Unit 16: Chemistry in Everyday Life

Drugs are low molecular mass (~ 100-500 u) substances which interact with targets in the body and produce a biological response

Medicines are chemicals that are useful in diagnosis, prevention and treatment of diseases. The branch of Chemistry which deal with the treatment of diseases using suitable chemical is know Chemotherapy.

Classification of Drugs

a. On the basis of pharmacological effect

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

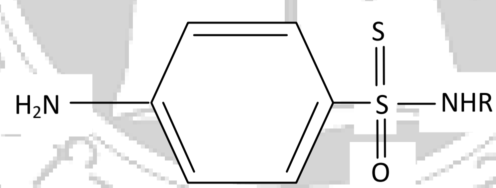
b. On the basis of drug action.

It is based on the action of a drug on a particular biochemical process. For example, all antihistamines inhibit the action of the compound, histamine which causes inflammation in the body. There are various in which action of histamines can be blocked.

c. On the basis of chemical structure

Drugs classified in this way share common structural features and often have similar pharmacological activity.

Example, sulphonamides have common structural.



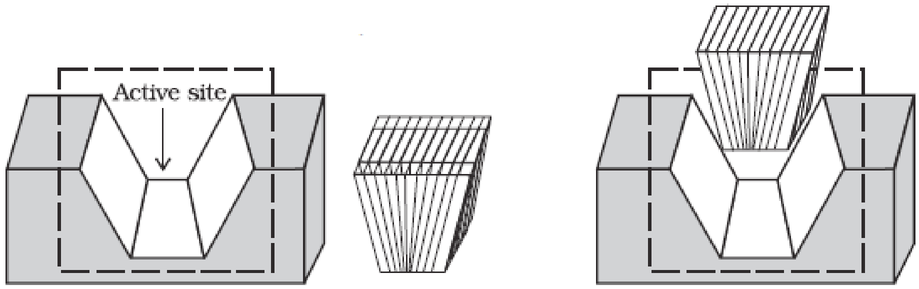
Structural features of sulphonamides

d. On the basis of molecular targets.

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

Enzymes are the proteins which perform the role of biological catalysts in the body are called enzymes

Functions of enzymes:



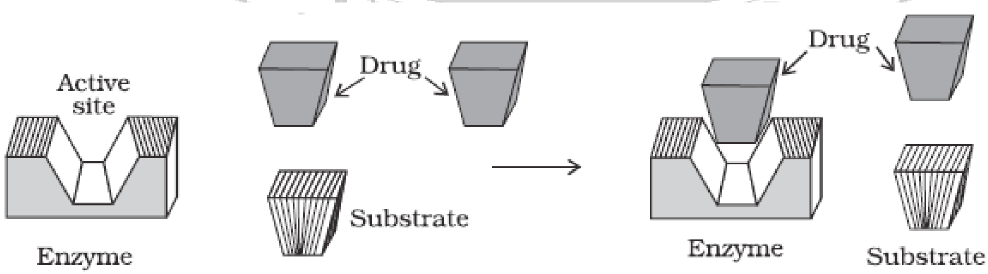
(a) Enzyme (b) Substrate (c) Enzyme holding substrate

(i) The first function of an enzyme is to hold the substrate for a chemical reaction. Active sites of enzymes hold the substrate molecule in a suitable position, so that it can be attacked by the reagent effectively

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

Role of drugs in Enzyme Catalysis:

- Main role of drugs is to either increase or decrease role of enzyme catalysed reactions.
- Inhibition of enzymes is a common role of drug action.
- Enzyme inhibitor is drug which inhibits catalytic activity of enzymes or blocks the binding site of the enzyme and eventually prevents the binding of substrate with enzyme.
- Drug can inhibit attachment of substrate on active site of enzymes in following ways.
  (a) Competitive Inhibition : Competitive Inhibitors are the drugs that compete with the natural substrate for their attachment on the active sites of enzymes

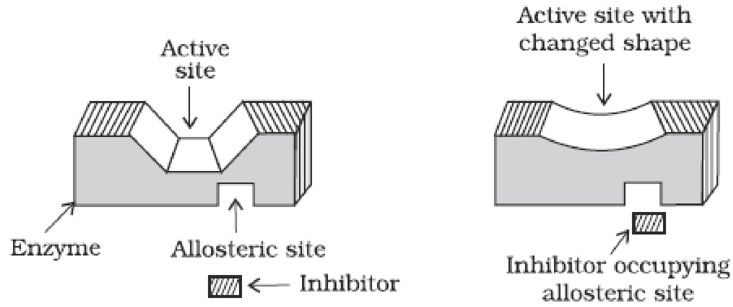


Drug and substrate competing for active site of enzyme

Drug blocks the active site of enzyme

  (b) Non-Competitive Inhibition : Some drugs do not bind to the enzyme's active site, instead bind to a different site of enzyme called allosteric site. This binding of inhibitor at allosteric site changes the shape of the active site in such a way that substrate cannot recognize it. If the bond formed between an enzyme and an inhibitor is a strong covalent bond and cannot be broken easily, then

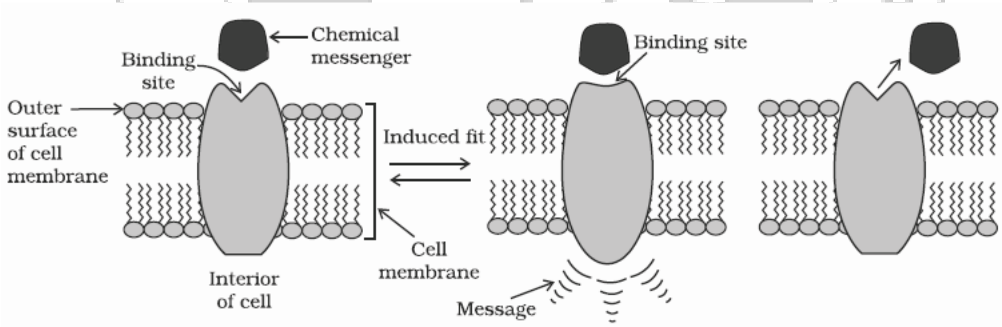
the enzyme is blocked permanently. The body then degrades the enzyme-inhibitor complex and synthesizes the new enzyme.



Non-competitive inhibitor changes the active site of enzyme after binding at allosteric site

Receptors as Drug Targets:

Proteins which are vital for communication system in the body are called receptors. In the body, message between two neurons and that between neurons to muscles is communicated through chemical messengers. They are received at the binding sites of receptor proteins. To accommodate a messenger, shape of the receptor site changes which brings about the transfer of message into the cell. Chemical messenger gives message to the cell without entering the cell



(a) *Receptor receiving chemical messenger*

(b) *Shape of the receptor changed after attachment of messenger*

(c) *Receptor regains structure after removal of chemical messenger*

- Receptors show selectivity for one chemical messenger over the other because their binding sites have different shape, structure and amino acid composition.
- Drugs that bind to the receptor site and inhibit its natural function are called antagonists. These are useful when blocking of message is required. Drugs that mimic the natural messenger by switching on the receptor are called agonists. These are useful when there is lack of natural

chemical messenger.

Therapeutic effect: Desirable or beneficial effect of a drug like treatment of symptoms and cure of a disease on a living body is known as therapeutic effect

Therapeutic action of different classes of drugs

(i) **Antacid**: Chemical substances which neutralize excess acid in the gastric juices and give relief from acid indigestion, acidity, heart burns and gastric ulcers. Examples: Eno, gelusil, digene etc.

(ii) **Antihistamines**: Chemical substances which diminish or abolish the effects of histamine released in body and hence prevent allergic reactions. Examples: Brompheniramine (Dimetapp) and terfenadine (Seldane)

(iii) **Neurologically Active Drugs**: Drugs which have a neurological effect i.e. affects the message transfer mechanism from nerve to receptor.

<u>(a) Tranquilizers</u> : Chemical substances used for the treatment of stress and mild or severe mental diseases. For example, Derivatives of barbituric acids like veronal, amytal, nembutal, luminal, seconal

<u>(b) Analgesics</u> : Chemical substances used to relieve pain without causing any disturbances in the nervous system like impairment of consciousness, mental confusion, incoordination or paralysis etc.

Classification of Analgesics :

Non-narcotic analgesics:	Narcotic analgesics:
They are non-addictive drugs	When administered in medicinal doses, these drugs relieve pain and produce sleep
Examples: Aspirin, Ibuprofen, Naproxen, Dichlofenac Sodium	Examples : Morphine and its derivatives

(iv) Antimicrobials: Drugs that tends to destroy/prevent development or inhibitthe pathogenic action of microbes such as bacteria (antibacterial drugs), fungi (antifungal agents), virus (antiviral agents), or other parasites (antiparasitic drugs) selectively.

Types of antimicrobial drugs

<u>(a) Antibiotics</u> : Chemical substances produced by microorganisms that kill or prevent the growth of other microbes

Classification of antibiotics on basis of mode of control of microbial diseases:

Bactericidal	Bacteriostatic
Drugs that kills organisms in body	Drugs that inhibits growth of organisms
Examples: Penicillin, Aminoglycosides, Ofloxacin	Examples: Erythromycin, Tetracycline, Chloramphenicol

Classification of antibiotics on basis of its spectrum of action:

Broad spectrum antibiotics	Narrow spectrum antibiotics	Limited spectrum antibiotics
Antibiotics which kill or inhibit a wide range of Gram-positive and Gram-negative bacteria	Antibiotics which are effective mainly against Gram- positive or Gram-negative bacteria	Antibiotics effective against a single organism or disease
Examples: Ampicillin and Amoxycillin	Examples: Penicillin G	

(b) Antiseptics : Chemical substances that kill or prevent growth of microorganisms and can be applied on living tissues such as cuts, wounds etc. Examples: Soframicine, dettol

(c) Disinfectants : Chemical substances that kill microorganisms but cannot be applied on living tissues such as cuts, wounds etc. Examples: Chlorine (Cl_2), bithional, iodoform etc.

(v) Antifertility Drugs : Chemical substances used to prevent conception or fertilization.
Examples: Norethindrone, ethynylestradiol (novestrol)

Chemicals in Food:

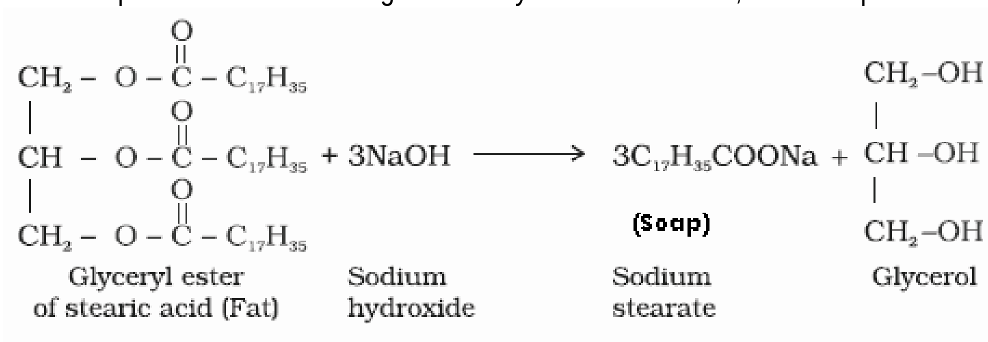
Food additives are the substances added to food to preserve its flavour or improve its taste and appearance.

Different types of food additives:

No.	Name of food additive	Examples
1	Artificial Sweetening Agents: Chemical compounds which gives sweetening effect to the food and enhance its flavour	Aspartame, Sucrolose and Alitame
2	Food preservatives: Chemical substances which are added to food material to prevent their spoilage due to microbial growth	Sugar, Salts, Sodium benzoate
3	Food colours: Substances added to food to increase the acceptability and attractiveness of the food product	Allura Red AC, Tartrazine
4	Nutritional supplements: Substances added to food to improve the nutritional value	Vitamins, minerals etc.
5	Fat emulsifiers and stabilizing agents: Substances added to food products to give texture and desired consistency	Egg yolk (where the main emulsifying
6	Antioxidants :Substances added to food to prevent oxidation of food materials	Butylated Hydroxy Toluene (BHT), Butylated Hydroxy Anisole (BHA)

Soaps:

It is a sodium or potassium salts of long chain fatty acids like stearic, oleic and palmitic acid.



The process of making soap by hydrolysis of fats or oils with alkalies is known as Saponification reaction.

Types of soaps

No.	Descriptions
1	Medicated soaps: These soaps are the soft soaps containing substances with medicinal properties. Neem soap, carbolic soaps are some common examples of medicated soaps.
2	Shaving soaps: These soaps are potassium sodium stearates and produce lasting lather. These contain glycerol to prevent rapid drying. A gum called rosin is added in these soaps which forms sodium rosinate which lathers well
3	Transparent soaps: These soaps are prepared by dissolving the soap in ethanol and then evaporating the excess solvent
4	Floating soaps: These soaps float in water and are prepared by beating tiny air bubbles into the product before it hardens
5	Soap chips: These are prepared by running a thin sheet of melted soap onto a cool cylinder and scrapping off the soaps in small broken pieces
6	Soap granules: These are dried miniature soap bubbles
7	Soap powder and scouring soaps: These substances contain some soap, a scouring agent (abrasive) such as powdered pumice or finely divided sand and builders like sodium carbonate and trisodium phosphate. Builders help the soaps in its cleaning action

Advantages of using soaps:

Soap is a good cleansing agent and is 100% biodegradable i.e., micro- organisms present in sewage water can completely oxidize soap. Therefore, soaps do not cause any pollution problems.

Disadvantages of using soaps:

- Soaps cannot be used in hard water because hard water contains metal ions like Ca^{2+} and Mg^{2+} which react with soap to form white precipitate of calcium and magnesium salts

$$2C_{17}H_{35}COONa + CaCl_2 \longrightarrow 2NaCl + (C_{17}H_{35}COO)_2Ca$$

Soap — Insoluble calcium stearate (Soap)

$$2C_{17}H_{35}COONa + MgCl_2 \longrightarrow 2NaCl + (C_{17}H_{35}COO)_2Mg$$

Soap — Insoluble magnesium stearate (Soap)

- These precipitates stick to the fibres of the cloth as gummy mass and block the ability of soaps to remove oil and grease from fabrics. Therefore, it interferes with the cleansing ability of the soap and makes the cleansing process difficult.

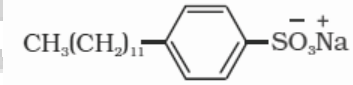
- In acidic medium, the acid present in solution precipitate the insoluble free fatty acids which adhere to the fabrics and hence block the ability of soaps to remove oil and grease from the fabrics. Hence soaps cannot be used in acidic medium.

Detergents:

Detergents are sodium salts of long chain of alkyl benzene sulphonic acids or sodium salts of long chain of alkyl hydrogen sulphates.

$CH_3(CH_2)_{10}CH_2OSO_3^-Na^+$

Sodium laurylsulphate



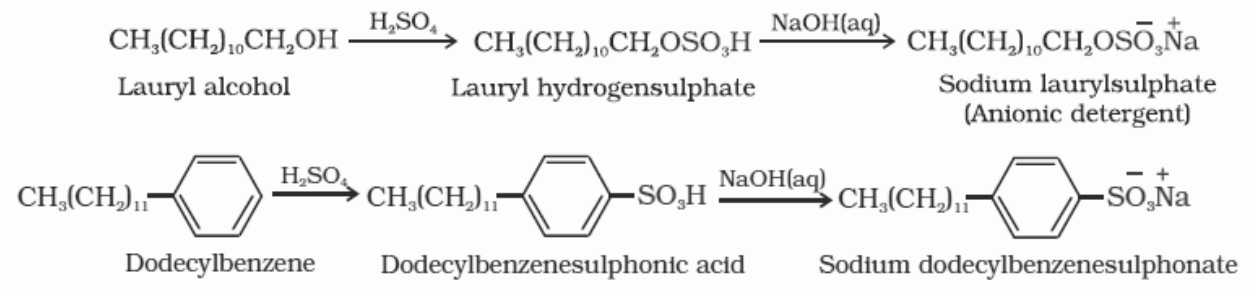
Sodium dodecylbenzenesulphonate

Classification of detergents:

(a) Anionic detergents:

Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons. Alkyl hydrogensulphates formed by treating long chain alcohols with concentrated sulphuric acid are neutralised with alkali to form anionic detergents. Similarly alkyl benzene sulphonates are obtained by neutralising alkyl benzene sulphonic acids with alkali.

Example:



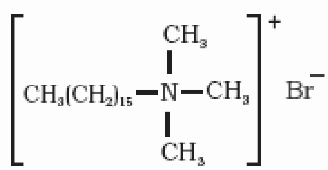
Anionic detergents are termed so because a large part of molecule is an anion.

Uses: They are used in household cleaning like dishwasher liquids, laundry liquid detergents, laundry powdered detergents etc.

Advantage: They are effective in slightly acidic solutions where soaps do not work efficiently

<u>(b) Cationic detergents</u>: Cationic detergents are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Cationic parts possess a long hydrocarbon chain and a positive charge on nitrogen atom.

Example:



Cetyltrimethyl ammonium bromide

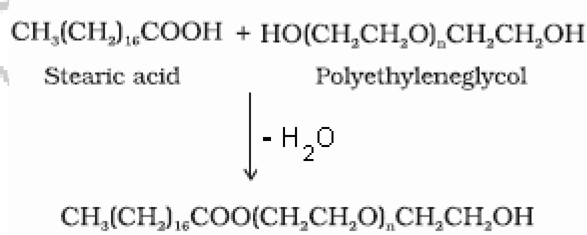
Cationic detergents are termed so because a large part of molecule is a cation

Use: Since they possess germicidal properties, they are used as germicides

<u>Advantage</u>: They has strong germicidal action

<u>Disadvantage</u>: These detergents are expensive

<u>(c) Non-ionic detergents</u>: They do not contain any ion in their constitution. They are like esters of high molecular mass. Example: Detergent formed by condensation reaction between stearic acid reacts and polyethyleneglycol.



Use: Making liquid washing detergents

Advantage: They have effective H- bonding groups at one end of the alkyl chain which make them freely water soluble.

Biodegradable detergents: Detergents having straight hydrocarbon chains that are easily decomposed by microorganisms. Example: Sodium lauryl sulphate

Non-Biodegradable detergents: Detergents having branched hydrocarbon chains that are not easily decomposed by microorganisms.