UNIT 15

CHEMISTRY IN EVERYDAY LIFE

Vladimir Prelog

Prof. Vladimir Prelog was a Swiss Chemist who shared 1975 Nobel Prize for Chemistry with John W Cornforth for his work on Stereo Chemistry. He has done wide ranging research on alkaloids, antibiotics, enzymes and other natural compounds. He was distinguished for his contribution to the development of modern stereo chemistry. Prelog synthesized many natural products and worked on problems of stereo chemistry like adamenline, boromycin analoids and rifamycins

G6P3T1

Learning Objectives

After studying this unit, the students will be able to

- recognize the term drug and chemotherapy
- classify the drugs based on their properties
- describe the drug-target interaction.
- discuss some important classes of drugs.
- explain the chemistry of cleansing agents
- describe the chemicals in food
- explain the important terms in polymer chemistry.
- describe the preparation of some important synthetic polymers
- appreciate the importance of polymers in today life

INTRODUCTION

Chemistry touches every aspect of our lives. The three-basic requirement of our life: food, clothes, shelter are all basically chemical compounds. Infact, life itself is a complicated system of interrelated chemical process. In this unit, we will learn the chemistry involved in the field of medicines, food materials, cleansing agents and polymers.

15.1 Drug

The word drug is derived from the French word "*drogue*" meaning "*dry herb*". A drug is a substance that is used to modify or explore physiological systems or pathological states for the benefit of the recipient. It is used for the purpose of diagnosis, prevention, cure/relief of a disease.The drug which interacts with macromolecular targets such as proteins to produce a therapeutic and useful biological response is called medicine. The specific treatment of a disease using medicine is known as chemotherapy. An ideal drug is the one which is non-toxic, bio-compatible and bio-degradable, and it should not have any side effects. Generally, most of the drug molecules that are used now a days have the above properties at lower concentrations. However, at higher concentrations, they have side effects and become toxic. The medicinal value of a drug is measured in terms of its therapeutic index, which is defined as the ratio between the maximum tolerated dose of a drug (above which it become toxic) and the minimum curative dose (below which the drug is ineffective). Higher the value of therapeutic index, safer is the drug.

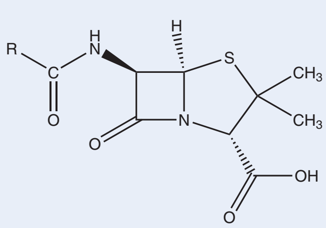
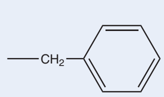
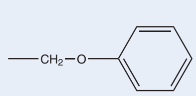
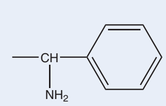
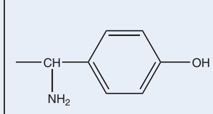
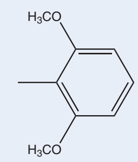
15.1.1 Classification of drugs:

Drugs are classified based on their properties such as chemical structure, pharmacological effect, target system, site of action etc. We will discuss some general classifications here.

Classification based on the chemical structure:

In this classification, drugs with a common chemical skeleton are classified into a single group. For example, ampicillin, amoxicillin, methiceillinetc.. all have similar structure and are classified into a single group called penicillin. Similarly, we have other group of drugs such as opiates, steroids, catecholamines etc. Compounds having similar chemical structure are expected to have similar chemical properties. However, their biological actions are not always similar. For example, all drugs belonging to penicillin group have same biological action, while groups such as barbiturates, steroids etc.. have different biological action.

Penicillins

	R group-Drug Name				
	 Penicillin G	 Penicillin V	 Ampicillin	 Amoxicillin	 Mithicillin

Classification based on Pharmacological effect:

In this classification, the drugs are grouped based on their biological effect that they produce on the recipient. For example, the medicines that have the ability to kill the pathogenic bacteria are grouped as antibiotics. This kind of grouping will provide the full range of drugs that can be used for a particular condition (disease). The physician has to carefully choose a suitable medicine from the available drugs based on the clinical condition of the recipient.

Examples:

Antibiotic drugs: amoxicillin, ampicillin,cefixime, cefpodoxime, erythromycin, tetracycline etc..

Antihypertensive drugs: propranolol, atenolol, metoprolol succinate, amlodipine etc…

Classification based on the target system (drug action):

In this classification, the drugs are grouped based on the biological system/process, that they target in the recipient. This classification is more specific than the pharmacological classification.For example, the antibiotics streptomycin and erythromycin inhibit the protein synthesis (target process) in bacteria and are classified in a same group. However, their mode of action is different. Streptomycin inhibits the initiation of protein synthesis, while erythromycin prevents the incorporation of new amino acids to the protein.

Classification based on the site of action (molecular target):

The drug molecule interacts with biomolecules such as enzymes, receptors etc,, which are referred as drug targets. We can classify the drug based on the drug target with which it binds. This classification is highly specific compared to the others. These compounds often have a common mechanism of action, as the target is the same.

15.1.2 Drug–target Interaction:

The biochemical processes such as metabolism (which is responsible for breaking down the food molecules and harvest energy in the form of ATP and biosynthesis of necessary biomolecules from the available precursor molecules using many enzymes),cell-signaling (senses any change in the environment using the receptor molecules and send signals to various processes to elicit an appropriate response) etc… are essential for the normal functioning of our body. These routine processes may be disturbed by any external factors such as microorganism, chemicals etc.. or by a disorder in the system itself. Under such conditions we may have to take medicines to restore the normal functioning of the body.

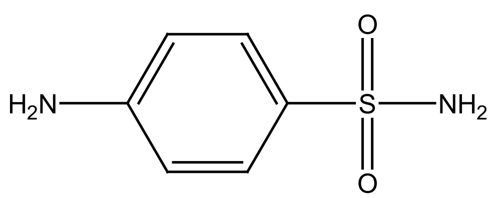
These drug molecules interact with biomolecules such as proteins, lipids, etc..that are responsible for different functions of the body. For example, proteins which act as biological catalysts are called enzymes and those which are important for communication systems are called receptors. The drug interacts with these molecules and modify the normal biochemical reactions either by modifying the enzyme activity or by stimulating/suppressing certain receptors.

Enzymes as drug targets:

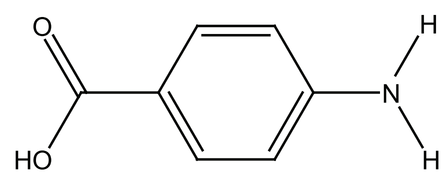
In all living systems, the biochemical reactions are catalysed by enzymes. Hence, these enzyme actions are highly essential for the normal functioning of the system. If their normal enzyme activity is inhibited, then the system will be affected. This principle is usually applied to kill many pathogens.

We have already learnt that in enzyme catalysed reactions, the substrate molecule binds to the active site of the enzyme by means of the weak interaction such as hydrogen bonding, van der Waals force etc… between the amino acids present in the active site and the substrate.

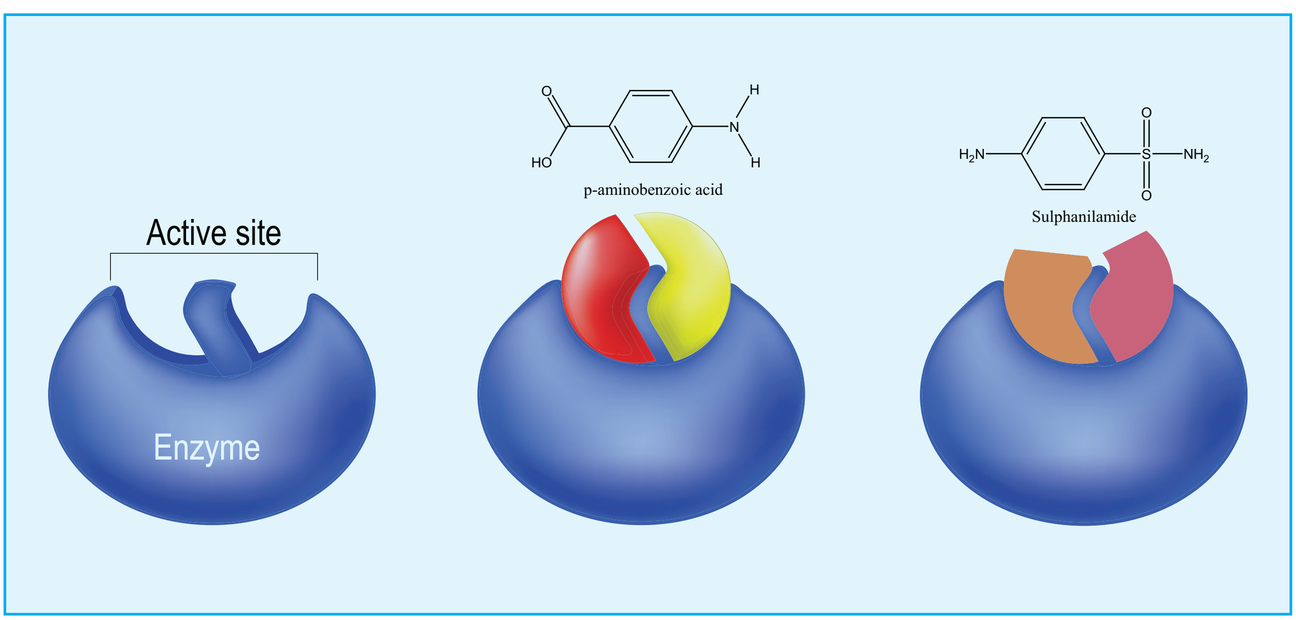
When a drug molecule that has a similar geometry (shape)as the substrate is administered, it can also bind to the enzyme and inhibit its activity.In other words, the drug acts as an inhibitor to the enzyme catalyst. These type of inhibitors are often called competitive inhibitors. For example the antibiotic sulphanilamide, which is structurally similar to *p*-aminobenzoic acid (PABA) inhibits the bacterial growth. Many bacteria need PABA in order to produce an important coenzyme, folic acid. When the antibiotic sulphanilamide is administered, it acts as a competitive inhibitor to the enzyme dihydropteroate synthase (DHPS) in the biosynthetic pathway of converting PABA into folic acid in the bacteria. It leads to the folic acid deficiency which retards the growth of the bacteria and can eventually kill them.



Sulphanilamide



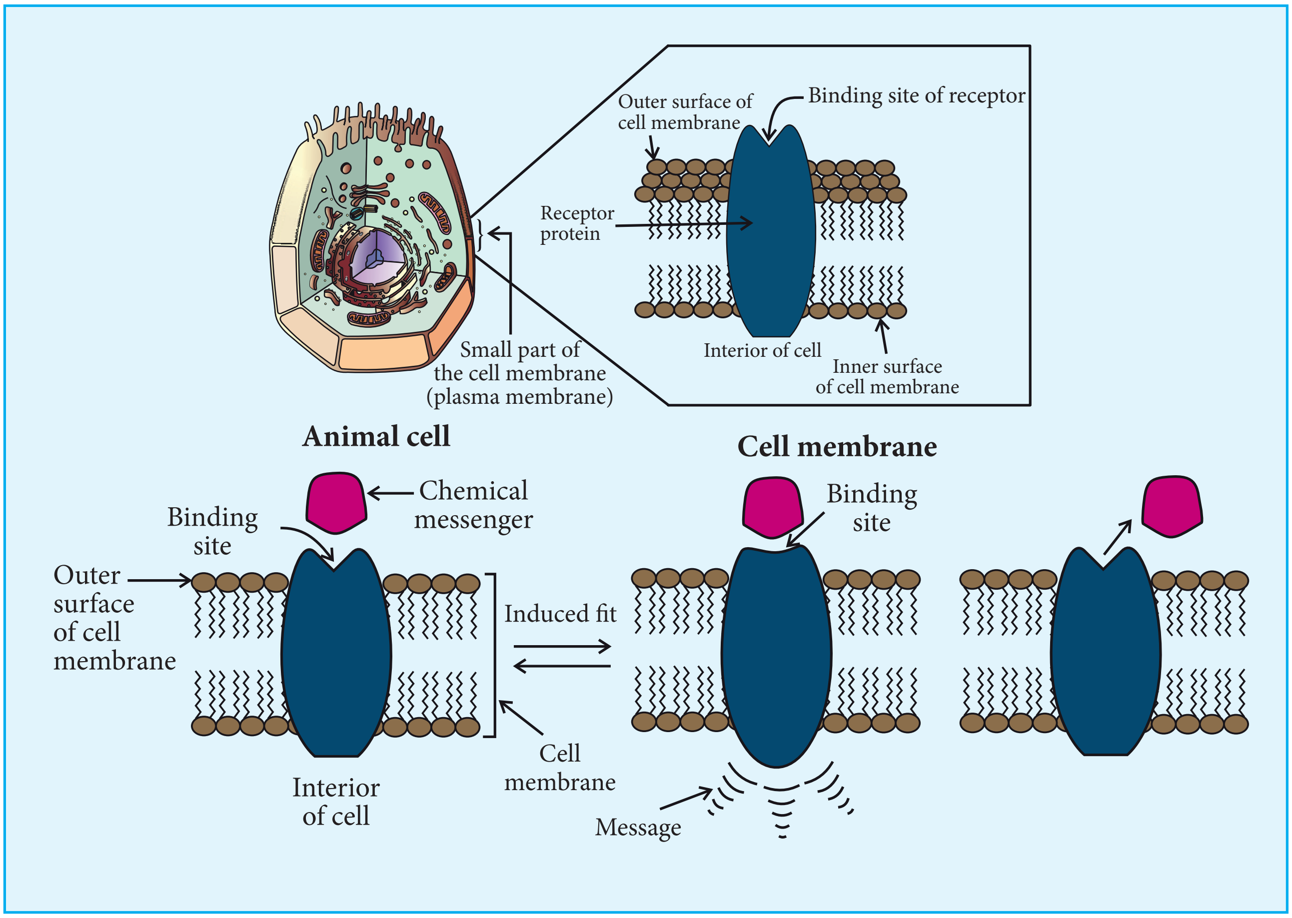
p-aminobenzoic acid



In certain enzymes, the inhibitor molecule binds to a different binding site, which is commonly referred to as allosteric site, and causes a change in its active site geometry (shape). As a result, the substrate cannot bind to the enzyme. This type of inhibitors are called allosteric inhibitors.

Receptor as drug targets:

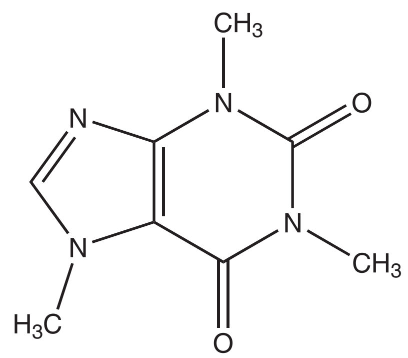
Many drugs exert their physiological effects by binding to a specific molecule called a receptor whose role is to trigger a response in a cell. Most of the receptors are integrated with the cell membranes in such a way that their active site is exposed to outside region of the cell membrane. The chemical messengers, the compounds that carry messages to cells, bind to the active site of these receptors. This brings about the transfer of message into the cell. These receptors show high selectivity for one chemical messenger over the others. If we want to block a message, a drug that binds to the receptor site should inhibit its natural function. Such drugs are called **antagonists**. In contrast, there are drugs which mimic the natural messenger by switching on the receptor. These type of drugs are called **agonists** and are used when there is lack of chemical messenger.

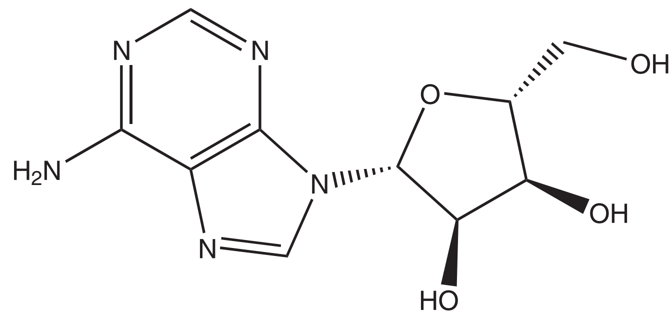


For example, when adenosine binds to the adenosine receptors, it induces sleepiness. On the other hand, the antagonist drug caffeine binds to the adenosine receptor and makes it inactive. This results in the reduced sleepiness (wakefulness).

The agonist drug, morphine, which is used as a pain killer, binds to the opioid receptors and activates them. This supress the neuro transmitters that causes pain.

Most receptors are chiral and hence different enantiomers of a drug can have different effect

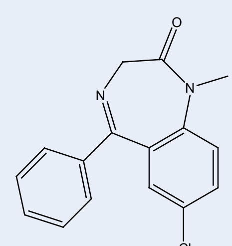
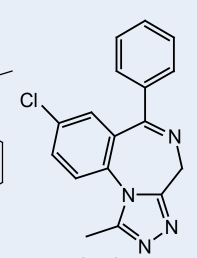
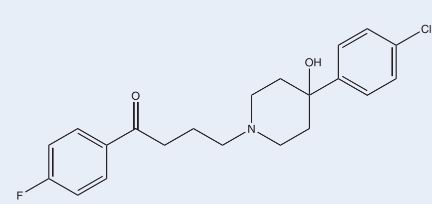


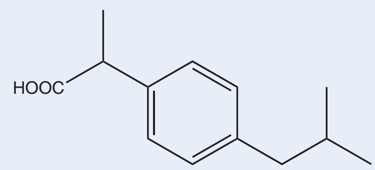
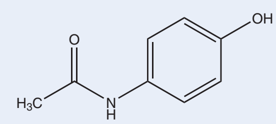
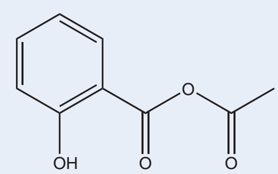
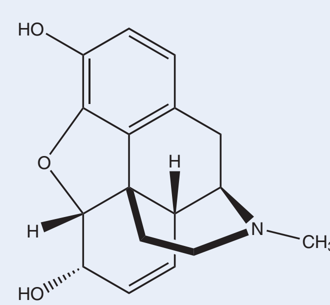
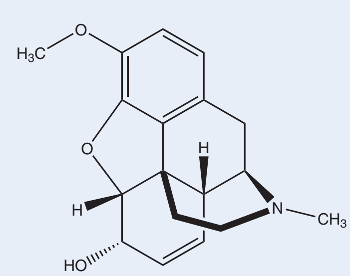


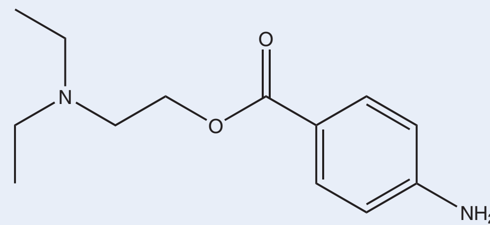
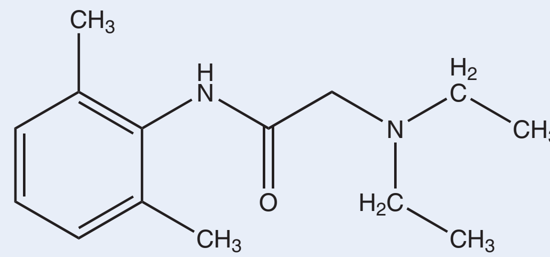
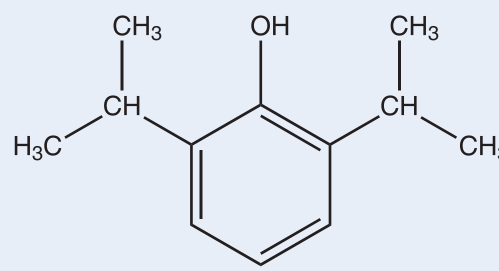
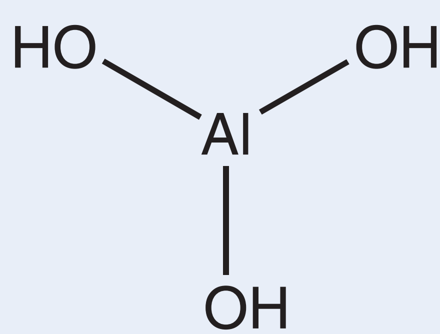
ADENOSINE

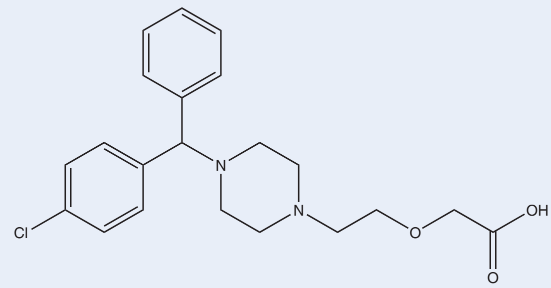
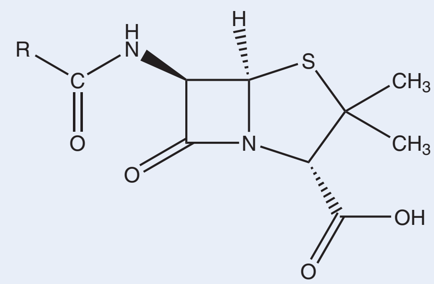
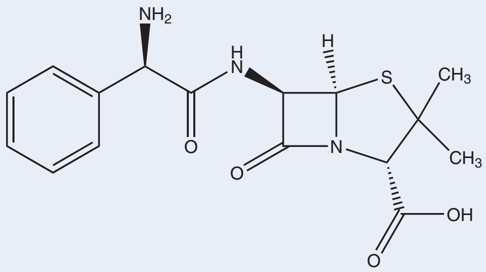
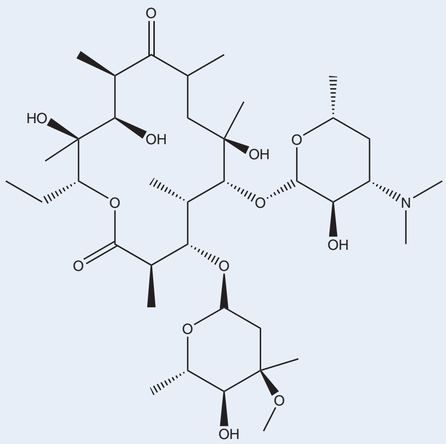
Therapeutic action of Different classes of Drugs:

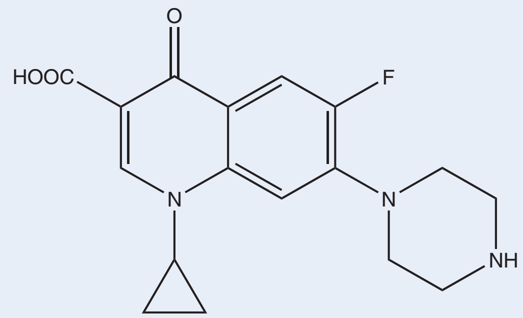
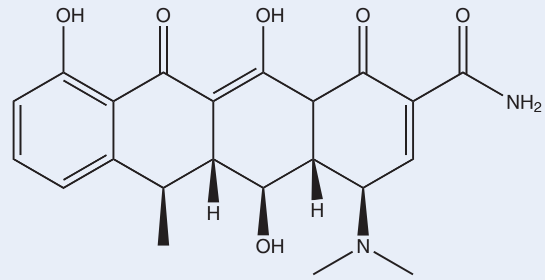
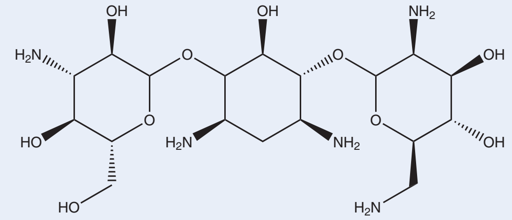
The developments in the field of biology allowed us to understand various biological process and their mechanism in detail. This enabled to develop new safer efficient drugs. For example, to treat acidity, we have been using weak bases such as aluminium and magnesium hydroxides. But these can make the stomach alkaline and trigger the production of much acid. Moreover, This treatment only relives the symptoms and does not control the cause. Detailed studies reveal that histamines stimulate the secretion of HCl by activating the receptor in the stomach wall. This findings lead to the design of new drugs such as cimetidine, ranitidine etc.. which binds the receptor and inactivate them. These drugs are structurally similar to histamine.In this section, we shall discuss the therapeutic action of a few important classes of drugs.

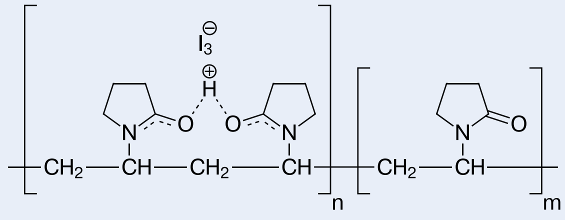
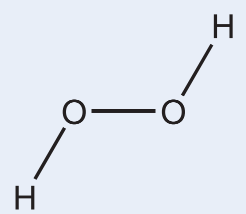
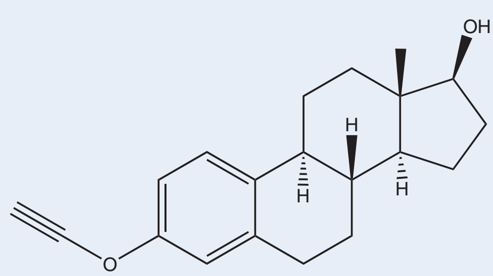
Class of Drugs	Mode of action	Chemical structure of some important structures
Tranquilizers They are neurologically active drugs. **Major tranquilizers:** Haloperidol, clozapine **Minor tranquilizers:** Diazepam (Valium), alprazolam	Acts on the central nervous system by blocking the neurotransmitter dopamine in the brain **Uses** Treatment of stress, anxiety, depression, sleep disorders and severe mental diseases like schizophrenia	 Valium  alprazolam 

Analgesics (Non – narcotic) Analgesics reduce the pain without causing impairment of consciousness. **1. Anti-inflammatory drugs** **Example** Acetaminophen or paracetamol, Ibuprofen, Asprin. **Antipyretics** Example **Salicylates** Acetylsalicylic acid (aspirin), **Acetaminophen or Paracetamol** **iii. Nonsteroidal anti-inflammatory drugs (NSAIDs)** Ibuprofen	They alleviate pain by reducing local inflammatory responses **Uses** Used for short-term pain relief and for modest painlike headache, muscle strain, bruising, or arthritis. These drugs have many other effects such as reducing fever (antipyretic) and preventing platelet coagulation. Due to this property, aspirin finds useful in the prevention of heart attacks Reduces fever by causing the hypothalamus to override a prostaglandin-induced increase in temperature..	  
2. **Opioids (Narcotic Analgesics)** **Examples** Morphine, codeine	Relive pain and produce sleep. These drugs are addictive. In poisonous dose,these produces coma and ultimately death. **Uses** Used for either short-term or long-term relief of severe pain. Mainly used for post operative pain, pain of terminal cancer.	 

Anaesthetics 1. Local anaesthetics Examples **Ester-linked local anaesthetic** - Procaine **Amide-linked local anaesthetic** - Lidocaine	It causes loss of sensation, in the area in which it is applied without losing consciousness. They block pain perception that is transmitted via peripheral nerve fibres to the brain **Uses** They are often used during minor surgical procedures.	  Lidocaine
2. General anaesthetics Example **Intravenous general anaesthetics**– Propofol **Inhalational general anaesthetics**- Isoflurane	Cause a controlled and reversible loss of consciousness by affecting central nervous system **Uses** They are often used for major surgical procedures.	 Propofol
Antacids **Examples** Milk of Magnesia, Sodium bicarbonate, calcium bicarbonate, aluminium hydroxide Ranitidine, Cemitidine Omeprazole, rabeprazole	Neutralize the acid in the stomach that causes acidity. **Uses** To relieve symptoms such as burning sensation in the chest/ throat area (heart burns) caused by acid reflux.	

Antihistamines Examples Cetirizine, levocetirizine, desloratadine, brompheniramine Terfenadine	Block histamine release from histamine-1 receptors **Uses** To provide relief from the allergic effects	 Cetirizine
Antimicrobials 1. Beta-Lactams Examples Penicillins, ampicillin, cephalosporins, carbapenems, and monobactams	Inhibits bacterial cell wall biosynthesis **Uses** To treat skin infections, dental infections, ear infections, respiratory tract infections, pneumonia, urinary tract infections, and gonorrhoea	 Penicillins  Ampicillin
2. Macrolides Examples Erythromycin, azithromycin	Targets bacterial ribosomes and prevent protein production **Uses** To treat respiratory tract infections, genital, gastrointestinal tractand skin infections	

3. Fluoroquinolones Examples Clinafloxacin, ciprofloxacin, levofloxacin	Inhibits bacterial enzyme DNA gyrase **Uses** To treat urinary tract infections, skin infections, and respiratory infections (such as sinusitis, pneumonia, bronchitis), pulmonary infections in cystic fibrosis	
4. Tetracyclines Examples Doxycycline, minocycline, oxytetracycline	Inhibit the bacterial protein synthesis via interaction with the 30S subunit of the bacterial ribosome **Uses** Used in the treatment of peptic ulcer disease, infections of the respiratory tract, cholera, acne vulgaris.	
5. Aminoglycosides Examples Kanamycin, gentamicin, neomycin	Bind to the 30S subunit of the bacterial ribosome, thus stopping bacteria from making proteins **Uses** Used to treat infections caused by gram-negative bacteria	

6. Antiseptics Examples Hydrogen peroxide, povidone-iodine, benzalkonium chloride	Stop or slow down the growth of microorganisms – Applied to living tissue **Uses** To reduce the risk of infection during surgery and other procedures	
7. Disinfectants Examples Chlorine compounds, alcohol, Hydrogen peroxide.	Stop or slow down the growth of microorganisms – Generally used on inanimate objects	 Hydrogen peroxide
Antifertility drugs **Example** **Synthetic oestrogen** - Ethynylestradiol, Menstranol **Synthetic Progesterone** - Norethindrone, Norethynodrel	These synthetic hormones that suppresses ovulation/ fertilisation. **Uses** Used in birth control pills.	

15.2 Food additives:

Have you ever noticed the ingredients that is printed on the cover of the packed food materials such as biscuits, chocolates etc...You might have noticed that emulsifiers such as 322, 472E, dough conditioners 223 etc… are used in the preparation, in addition to the main ingredients such as wheat flour, edible oil, sugar, milk solid etc… Do you think that these substances are necessary? Yes. These substances enhance the nutritive, sensory and practical value of the food. They also increase the shelf life of food. The substances which are not naturally a part of the food and added to improve the quality of food are called food additives.

15.2.1 Important categories of food additives

- Aroma compounds
- Food colours
- Preservatives
- Stabilizers
- Artificial Sweeteners
- Antioxidants
- Buffering substances
- Vitamins and minerals

Advantages of food additives:

1. Uses of preservatives reduce the product spoilage and extend the shelf-life of food
2. Addition of vitamins and minerals reduces the mall nutrient
3. Flavouring agents enhance the aroma of the food
4. Antioxidants prevent the formation of potentially toxic oxidation products of lipids and other food constituents

15.2.2. Preservatives:

Preservatives are capable of inhibiting, retarding or arresting the process of fermentation, acidification or other decomposition of food by growth of microorganisms. Organic acids such as benzoic acid, sorbic acid and their salts are potent inhibitors of a number of fungi, yeast and bacteria. Alkyl esters of hydroxy benzoic acid are very effective in less acidic conditions. Acetic acid is used mainly as a preservative for the preparation of pickles and for preserved vegetables. Sodium metasulphite is used as preservatives for fresh vegetables and fruits. Sucrose esters with palmitic and steric acid are used as emulsifiers. In addition that some organic acids and their salts are used as preservatives. In addition to chemical treatment, physical methods such as heat treatment (pasteurisation and sterilisations), cold treatment (chilling and freezing) drying (dehydration) and irradiation are used to preserve food.

15.2.3. Antioxidants:

Antioxidants are substances which retard the oxidative deteriorations of food. Food containing fats and oils is easily oxidised and turn rancid. To prevent the oxidation of the fats and oils, chemical BHT(butylhydroxy toluene), BHA(Butylated hydroxy anisole) are added as food additives. They are generally called antioxidants. These materials readily undergo oxidation by reacting with free radicals generated by the oxidation of oils, thereby stop the chain reaction of oxidation of food. Sulphur dioxide and sulphites are also used as food additives. They act as anti-microbial agents, antioxidants and enzyme inhibitors.

15.2.4 Sugar Substituents:

Those compounds that are used like sugars (glucose, sucrose) for sweetening, but are metabolised without the influence of insulin are called sugar substituents. Eg. Sorbitol, Xylitol, Mannitol.

15.2.5 Artificial sweetening agents:

Synthetic compounds which imprint a sweet sensation and possess no or negligible nutritional value are called artificial sweeteners. Eg. Saccharin, Aspartame, sucralose, alitame etc…

15.3 Cleansing agents:

Soaps and detergents are used as cleansing agents. Chemically soap is the sodium or potassium salt of higher fatty acids. Detergent is sodium salt of alkyl hydrogen sulphates or alkyl benzene sulphonic acids.

15.3.1 Soaps:

Soaps are made from animal fats or vegetable oils. They contain glyceryl esters of long chain fatty acids. When the glycerides are heated with a solution of sodium hydroxide they become soap and glycerol. We have already learnt this reaction under the preparation of glycerol by saponification. Common salt is added to the reaction mixture to decrease the solubility of soap and it helps to precipitate out from the aqueous solution. Soap is then mixed with desired colours, perfumes and chemicals of medicinal importance.

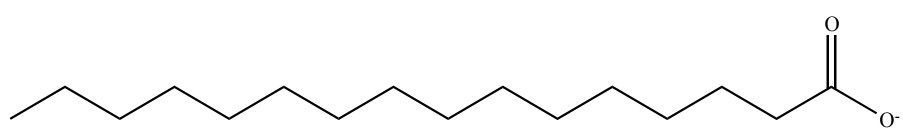
Total fatty matter:

The quality of a soap is described in terms of total fatty matter (TFM value). It is defined as the total amount of fatty matter that can be separated from a sample after splitting with mineral acids., Higher the TFM quantity in the soap better is its quality.

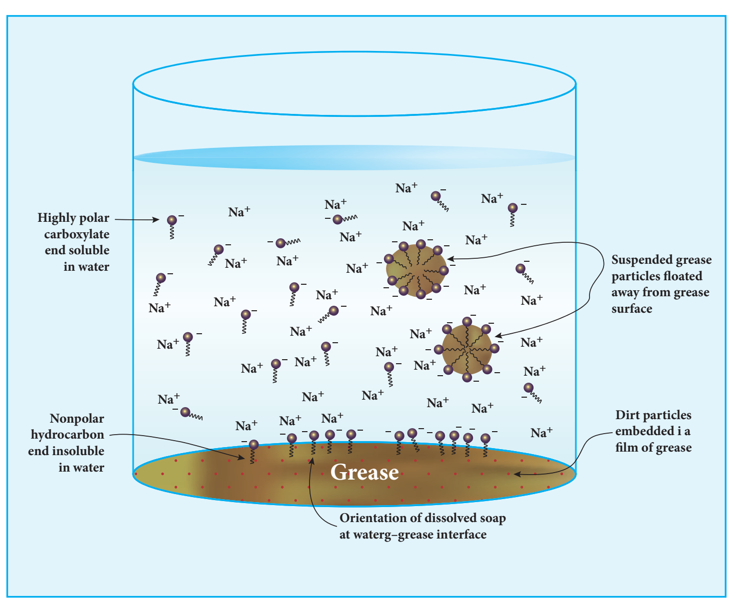
As per BIS standards, Grade-1 soaps should have 76% minimum TFM, while Grade-2 and 3 must have 70 and 60% , minimum respectively. The other quality parameters are lather, moisture content,mushiness, insoluble matter in alcohol etc..

The cleansing action of soap:

To understand how a soap works as a cleansing agent, let us consider sodium palmitate an example of a soap. The cleansing action of soap is directly related to the structure of carboxylate ions (palmitate ion) present in soap. The structure of palmitate exhibit dual polarity. The hydrocarbon portion is non polar and the carboxyl portion is polar.



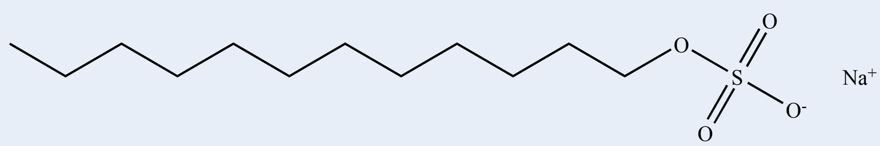
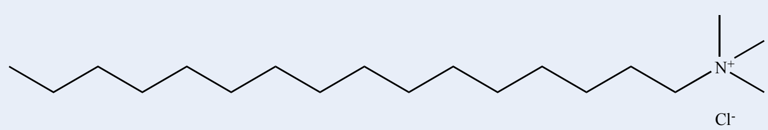
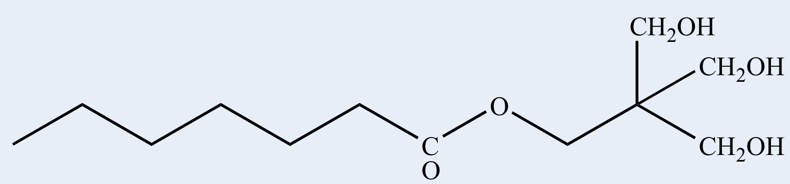
The nonpolar portion is hydrophobic while the polar end is hydrophilic. The hydrophobic hydro carbon portion is soluble in oils and greases, but not in water. The hydrophilic carboxylate group is soluble in water. The dirt in the cloth is due to the presence of dust particles intact or grease which stick. When the soap is added to an oily or greasy part of the cloth, the hydrocarbon part of the soap dissolve in the grease, leaving the negatively charged carboxylate end exposed on the grease surface. At the



same time the negatively charged carboxylate groups are strongly attracted by water, thus leading to the formation of small droplets called micelles and grease is floated away from the solid object. When the water is rinsed away, the grease goes with it. As a result, the cloth gets free from dirt and the droplets are washed away with water. The micelles do not combine into large drops because their surfaces are all negatively charged and repel each other. The cleansing ability of a soap depends upon its tendency to act as a emulsifying agent between water and water insoluble greases.

15.3.2 Detergents:

Synthetic detergents are formulated products containing either sodium salts of alkyl hydrogen sulphates or sodium salts of long chain alkyl benzene sulphonic acids. There are three types of detergents.

Detergent Type	Example
Anionic detergent	Sodium Lauryl sulphate (SDS) 
Cationic detergent	n-hexaadecyltrimethyl ammonium chloride  *N,N,N*-trimethylhexadecan-1-aminium chloride
Non-ionic detergent	Pentaerythrityl stearate.  3-hydroxy-2,2-bis(hydroxymethyl)propyl heptanoate

Detergents are superior to soaps as they can be used even in hard water and in acidic conditions. The cleansing action of detergents are similar to the cleansing action of soaps.

15.4 Polymers

The term Polymer is derived from the Greek word 'polumeres' meaning "having many parts". The constitution of a polymer is described in terms of its structural units called monomers. Polymers consists of large number of monomer units derived from simple molecules. For example: PVC(Poly Vinyl Chloride). is a polymer which is obtained from the monomer vinyl chloride. Polymers can be classified based on the source of availability, structure, molecular forces and the mode of synthesis. The following chart explain different classification of polymers.

15.4.1 Classification of Polymers:

- **Polymers**
  - **Source**
    - Natural polymers (obtained from plants/ animals). E.g. Cellulose, Silk
    - Synthetic polymers (man made from chemicals) E.g. polythene, PVC, etc.,
    - Semisynthetic polymers (natural polymers-modified by chemical treatment) E.g. viscose rayon, cellulose diacetate
  - **Structure**
    - Linear polymers (long continuous chain) E.g. HDPE, PVC.
    - Branched polymers (one main chain with small chains as branches) E.g. polypropylene, LDPE.
    - Cross linked polymers (linking of chain polymers) E.g. bakelite, melamine, formaldehyde
  - **Molecular foces**
    - Elastomers (soft and stretchy) E.g. neoprene, buna-S, buna-N
    - Fibers-Polymer chains forms fibers by hydrogen bonding (high tensile strength) E.g.Nylon-6,6, Terylene
    - Thermoplastic They become soft on heating and hard on cooling. they can be remolded E.g.polythene, PVC, polystrene
    - Thermosetting Do not become soft on heating but set to an infusible mass upon heating. E.g. bakelite, melamine, formaldehyde
  - **Mode of synthesis**
    - Addition polymers. Formed by polymerisation of monomers without the elimination of any byproduct. E.g. polyethylene, PVC, teflon.
    - Condensation Polymer formed by the condensation of two or more monomers with the elimination of simple molecules like H_2O, NH_3, etc., E.g. Nylon-66, polyester.

15.4.2 Types of polymerisation

The process of forming a very large, high molecular mass polymer from small structural units i.e., monomer is called polymerisation. Polymerisation occurs in the following two ways

i. Addition polymerisation or chain growth polymerisation

ii. Condensation polymerisation or step growth polymerisation

Addition polymerisation

Many alkenes undergo polymerisation under suitable conditions. The chain growth mechanism involves the addition of the reactive end of the growing chain across the double bond of the monomer. The addition polymerisation can follow any of the following three mechanisms depending upon the reactive intermediate involved in the process.

i. Free radical polymerisation

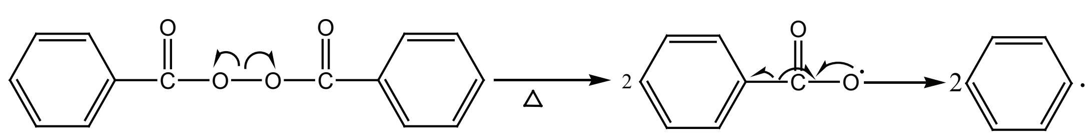
ii. Cationic polymerisation

iii. Anionic polymerisation

Free radical polymerisation

When alkenes are heated with free radical initiator such as benzyl peroxide, they undergo polymerisation reaction. For example styrene polymerises to polystyrene when it is heated to ionic with a peroxide initiator. The mechanism involves the following steps.

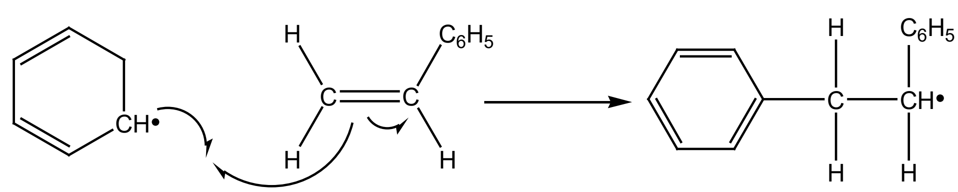
1. initiation – formation of free radical



benxoyl peroxide

phenyl free radical
$+ 2CO_2$

2. Propagation step

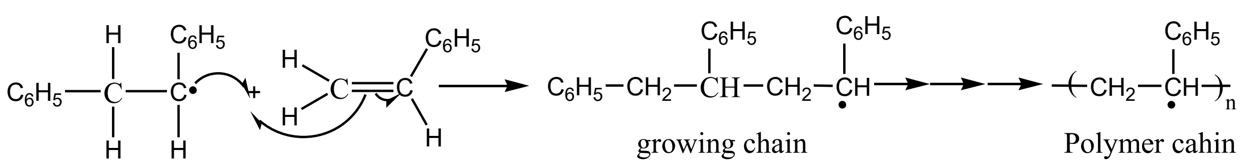


phenyl free radical

Styrene
(monomer)

Stabilised radical

The stabilized radical attacks another monomer molecule to give an elongated radical



growing chain

Polymer cahin

monomer

Chain growth will continue with the successive addition of several thousands of monomer units.

Termination

The above chain reaction can be stopped by stopping the supply of monomer or by coupling of two chains or reaction with an impurity such as oxygen.

$$2\ \left(CH_2 - \underset{\bullet}{\overset{C_6H_5}{\overset{|}{C}H}} \right)_n \longrightarrow \left(CH_2 - \overset{C_6H_5}{\overset{|}{C}H} \right)_n \left(\overset{C_6H_5}{\overset{|}{C}H} - CH_2 \right)_n$$

15.4. 3 Preparation of some important addition polymers

1. Polythene

It is an addition polymer of ethene. There are two types of polyethylene i) HDPE (High Density Polyethylene) ii) LDPE (Low Density polyethylene).

LDPE

It is formed by heating ethene at 200° to $300^\circ C$ under oxygen as a catalyst. The reaction follows free radical mechanism. The peroxides formed from oxygen acts as a free radical initiator.

$$\underset{\text{ethene}}{n\,CH_2 = CH_2} \xrightarrow[1000\ \text{atm}]{200^\circ\ -\ 300^\circ C} \underset{\text{Polythene}}{\left(CH_2 - CH_2 \right)_n}$$

It is used as insulation for cables, making toys etc…

HDPE

The polymerization of ethylene is carried out at 373K and 6to7 atm pressure using Zeiglar – Natta catalyst $[TiCl_4+(C_2H_5)_3Al]$ HDPE has high density and melting point and it is used to make bottles, pipe etc..,

Preparation of Teflon

The monomer is tetrafluroethylene. When the monomer is heated with oxygen (or) ammonium persulphate under high pressure, Teflon is obtained.

$$n\,CF_2 = CF_2 \xrightarrow{\Delta} \left(CF_2 - CF_2 \right)_n$$

It is used for coating articles and preparing non – stick utensils.

I. Preparation of Orlon (polyacrylonitrile – PAN)

It is prepared by the addition polymerisation of vinylcyanide (acrylonitrile) using a peroxide initiator.

$$\underset{\text{Prop - 2-enenitrile}}{n\,(CH_2 = \underset{CN}{\underset{|}{C}H})} \xrightarrow[\Delta]{\text{Peroxides}} \underset{\text{PAN}}{\left(CH_2 - \underset{CN}{\underset{|}{C}H_2} \right)_n}$$

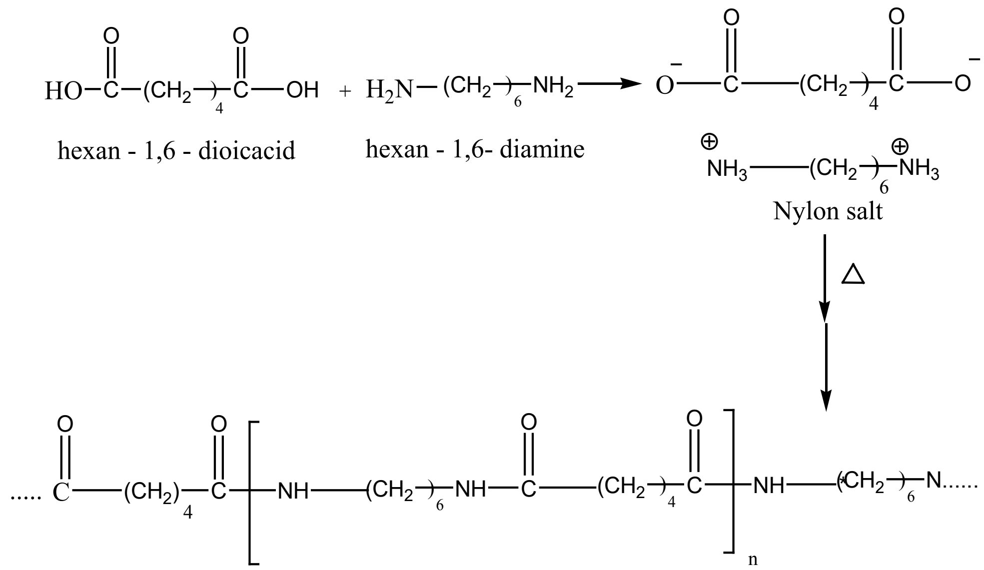
It is used as a substitute of wool for making blankets, sweaters etc…

Condensation polymerisation

Condensation polymers are formed by the reaction between functional groups an adjacent monomers with the elimination of simple molecules like H_2O, NH_3 etc…. Each monomer must undergo at least two substitution reactions to continue to grow the polymer chain i.e., the monomer must be at least bi functional. Examples : Nylon– 6,6, terylene….

Nylon – 6,6

Nylon – 6,6 can be prepared by mixing equimolar adipic acid and hexamethylene – diamine to form a nylon salt which on heating eliminate a water molecule to form amide bonds.

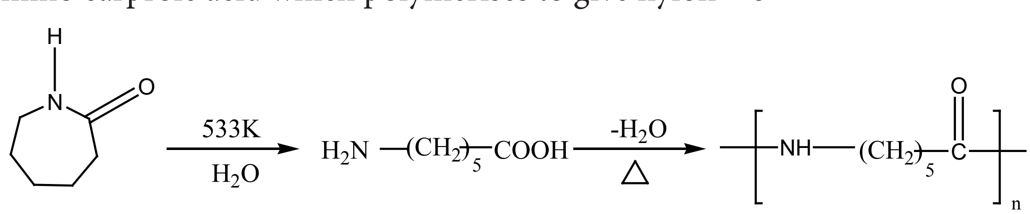


Poly (hexamethyleneadipamide)
Nylon 6,6

It is used in textiles, manufacture of cards etc…

Nylon – 6

Capro lactam (monomer) on heating at 533K in an inert atmosphere with traces of water gives ∈ amino carproic acid which polymerises to give nylon – 6

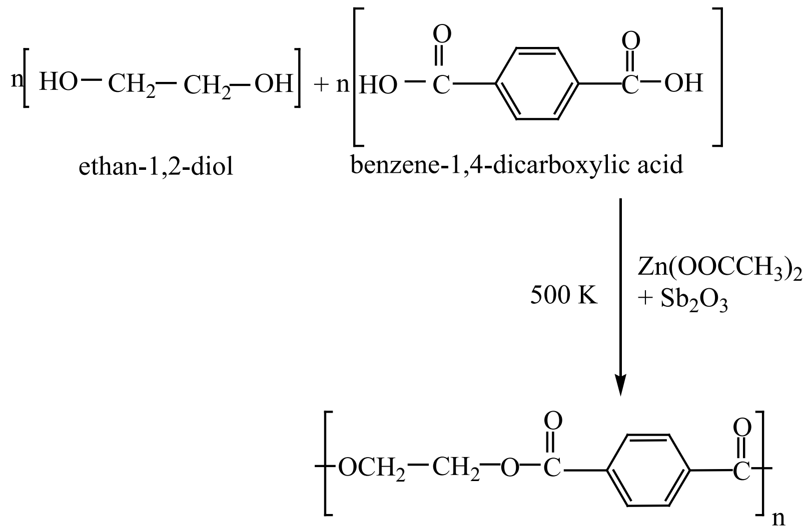


Nylon -6

It is used in the manufacture of tyrecards fabrics etc….

II. Preparation of terylene (Dacron)

The monomers are ethylene glycol and terepathalic acid (or) dimethylterephthalate. When these monomers are mixed and heated at 500K in the presence of zinc acetate and antimony trioxide catalyst, terylene is formed.



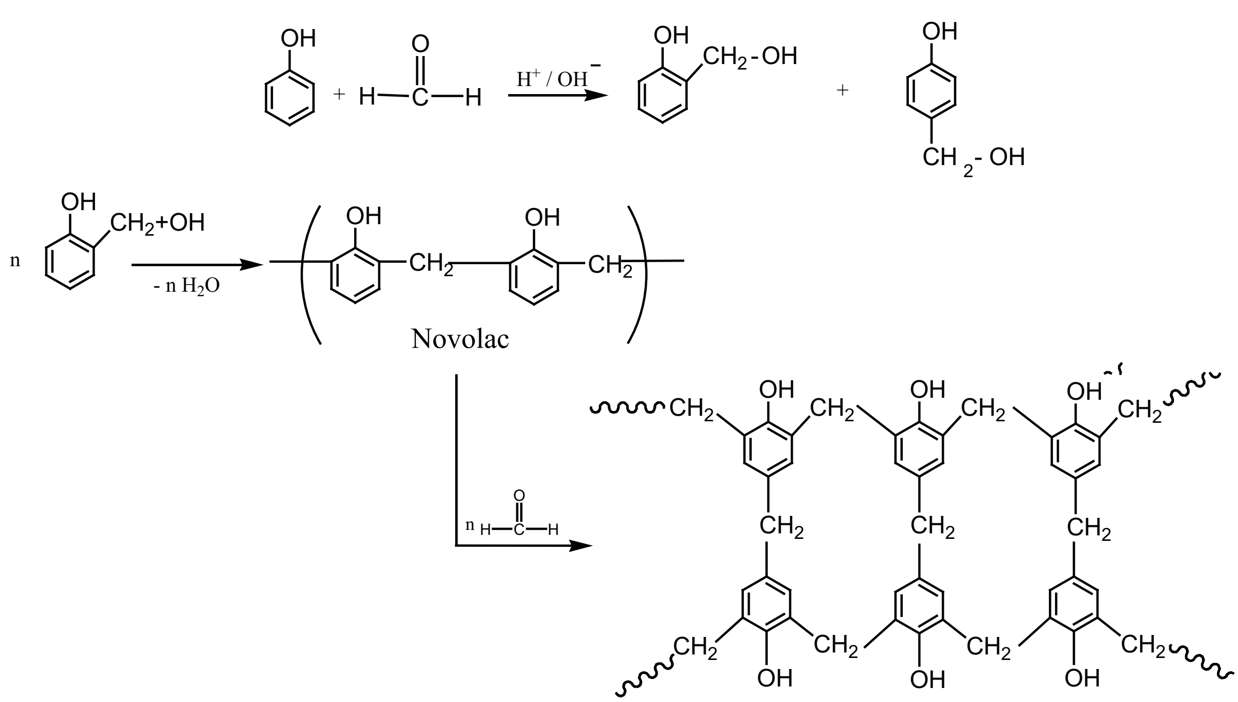
Terylene (an polyester)

It is used in blending with cotton or wool fibres and as glass reinforcing materials in safety helmets.

Preparation of Bakelite

The monomers are phenol and formaldehyde. The polymer is obtained by the condensation polymerization of these monomers in presence of either an acid or a base catalyst.

Phenol reacts with methanal to form ortho or para hydroxyl methylphenols which on further reaction with phenol gives linear polymer called novolac. Novalac on further heating with formaldehyde undergo cross linkages to form backelite.



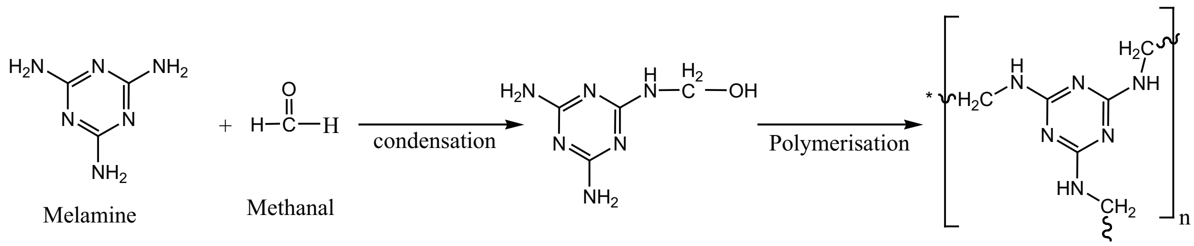
(Bakelite)

Uses:

Navolac is used in paints. Soft backelites are used for making glue for binding laminated wooden planks and in varinishes, Hard backelites are used to prepare combs, pens etc..

Melamine (Formaldehyde melamine):

The monomers are melamine and formaldehyde. These monomers undergo condensation polymerisation to form melamine formaldehyde resin.

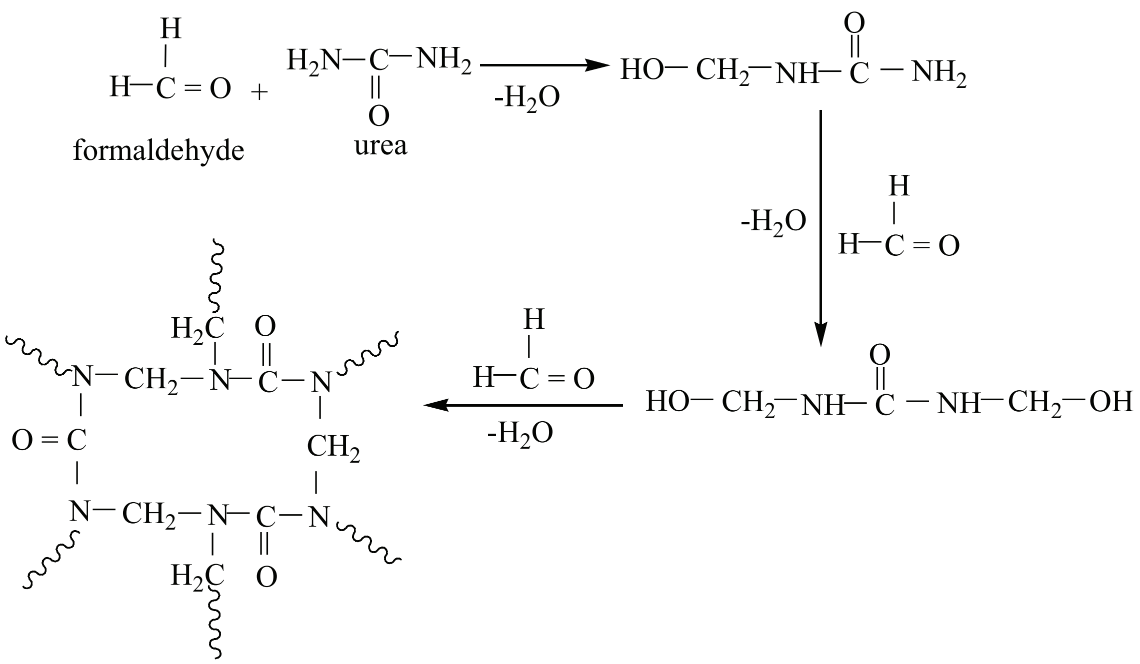


Uses: It is used for making unbreakable crockery

Melamine-formaldehyde polymer

Urea formaldehyde polymer:

It is formed by the condensation polymerisation of the monomers urea and formaldehyde.



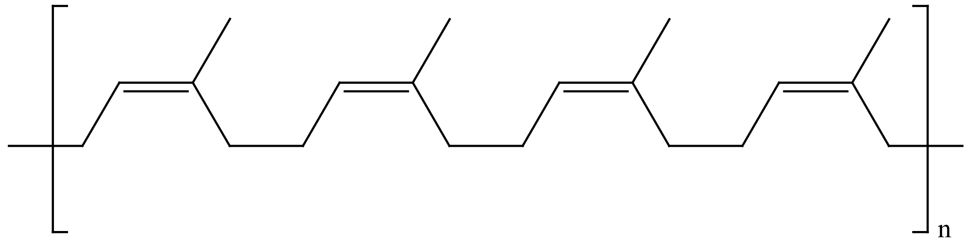
urea formaldehyde polymer

15.4.4 Co-polymers:

A polymer containing two or more different kinds of monomer units is called a co-polymer. For example, SBR rubber(Buna-S) contains styrene and butadiene monomer units. Co-polymers have properties quite different from the homopolymers.

15.4.5 Natural and Synthetic rubbers:

Rubber is a naturally occurring polymer. It is obtained from the latex that excludes from cuts in the bark of rubber tree (Ficus elastic). The monomer unit of natural rubber is cis isoprene (2-methyl buta-1,3-diene). Thousands of isoprene units are linearly linked together in natural rubber. Natural rubber is not so strong or elastic. The properties of natural rubber can be modified by the process called vulcanization.



cispolyisoprene

Vulcanization: Cross linking of Rubber

In the year 1839, Charles Good year accidently dropped a mixture of natural rubber and sulphur onto a hot stove. He was surprised to find that the rubber had become strong and elastic. This discovery led to the process that Good year called vulcanization.

Natural rubber is mixed with 3-5% sulphur and heated at 100-150˚C causes cross linking of the cis-1,4-polyisoprene chains through disulphide (-S-S-) bonds. The physical properties of rubber can be altered by controlling the amount of sulphur that is used for vulcanization. In sulphur rubber, made with about 1 to 3% sulphur is soft and stretchy. When 3 to 10% sulphur is used the resultant rubber is somewhat harder but flexible.

Synthetic rubber:

Polymerisation of certain organic compounds such as buta-1,3-diene or its derivatives gives rubber like polymer with desirable properties like stretching to a greater extent etc., such polymers are called synthetic rubbers.

Preparation of Neoprene:

The free radical polymeristion of the monomer, 2-chloro buta-1,3-diene(chloroprene) gives neoprene.

$$n\,CH_2=\underset{\displaystyle Cl}{\underset{|}{C}}-CH=CH_2 \xrightarrow[\text{Polymerisation}]{\text{free radical}} \left[CH_2-\underset{\displaystyle Cl}{\underset{|}{C}}=CH-CH_2\right]_n$$

It is superior to rubber and resistant to chemical action.

Uses: It is used in the manufacture of chemical containers, conveyer belts.

Preparation of Buna-N:

It is a co-polymer of acrylonitrile and buta-1,3-diene.

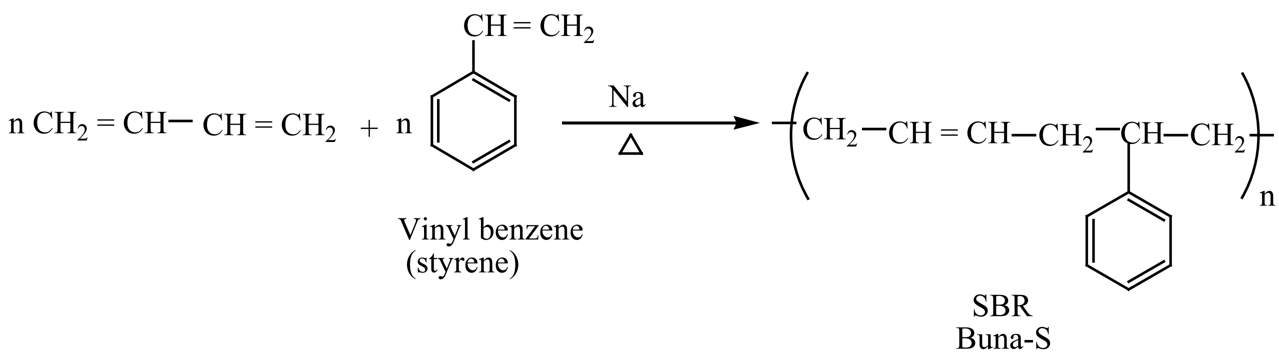
$$n\,CH_2=CH-CH=CH_2 + n\,CH_2=\underset{\displaystyle CN}{\underset{|}{CH}} \longrightarrow \left(CH_2-CH=CH-CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}-CH_2\right)_n$$

Vinyl cyanide Buna-N

It is used in the manufacture of hoses and tanklinings.

Preparation of Buna-S:

It is a co-polymer. It is obtained by the polymerisation of buta-1,3-diene and styrene in the ratio 3:1 in the presence of sodium.



15.4.6 Biodegradable Polymers

The materials that are readily decomposed by microorganisms in the environment are called biodegradable. Natural polymers degrade on their own after certain period of time but the synthetic polymers do not. It leads to serious environmental pollution. One of the solution to this problem is to produce biodegradable polymers which can be booker down by soil micro organism.

Examples:

Polyhydroxy butyrate (PHB)

Polyhydroxy butyrate-co-A- hydroxyl valerate (PHBV)

Polyglycolic acid (PGA), Polylactic acid (PLA)

Poly ($\in$ caprolactone) (PCL)

Biodegradable polymers are used in medical field such as surgical sutures, plasma substitute etc… these polymers are decomposed by enzyme action and are either metabolized or excreted from the body.

Preparation of PHBV

It is the co – polymer of the monomers 3 – hydroxybutanoic acid and 3-hydroxypentanoic acid. In PHBV, the monomer units are joined by ester linkages.

$$n\,CH_3-\underset{|}{\overset{OH}{CH}}-CH_2-COOH + n\,CH_3-CH_2-\overset{OH}{\underset{|}{CH}}-CH_2-COOH \xrightarrow{-H_2O}$$

$$\left[-O-\underset{CH_3}{CH}-CH_2-\underset{O}{\overset{}{\underset{\|}{C}}}-O-\underset{CH_2-CH_3}{CH}-CH_2-\underset{O}{\underset{\|}{C}}-\right]_n$$

Uses : It is used in ortho paedic devices, and in controlled release of drugs.

Nylon– 2-Nylon -6

It is a co – polymer which contains polyamide linkages. It is obtained by the condensation polymersiation of the monomers, glycine and E - amino caproic acid.

$$n\ H_2N-CH_2-COOH \quad + \quad n\ H_2N-(CH_2)_5-COOH \longrightarrow \left[HN-CH_2-\underset{\underset{O}{\|}}{C}-NH-(CH_2)_5-\underset{\underset{O}{\|}}{C} \right] + (2n-1)\ H_2O$$

Glycine — Aminocaproic acid

Nylon -2-nylon - 6

EVALUATION

C7M1B1

Choose the correct answer:

1. Which of the following is an analgesic?

   a) Streptomycin b) Chloromycetin c) Asprin d) Penicillin

2. Dettol is the mixture of

   a) Chloroxylenol and bithionol b) Chloroxylenol and α-terpineol

   c) phenol and iodine d) terpineol and bithionol

3. Antiseptics and disinfectants either kill or prevent growth of microorganisms. Identify which of the following statement is not true.

   a) dilute solutions of boric acid and hydrogen peroxide are strong antiseptics.

   b) Disinfectants harm the living tissues.

   c) A 0.2% solution of phenol is an antiseptic while 1% solution acts as a disinfectant.

   d) Chlorine and iodine are used as strong disinfectants.

4. Saccharin, an artificial sweetener is manufactured from

   a) cellulose b) toluene b) cyclohexene d) starch

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

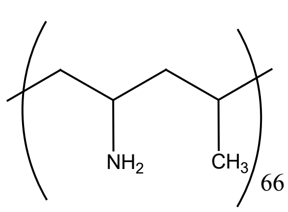
   a) antagonists b) agonists c) enzymes d) molecular targets

6. Aspirin is a/an

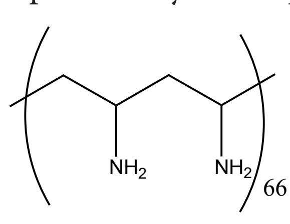
   a) acetylsalicylic acid b) benzoyl salicylic acid c) chlorobenzoic acid d) anthranilic acid

7. Which one of the following structures represents nylon 6,6 polymer?

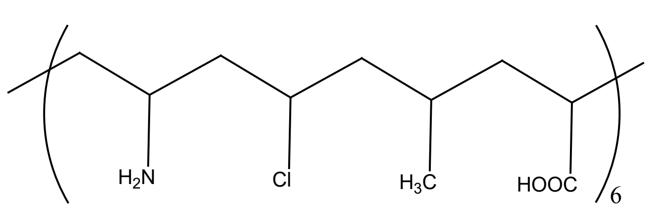
(a)

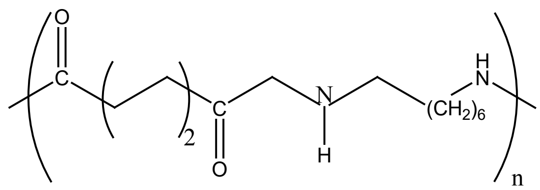


(b)



(c)



(d) 

8. Natural rubber has

a) alternate cis- and trans-configuration
b) random cis- and trans-configuration
c) all cis-configuration
d) all trans-configuration

9. Nylon is an example of

a) polyamide
b) polythene
c) polyester
d) poly saccharide

10. Terylene is an example of

a) polyamide
b) polythene
c) polyester
d) polysaccharide

11. Which is the monomer of neoprene in the following?

a) $CH_2{-}\underset{\displaystyle Cl}{\underset{|}{C}}{-}CH{=}CH_2$
b) $CH_2{=}CH{-}C{\equiv}CH$
c) $CH_2{=}CH{-}CH{=}CH_2$
d) $CH_2{=}\underset{\displaystyle CH_3}{\underset{|}{C}}{-}CH{=}CH_2$

12. Which one of the following is a bio-degradable polymer?

a) HDPE
b) PVC
c) Nylon 6
d) PHBV

13. Non stick cook wares generally have a coating of a polymer, whose monomer is

a) ethane
b) prop-2-enenitrile
c) chloroethene
d) 1,1,2,2-tetrafluoroethane

14. Assertion: 2-methyl-1,3-butadiene is the monomer of natural rubber

Reason: Natural rubber is formed through anionic addition polymerisation.

a) If both assertion and reason are true and reason is the correct explanation of assertion.
b) if both assertion and reason are true but reason is not the correct explanation of assertion.
c) assertion is true but reason is false.
d) both assertion and reason are false.

15. An example of antifertility drug is

a) novestrol
b) seldane
c) salvarsan
d) Chloramphenicol

16. The drug used to induce sleep is

a) paracetamol
b) bithional
c) chloroquine
d) equanil

17. Which of the following is a co-polymer?

a) Orlon
b) PVC
c) Teflon
d) PHBV

18. The polymer used in making blankets (artificial wool) is

a) polystyrene
b) PAN
c) polyester
d) polythene

19. Regarding cross-linked or network polymers, which of the following statement is incorrect? (NEET)

    a) Examples are Bakelite and melamine

    b) They are formed from bi and tri-functional monomers

    c) They contain covalent bonds between various linear polymer chains

    d) They contain strong covalent bonds in their polymer chain

20. A mixture of chloroxylenol and terpinecol acts as (NEET)

    a) antiseptic b) antipyretic c) antibiotic d) analgesic

Short Answer Questions

1. Which chemical is responsible for the antiseptic properties of dettol.
2. What are antibiotics?
3. Name one substance which can act as both analgesic and antiphyretic
4. Write a note on synthetic detergents
5. How do antiseptics differ from disinfectants?
6. What are food preservatives?
7. Who do soaps not work in hard water?
8. What are drugs? How are they classified
9. How the tranquilizers work in body.
10. Write the structural formula of aspirin.
11. Explain the mechanism of cleansing action of soaps and detergents
12. Which sweetening agent are used to prepare sweets for a diabetic patient?
13. What are narcotic and non – narcotic drugs. Give examples
14. What are anti fertility drugs? Give examples.
15. Write a note on co –polymer
16. What are bio degradable polymers? Give examples.
17. How is terylene prepared?
18. Write a note on vulcanization of rubber
19. Classify the following as linear, branched or cross linked polymers

    a) Bakelite b) Nylon c) polythene

20. Differentiate thermoplastic and thermosetting.