Chemistry in Everyday Life

16

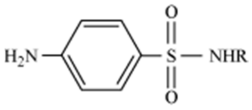
Drugs and Their Classification

Drugs

* Chemicals of low molecular masses (~100− 500 u) used for producing biological response by interacting with target macromolecules
* Drugs used for therapeutic effect are called medicines.
* Chemotherapy refers to the use of chemicals for therapeutic effect.

Classification of Drugs

* Based on pharmacological effect:
  Useful for doctors as it provides the whole range of drugs available to cure a particular type of problem
* Based on drug action:
  On the basis of the action of a drug on a particular biochemical process
* Based on chemical structure:
  Drugs classified on this basis have common structural features, and also may have similar pharmacological activity. For example, sulphonamides have common structural features as follows:

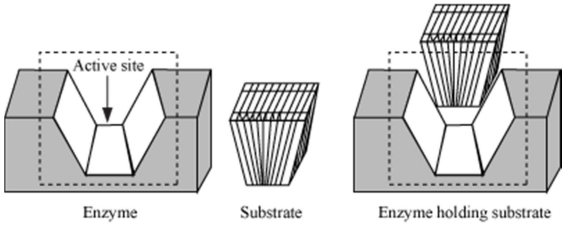


* Based on molecular targets:
  Useful for medicinal chemists
  Target molecules or molecular targets are the biomolecules with which drugs interact; for example, carbohydrates, lipids, proteins and nucleic acids.

Drug− Target Interaction

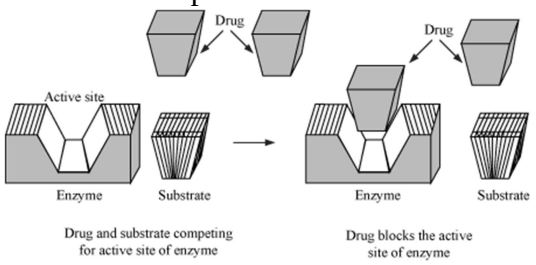
Enzymes as drug targets

* Catalytic action of enzymes: Two major functions of enzymes are −
  Substrate molecules are held in suitable positions by the active sites of enzymes through ionic bonding, H-bonding, van der Waals interaction or dipole− dipole interaction.

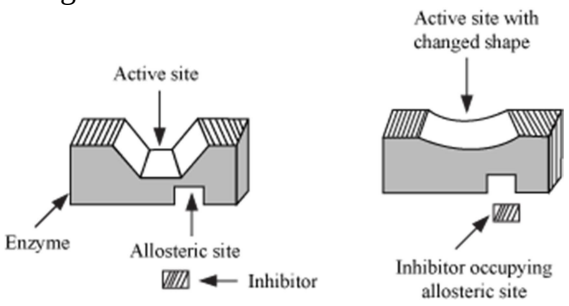


* To attack the substrate molecules, functional groups are provided by enzymes.
* Drug− enzyme interaction
  Drugs inhibit the catalytic action of enzymes by blocking the binding site of enzymes. Such drugs are called enzyme inhibitors.

* The two ways of drug– enzyme interaction are:
  Drugs compete with substrate molecules to attack the active site of enzymes. Such drugs are called competitive inhibitors.



* Some drugs change the shape of the active site of an enzyme. Such drugs bind to a different site, which is called allosteric site, and changes the shape of the active site in such a way that the substrate cannot recognise it.



Receptors as drug targets

* Receptors are proteins that are crucial to the communication process of the body.
* Chemical messengers are the chemicals through which messages between two neurons and between neurons and muscles are communicated.
* Antagonists are drugs which bind to the receptor site and inhibit its natural function.
* Agonists are drugs that mimic the natural messenger by switching on the receptor.

Therapeutic Action of Different Classes of Drugs

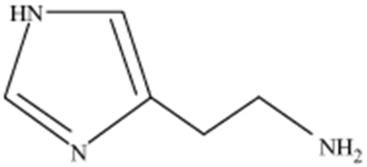
Antacids

* Used for the treatment of acidity
* Example: Sodium hydrogencarbonate or a mixture of aluminium and magnesium hydroxide
* Metal hydroxides are better alternatives.
  Reason: They do not increase the pH above neutrality as they are insoluble.

Anti-histamines

Histamines

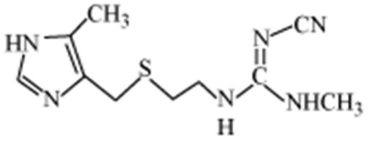
* Stimulate secretion of pepsin and hydrochloric acid in the stomach
* Also responsible for the nasal congestion associated with common cold, and allergic response to pollen



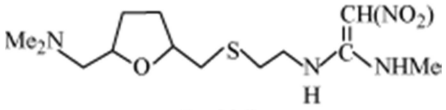
Histamine

Anti-histamine Drugs

* Cimetidine and ranitidine prevent the interaction of histamine with the receptors present in the stomach walls, and as a result, lesser amount of acid is released.

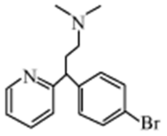


Cimetidine

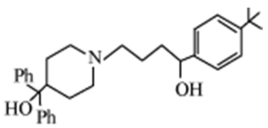


Ranitidine

* Brompheniramine (Dimetapp) and terfenadine (Seldane) interfere with the natural action of histamine by competing with histamine for finding sites of receptors.
* These anti-histamines do not affect the secretion of acid in the stomach. Reason: Anti-allergic and antacid drugs work on different receptors.



Brompheniramine
(Dimetapp, Dimetane)



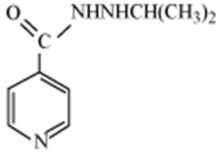
Terfenadine (Seldane)

Neurologically-Active Drugs

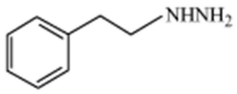
* They affect the mechanism of message transfer from nerve to receptor.
* Example: Tranquilisers and analgesics

Tranquilisers

* Used for the treatment of stress and mental diseases
* Anti-depressant drugs are used when a person is suffering from depression. Example: Iproniazid, phenelzine.

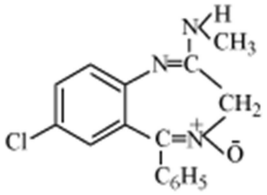


Iproniazid

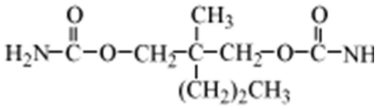


Phenelzine (Nardil)

* Chlordiazepoxide and meprobamate are suitable for relieving tension, and equanil is used for controlling depression and hypertension.



Chlordiazepoxide



Meprobamate

- Barbiturates (derivatives of barbituric acid viz., veronal, amytal, nembutal, luminal) constitute an important class of tranquilisers. They are hypotonic, i.e., sleep-producing agents.

Analgesics

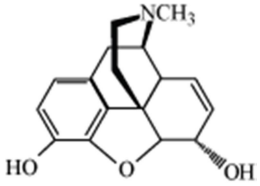
* Used for reducing pain, without causing impairment of consciousness, mental confusion, incoordination or paralysis, or some other disturbances of the nervous system
* Two types: Non-narcotic (non-addictive) analgesics and narcotic drugs

Non-narcotic drugs

* Example: Aspirin and paracetamol
* Aspirin inhibits the synthesis of chemicals known as prostaglandins, which stimulate inflammation in the tissue and cause pain.
* Aspirin also finds use in the prevention of heart attacks.
  Reason: Because of its anti-blood-clotting action
* These drugs also reduce fever (**anti-pyretic**), and relieve skeletal pain occurring due to arthritis.

Narcotic drugs

* Relieve pain and produce sleep (in medicinal doses)
* Produce stupor, coma, convulsions and ultimately death (in poisonous doses)
* Used for the relief of post-operative pain, cardiac pain and pains of terminal cancer, and in child birth
* Example: Morphine and its homologous such as heroin, codeine



Morphine

Antimicrobials and Antifertility Drugs

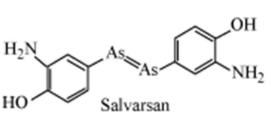
Antimicrobials

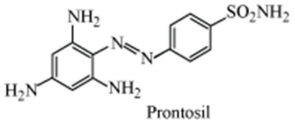
* Inhibit the pathogenic action of microbes such as bacteria, fungi, virus and other parasites.
* Example: Antibiotics, antiseptics, disinfectants

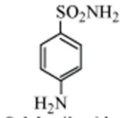
Antibiotics

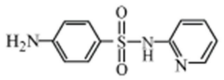
* Used for treating infections because of their low toxicity for humans and animals
* Inhibit the growth, and even destroy, microorganisms
* Sulpha drugs contain sulphanilamide, which is the real active compound. One of the most effective one is sulphapyridine.

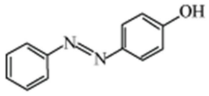
* Structures of some antibiotics are as follows:


Salvarsan


Prontosil


Sulphanilamide

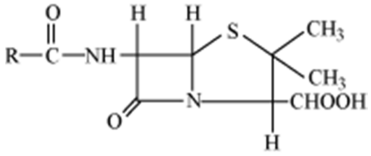

Sulphapyridine


Azodye

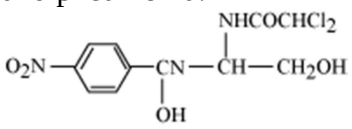
* Have either cidal (killing) effect or a static (inhibitory) effect on microbes. A few examples are listed in the given table.

Bactericidal	Bacteriostatic
Penicillin	Erythromycin
Aminoglycosides	Tetracycline
Ofloxacim	Chloramphenicol

* Antibiotics which kill or inhibit a wide range of gram-positive and gram-negative bacteria are called **broad-spectrum antibiotics**. Ampicillin and amoxicillin, which are synthetic modifications of penicillin, are broad-spectrum antibiotics.


General Sturcture of Pencillin

* Chloramphenicol is a broad-spectrum antibiotic which is used orally for the treatment of typhoid, dysentery, acute fever and pneumonia.


Chloramphenicol

* Vancomycin and ofloxacin are broad-spectrum antibiotics.
* Dysidazirine, an antibiotic, is toxic towards certain strains of cancer cells.
* Antibiotics which are effective mainly against gram-positive or gram-negative bacteria are called narrow-spectrum antibiotics. Example: Penicillin G.
* Antibiotics which are effective against a single organism or disease are called limited-spectrum antibiotics.

Antiseptic

* Chemicals which either kill or prevent the growth of microorganisms
* Antiseptics are applied to living tissues such as wounds, cuts, ulcers and diseased skin surfaces.

Example:

- Furacine
- Soframicine
- Dettol (mixture of chloroxylenol and terpineol)
- Tincture of iodine (2 − 3% solution of iodine in alcohol− water mixture): Applied on wounds
- Iodoform: An antiseptic for wounds
- Boric acid in dilute aqueous solution: Weak antiseptic for the eyes

Disinfectant

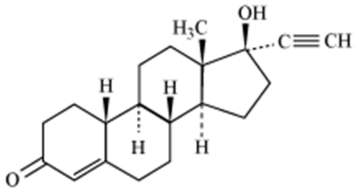
* Chemicals which either kill or prevent the growth of microorganisms
* Applied to inanimate objects such as floors, drainage system, instruments, etc.

Example:

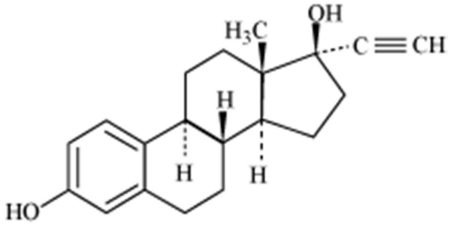
- 0.2 to 0.4 ppm of chlorine in aqueous solution
- Sulphur dioxide in low concentration
- 0.2% solution of phenol is used as an antiseptic while 1% solution of phenol is used as a disinfectant.

Antifertility Drugs

* Used in family planning
* Example: norethindrone, ethynylestradiol (novestrol)
* Norethindrone: Synthetic progesterone


Norethindrone

* Ethynylestradiol (novestrol): Oestrogen derivative, which is used in combination with progesterone derivative



Ethynylestradiol (novestrol)

Chemicals in Food & Cleansing Agents

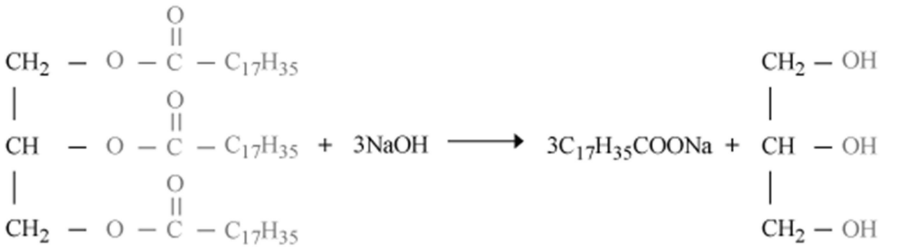
Chemicals in Food

* Chemicals are added to food as −
* Food colours
* Flavours and sweeteners
* Fat emulsifiers and stabilising agents
* Flour improvers: anti-staling agents and bleaches
* Anti-oxidants
* Preservatives
* Nutritional supplements (like minerals, vitamins, amino acids)
* Artificial sweetening agents
* Chemicals that sweeten food
* Do not add calories to our body
* Saccharin (ortho-sulphobenzimide) is the first popular artificial sweetening agent.
* Some other artificial sweetening agents are aspartame, alitame, sucrolose, etc.
* Food preservatives
* Chemicals that prevent food from spoilage due to microbial growth
* Example: Table salt, vegetable oil, sodium benzoate (C_6H_5COONa), salts of propanoic acid

Cleansing Agents

Soaps

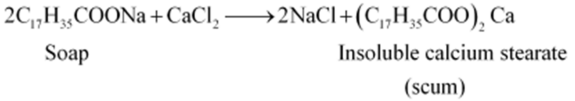
* Soaps are sodium or potassium salts of long-chain fatty acids (such as stearic acid, oleic acid, palmitic acid).
* Saponification: Heating of fat (glyceryl ester of fatty acid) with aqueous solution of NaOH to form soap containing sodium salts



Glyceryl ester of stearic acid (Fat) | Sodium hydroxide | Sodium stearate | Glycerol (or Glycerine)

* Potassium soaps are soft to the skin than sodium soaps.
* Soaps do not work in hard water.

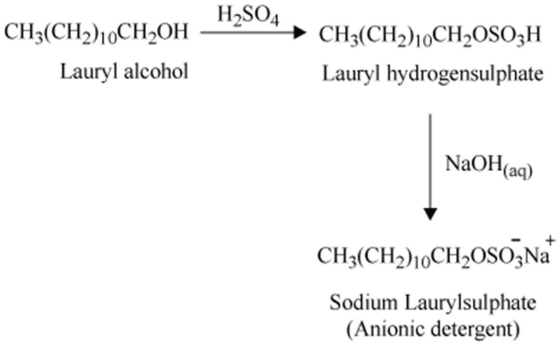
  Reason: Hard water contains calcium and magnesium ions. When soaps are dissolved in hard water, these ions displace sodium or potassium from their salts and form insoluble calcium or magnesium salts of fatty acids. These insoluble salts separate as scum.



* **Synthetic detergents**: Work in both hard and soft water.

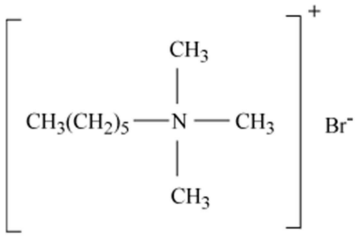
  Classified into the following three categories −
* Anionic detergents: Sodium salts of sulphonated long-chain alcohols or hydrocarbons. Anionic part is involved in the cleansing action.

Example:



* Cationic detergents: Quaternary ammonium salts of amines, with acetates, chlorides or bromides as anions.

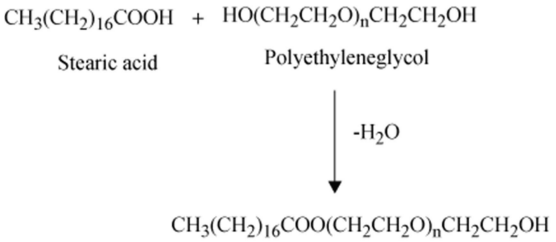
Example:



Cetyltrimethyl ammonium bromide

* Non-ionic detergents: Do not contain any ion.

Example:



* The more the branching of chain in detergents, the more is the difficulty in their degradation.

Solved Examples

Ex.1 Explain the following types of substances with one suitable example, for each case:

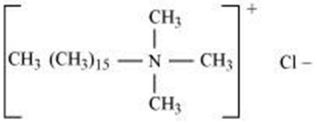
(i) Cationic detergents

(ii) Food preservatives

(iii) Analgesics

Sol.(i) Cationic detergents are quaternary ammonium salts such as chlorides and acetates.

Example − Cetyl trimethyl ammonium chloride



These detergents are very good cleansing agents and are used as germicidals.

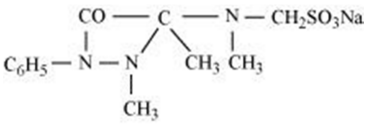
(ii) Food preservatives are chemical substances used for inhibiting the growth of micro-organisms in food materials so as to prevent their spoilage.

Example − benzoic acid and sulphur dioxide

Benzoic acid is used for preserving fruits, fruit juices, jams, etc.,as it is soluble in water, while sulphur dioxide is used for the preservation of colourless food materials.

(iii) Analgesics are the chemical substances used for relieving pain. They are also used for alleviating fever.

Example − Aspirin, Analgin, Novalgin



Novalgin

Ex. 2 What are the following substances? Give one example of each type.

(i) Antacid

(ii) Non-ionic detergents

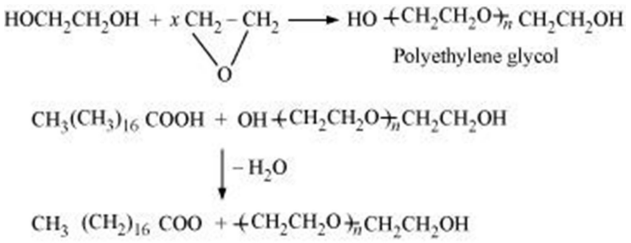
(iii) Antiseptics

Sol.(i) Antacids are stomach acid neutralisers. They raise the pH to reduce acidity in the stomach.

Example − aluminium hydroxide

(ii) Non-ionic detergents produce electrically neutral colloidal particles in solution.

Example − esters of high molecular mass formed by reaction between stearic acid and polyethylene glycol



(iii) Antiseptics are used for destroying microorganisms off the skin of humans and animals.

Example − boric acid.

Ex.3 Explain the following terms with one suitable example in each case.

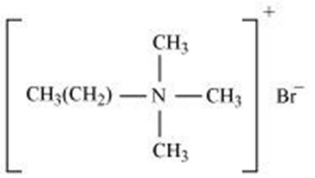
(i) Cationic detergents

(ii) Enzymes

(iii) Antifertility drugs

Sol.(i) Cationic detergents: Cationic detergents are quaternary ammonium salts of acetates, chlorides, or bromides. These are called cationic detergents because the cationic part of these detergents contains a long hydrocarbon chain and a positive charge on the N atom.

Example: cetyltrimethylammonium bromide



Cetyltrimethylammonium bromide

(ii) Enzymes: Biological catalysts are known as enzymes. They are made up of proteins. Enzymes are very specific for a particular reaction and for a particular substrate.

Example: Invertase, zymase

(iii) Antifertility drugs: These drugs are used to prevent pregnancy in women. They are also used for family planning. Antifertility drugs basically contain a mixture of synthetic estrogen and progesterone derivatives that prevent pregnancy by controlling the menstrual cycle.

Example:norethindrone, ethynylestradiol (novestrol)