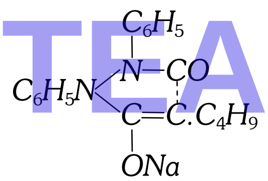


Paracetamol
(4-Acetamidophenol)



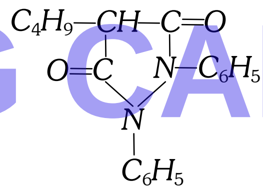
Methacetin
(4-Methoxy acetanilide)

Phenyl butazone is a pyrazolone derivative. Its structure is,



Phenyl butazone

or



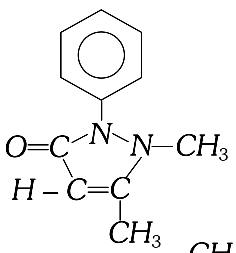
Butazolidine

It is highly toxic and hence not considered as a safe drug. Oxyphenyl butazone is less toxic and is used in place of phenyl butazone.

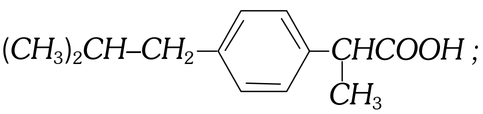
(2) **Analgesics :** Drugs which relieve or decrease pain are termed analgesics. These are of two types,

(i) ***Narcotics*** : These are mainly opium and its products such as morphine, codeine and heroin. These produce analgesia and sleep and in high doses cause unconsciousness. They are very potent drugs and their chronic use leads to addiction.

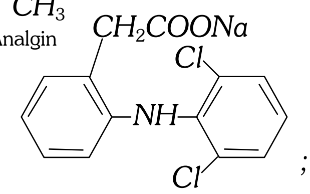
(ii) ***Non-narcotics*** : These are the drugs which are not potent and do not cause addiction. Common drugs are aspirin and analgin. These drugs also have antipyretic properties.



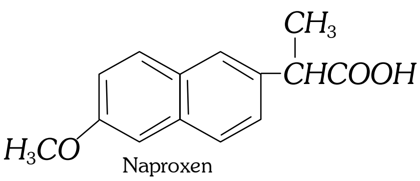
Analgin



Ibuprofen



Diclofenac
Sodium



Naproxen

(3) **Antimicrobials :** *These are the chemical substances used to cure infections due to micro-organisms. These are also called microbes.* Any organism which causes disease is called ***pathogen***.

The control of microbial diseases can be achieved by the following three ways,

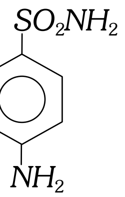
(i) By drugs which kill the organism in the body (**bactericidal**).

(ii) By drugs which inhibit or arrest the growth of the organism (**bacteriostatic**) and

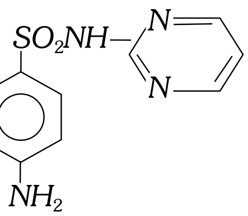
(iii) By increasing immunity and resistance to infection of the body (**immunity**).

Antimicrobial substances may be synthetic chemicals like *sulphonamides, paraamino salicylic acid* or they may be antibiotics like tetracycline, penicillin, chloramphenicol, etc.

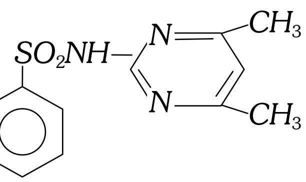
The common example of antimicrobial drug is *sulphanilamides* which are effective in wide range of micro-organisms. These are structural analogues of *p*-amino benzoic acid.



Sulphanilamide
(*p*-amino benzene sulphonamide)



Sulphadiazine



Sulphadimidine

Large number of derivatives of sulphanilamide such as ***sulphadiazine, sulphadimidine, sulphadimethoxine, sulphadoxine, sulphasomidine*** are being used as anti-microbials.

Sulphonamides in combination with ***trimethoprim*** are preferred in the treatment of infections of urinary tract.

(4) **Antiseptics and disinfectants**

(i) ***Antiseptics*** **:** The chemical substances which are used to kill or prevent the growth of micro-organisms are called *antiseptics*. These are not harmful to living tissues and can be safely applied on wounds, cuts, ulcers, diseased skin surfaces. These are also used to reduce odours resulting from bacterial decomposition of the body or in the mouth. They are, therefore mixed with deodorants, face powders and breath purifiers. We all must be familiar with antiseptic creams like *furacin, soframycin* etc.

(ii) ***Disinfectants*** **:** *The chemical substances which are used to kill microorganisms but they cannot be applied on living tissues* are called *disinfectants*. Therefore, disinfectants also kill micro organisms but these are not safe for living tissues. Disinfectants play a major role in water treatment and in public health sanitation. These are commonly applied to inanimate objects such as floors, instruments, etc.

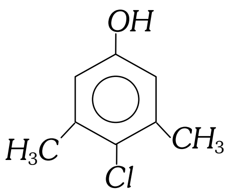
The same substance can act as disinfectant as well as antiseptic depending upon its concentration. For example, *a 0.2% solution of* ***phenol*** *acts as antiseptic and its 1% solution acts as disinfectant.*

The common examples are,

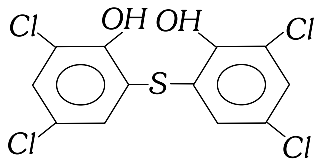
(a) Cl_2 is used for making water fit for drinking at a concentration 0.2 to 0.4 ppm.

(b) ***Dettol*** is an antiseptic. It is a mixture of chloroxylenol and terpeneol in a suitable solvent. Chloroxylenol has both antiseptic and disinfectant properties.

(c) ***Bithional*** is antiseptic which is generally added to medicated soaps to reduce the odour produced by bacterial decomposition of organic matter on the skin.



Chloroxylenol



Bithional

(d) ***Iodine*** is powerful antiseptic. It is used as a tincture of iodine which is 2-3% iodine solution of alcohol-water.

(e) Low concentrations of ***sulphur dioxide*** are used for sterilizing and preservation of squashes.

(f) A dilute aqueous solution of ***boric acid*** is used as a weak antiseptic for eyes. It also forms a part of antiseptic baby talcum powders.

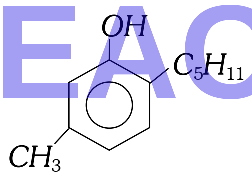
(g) ***Iodoform*** is also used as an antiseptic powder for wounds.

(h) ***Hydrogen peroxide*** is also used as non-irritating strong antiseptic.

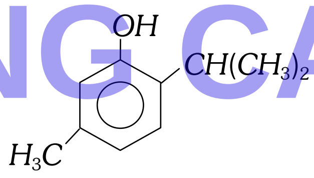
(i) **Hexachlorophene** is mainly used in soaps, creams, dusting powders and emulsions.

(j) ***Amyl metacresol*** (5-methyl-2-pentyl phenol) is an antiseptic which is used commonly as a mouthwash or gargles in infections of the mouth and throat.

(k) A naturally occurring phenol derivative, **thymol** is used as a powerful disinfectant than phenol.



Amyl metacresol

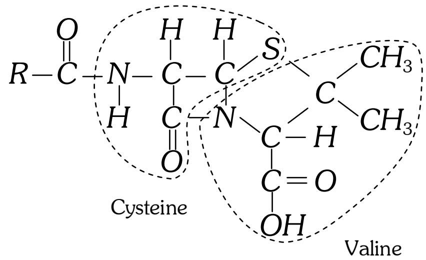


Thymol

(l) Some organic dyes are also effective antiseptics. These are used for the treatment of infectious diseases. The common examples of antiseptic dyes are ***gention violet*** and ***methylene blue***.

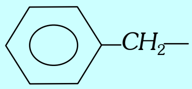
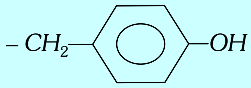
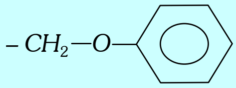
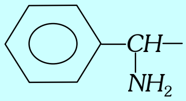
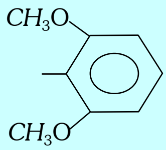
(5) Antibiotics : *A chemical substance produced by or derived from living cells which is capable of inhibiting the life processes or even destroying micro-organism* is called ***Antibiotics***.

The first antibiotic, discovered by *Alexander Fleming* in 1929 from the mould *penicillium notatum*, was penicillin. In 1938, *Ernst Chain* and *Howard Florey* isolated penicillin in pure form and proved its effectiveness as an antibiotic. It was introduced into medical practice in 1941. Penicillin is used against large number of infections caused by various cocci, gram positive bacteria, etc. It is an effective drug for pneumonia, bronchitis, sore throat and abcesses.



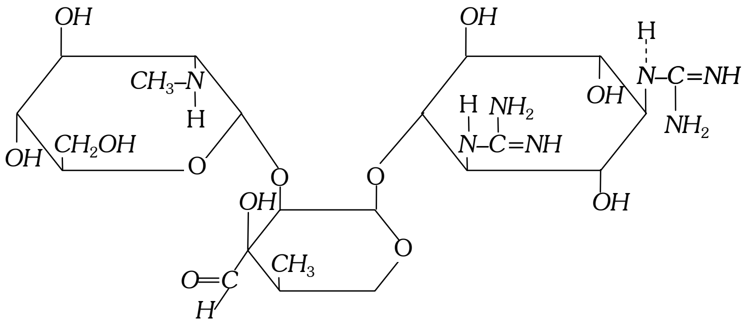
General structure of penicillin

Several naturally occurring penicillins have been isolated all of these have the empirical formula, $C_9H_{11}O_4SN_2R$

Name	***Value of R***	***Chemical name***
Penicillin-G or II		**Benzyl penicillin**
Penicillin –F or I	$-CH_2-CH=CH-CH_2-CH_3$	**2-Pentenyl penicillin**
Penicillin-K or IV	$-(CH_2)_6-CH_3$	**n-Heptyl penicillin**
Penicillin-X or III		**p-Hydroxy benzyl penicillin**
Penicillin-Y or V		**Phenoxy methyl penicillin**
Ampicillin		**Benzyl amine penicillin**
Methicillin		**2, 6- dimethoxy phenyl penicillin**

The commonly used antibiotics are :

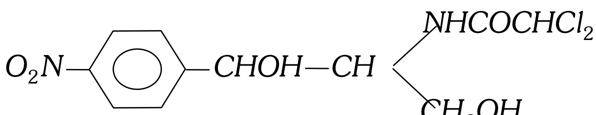
(i) ***Streptomycin*** : ***It was discovered in 1944*** by **Waksman**. It is effective against tuberculosis. It is also used for other common infections like throat, lungs, ears and kidney. *It is very effective in the treatment of meningitis and pneumonia*. Streptomycin is an amino base and forms salts that are very soluble in water. The sulphate and calcium chloride double salts are white amorphous powders. The molecule contains two strongly basic quanido groups and a weakly basic methylamino group.



Streptomycin

Streptomycin is rapidly absorbed after intramuscular injection. Oral administration of streptomycin is of no value in the treatment.

(ii) ***Chloramphenicol*** : *It is a broad spectrum antibiotic*. It was first isolated from a species of *streptomyces*. It has been produced synthetically on commercial basis. It is white or greyish white needle like crystalline substance. It has a bitter taste. One gram of chloramphenicol is soluble in about 400 *mL* of water. It is freely soluble in alcohol.

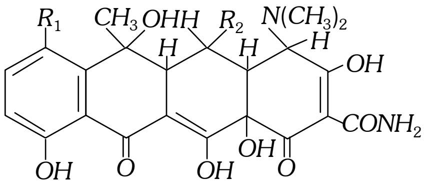


Chloramphenicol

It is effective against certain gram-positive and gram-negative bacteria, some rickettsiae and viruses. It is very effective in the treatment of typhoid fever, para-typhoid fevers, diarrhoea and dysentary. *It is also specific for influenza, meningitis, pneumonia, whooping cough and urinary tract infection*.

Chloramphenicol may cause serious complications and hence it should not be used indiscriminately or for minor infections. Chloramphenicol in high concentrations inhibits the growth of animal and plant cells.

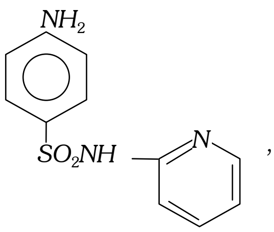
(iii) ***Tetracyclines*** : The tetracyclines contain hydronaphthacene skeleton as the characteristic structural unit. The structures of tetracyclines are given as follows,

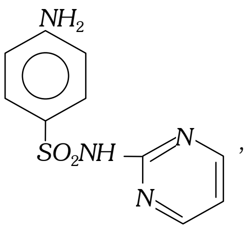


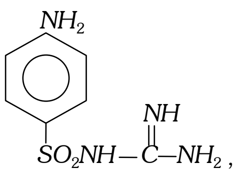
Chlortetracycline (Aureomycin)	$R_1=Cl, R_2=H$
Oxytetracycline (Terramycin)	$R_1=H, R_2=OH$
Tetracycline	$R_1=R_2=H$

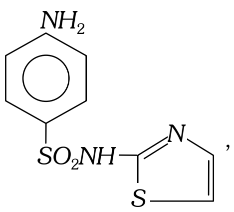
Tetracyclines are broad spectrum antibiotics and are effective against a number of types of bacteria, larger viruses, protozoa, parasites and typhus fever. These can be given orally.

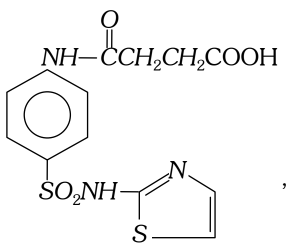
(6) **Sulpha drugs :** These are synthetic chemotherapeutic agents which contain sulphonamide, $-SO_2NH_2$ group in their structure. These were the first effective chemotherapeutic agents to be widely used *for the cure of bacterial infections in humans*. They have also been found to be active against gram-positive and gram negative cocci, bacilli and protozoa. At present sulphanilamides have been largely replaced by antibiotics for the treatment of most of the bacterial diseases. Some successful sulphanilamides are given below,

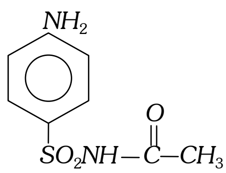

Sulphapyridine


Sulphadiazine


Sulphaguanidine


Sulphathiazol


Succinyl sulphathiazole

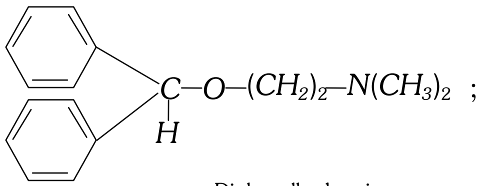

Sulpha acetamide

Name of drug	*Uses*
Sulphapyridine	**Used to cure pneumonia.**
Sulphadiazine	**Used to cure pneumonia, throat infections, meningitis, etc.**
Sulphaguanidine	**Used to cure bacillary dysentary.**
Sulphathiazole	**Useful against staphylococcal infections and bubonic plague.**

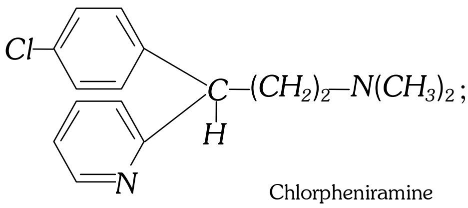
Succinyl sulphathiazole	**Useful in intestinal infections such as bacillary dysentary and cholera.**
Sulpha acetamide	**Used to cure urinary tract infections.**

(7) **Antihistamines :** *Antihistamines are chemical substances which diminish or abolish the main actions of histamine released in the body and hence prevent the allergic reactions*. In other words, antihistamines are also called *anti-allergic drugs*.

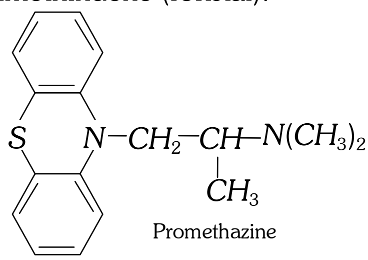
The common antihistamine drugs are *diphenylhydramine (Benadryl), pheniramine maleate (Avil),* chlorpheniramine (Zeet), Promethazine, triprolidine (actidil), Antazoline (antistine), Dimethindene (foristal).



Diphenylhydramine



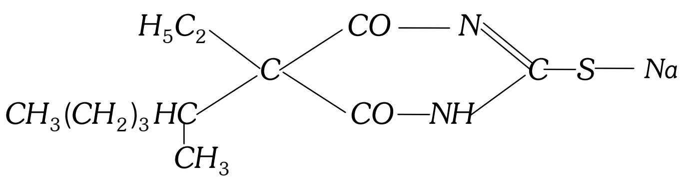
Chlorpheniramine



Promethazine

(8) **Anaesthetics :** It may be defined as those drugs which produce insensibility to the vital functions of all types of cell especially of nervous system. Anaesthetics may be classified into two groups on the basis of their applications,

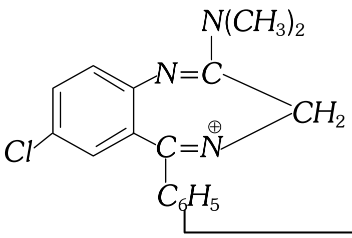
(i) ***General anaesthetics*** : These depress the central nervous system to such an extent that all sensitivity to pain or feeling is lost, *i.e.*, they produce unconsciousness all over the body. *These are used for major surgical operations*. These may be used in the form of gas, *e.g.*, nitrous oxide, cyclopropane, ethylene, either or may be given in the injection from, *e.g.*, sodium pentothal.



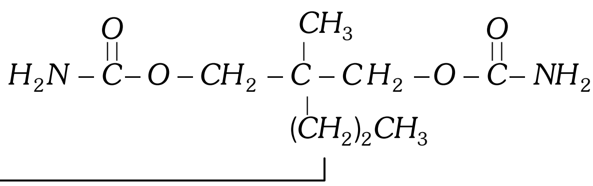
Sodium pentothal

(ii) ***Local anaesthetics*** : These affect only a part of the body insensitive to pain or feeling. Common local anaesthetics are : *xylocaine (used in jelly form), ethyl chloride (used in spray form) and procaine (used in injection)*. These are used *for small surgical operations like tooth extraction, stitching of a wound or incision of an abscess*. Some other modern local anaesthetics are; α-eucaine, orthocaine (orthoform) and dimethisoquin.

(9) **Tranquillizer or Hypnotics :** The chemical substances used for the treatment of stress, mild and severe mental diseases are called ***tranquillizers***. These are used to release mental tension and reduce anxiety.



Chlordiazepoxide



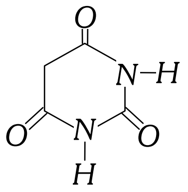
Meprobamate

For releasing tension

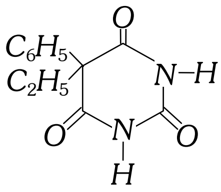
These derivatives are called as barbiturates.

These are also called *psychotherapeutic drugs*. These drugs make the patient passive and help to control their emotional distress or depression.

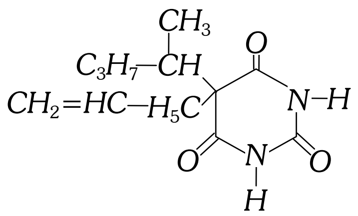
The most commonly used tranquillizers are barbituric acid and its derivatives such as *veronal, amytal, membutal, seconal* and *luminal*.



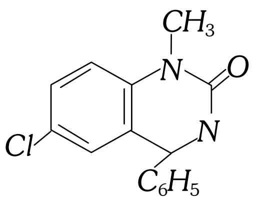
Barbituric acid



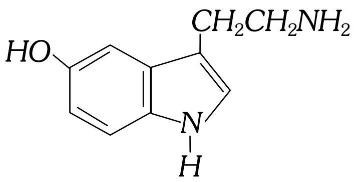
Luminal



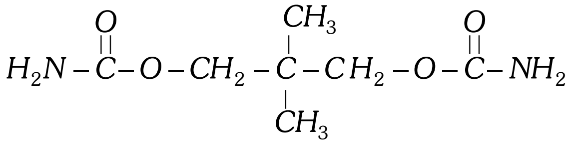
Seconal



Valium



Serotonin



Equanil
Used in depression and hypertension

It may be noted that different terms are used for drugs which are used to cure mental diseases. Some of these terms are ,

(i) ***Sedatives*** **:** These act as depressant and suppress the activities of central nervous system. They are given to patients who are mentally agitated and violent. Sedatives give a feeling of calmness, relaxation or drowsiness in the body. Their high doses induce sleep. The common sedatives are *valium, barbiturates* (obtained from barbituric acid).

(ii) ***Antidepressants*** **:** These drugs are given to patients with shattered confidence. These produce a feeling of well being and confidence in the person of depressed mood. Therefore, these are also called *mood booster drugs*. The common examples are *vitalin, cocain, methedrine* etc.

(10) **Anti-Malarials :** Malaria is highly wide spread infectious disease, caused by sporozoa of genus plasmodium. It is charactrised clinically by periodic fever, anaemia and enlargement of liver and spleen. The four species, *Plasmodium vivax, Plasmodium malariae, Plasmodium ovale* and *Plasmodium falciparum* are responsible for malaria in man. Thus, there are four types of malaria,

Protozoa	*Malaria caused*
Plasmodium vivax	**Fever on alternate days**
Plasmodium malariae	**Fever once in three days**
Plasmodium ovale	**Fever once in three days**
Plasmodium falciparum	**Fever once in four days**

The chemotherapy of malaria is connected with different stages in the cycle of malarial parasite. The mosquito injects the parasite into the blood of a human being. It immediately goes to the liver cells where is multiplies. Once the parasites have grown in number, these come to blood and enter the red blood corpuscles where they also multiply. Eventually, the red cells burst liberating the parasites as well as toxins. These toxins cause fever, chills and rigour. The liberated parasites attack the fresh red cells and the cycle continues. Depending upon the periodicity of this cycle in the red cells fever comes on alternate days, once in three days or once in four days. Some of the liberated parasites go back to liver and continue the cycle there.

Choice of an antimalarial drug depends on the point of its action on the life cycle of the malarial parasite. Various drugs used are :

(i) ***Primaquine*** : It destroys sporozites in the liver. It is too toxic, and its long term use is not advisable.

(ii) ***Chloroquine, proquanil and pyrimethamine*** : These kill the parasites in blood.

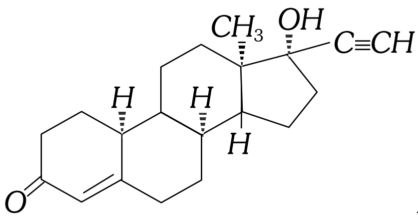
(11) **Antifertility drugs :** *These are the chemical substances used to control the pregnancy*. These are also called *oral contraceptives*. The basic aim of antifertility drugs is to prevent conception or fertilization.

Oral contraceptives belong to the class of natural products known as steroids.

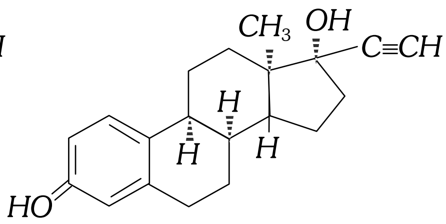
These control the female menstrual cycle and ovulation. The birth control pills are essentially a mixture of esterogen and *progesterone derivatives* which are more potent than the natural hormones.

These common pills are used for a combination of progesterone, norethindrone and estrogen ethynylestradiol.

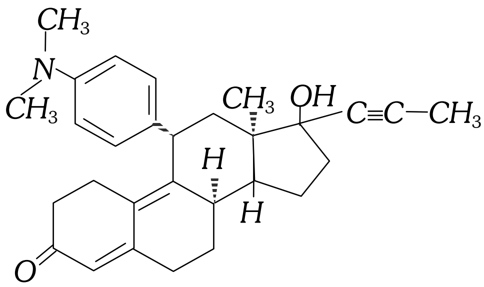
Mifepristone is a synthetic steroid which blocks the effects of progesterone and is used as a "morning after pill" in many countries.



Norethindrone



Ethynylestradiol



Mifepristone

Ormeloxifene (*Centchroman, Saheli*) has also been developed and tested at the Central Drug Research Institute, Lucknow as an effective antifertility drug to acceptable degree. The oral contraceptives are commonly known as *pills* or *oral pills* and have been used worldwide for birth control.

Drugs or Medicines from plants

- Bark of willow tree which contains salicyclic acid. It is used to get relief from pain and fever.
- Alkaloid Reserpine from *Rauwolfia serentina* for high blood pressure (hypertension).
- Alkaloid Quinine from Cinchona tree for Malaria.

Chemicals in Medicines

• Analgesics	Relieve pain	Aspirin, ibuprofen, diclofenac sodium, naproxen, narcotics (morphine, codeine, heroin).
• Antipyretics	Lower body temperature	Aspirin, paracetamol, phenacetin.
• Antiseptics & disinfectants	Kill or prevent the growth of micro-organisms.	0.2% phenol (antiseptic), 1% phenol (disinfectant), chlorine, dettol (chloroxylenon and terpeneol), bithional, iodine, boric acid.
• Tranquilizers	Treatment of stress, mental diseases	Derivatives of barbituric acid (veronal, amytal, membutal, luminal, seconal), chlordiazepoxide, meprobamate, valium, serotonin.
• Antimicrobials	Cure infections due to micro-organisms (microbes)	Antibiotics, Sulphonamides
• Anti fertility drugs	Birth control	Oral contraceptives, estrogen (ethynylestradiol) and progesterone (norethnidrone), mifepristone.
• Antibiotics	Produced by micro-organisms and can inhibit the growth of other micro-organisms.	Penicillin, tetracycline, chloramphenicol, ampicillin, amoxicillin Sulpha drugs (sulphanilamide, sulphadiazine, sulphaguanidine)
• Antacids	Remove excess acid in stomach	Magnesium hydroxide, magnesium carbonate, magnesium trisilicate, aluminium hydroxide gel,

sodium bicarbonate, aluminium phosphate, prazole, lansoprazole.

Rocket Propellant.

Rocket propellants consist of rocket engines powered by propellants. These are used both in space vehicles as well as in offensive weapons such as missiles. The propellants are chemical substances which on ignition provide thrust for the rocket to move forward. These substances are called ***rocket propellants***. A propellant is a combination of ***an oxidiser*** and ***a fuel*** which when ignited undergoes combustion to release large quantities of hot gases. The passage of hot gases through the nozzle of the rocket motor provides the necessary thrust for the rocket to move forward according to Newton's third law of motion.

The function of a rocket propellant is similar to that of petrol in a motor car except that in the later case, the oxygen needed for burning the fuel is taken from the atmospheric air.

(1) **Types of rocket propellants :** Depending upon the physical state, propellants can be classified as :

(i) ***Solid propellants*** **:** The solid propellants are mixtures of solid fuel and a solid oxidiser. These are further divided into two classes,

(a) *Composite propellants* : These are solid propellants which use polymeric binder such as polyurethane or 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 metal along with the fuel.

(b) *Double base propellants* : These are solid propellants which mainly use nitroglycerine and nitrocellulose. The nitrocellulose gels in nitroglycerine set in as a solid mass.

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

(ii) ***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,

(a) *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.

(b) *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.

Note : ✹ *Hydrazine can act both as a monoliquid as well as a biliquid propellant. Hydrazine* (H_2N-NH_2) acts as a monoliquid propellant as it decomposes exothermally into hot gaseous mixture of N_2 and H_2,

$$H_2N-NH_2 \rightarrow N_2 + 2H_2 + \text{heat}$$

As a biliquid propellant with liquid oxygen as oxidiser,

$$H_2N-NH_2 + O_2 \rightarrow N_2 + 2H_2O + \text{heat}$$

Advantages of Biliquid Propellants over Solid Propellants

- The biliquid propellants give higher thrust than solid propellants.
- The thrust generated by liquid propellants can be controlled by switching on and off the flow of propellants. On the other hand, the thrust cannot be controlled in solid propellants.

(iii) ***Hybrid propellants*** **:** These are the propellants which consist of solid fuel and a liquid oxidiser. For example, liquid N_2O_4 (liquid oxidiser) and acrylic rubber (solid fuel).

(2) Examples of Propellants used in Different Rockets

(i) ***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.

(ii) Russian rockets such as ***Proton*** used a liquid propellant consisting of kerosene and liquid oxygen.

(iii) The Indian satellites SLV-3 and ASLV used composite solid propellants.

(iv) The rocket PLSV will use solid propellant in the first and third stages and liquid propellant in second and fourth stages. The liquid propellant will consist of N_2O_4 and unsymmetrical dimethyl hydrazine (UDMH) and N_2O_4 and monomethyl hydrazine (MMH) respectively.

In our country, Indian Space Research Organization (ISRO) has been set up to launch and utilize two classes of satellites : remote sensing satellites and communication satellites. The Polar Satellite Launch Vehicle (PSLV) is a remote sensing satellite. India has succeeded in launching several space vehicles using various rocket propellants. India's latest vehicle, PSLV–C4 took flight on 12th September, 2002 and it was named METSAT MISSION. It consists of four stage vehicle. The first stage is one of the largest solid propellant boosters in the world and carries about 138 tonnes of hydroxyl terminated polybutadiene (HTPB) based propellant.

The second stage uses indigenously built VIKAS engine and carries 40 tonnes of liquid propellant unsymmetrical dimethyl hydrazine (VDMH) as fuel and nitrogen tetroxide (N_2O_4) as oxidizer.

The third stage uses 7.6 tonne of HTPB based solid propellant.

The fourth and terminal stage of PSLV-C4 has a twin engine configuration using liquid propellant. Each engine uses 2.5 tonnes of monomethyl hydrazine as fuel and mixed oxides of nitrogen as oxidizer.

(3) Calculation of specific impulse of propellant

The function of rocket propellant is based on specific impulse which measures the kinetic energy producing ability of the propellant. The specific impulse (I_s) can be calculated from the following equation,

$$I_s = \frac{1}{g}\sqrt{\left(\frac{2\gamma}{\gamma-1}\right)\left(\frac{gRT_c}{M}\right)\left(1-\frac{p_c}{p_e}\right)^{\frac{\gamma-1}{\gamma}}}$$

Where,

γ = Ratio of specific heat at constant pressure to specific heat at constant volume.

T_c = Combustion chamber temperature.

M=Average molecular mass of exhaust products.

P_e=External pressure

P_c = Chamber pressure, and

R = Gas constant

The above equation shows that the conditions favouring high specific impulse are high chamber temperature and pressure, low molecular mass of exhaust products and low external pressure.

The higher the temperature and pressure achieved in the chamber, the higher the kinetic energy of the gases escaping through the nozzle.

Chemical in cosmetics.

The word cosmetics is derived from the Greek word *Kosmetikos*. It means decorating. beautifying or improving complexion of skin. In India from the ancient times *Henna* has been used to decorate hands and some other parts of the body. Some of the cosmetics which find use in daily life are discussed below,

(1) **Creams** : Creams are used for facial make-up. These are often classified as : cleansing creams, cold creams, vanishing creams, sunburn creams and bleach creams.

(i) ***Cleansing creams*** : Remove facial make up, surface grime, lipstic and oil.

(ii) ***Cold creams*** : Lubricate the skin and prevent roughness and chaffing.

(iii) ***Vanishing creams*** : Keep the skin cool and oily.

(iv) ***Sunburn creams*** : Save the skin from sunburn in summer.

(v) ***Bleach cream*** : Exert a bleaching effect on dark skin.

(2) **Perfumes** : Perfumes are the materials, used to provide fragrance. Several requirements have to be fulfilled to make a good perfume and any material, which just gives good smell, may not be a perfume.

A perfume invariably consists of three ingredients : a vehicle, fixative and odour producing substance.

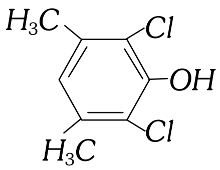
(i) ***Vehicle*** : The vehicle is also called solvent. The role of the solvent is to keep the odour-producing substances in solution. Ethanol and water mixture is the most common vehicle used in perfumery.

(ii) ***Fixative*** : The function of the fixative is to equalize the rate of evaporation of various odouriferous components of the perfume by suitably adjusting their volatility. *Sandalwood oil* finds use as fixative. Other substances used as fixative are b*enzoin, glyceryl diacetate* and esters of cinnamyl alcohol.

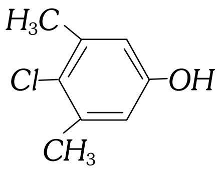
(iii) ***Odourous substances*** : Both natural and synthetic substances are used to impart odour to a perfume. For example, terpenoids like linalool which occur in essential oils are natural odour producing compounds, while anisaldelyde (*p*-methoxybenzaldehyde), is a synthetic odour producing compound.

(3) **Talcum powder** : Talcum powder is used to reduce irritation of the skin. Talcum powders like face powders contain talc $(Mg_3(OH)_2Si_4O_{10})$. Chalk, zinc oxide, zinc sterate and a suitable perfume act as the other main constituents of talcum powder. Often specific ingredients like antiseptic and cooling agents are added. The role of the talc is to act as a powder base and to make skin smooth. Chalk absorbs secretion (perspiration) without showing any evidence of such absorption. Zinc oxide masks enlarged pores and minor blemishes, whereas zinc sterate makes powder adhere to skin. Baby talcum powders contain considerable amounts of zinc stearate for adhesiveness and boric acid, for antiseptic purposes. Talcum powders need to be dusted with care to prevent inhalation of the fine particles, which irritate the lungs.

(4) **Deodorants** : As the name suggests, deodorants are applied primarly to mask the body odour. The body odour results from the bacterial action following perspiration. A deodorant must therefore, possess anti-bacterial properties. Aluminium salts, have been found to possess excellent antibacterial properties. In addition to aluminium salts, ZnO, ZnO_2 and $(C_{17}H_{35}COO)_2Zn$ also find use in deodorant preparations because they are astringents as well as antiseptics. Phenolic antibacterials, which have figured as effective body deodorant are parachlorometaxylenol and dichlorometaxylenol having following structures.



Dichlorometaxylenol



p-Chlorometaxylenol

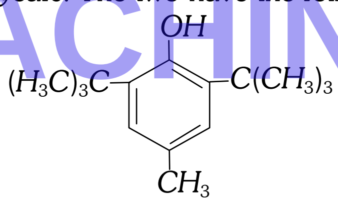
Powder formulations generally have deodorants.

Chemicals in food.

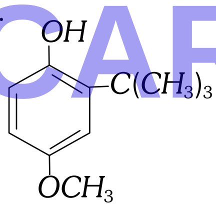
Many chemicals are added to food for their preservation and enhancing their appeal. These include flavourings, sweeteners, dyes, antioxidants, fortifiers, emulsifiers and antifoaming agents. With the exception of the preservatives, fortifying agents, antioxidants and artificial sweeteners, the remaining classes of chemicals mentioned above are added either for ease in processing or for cosmetic purposes, in the real sense these have no nutritive value.

(1) **Antioxidants** : Antioxidants are the important and necessary food additives. These compounds retard the action of oxygen on the food and thereby help in its preservation. These act as sacrificial materials, *i.e.*, these are more reactive towards oxygen than are the materials they are protecting. They also reduce the rate of involvement

(2) of free radicals in the aging process. The two most familiar antioxidants used are *butylated hydroxy toluene (BHT) and butylated hydroxy anisole (BHA)*. The addition of *BHA* to butter increases its storage life from months to years. The two have the following structures.



(BHT)



(BHA)

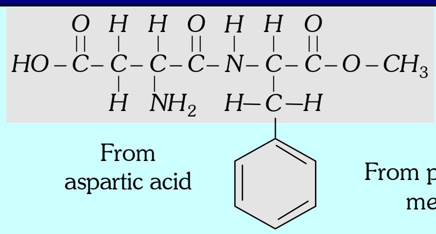
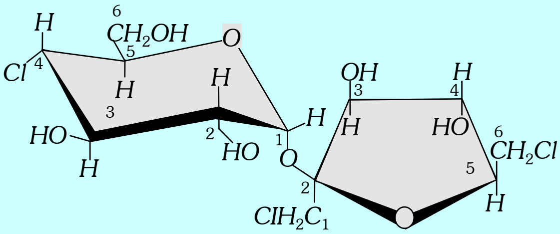
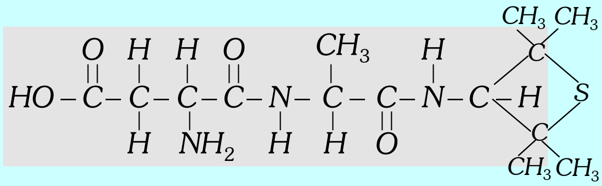
Sometimes *BHT* and *BHA* are added in combination with citric or ascorbic acids to produce a more active synergietic effect. Sulphur dioxide and sulphite are useful antioxidants for wine and beers, sugars syrups and cut peeled or dried fruits and vegetables.

(2) **Preservatives** : The preservatives prevent spoilage of food due to microbial growth. The most common preservative used is sodium benzoate, C_6H_5COONa. It is metabolized by conversion to hippuric acid, $C_6H_5CONHCH_2COOH$ which ultimately is excreted in the urine. Salts of propionic acid and sorbic acid are also used as preservatives.

(3) **Artificial sweetener** : The artificial sweeteners are another type of food additives. The first popular artificial sweetener was saccharin. It was marketed as its water soluble sodium or calcium salt. Saccharin is approximately 300 times sweeter than cane sugar. It has proved to be a lifesaver for countless diabetics and is of great value to people who need to control intake of calories.

Besides saccharin, the other commonly marketed artificial sweeteners are described here.

Aspartame is unstable at cooking temperatures, limiting its use as a sugar substitute to cold foods and soft drinks. Alitame is more stable than aspartame during cooking. One potential problem with alitame and similar type of high-potency sweetners is the difficulty in controlling sweetness of food. Sucralose is predicted to become a great commercial success.

Artificial Sweetener	*Structural Formula*	*Sweetness value in comparison to cane sugar*
Aspartame		**160**
Sucralose		**650**
Alitame		**2000**

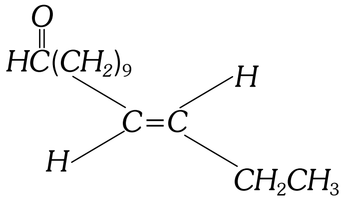
(4) **Edible colours** : Edible colours used for food are essentially dyes. The use of food dyes is extremely wide spread. They are used to colour everything from meat to fruit. For example, dyes are used to dye orange peels so that oranges retain their colour. Colour is one of the ingredients in fruit juices. There is a great deal of controversy over the potential harm the dyes may cause. This controversy becomes more meaningful particularly keeping in view the fact that food dyes add nothing to the nutritive value of food. The use of azo dyes has raised considerable anxiety in that some of them are dangerous for young children and asthma patients. Tetrazine, a very widely used dye is especially a suspect. However, natural dyes like *Carotene* are safe food edible colours. For protection of consumer interests, the government of India have passed Prevention of Food Adulteration act (PFA).

Pheromones, Sex Attractants.

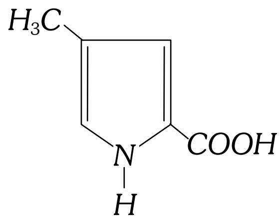
A major drawback with chemical insecticides is their lack of specificity. Non-specificity of insecticides may kill helpful insects, such as honeybees, which aid in pollination. The more specific we make our insect control, the less we will disrupt the environment. Although, in the past, it looked as if specific control was beyond the scope of chemistry, but some developments have shown that it is entirely possible to control populations of certain insects very effectively and specifically using substances known as ***pheromones***.

Pheromones provide chemical means of establishing communication. There are sex, trail and defense pheromones to mention a few. One of the most important roles pheromones play is as *sex attractants*. Sex pheromones tell the honeybee which flower to pollinate. The sex pheromones are remarkably powerful. A few hundred molecules may be all that are necessary to invoke a response. In addition to this fascinating parameter, it has been claimed that the sex attractants in some species can attract males from over two miles away. (The sex attractants are usually emitted by the females, although there are some male insects which also produce them). By baiting a trap with a small amount of sex attractant of an insect pest, one can collect all the males in the vicinity. They may then be disposed of or sterilized. Since mating cannot take place, the reproductive cycle is halted and the pest is controlled. The advantages to this method are immediately obvious. It is very specific since, (except in very rare instances), each insect has its own attractant. There is no spraying, hence no pesticide residues. In addition, the concentration of the attractants is so small that there would be no effect on any other species, even indirectly. For example, the gypsy moth attractants, attracts male moths in the area when a trap is baited with only $1 \times 10^{-9} g$. Gypsy moths are highly voracious eaters and will completely denude trees if they go unchecked.

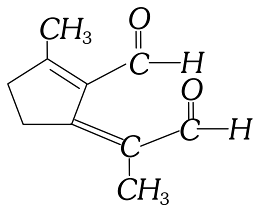
Names and structures of some pheromones



Sex pheromone of the spruce budworm



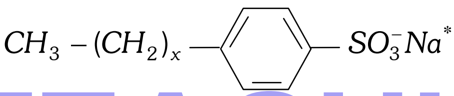
Trail pheromone



Defense pheromone of larvae of Chrysomelid beetle

Detergents.

As a result of high dissolving power, the naturally occurring water always contains dissolved materials, particularly ionic substances. Hard water contains certain metal ions, such as Ca^{2+} and Mg^{2+}. These ions react with soap. (sodium salts of stearic and similar organic acids), to produce a curdy precipitate of calcium and magnesium salts. This precipitate adheres to clothing and blocks the ability of soaps to remove oil and grease from fabrics. Synthetic detergents are very similar to the salts of fatty acids found in soap, except that they are manufactured chemically from materials others than animal fats, Examples include salts called ***sodium alkylbenzenesulphonates,*** which have the general structure.



Sodiumalkylbenzenesulphonates

Note : ✹ *The anions of synthetic detergents donot precipitate in the presence of* Ca^{+2}/Mg^{+2}, *so their cleansing action is not affected by hard water.*

Types of detergents

(1) Anionic detergent : Long chain alcohols are used in the manufacture of some of the synthetic anionic detergents. The long chain alcohols are treated with concentrated sulphuric acid to form alkyl hydrogen sulphates of high molecular mass and finally the alkyl sulphates are neutralized with alkali to form salts.

$$CH_3-(CH_2)_{16}CH_2OH + H_2SO_4 \rightarrow CH_3-(CH_2)_{16}CH_2OSO_3H$$

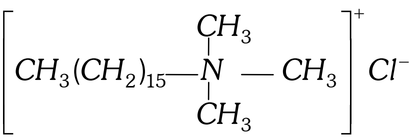
$$\downarrow NaOH(aq.)$$

$$CH_3-(CH_2)_{16}CH_2OS\bar{O}_3\,Na^{+}$$

Anionic Detergent

Note : ✹ *The single anionic detergents is largest use today in household detergents is alkylbenzene-sulphonate.*

(2) Cationic detergent : These are mostly acetates or chlorides of quaternary amines. Being more expensive than the anionic detergents they find limited use. Such detergents however, possess germicidal properties and are used quite extensively as germicides. ***Cetyltrimethyl-ammonium chloride***, is an example.



Cationic Detergent

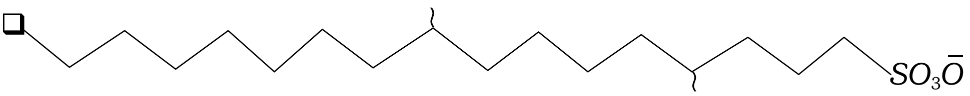
(3) **Non ionic detergent** : Esters of high molecular mass formed by reactions between polyethylene glycol and stearic acid.

$$\underset{\text{Ethyleneglycol}}{HOCH_2-CH_2OH}+\underset{\text{Ethyleneoxide}}{nCH_2\underset{O}{-}CH_2}\rightarrow\underset{\text{Polyethyleneglycol}}{HO(CH_2CH_2O)_nCH_2CH_2OH}$$

$$CH_3(CH_2)_{16}COOH+HO(CH_2CH_2O)_nCH_2CH_2OH\xrightarrow{-H_2O}\underset{\text{Nonionic Detergent}}{CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH}$$

Some liquid dishwashing detergents are of nonionic type.

Note : ❑



Detergent molecules associated with branched hydrocarbon tail which is a source of pollution.

The hydrocarbon side chain stops bacteria from attacking and breaking the chains. This results in slow degradation of detergent molecules leading to their accummulation. These days the amount of branching can be kept to a minimum. Unbranched chains are more prone to attack by bacteria so the detergents are more easily biodegraded and pollution is prevented.

New High Performance Materials .

(1) **Carbon fibres** : These fibres are stronger than steel, stiffer than titanium and lighter than aluminium. Carbon fibres are produced in a number of ways, and from a variety of starting materials or precursors such as viscose rayon, polyacrylonitrile, pitch, resins, gases such as (methane, and benzene). Their characteristics are strongly influenced by the manufacturing techniques employed.

Carbon fibres reinforced in a light weight matrix, generally an epoxy resin, polyester resin or polyamide, are called Carbon Fibre Reinforced Plastics (CFRP). When the carbon fibres are reinforced in a carbon matrix, they are known as Carbon Fibre Reinforced Carbon (CFRC), commonly known as carbon-carbon composites.

On the basis of the characteristics of carbon fibres, carbon firbre reinforced plastics (CFRP) and carbon fibre reinforced carbons (CFRC), their applications can be broadly classified into three categories,

(i) High technology sector including aerospace, military and nuclear fields.

(ii) General engineering sector including sports, transportation and chemical fields.

(iii) Biomedical sector.

In the biomedical field, carbon fibres have exciting applications, such as components of bone plates, hip joint prostheses, ligaments, and hydraulic motors for artificial heart implants. Activated carbon fibres are finding increasing applications in appliances for water treatment, gas masks, air filters, catalyst carriers for platinum, and so on. Activated carbon fibres in textile form are used in extremely hostile environments. The main advantages of using carbon fibres are that they can be woven in any form and a surface area of as high as 3000 m^2/g can be obtained.

Carbon fibres in India are mainly used in defence sector as nose tips and head shields of missiles (like 'Agni') by DRDO, Hyderabad, and in the aerospace sector by ISRO and other aerospace organizations for producing components parts, nozzles of rockets/missiles.

(2) **Ceramics** : The term ceramics comes from the Greek word keramikos which means burnt stuff, indicating thereby, that desirable properties of these materials are normally achieved through a high-temperature heat treatment process called firing. In the past, the most important materials in this class were the traditional ceramics, prepared from clay, (kaoloinite) a silicate. In the category of traditional ceramics we have porcelain, bricks, tiles, glass and temperature resistant ceramics.

Most ceramic materials fall into an application-classification scheme which is given below,

(i) ***Clay products*** : Porcelain, pottery, tablewares, sanitary fittings, building bricks, tiles and sewer pipes.

(ii) ***Glass ceramics*** : Kitchenware.

(iii) ***Refractory materials*** : Refractory bricks used as furnace linings.

(iv) ***Abrasive ceramics*** : Cutting and grinding tools. (familiar examples are silicon and tungsten carbides).

Recently, a family of ceramics have been found to be superconductors with high critical temperatures. One such material is yttrium barium copper oxide, which has a critical temperature of about 92 K. New super conduction ceramic materials reported to have even higher critical temperatures have been and are currently being developed. Several of these materials and their critical temperatures are listed below,

Super conducting ceramic materials and their critical temperatures.

Material	*Elements present in the materilal*	*Critical temp./K*
$YBa_2Cu_3O_7$	Y, Ba, Cu, O	92
$Bi_2Sr_2Ca_2Cu_3O_{10}$	Bi, Sr, Ca, Cu, O	110
$Tl_2Ba_2Ca_2Cu_3O_{10}$	Tl, Ba, Ca, Cu, O	125
$HgBa_2Ca_2Cu_2O_8$	Hg, Ba, Ca, Cu, O	153

Note : ✸ *Numerous applications of super conducting materials exist. Some of these are,*

- ✸ *Electrical power transmission.*
- ✸ *Magnets for high energy particle accelerators.*
- ✸ *High speed switching and signal transmission for computer.*