CHEMISTRY IN EVERYDAY LIFE

DRUGS

Drugs are chemicals of low molecular masses which interact with macromolecular targets and produce as biological response. When biological response is therapeutic and useful, these chemicals, are called medicines and if taken in higher doses, they behave as poisons. Use of chemicals for therapeutic effect is called Chemotherapy.

Classification of Drugs:

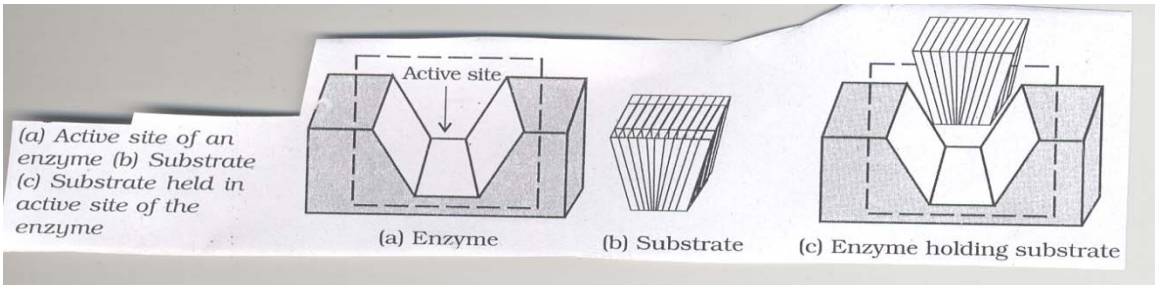
a) On the basis of pharmacological effect: It is useful for doctors because it provides them the whole range of drugs available for treatment of a particular problem. For e.g.: analgesics for pain killing effect, antiseptics kill or arrest growth of microorganisms.
b) On the basis of drug action: It is based on the action of a drug on a particular biochemical process. Eg- antihistamines which inhibit the action of histamines which causes inflammation in the body.
c) On the basis of Chemical structure: Some drugs share a common feature and often have similar Pharmacological activity. Eg; Sulphonamides have $H_2N\text{-}C_6H_4\text{-}SO_2\text{-}NHR$ structural feature in common.
d) On the basis of molecular targets: Drugs usually interact with biomolecules such as carbohydrates, lipids, proteins & nucleic acid. These are called target molecules. Drugs possessing some common structural feature have the same mechanism of action on targets.

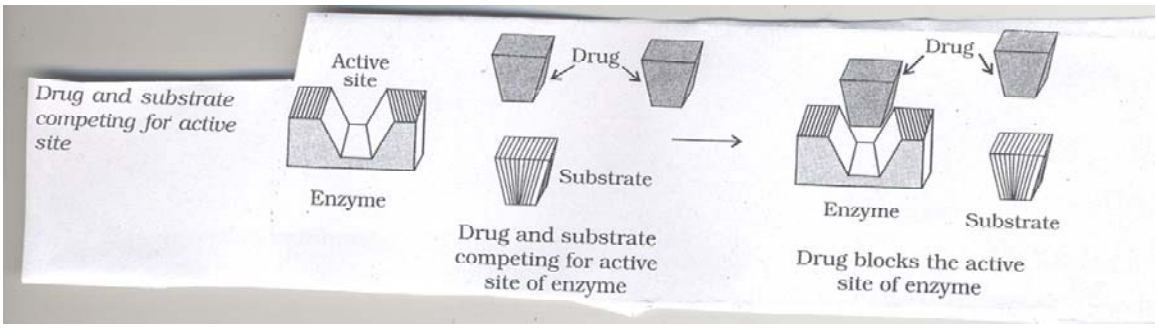
DRUG –TARGET INTERACTION

Macromolecules of biological origin perform various functions in the body. For eg- Proteins which perform role of biological catalyst in the body are called ENZYMES & those which are crucial to communication system are called RECEPTORS.
Hormones are biological chemical messengers secreted by endocrine glands. Example- Insulin, noradrenalin.

ENZYMES AS DRUG TARGETS:

a) Catalytic action of enzymes : For understanding interaction between drug and enzyme we first study the function of enzymes.
Enzymes hold the substrate for a chemical reaction. Active sites of enzymes hold substrate molecule in a suitable position, so that it can be attacked by the reagent effectively. Substrate binds themselves to the active sites by ionic bonding, hydrogen or by vanderwaals interaction.





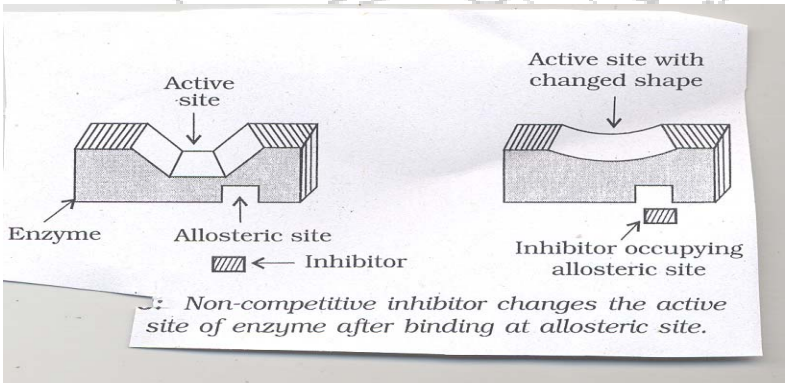
It provides functional groups that will attack the substrate and carry out chemical reaction.

b) Drug-enzyme interaction: Drugs inhibit any of the above mentioned activities of enzymes. These can block the binding site of enzyme and prevent the binding of substrate or can inhibit catalytic activity of enzyme. These are called enzyme inhibitor.
These can occur in two different ways---

(i) Drugs compete with the natural substrate for their attachment on active sites of enzymes. These are called competitive inhibitors.

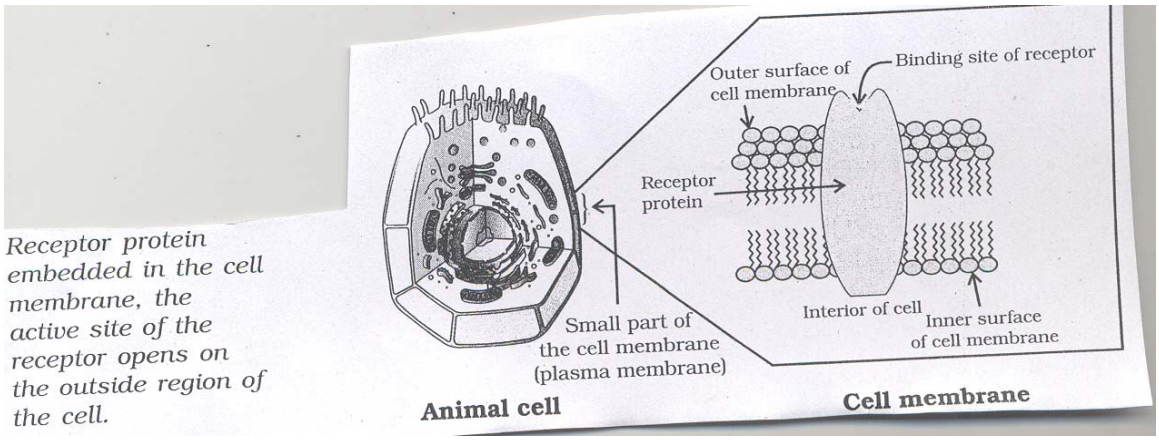
(ii) Some drugs do not bind to the enzyme's active site. These bind to some different enzyme site called allosteric site. This binding of inhibitor at allosteric site changes the shape of the active site in such a way that substrate cannot recognize it.

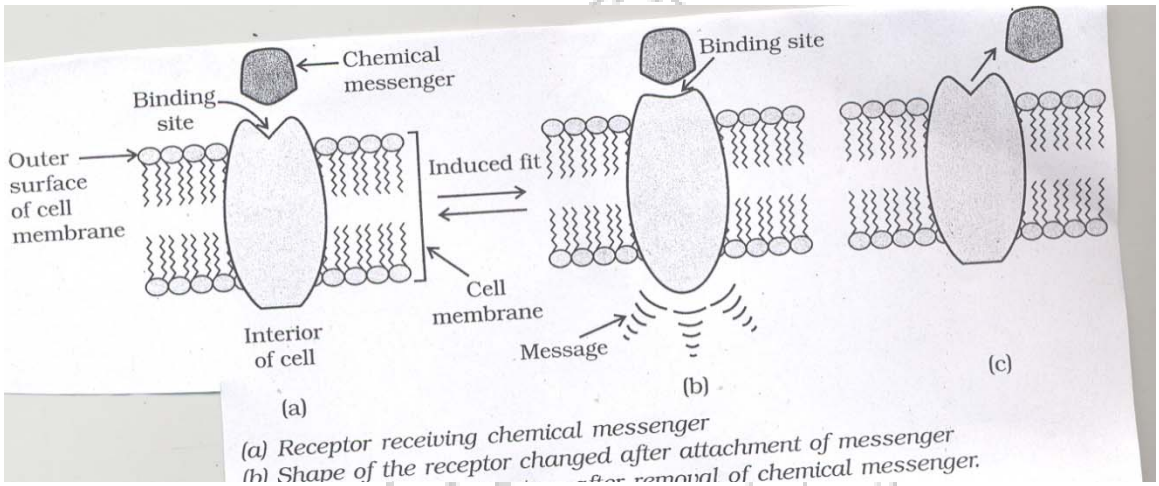
If the bond between an enzyme and inhibitor is a strong covalent bond and it cannot be easily broken, then the enzyme is blocked permanently. The body then degrades the enzyme-inhibitor complex and synthesizes the new enzyme.



RECEPTORS AS DRUG TARGETS

Receptors are proteins that are crucial to body's communication process. Receptor proteins are embedded in cell membranes in such a way that their small part possessing active site projects out of the surface of the membrane and opens on the outside region of the cell membrane.





There are a large no. of different receptors in the body that interact with different chemical messengers. These receptors show selectivity for one chemical messenger over the other because their binding sites have different shape, structure and aminoacid composition.
Drugs that bind to the receptor site and inhibit its natural function are called antagonists. Drugs that mimic the natural messenger by switching on the receptors are called agonists. These are useful when there is lack of natural chemical messenger.

CHEMICALS IN MEDICINE

The chemical substances used for treatment of diseases and for reducing suffering from pain are called medincines or drugs.
Chemotherapy- is a science in which suitable chemicals are used for treatment of diseases.

1) **Antipyretics**- The chemicals use to lower body temperature in high fever are called antipyretics. Eg- Aspirin, paracetamol and phenacetin

2) **Analgesics**- The chemical substances used to relieve pains without causing impairment of consciousness, mental confusion, incoordination or paralysis or some other disturbances of nervous system are called analgesics. These are of two types.
   a) Non-narcotic drugs or non-addictive drugs- Eg- aspirin, analgin, novalgin, naproxen, ibuprofen & diclofenac sodium or potassium.
      Aspirin: Finds use as antipyretic, prevention of heart attack because of its anti-blood clotting action. Aspirin is supposed to be toxic to liver which gets hydrolysed in stomach giving salicylic acid which sometimes cause bleeding in stomach. Therefore, overdosage and its use in empty stomach should be avoided.
   b) Narcotic drugs or Addictive drugs- Which produce sleep and unconsciousness. These can also be used as analgesics. Eg- morphine, codeine, heroin, marijuana. When used in medicinal doses, they relieve pain and produce sleep. In excessive doses, they produce stupar coma, convulsions and ultimately leading to death. These narcotics are called opiates because they are obtained from opium poppy.

3) **Antiseptics and disinfectants**:
   Antiseptics are chemical substances used either to kill or prevent the growth of micro-organisms. These are not harmful to living tissues and can be applied on wounds, ulcers, diseased skin surfaces. They are also used to reduce odours resulting from bacterial decomposition of the body or in the mouth. Eg- Soframycin, Bithional is added to medicated soaps, tincture of Iodine (2-3% soln of iodine in alcohol-water mixture), Iodoform, Boric acid in dilute aqueous solution is antiseptic for eyes etc.
   Disinfectants are chemical substances which are used to kill micro-organisms but they cannot be applied on living tissues. They play a major role in water treatment and public health sanitation. These are commonly applied on inanimate objects like floors, drainage system etc. Eg- Cl_2 at a conc. of 0.2 to 0.4 ppm makes water fit for drinking, Phenol derivative, thymol.
   Some substances act both as antiseptics and disinfectants. Eg- Dettol (a mixture of chloroxylenol and terpineol), 0.2% soln. of phenol acts as antiseptic & 1% soln acts as disinfectant.

4) **Tranquilizers**: The chemical substances used for treatment of stress, mild and severe mental diseases are called tranquilizers. They release mental tension and reduce anxiety. These are essential component of sleeping pills. These are also called psychotherapeutic drugs. Noradrenaline, a hormone which induces feeling of well being and helps in changing mood. If the level of nordrenaline is low for some reason, then signal sending activity becomes low, and the person suffers from depression. In such situations, antidepressant drugs are required.
   Eg: iproniazid and phenalzine are antidepressant drugs. They inhibit the enzyme which catalyse the degradation of noradrenaline.
   Chlordiazepoxide and meprobamate are used to relieve tension.
   Equanil, diazepam,veronal and serotonin are used in controlling depression and hypertension
   Barbiturates like veronal, amytal, membutal, seconal and luminal are hypotonic ie: sleep producing agents.

5) **Antimalarials**: These are chemical substances used for treatment of malaria. Eg- Chloroquine, paraquine etc.

6) **Antimicrobials**: are chemical substances used to cure infections due to micro-organisms. The disease in human beings may be caused due to variety of micro-organisms like virus, bacteria etc. which are called microbes. They can be seen only by microscope. The disease causing microbes are called pathogens. Our body possesses natural defense mechanism against the pathogenic microbes. Skin is impervious to microbes. Our body secretions kill the microbes or inhibit their growth. Some common examples are lysozyme in tears, nasal secretions, saliva, lactic acid in sweat etc. The pathogens reach the tissues due to breach in defence mechanism and cause infections.

   The control of microbial diseases can be achieved by:
   (i) Drugs which kill organisms in the body (bactericidal)
   (ii) Drugs which inhibit or arrest the growth of organisms (bacteriostatic)
   (iii) Increasing immunity and resistance to infections of the body (immunity)
   Antimicrobial substances may be synthetic chemicals like sulphonamides or antibiotics- like tetracycline, penicillin, chloramphenicol etc. The common example of antimicrobial drug is sulphanilamides which are effective in wide range of micro-organisms.

7) **Antifertility Drugs**: These chemical substances control pregnancy. Their basic aim is to prevent conception or fertilization. The birth control pills are essentially a mixture of esterogen and progesterone derivative. Both of these compounds are hormones. Progesterone suppresses ovulation. Synthetic progesterone are more potent than progesterone.
   The common pills used for a combination of progesterone, norethindrone and estrogen (ethynylestradiaol) is novestrol.

8) **Antacids**: The chemical substances which neutralize excess acid in the gastric juices and give relief from acid indigestion, acidity, heart burns, and gastric ulcers are called antacids. Baking soda in water is a common antacid. Other example are magnesium hydroxide, calcium carbonate, sodium bicarbonate, potassium bicarbonate, magnesium carbonate, potassium bicarbonate, aluminium phosphate. Magnesium oxide is also used as an antacid ingredient since it reacts with water to form $Mg(OH)_2$. The antacids are available in the form of liquids, gels or tablets. Generally, liquid antacids are more effective than tablets because of great surface area available for interaction and neutralization of acid. An advancement in treatment of hyperacidity came through the discovery that histamines stimulates the secretion of pepsin and hydrochloric acid. To prevent interaction of histamines with the receptors present in the stomach wall, the drug cimetidine has been designed. This resulted in release of lesser amount of acid. The drug is now replaced by ranitidine. A more effective new class of drugs is omeprazole and lansoprazole which prevents formation of acid in stomach.

9) **Antihistamines**: are chemical substances which diminish or abolish the main actions of histamines release in the body and hence prevent the allergic reactions caused by antigens. Histamines are responsible for nasal congestion associated with common colds, cough,

allergic response to pollens etc. Synthetic drugs such as bromopheniramine (Dimetapp) and terfenadine (seldane) are used as antihistamines. Antihistamines are also called anti-allergic drugs. These are used to treat allergy, eg, skin rashes, conjunctivitis etc. These drugs relieve sneezing , nasal discharge, mild asthama, itching of eyes, nose and throat. The common antihistamine drugs are Benadryl, avil, zeet, bromethazine, actidil, anistine, foristal etc.

10) **Anaesthetics**: are chemical sunstances which produce general or local insensibility to pains and other sensations. Cocaine, novocaine are local anaesthetic chloroform, diethyl & vinyl ethers are general anaesthetics.

11) **Antibiotics**: are chemical substances which are produced by micro-organisms (bacteria, fungi and moulds) and can inhibit the growth or even destroy micro-organisms. Antibiotic refers to a substance (produced wholly or partly by chemical synthesis) which in low concentration inhibits growth or destroys micro-organisms by intervening in their metabolic processes.
First antibiotic produced was penicillin by Alexander Fleming in 1929. Antibiotic can be either bactericidal or bacteriostatic.
Bactericidal: Pencillin, Aminoglycosiders, Ofloxacin.
Bacteriostatic: Erythromcin, Tetracycline, Chloramphenicol.
Pencillin is narrow spectrum. These can be used for curing sore throat, reheumatic fever, local infections etc. Streptomycin, neomycin is used for treatment of tuberculosis, meningitis, pneumonia etc.
Broad spectrum antibiotics are effective against several micr-organisms. Thereforem these are for curing a variety of diseases. Eg- thetracycline, chloromycetin and chloramphenicol. Eg- Chloramphenicol is a broad spectrum antibiotic which is used for curing typhoid, acute fever, dysentery, whooping cough, pneumonia, eye infections, certain urine infections etc. Sulphadrugs are used against pneumonia, tuberculosis, diphtheria etc. Some examples are sulphadiazine, sulphathiazole, sulphaacetamide etc.

S.No.	Type of Medicine	Used as	Examples
1	Analgesics	Relieve Pain	Aspirin, Ibuprofen
2	Antipyretics	Lowers body temperature	Paracetamol, Phenacetin
3	Antiseptics & Disinfectants	Kill or prevent growth of microorganism	Phenol, Chlorine, dettol
4	Tranquilizers	Treatment of stress & mental diseases	Barbituric acid & its derivatives (Seconal, Luminal, Veronal etc)
5	Antimicrobials	Cure infections due to microorganisms	Sulphonamides
6	Antifertility drugs	Birth control	Novestrol (ethynylestradiol) & Progestrone (norethindrone), mifepristone
7	Antacids	Removes excess acid in stomach	Magnesium hydroxide, Magnesium trisilicate, aluminium hydroxide gel

8	Antihistamines	Treatment of hyperacidity, stimulates secretion of pepsin & HCl in the stomach. Also responsible for nasal congestion associated with common cold	Brompheniramine & terfenadine
9	Antibiotics	Produced by microorganisms & can inhibit the growth of other microbes	Pencillin, Tetracycline, Chloramphenicol

Chemicals in Food

Many chemicals are added to food for their preservation and enhancing their appeal. These include flavourings, sweetness, antioxidants, fortifiers, emulsifiers and antifoaming agents.

1. **Antioxidants**:
   Antioxidants are the important class of compounds which prevent oxidation of food materials. These compounds retard the action of oxygen on the food and thereby help in preservation. These act as sacrificial materials. i.e. they are more reactive towards oxygen than the materials they are protecting. They also reduce the rate of involvement of free radicals in the aging process. Most important antioxidants used are butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT). The addition of BHA to butter increases its storage life.

BHT **BHA**

   Sometimes BHT and BHA are added in combination with citric or ascorbic acid to produce a more active synergistic effect. SO_2 and sulphate are useful antioxidants for wine and beers, sugar syrups and cut peeled on dried fruits and vegetables.

2. **Preservatives:**
   These are the chemical substances which are added to the food materials to prevent their spoilage and to retain their nutritive value for long periods. These preservatives prevent rancidity of food & inhibit the growth of microorganisms during storage. Example: Common salt, sugar, oils, Sodium benzoate, salts of propanoic acid and ascorbic acid.

3. **Artificial Sweetening agents:**
   The artificial sweetners are another type of food additives. Eg; Saccharin which is marketed as soluble of calcium salt. It is 300 times sweet than cane sugar. It is life saver for diabetic patients and is of great value to people who need to control intake of calories.
   Aspartame: Unstable at cooking temperature, therefore it is used as a sugar substitute to cold foods and soft drinks.
   Alitame: more stable during cooking than aspartame
   Sucralose: good artificial sweetener.

4. **Edible colors**:
   Edible colour that are used for food are dyes; ex- dyes are used to dye orange peels so hat oranges retain their colour. Colour is also added to fruit juices. Food colours do not have any nutritional value. The use of some of the azodyes are dangerous for young children and asthma patients.
   Terazime, a widely used dye is harmful
   Natural dyes like carotene are safe food edible colours.
   PFA {Prevention of food Adulteration Act}- govt. has passed it for the protection of consumer interests.

SOAPS AND DETERGENT

Soaps are sodium or potassium salts of long chain fattyacids. Soaps containing sodium salts are formed by heating fat (ie glyceryl ester of fatty acid) with aqueous sodium hydroxide solution and potassium salts are prepared by using potassium hydroxide. This reaction is known as saponification. Soap obtained remains in colloidal form and is precipitated from the solution by adding NaCl.

Soaps cannot be used in hard water as hard water contains certain metal ions such as Ca^{2+} and Mg^{2+} which form a curdy white precipitate of calcium and magnesium salt. This is called scum and is hinderance to good washing because this insoluble ppt. adheres onto the fibre of the cloth as gummy mass.

Synthetic detergents: They are sodium or potassium salts of sulphonic acid. Eg: sodium alkylbenzene sulphonate which have a general formula: $CH_3(CH_2)xC_6H_4SO_3Na^+$

Advantages of detergents:

Detergents can be work in hard water. The anions of synthetic detergent do not precipitate in the presence of Ca^{2+} and Mg^{2+}. They can work will even in acidic water.

Types of detergents;

There are three types of detergents;

(a) Anionic detergents are synthesized from long chain alcohol. The long chain alcohols are treated with conc. H_2SO_4 to form alkyl hydrogen sulphate of high molecular mass and finally alkyl sulphate are neutralized with alkali to form salts. It is called anionic detergent because large part of the molecule is anion. The anionic detergent is largest in use as household detergents. E.g.- Alkylbenzenesulphonate . They are effective in acidic solutions to form an alkyl hydrogen sulphate which is soluble where as soap are not effective due to formation of insoluble fatty acids.
$CH_3(CH_2)_{11}OSO_3^-Na^+$, $CH_3(CH_2)_{11}C_6H_4SO_3^-Na^+$

(b) Cationic detergent: These are mostly acetates or chlorides of quaternary ammonium salt. They are more expensive therefore are used to limited extent. Such detergent possess germicidal properties and are extensively used as germicides. e.g $[CH_3(CH_2)_{11}N^+(CH_3)_3]Br^-$

(c) Non-Ionic detergent: Some of the detergent are non- ionic , like the esters of high molecular mass formed by reactions between polyethylene glycol and stearic acid. They do not possess any ion.

$$CH_3(CH_2)_{16}COOH+HO(CH_2CH_2O)_nCH_2CH_2OH \longrightarrow CH_3(CH_2)_{16}COO(CH_2CH_2O)nCH_2CH_2OH$$

Some liquid dishwashing detergents are of non-ionic type branched hydrocarbon chain detergents are non-biodegradable and cause water pollution. The hydrocarbon side chain stops bacteria from attacking and breaking the chain. These molecules degrade slowly leading to water pollution.
Unbranched or linear alkyl chain detergents do not create pollution as they are more prone to attack by bacteria, thus can be biodegraded.