Competitive and non-competitive inhibitors

The noncompetitive inhibitor reacts either remote from or very close to the active site. The net effect of a non competitive inhibitor is to change the shape of the enzyme and thus the active site, so that the substrate can no longer interact with the enzyme to give a reaction. Competitive inhibition is a form of enzyme inhibition where binding of the inhibitor to the active site on the enzyme prevents binding of the sunstrate and *vice versa*.

How receptors acts as drug targets

These receptor molecules all have a specific role in the control of cellular processes and there are naturally occurring ligands that bind to the receptor molecule, forming a ligand-receptor complex. Ligands usually have a complementary structure to the receptor site, so this is a very similar situation to the enzyme-substrate mechanism discussed in the previous section.Many drug molecules act as ligands for a range of receptor sites, which explains the wide range of physiological effects produced by some drug.

Chemical messengers

A chemical messenger is any compound that serves to transmit a message. A chemical messenger may refer to: hormone, long range chemical messenger, neurotransmitter, communicates to adjacent cells, neuropeptide, a protein sequence which acts as a hormone or neurotransmitter.

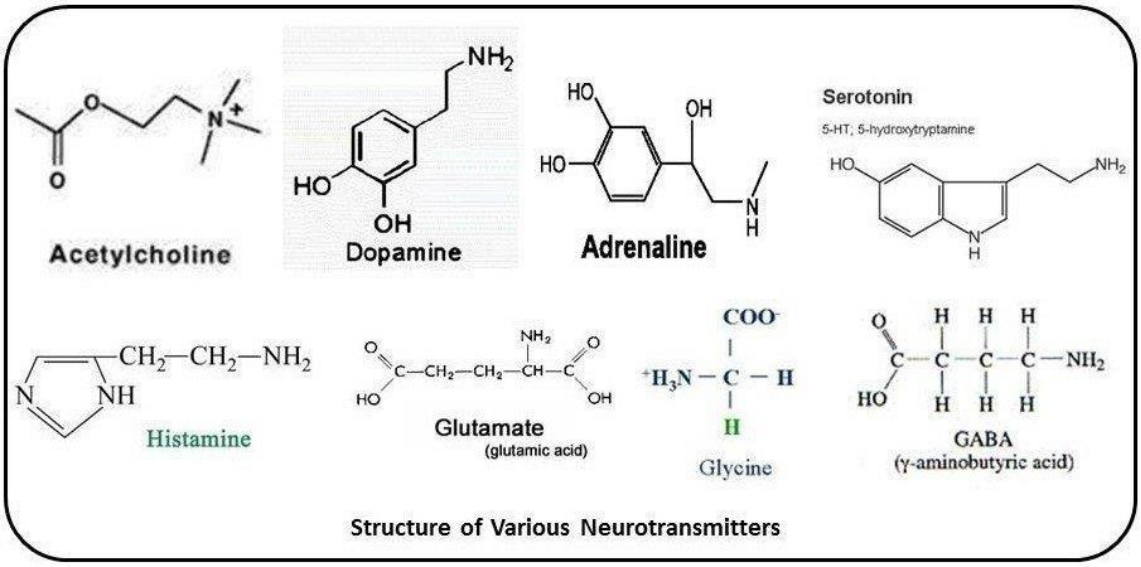
Types of chemical messenger

Hormone, long range chemical messenger.
Neurotransmitter, communicates to adjacent cells.
Neuropeptide, a protein sequence which acts as a hormone or neurotransmitter.
Pheromone, a chemical factor that triggers a social response in members of the same species.

Neurotransmitters

A chemical substance which is released at the end of a nerve fibre by the arrival of a nerve impulse and, by diffusing across the synapse or junction, effects the transfer of the impulse to another nerve fibre, a muscle fibre, or some other structure.

Structure of neuro transmitters



Adrenergic receptors

The adrenergic receptors (or adrenoceptors) are a class of G protein-coupled receptors that are targets of the catecholamines, especially norepinephrine (noradrenaline) and epinephrine (adrenaline).

Types of adrenergic receptors

The adrenergic receptors are a class of G protein-coupled receptors that are targets of the catecholamines, especially norepinephrine and epinephrine.

Side-effects of drugs

Possibly the most common side effects of any prescription drug are gastrointestinal issues, including nausea, constipation and diarrhea, because most drugs go through the digestive system to be absorbed. Other common after effects include drowsiness, pain and skin reactions.

Antipyretics

Antipyretics are substances that reduce fever. Antipyretics cause the hypothalamus to override a prostaglandin-induced increase in temperature. The body then works to lower the temperature, which results in a reduction in fever. For example, Novalgin.

Antacids

An antacid is a substance which neutralizes stomach acidity, which in turn relieves heartburn, indigestion or stomach upset.e.g Histamine.

Functions of antacids

Antacids may be used:

To reduce the symptoms of acid reflux which may cause heartburn or inflammation of the gullet. These conditions are sometimes called gastro-oesophageal reflux disease (GORD).
To relieve some of the symptoms caused by ulcers in the stomach and part of the gut.
In other conditions where it is helpful to neutralise stomach acid.
Before the discovery of other more modern medicines, antacids were commonly used for the above conditions. They were also used to help heal ulcers in the stomach and duodenum.

Antihistamines

The drugs which interfere with the natural action of histamine by competing with histamine for binding the sites of receptor where histamine exerts its effect are called antihistamines. e.g., Seldane, Dimetane.

Functions of antihistamines

Antihistamines function to block the release of a chemical called histamine, which is one of your body's natural defences. When your body recognises a foreign substance, also called an allergen, it reacts defensively through a sequence of reactions leading to the release of various chemicals, one of which is histamine. These constitute your body's allergic response to the allergen. Itching is one of the responses to the allergen and it can range from mild to extremely uncomfortable and painful.
Antihistamines work to:

Alleviate red and irritated eyes
Reduce a runny nose and sneezing
Ease itching in the throat, nose or eyes

Tranquilizers

Drugs which are used for the treatment of stress, fatigue, mild and severe mental diseases are called tranquilizers. The principal minor tranquilizers are the benzodiazepines, among which are diazepam (Valium), chlordiazepoxide (Librium), and alprazolam (Xanax).

Function of tranquilizers

Major tranquilizers are highly selective in alleviating the delusions, hallucinations, and disordered thinking of schizophrenics and other psychotic patients. The drugs return agitated, excited, and irrational patients to a state of rational calm, and they have enabled many seriously ill people who would otherwise be hospitalized to live at home and engage in productive work. Major tranquilizers do not cure schizophrenia but merely suppress its symptoms, and they are usually prescribed on a long-term basis.

Sulpha drugs

Sulphonamide (also called sulphonamide, sulfa drugs or sulpha drugs) is the basis of several groups of drugs. The original antibacterial sulfonamides are synthetic antimicrobial agents that contain the sulphonamide group. Some sulfonamides are also devoid of antibacterial activity.e.g Hydrochlorodiazide.

Functions of sulpha drugs

Sulphonamides are used to treat allergies and cough, as well as antifungal and antimalarial functions. The moiety is also present in other medications that are not antimicrobials, including thiazide diuretics (including hydrochlorothiazide, metolazone, and indapamide, among others), loop diuretics (including furosemide, bumetanide, and torsemide), acetazolamide, sulphonylureas (including glipizide, glyburide, among others), and some COX-2 inhibitors (e.g., celecoxib). Sulphasalazine, in addition to its use as an antibiotic, is also used in the treatment of inflammatory bowel disease.

Analgesics

Analgesics are those drugs that mainly provide pain relief. The primary classes of analgesics are the narcotics, including additional agents that are chemically based on the morphine molecule but have minimal potential; nonsteroidal anti-inflammatory drugs (NSAIDs) including the salicylates; and acetaminophen.

Functions of analgesics

Analgesics are those drugs whose primary purpose is pain relief. The primary classes of analgesics are the narcotics, including additional agents that are chemically based on the morphine molecule but have minimal abuse potential; nonsteroidal anti-inflammatory drugs (NSAIDs) including the salicylates; and acetaminophen . Other drugs, notably the tricyclic antidepressants and anti-epileptic agents, such as gabapentin, have been used to relieve pain, particularly neurologic pain, but are not routinely classified as analgesics. Analgesics provide symptomatic relief but have no effect on causation, although clearly the NSAIDs, by virtue of their dual activities as pain relievers and anti-inflammatory, may be beneficial in both regards.

Types of analgesics

These are classified as follows:
(i) Non-narcotic (non-addictive) analgesics
(ii) Narcotic drugs

Non-narcotic analgesics

Aspirin and paracetamol belong to the class of non-narcotic analgesics. Aspirin is the most familiar example. Aspirin inhibits the synthesis of chemicals known as prostaglandins which stimulate inflammation in the tissue and cause pain. These drugs are effectivein relieving skeletal pain such as that due to arthritis. These drugshave many other effects such as reducing fever (antipyretic) andpreventing platelet coagulation. Because of its anti blood clottingaction, aspirin finds use in prevention of heart attacks.

Limitations of non-narcotic analgesics

Aspirin is supposed to be toxic to liver. It also acts as a gastric irritant because it gets hydrolysed to salicyclic acid in stomach which produces ulcers and sometimes causes bleeding. Overdose should be avoided.

Working of narcotic analgesics

Morphine and many of its homologues, when administered in medicinal doses, relieve pain and producesleep. In poisonous doses, these produce stupor, coma, convulsions and ultimately death. Morphine narcotics are sometimes referred to as opiates, since they are obtained from the opium

poppy. These analgesics are chiefly used for the relief of postoperative pain, cardiac pain and pains of terminal cancer, and in child birth.

Antimicrobials

An antimicrobial tends to destroy/prevent development or inhibit thepathogenic action of microbes such as bacteria (antibacterial drugs), fungi (antifungal agents), virus (antiviral agents), or other parasites(antiparasitic drugs) selectively. Antibiotics, antiseptics and disinfectantsare antimicrobial drugs.

Antimicrobials

An antimicrobial is an agent that kills microorganisms or inhibits their growth.Antimicrobial medicines can be grouped according to the microorganisms they act primarily against.
In 1928, Alexander Fleming became the first to discover a natural antimicrobial fungus known as Pencillium *rubens*. The substance extracted from the fungus he named pencillin and in 1942 it was successfully used to treat a *Streptococcus* infection. Penicillin also proved successful in the treatment of many other infectious diseases such as gonorrhea, strep throat and pneumonia, which were potentially fatal to patients until then.
Many antimicrobial agents exist, for use against a wide range of infectious diseases.

Methods of controlling microbial diseases using antimicrobials

By using bactericiadal drug
By using bacteriostatic drug
By increasing immunity and resistance of the body to infections

Antibiotics

Antibiotics are used as drugs to treat infections because of their low toxicity for humans and animals. Initially antibiotics were classified as chemical substances produced by microorganisms (bacteria, fungi and molds) that inhibit the growth or even destroy microorganisms. e.g., penicillin.

Discovery of antibiotics

The first antibiotic was discovered by Alexander Fleming in 1929. The industrial production of penicillin involves the development of a large scale fermentation technique.

Antiseptics

Antiseptic(s) are antimicrobial substances that are applied to living tissue/skin to reduce the possibility of infection, sepsis, or putrefaction
e.g., Hydrogen peroxide is used as a 6% (20 Vols) solution to clean and deodorize wounds and ulcers. More commonly, 3% solutions of hydrogen peroxide have been used in household first aid for scrapes, etc. However, the strong oxidization causes scar formation and increases healing time during fetal development.

Disinfectants

Disinfectants are antimicrobial agents that are applied to non-living objects to destroy microorganisms that are living on the objects.
A perfect disinfectant would also offer complete and full microbiological sterilisation, without harming humans and useful form of life, be inexpensive, and noncorrosive. However, most disinfectants are also, by nature, potentially harmful (even toxic) to humans or animals.
e.g., Propylene glycol.

Types of antibiotics

The types of antibiotics can either be bactericiadal or bacteriostatic.

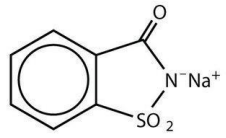
Antifertility drugs

Antibiotic revolution has provided long and healthy life to people. The life expectancy has almost doubled. The increased population has caused many social problems in terms of food resources, environmental issues,employment, etc. To control these problems, population is required to be controlled. This has lead to the concept of family planning. Anti fertility drugs are of use in this direction.
Birth control pills essentially contain a mixture of synthetic estrogen and progesterone derivatives. Both of these compounds are hormones. It is known that progesterone suppresses ovulation. Synthetic progesterone derivatives are more potent than progesterone. Norethindrone is an example of synthetic progesterone derivative most widely used as anti fertility drug.

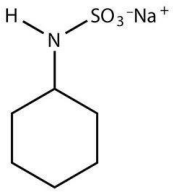
Food additives

The chemicals which are added to food to improve its keeping qualities, appearance, taste and odour. e.g., Food colours, Preservatives.

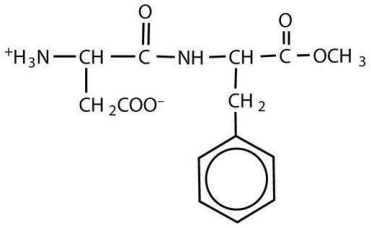
Artificial sweetening agents



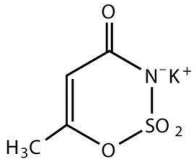
Saccharin



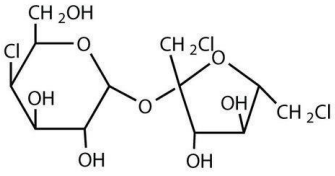
Cyclamate



Aspartame



Acesulfame K



Sucralose

Saccharin - The first most popular artificial sweetener. It is insoluble in water so it is sold in the market as its calcium salt.

Aspartame - One of the most successful and widely used artificial sweetener. It is 100 times as sweet as sucrose.

Alitame - It is similar to aspartame. It is more stable than aspartame. It is about 2000 times as sweet as sucrose.

Sucrolose - It looks and tastes like sucrose and is stable at temperatures used for cooking and baking. It is 600 times sweeter than sucrose.

Food preservatives

Chemical substances which are used to protect food against bacteria, yeasts and moulds are called preservatives. e.g., Sodium benzoate, sodium metabisulphite, epoxides, sorbic acid and its salts.

Antioxidants

An antioxidant is a molecule that inhibits the oxidation of other molecules. Oxidation is a chemical reaction that can produce free radicals, leading to chain reactions that may damage cells. Antioxidants such as thiols or ascorbic acid (vitamin C) terminate these chain reactions.

Surface active agents or surfactants

Chemical substances which concentrate at the surface of the solution or interfaces, form surface films, reduce surface tension and help in removing dirt and dust by emulsifying grease.

Types of surface active agents

A substance which tends to reduce the surface tension of liquid in which it is dissolved is called as surfactants.
There are types of surface active agents,
1. Soaps
2. Detergents
3. Emulsifiers
4. Foaming agents
5. Dispersants

Soap

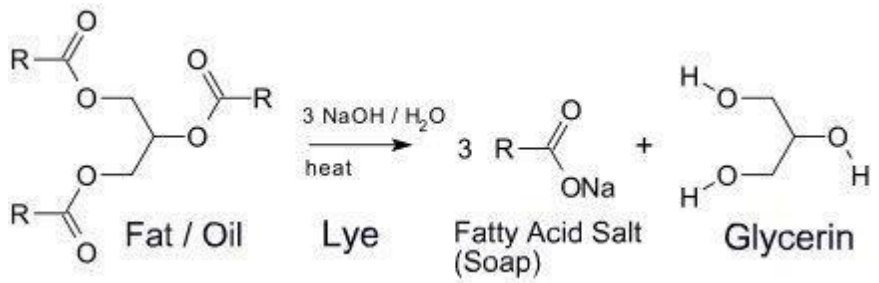
Soap is a sodium salt or potassium salt of long chain fatty acids having cleansing action in water. They are used as cleansing agents to remove dirt, oil from the skin and clothes. Examples : sodium stearate, sodium oliate and sodium palmitate formed using stearic acid oleic acid and palmitic acid.

Types of soap

Toilet soaps
Floating soaps
Medicated soaps

Laundry soaps
Soap chips

Saponification method



Saponification is a process that produces soap, usually from fats and lye using aqueous sodium hydroxide solution.

Cleansing action of soaps

Most of the dirt is oily in nature and oil does not dissolve in water. The molecule of soap constitutes sodium or potassium salts of long chain carboxylic acids. In the case of soaps the carbon chain dissolves in oil and the ionic end dissolves in water. Thus the soap molecules form structures called micelles. In micelles one end is towards the oil droplet and the other end which is the ionic faces outside. Therefore, it forms emulsion in water and helps in dissolving the dirt r when we wash our clothes. The soap is a kind of molecule in which both the ends have different properties. The first one is the hydrophilic end which dissolves water and is attracted towards it whereas the second one is the hydrophobic end that is dissolved in hydrocarbons and is water repulsive in nature. If on the surface of water, soap is present then the hydrophobic tail which is not soluble in water will align along the water surface.
In water the soap molecule is uniquely oriented which helps to keep the hydrocarbon part outside the water. When the clusters of molecules are formed then hydrophobic tail comes at the interior of the cluster and the ionic end comes at the surface of the cluster and this formation is called micelle. When the soap is in the form of micelles then it has the ability to clean the oily dirt which gets accumulated at the centre. These micelles remain as a colloid in the solution. Therefore the dirt from the cloth is easily washed away. The soap solution appears cloudy as it forms a colloidal solution which scatters light.

Soap as cleansing agent-advantages and disadvantages

Advantages of soaps :
1. It is smooth and non harmful for human use.

2. It can be permanently removed by washing of water.
Disadvantage of soaps :
1. It can not be used in hard water.
2. It is ineffective in acidic solution.

Detergents

Detergents are generally ammonium or sulphonate salts of long chain carboxylic acids. The charged ends of these compounds do not form insoluble precipitates with the calcium and magnesium ions in water.

Detergents

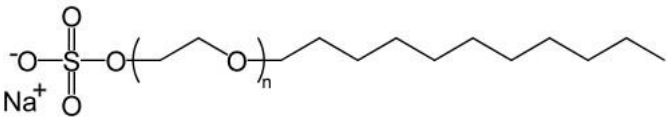
A water-soluble cleansing agent that combines with impurities and dirt to make them more soluble and differs from soap in not forming a scum with the salts in hard water. e.g deoxycholic acid.

Detergents-classification and synthesis

Types of detergents are:

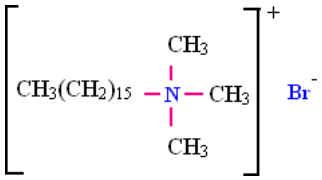
Anionic detergents
Cationic detergents
Non-ionic detergents

Anionic detergents



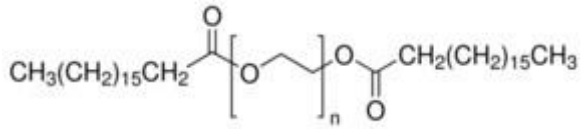
Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons. Alkyl hydrogen sulphates formed by treating long chain alcohols with concentrated sulphuric acid are neutralised with alkali to form anionic detergents. Similarly alkyl benzene sulphonates are obtained by neutralising alkyl benzene sulphonic acids with alkali.
In anionic detergents, the anionic part of the molecule is involved in the cleansing action. Sodium salts of alkyl benzene sulphonates are an important class of anionic detergents.They are mostly used for household work. Anionic detergents are also used in toothpastes.
e.g Sodium lauryl sulphate(image

Cationic detergents



Cationic detergents are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Cationic part possess a long hydrocarbon chain and a positive charge on nitrogen atom. Hence, these are called cationic detergents.Cetyl trimethylammonium bromide is a popular cationic detergent and is used in hair conditioners.Cationic detergents have germicidal properties and are expensive,therefore, these are of limited use.

Non-ionic detergents



Non-ionic detergents do not contain any ionin their constitution. One such detergent is formed when stearicacid reacts with polyethyleneglycol.
Liquid dish washing detergents are non-ionic type. Mechanism of cleansing action of this type of detergents is the same as that of soaps. These also remove grease and oil by micelle formation.

Cleansing action of detergents

Detergents are a type of surface active agent or surfactant that consists of a hydrophobic "tail" and a hydrophilic "head". In aqueous solution the surfactant molecules tend to form "micelle" structures in order to keep their tails together and away from the solution phase. It is possible for the oily molecules in most dirt to enter the centre of these micelles and therefore be effectively dispersed in the water and washed away. This process proceeds much more rapidly with some mechanical action which is why scrubbing, mixing etc. is usually required.

Advantages of detergents over soap

Synthetic detergents can be used in hard water without any wastage while soap gets wasted in water.
Synthetic detergents can be used in acidic medium while soaps get precipitated in acidic medium.

Synthetic detergents decrease the surface tension of water to greater extent and hence have stronger cleansing action than soaps.

Pollution caused by detergents

Detergents have highly branched hydrocarbon chains which cause pollution. The side chains stop bacteria from attacking and breaking the chains. This results in slow degradation of detergent molecule leading to their accumulation. In most of the detergents, branching is kept to a minimum so that the detergents become easily biodegradable and hence pollution is prevented.

Medicines

Chemical substances of natural or synthetic origin which are used for curing diseases and reduce suffering from pain are called medicines. It does not causes addiction and is non-toxic. e.g., Penicillin.

Characteristics of medicines

It cures diseases.
It is non-addictive.
It is safe to use.

Drugs

A drug is a chemical substance which also cures the disease but is habit forming, causes addiction and has serious side effects. e.g., Heroin.

Characteristics of drugs

It is dangerous and causes serious health issues.
It is addictive.
It has serious side effects.

Difference between chemotherapy and medicinal chemistry

The branch of chemistry which deals with the treatment of diseases using different chemicals is known as chemotherapy. On the other hand, medicinal chemistry deals with the design and synthesis of drugs based on an understanding of how these work in our body.

Difference between drugs and medicine

Medicines	Drugs
They are safe to use	They are unsafe to use
They are not addictive	They are addictive
They do not cause serious health problems	They cause serious health problems

Drugs classification

On the basis of pharmacological effect.
On the basis of drug action.
On the basis of chemical structure.
On the basis of molecular targets.

Classification of drugs on the basis of pharmacological effect

This classification is useful for doctors as it provides them with the whole range of drugs available for the treatment. e.g., Analgesics reduce pain while antiseptics either kill or stop the growth of micro-organisms.

Classification of drugs on the basis of drug action

This is based on the action of drug on a particular process. e.g., antihistamines inhibit the action of histamine which causes inflammation in the body.

Classify drugs on the basis of chemical structure

Drugs having common structural features often have similar pharmacological activity. e.g., all sulphonamides having the common structural feature that are mostly bacterial.

Drug classification on the basis of molecular targets

Drugs usually interact with the biomolecules such as lipids, nucleic acids. These are called target molecules or drug targets. This classification is more useful for the medicinal chemists.

Drug-target interaction

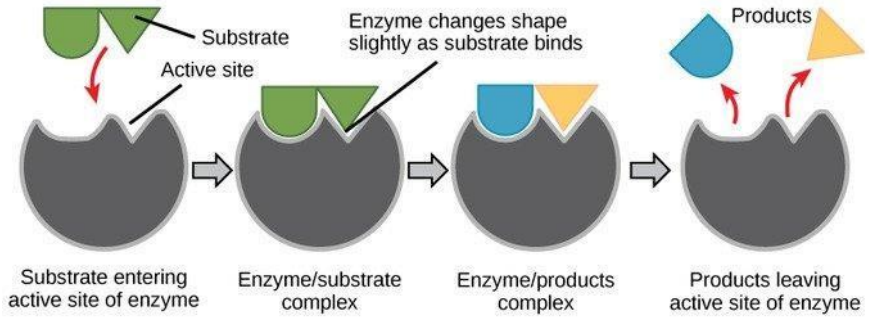
Enzymes as drug targets.

Receptors as drug targets.

Roles of proteins in the body

can acts as biological catalyst.
are crucial to communication system.
carry polar molecules across the membranes.

Enzyme and substrate molecules



The basic mechanism by which enzymes catalyze chemical reactions begins with the binding of the substrate (or substrates) to the active site on the enzyme. The active site is the specific region of the enzyme which combines with the substrate.
The binding of the substrate to the enzyme causes changes in the distribution of electrons in the chemical bonds of the substrate and ultimately causes the reactions that lead to the formation of products. The products are released from the enzyme surface to regenerate the enzyme for another reaction cycle. The active site has a unique geometric shape that is complementary to the geometric shape of a substrate molecule similar to the fit of puzzle pieces. This means that enzymes specifically react with only one or a very few similar compounds.

Drug-enzyme interaction

Drug enzyme interaction is similar to drug receptors interactions. The drugs resemble the natural substrates, bind enzymes and cause change in their activity. This may take place by:
Activation of enzymes
Inhibition of enzymes

In therapeutic drugs causing inhibition on enzymes are generally used. This combination of drugs with the enzyme may be:
Competitive
Non competitive

Non competitive response is irreversible until new enzyme is generated.

Competitive and non-competitive inhibitors

A non-competitive inhibitor binds to the enzyme away from the active site, altering the shape of the enzyme so that even if the substrate can bind, the active site functions less effectively. Most of the time, the inhibitor is reversible.
Drugs, which compete with natural substrate for their attachment on the active sites of enzymes are called competitive inhibitors.