Chemistry in Everyday Life

- The principles of chemistry have been used for the benefit of mankind.

Chemistry in everyday life

Source:-Google images-Chemistry in everyday life

Drugs and their Classification

- **Drugs are chemicals of low molecular masses (~100 – 500u).**
- **These** interact with macromolecular targets and produce a biological response.
- When the biological response is therapeutic and useful, these chemicals are called **medicines and are used in diagnosis, prevention and** treatment of diseases.
- If taken in doses higher than those recommended, most of the drugs used as medicines are potential poisons.
- Use of chemicals for therapeutic effect is called **chemotherapy,**

Classification of Drugs

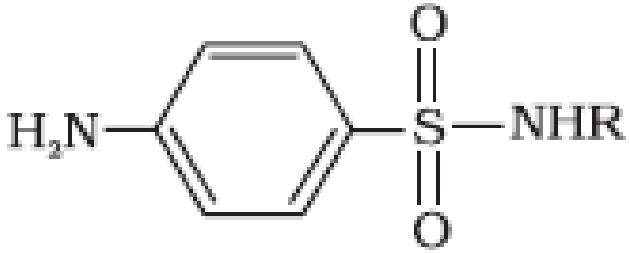
- ***(a) On the basis of pharmacological effect***
- It is useful for doctors because it provides them the whole range of drugs available for the treatment of a particular type of problem.

- 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 ways in which action of histamines can be blocked.

(c) On the basis of chemical structure

- It is based on the chemical structure of the drug.
- Drugs classified in this way share common structural features and often have similar pharmacological activity.
- For example, sulphonamides have common structural feature, given below.



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.

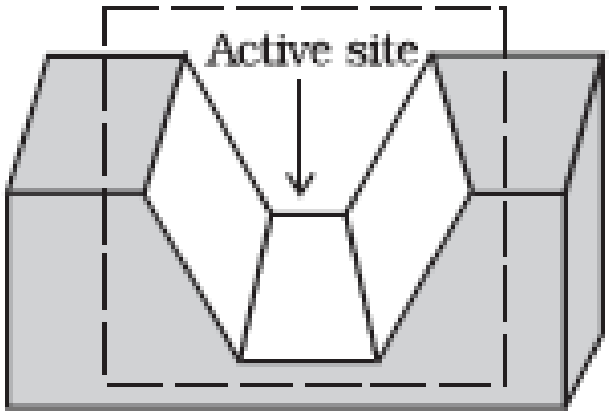
Drug-Target Interaction

- Macromolecules of biological origin perform various functions in the body.
- For example, proteins which perform the role of biological catalysts in the body are called **enzymes, those which are crucial to** communication system in the body are called **receptors.**
- **Carrier proteins** carry polar molecules across the cell membrane.
- Nucleic acids have coded genetic information for the cell.
- Lipids and carbohydrates are structural parts of the cell membrane

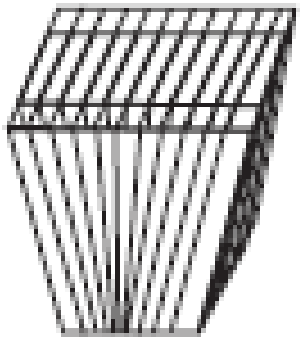
(a) Catalytic action of enzymes

- For understanding the interaction between a drug and an enzyme, it is important to know how enzymes catalyse the reaction .
- In their catalytic activity, enzymes perform two major functions:
- (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.

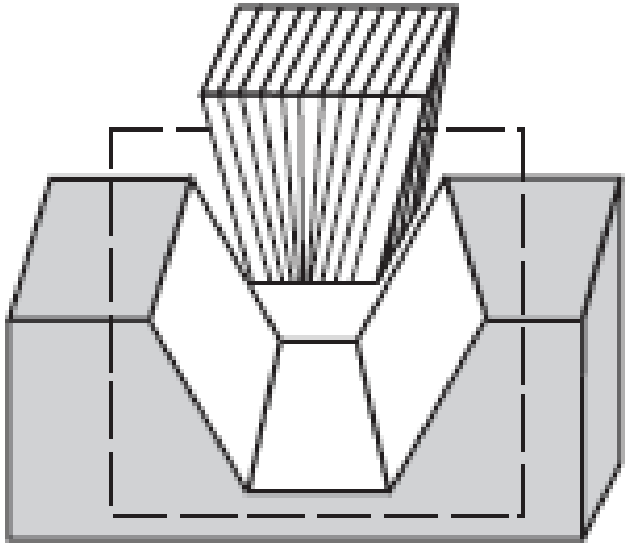
- Substrates bind to the active site of the enzyme through a variety of interactions such as ionic bonding, hydrogen bonding, van der Waals interaction or dipole-dipole interaction
- (ii) The second function of an enzyme is to provide functional groups that will attack the substrate and carry out chemical reaction.



(a) Enzyme



(b) Substrate

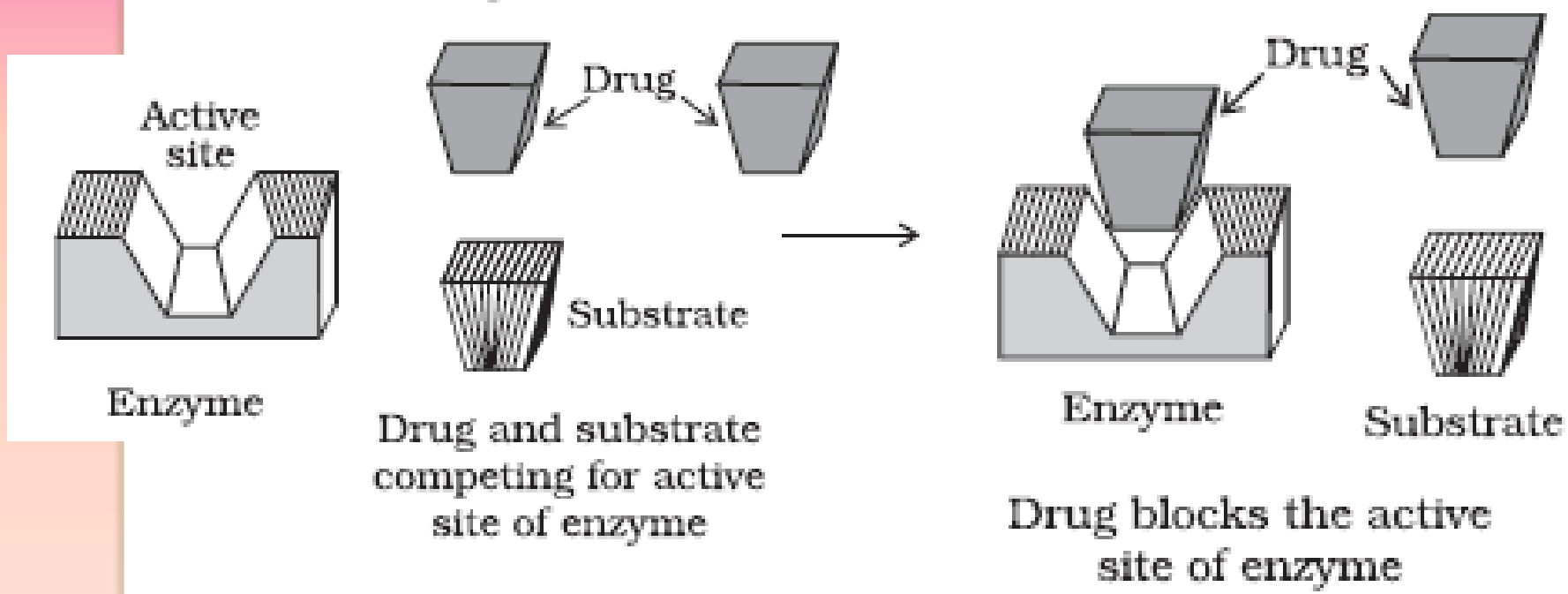


(c) Enzyme holding substrate

(b) Drug-enzyme interaction

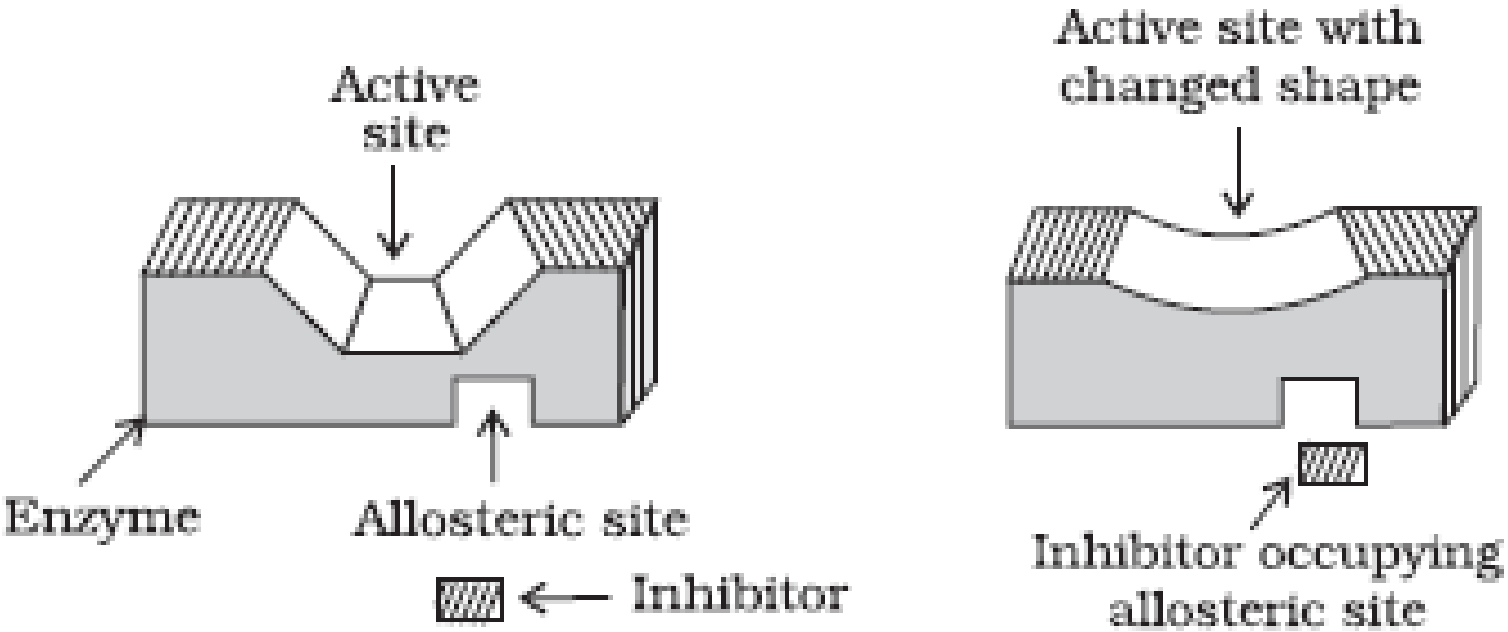
- Drugs inhibit any of the above mentioned activities of enzymes.
- These can block the binding site of the enzyme and prevent the binding of substrate, or can inhibit the catalytic activity of the enzyme.
- Such drugs are called **enzyme inhibitors.**
- Drugs inhibit the attachment of substrate on active site of enzymes in two different ways;

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



(ii) Some drugs do not bind to the enzyme's active site. These bind to a different site of enzyme which is called **allosteric site.**

- This binding of inhibitor at allosteric site changes the shape of the active site in such a way that substrate cannot recognise 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 synthesises the new enzyme.

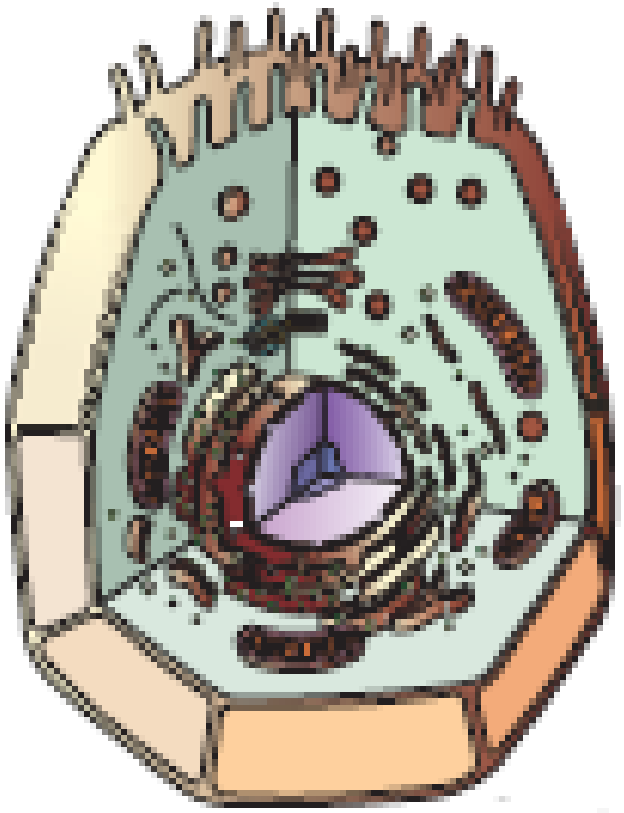


Non-competitive inhibitor changes the active site of enzyme after binding at allosteric site.

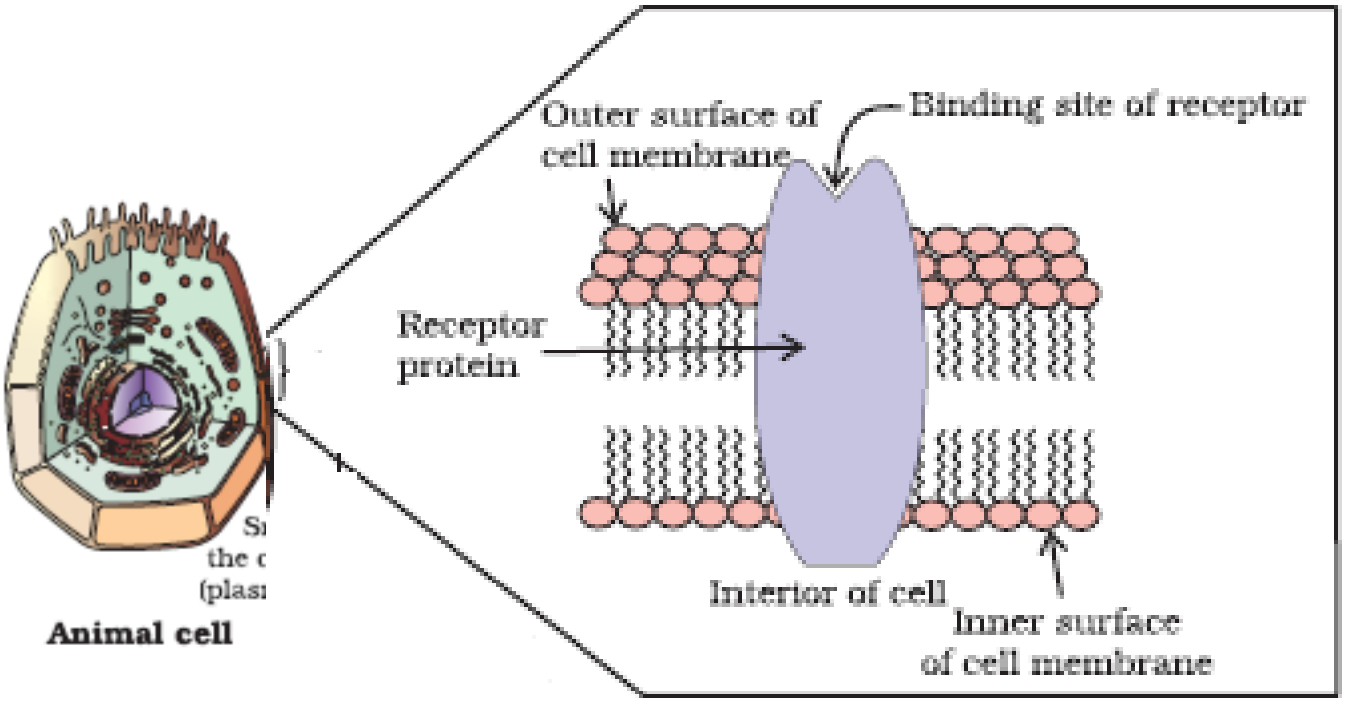
Receptors as Drug Targets

- Receptors are proteins that are crucial to body's communication process.
- Majority of these are embedded in cell membranes .
- Receptor proteins are embedded in the cell membrane 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

Animal cell



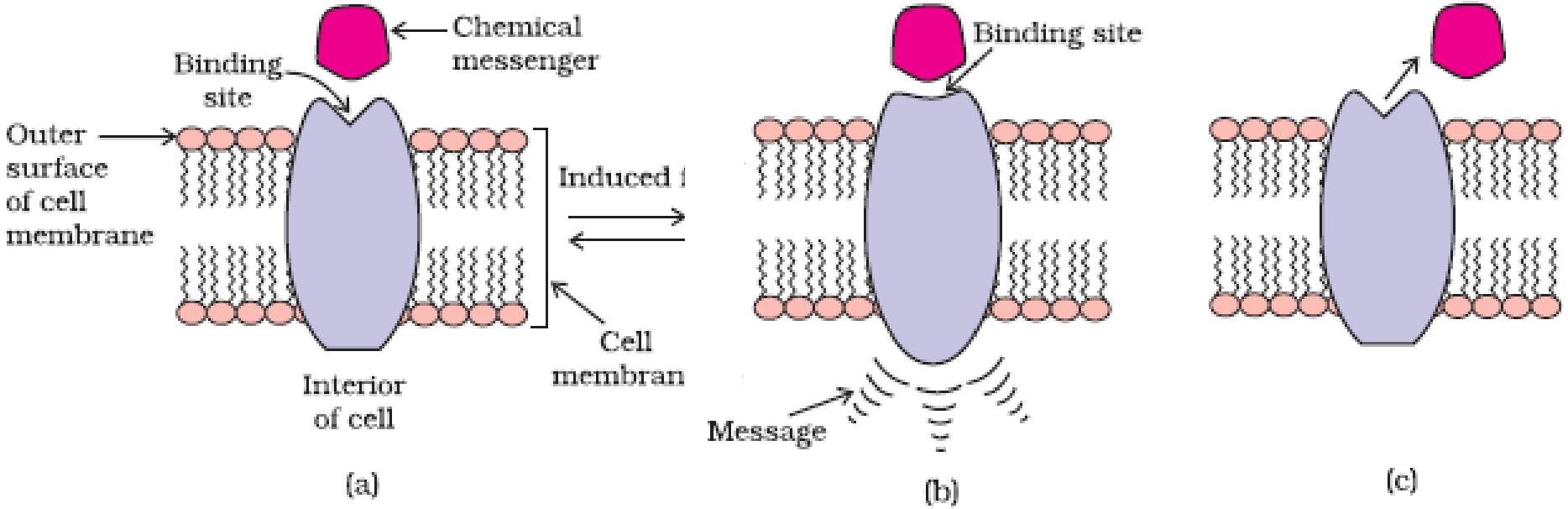
Animal cell



Cell membrane

- In the body, message between two neurons and that between neurons to muscles is communicated through certain chemicals.
- These chemicals, known as **chemical messengers are received at the binding sites of receptor** proteins.
- To accommodate a messenger, shape of the receptor site changes.
- This brings about the transfer of message into the cell.
- Thus, chemical messenger gives message to the cell without entering the cell

Chemical messenger



(a) Receptor receiving chemical messenger
(b) Shape of the receptor changed after attachment of messenger
(c) Receptor regains structure after removal of chemical messenger.

- There are a large number 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 amino acid composition.
- In the body, message between two neurons and that between neurons to muscles is communicated through certain chemicals.
- These chemicals, known as **chemical messengers are received at the binding sites of receptor** proteins.

- To accommodate a messenger, shape of the receptor site changes.
- This brings about the transfer of message into the cell.
- Thus, chemical messenger gives message to the cell without entering the cell Drugs that bind to the receptor site and inhibit its natural function are called **antagonists.**
- **These are useful when blocking of message is** required.
- There are other types of drugs that mimic the natural messenger by switching on the receptor, these are called **agonists.**
- These are useful when there is lack of natural chemical messenger.

Therapeutic Action of Different Classes of Drugs

- **Antacids**
- **Antihistamines**

Neurologically Active Drugs

- ***(a) Tranquilizers***
- ***(b) Analgesics***

(i) Non-narcotic (non-addictive) analgesics

(ii) Narcotic drugs

- **Antimicrobials**
- ***(a) Antibiotics***
- ***(b) Antiseptics and disinfectants***
- **Antifertility Drugs**

Antacids

- Over production of acid in the stomach causes irritation and pain.
- In severe cases, ulcers are developed in the stomach
- Sodium hydrogencarbonate or a mixture of aluminium and magnesium hydroxide.
- However, excessive hydrogencarbonate can make the stomach alkaline and trigger the production of even more acid.
- Metal hydroxides are better alternatives because of being insoluble, these do not increase the pH above neutrality.

Antihistamines

- Chemical histamine, stimulates the secretion of pepsin and hydrochloric acid in the stomach.
- The drug cimetidine (Tegamet), was designed to prevent the interaction of histamine with the receptors present in the stomach wall.
- This resulted in release of lesser amount of acid.
- The importance of the drug was so much that it remained the largest selling drug in the world until another drug, ranitidine (Zantac), was discovered.

- Histamine is a potent vasodilator.
- It has various functions.
- It contracts the smooth muscles in the bronchi and gut and relaxes other muscles, such as those in the walls of fine blood vessels.
- Histamine is also responsible for the nasal congestion associated with common cold and allergic response to pollen.
- Synthetic drugs, **brompheniramine (Dimetapp) and terfenadine (Seldane), act as antihistamines.**

Neurologically Active Drugs

(a) Tranquilizers

- **Tranquilizers and analgesics are neurologically active drugs.**
- **These** affect the message transfer mechanism from nerve to receptor.
- Tranquilizers are a class of chemical compounds used for the treatment of stress, and mild or even severe mental diseases.
- These relieve anxiety, stress, irritability or excitement by inducing a sense of well-being. They form an essential component of sleeping pills.

- There are various types of tranquilizers. They function by different mechanisms.
- For example, noradrenaline is one of the neurotransmitters that plays a role in mood changes.
- If the level of noradrenaline is low for some reason, then the signal-sending activity becomes low, and the person suffers from depression.
- In such situations, **antidepressant drugs are required.**

- These drugs inhibit the enzymes which catalyse the degradation of noradrenaline.
- If the enzyme is inhibited, this important neurotransmitter is slowly metabolised and can activate its receptor for longer periods of time, thus counteracting the effect of depression.
- Iproniazid and phenelzine are two such drugs.

- Some tranquilizers namely, chlordiazepoxide and meprobamate, qare relatively mild tranquilizers suitable for relieving tension.
- Equanil is used in controlling depression and hypertension.
- Derivatives of barbituric acid viz., veronal, amytal, nembutal, luminal and seconal constitute an important class of tranquilizers.
- These derivatives are called **barbiturates. Barbiturates are hypnotic, *i.e.*,** sleep producing agents.
- Some other substances used as tranquilizers are valium and serotonin.

Analgesics

- **Analgesics reduce or abolish pain without causing impairment of** consciousness, mental confusion, incoordination or paralysis or some other disturbances of nervous system.

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

(i) *Non-narcotic (non-addictive) 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 effective in relieving skeletal pain such as that due to arthritis.
- These drugs have many other effects such as reducing fever (antipyretic) **and** preventing platelet coagulation.
- Because of its anti blood clotting action, aspirin finds use in prevention of heart attacks.

(ii) *Narcotic analgesics:*

- Morphine and many of its homologues, when administered in medicinal doses, relieve pain and produce sleep.

- In poisonous doses, these produce stupor, coma, convulsions and ultimately death.

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

Antimicrobials

- Diseases in human beings and animals may be caused by a variety of microorganisms such as bacteria, virus, fungi and other pathogens.
- An antimicrobial tends to destroy/prevent development or inhibit the pathogenic action of microbes such as bacteria (antibacterial drugs), fungi (antifungal agents), virus (antiviral agents), or other parasites (antiparasitic drugs) selectively.
- Antibiotics, antiseptics and disinfectants are antimicrobial drugs.

Antibiotics

- Antibiotics are used as drugs to treat infections because of their low toxicity for humans and animals.
- Medicine, **arsphenamine,** known as **salvarsan. ------** an arsenic based structures in order to produce less toxic substances for the treatment of syphilis.
- antibacterial agent, **prontosil,**
- Soon it was discovered that in the body prontosil is converted to a compound called **sulphanilamide,**

- The real revolution in antibacterial therapy began with the discovery of Alexander Fleming in 1929, of the antibacterial properties of a *Penicillium fungus*.
- Antibiotics have either cidal (killing) effect or a static (inhibitory) effect on microbes.
- A few examples of the two types of antibiotics are as follows:

Bactericidal	Bacteriostatic
Penicillin	Erythromycin
Aminoglycosides	Tetracycline
Ofloxacin	Chloramphenicol

broad spectrum antibiotics.

- The range of bacteria or other microorganisms that are affected by a certain antibiotic is expressed as its spectrum of action.
- Antibiotics which kill or inhibit a wide range of Gram-positive and Gram-negative bacteria are said to be **broad spectrum antibiotics.**

- Those effective mainly against Gram-positive or Gram-negative bacteria are **narrow spectrum antibiotics.**
- **If effective against a single organism or disease, they are** referred to as **limited spectrum antibiotics. Penicillin G has a narrow** spectrum.
- Ampicillin and Amoxycillin are synthetic modifications of penicillins. These have broad spectrum.
- It is absolutely essential to test the patients for sensitivity (allergy) to penicillin before it is administered

- *Chloramphenicol, is a broad spectrum antibiotic.*
- It is rapidly absorbed from the gastrointestinal tract and hence can be given orally in case of typhoid, dysentery, acute fever, certain form of urinary infections, meningitis and pneumonia.
- *Vancomycin* and *ofloxacin are the other important broad spectrum antibiotics.*
- The antibiotic *dysidazirine is supposed to be toxic towards certain* strains of cancer cells.

Antiseptics and disinfectants

- Antiseptics and disinfectants are also the chemicals which either kill or prevent the growth of microorganisms.
- **Antiseptics are applied to the living tissues such as wounds, cuts,** ulcers and diseased skin surfaces.
- Examples are **furacine, soframicine, etc. These are not ingested like antibiotics.**
- **Commonly** used antiseptic, dettol is a mixture of **chloroxylenol and terpineol.**
- Bithionol (the compound is also called bithional) is added to soaps to impart antiseptic properties.
- Iodine is a powerful antiseptic. Its 2-3 per cent solution in alcohol water mixture is known as **tincture of iodine.**
- **It is applied** on wounds.

- **Iodoform is also used** as an antiseptic for wounds.
- Boric acid in dilute aqueous solution is weak antiseptic for eyes.
- **Disinfectants are applied to inanimate objects such as floors,** drainage system, instruments, etc.
- Same substances can act as an antiseptic as well as disinfectant by varying the concentration.
- For example, 0.2 per cent solution of phenol is an antiseptic while its one percent solution is disinfectant.
- Chlorine in the concentration of 0.2 to 0.4 ppm in aqueous solution and sulphur dioxide in very low concentrations, are disinfectants.

Antifertility Drugs

- 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.
- Antifertility 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 antifertility drug.
- The estrogen derivative which is used in combination with progesterone derivative is **ethynylestradiol (novestrol).**

Chemicals in Food

- Chemicals are added to food for
- (i) their preservation,
- (ii) enhancing their appeal, and
- (iii) adding nutritive value in them.

- Main categories of food additives are as follows:

Food additives

- (i) Food colours
- (ii) Flavours and sweeteners
- (iii) Fat emulsifiers and stabilising agents
- (iv) Flour improvers - antistaling agents and bleaches
- (v) Antioxidants
- (vi) Preservatives
- (vii) Nutritional supplements such as minerals, vitamins and amino acids.

Except for chemicals of category (vii), none of the above additives have nutritive value.

These are added either to increase the shelf life of stored food or for cosmetic purposes.

Artificial Sweetening Agents

- Natural sweeteners, e.g., sucrose add to calorie intake and therefore
- many people prefer to use artificial sweeteners.
- Ortho-sulphobenzimide, also called saccharin, is the first popular artificial sweetening agent.
- It is about 550 times as sweet as cane sugar.

Artificial Sweetening Agents other Examples

- **Aspartame is the most successful and widely used artificial** sweetener.
- It is roughly 100 times as sweet as cane sugar.
- **Alitame is high potency sweetener, although it is more stable than** aspartame, the control of sweetness of food is difficult while using it.
- **Sucrolose is trichloro derivative of sucrose.**
- **Its appearance and** taste are like sugar. It is stable at cooking temperature. It does not provide calories.

Food Preservatives

- Food preservatives prevent spoilage of food due to microbial growth.
- The most commonly used preservatives include
- Table salt, sugar, vegetable oils and sodium benzoate, C_6H_5COONa.
- Sodium benzoate is used in limited quantities and is metabolised in the body.
- Salts of sorbic acid and propanoic acid are also used as preservatives.

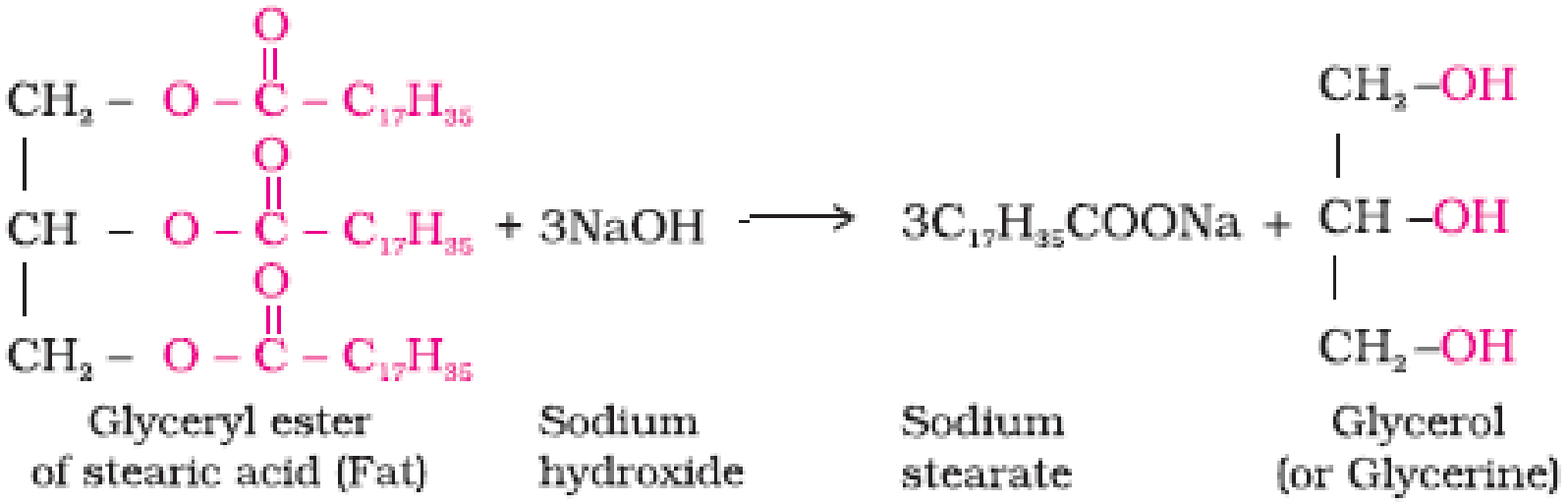
Cleansing Agents…….. detergents

- Two types of detergents are used as cleansing agents.
- These are soaps and synthetic detergents.
- These improve cleansing properties of water.
- These help in removal of fats which bind other materials to the fabric or skin.

Soaps

- Soaps are the detergents used since long.
- Soaps used for cleaning purpose are sodium or potassium salts of long chain fatty acids, e.g.,
- stearic, oleic and palmitic acids.
- Soaps containing sodium salts are formed by heating fat (*i.e., glyceryl ester of fatty acid) with aqueous* sodium hydroxide solution.
- This reaction is known as **saponification.**

Saponification



Types of soaps

- *Toilet soaps are prepared by using better grades of fats and oils* and care is taken to remove excess alkali.
- Colour and perfumes are added to make these more attractive.
- *Soaps that float in water are made by beating tiny air bubbles* before their hardening.
- *Transparent soaps are made by dissolving the* soap in ethanol and then evaporating the excess solvent.

Types of soaps…….Contd

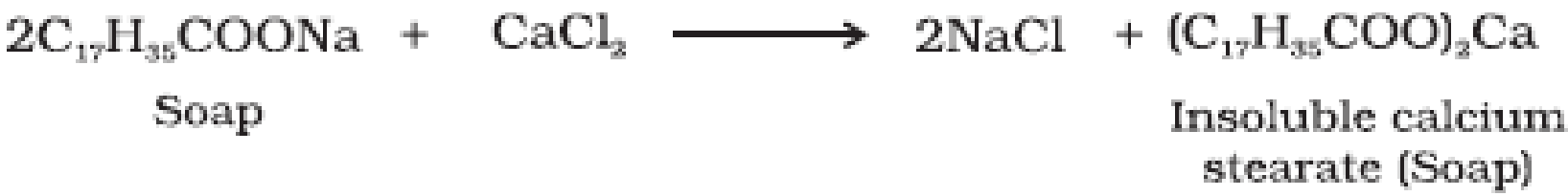
- In *medicated soaps, substances of medicinal value are added.*
- *In* some soaps, deodorants are added.
- *Shaving soaps contain glycerol to* prevent rapid drying.
- A gum called, rosin is added while making them.
- It forms sodium rosinate which lathers well.
- *Laundry soaps contain* fillers like sodium rosinate, sodium silicate, borax and sodium carbonate.

Types of soaps…….Contd

- Soap chips are made by running a thin sheet of melted soap onto a cool cylinder and scraping off the soaps in small broken pieces.
- *Soap granules are dried miniature soap bubbles.*
- *Soap powders and scouring soaps contain some soap, a scouring agent (abrasive) such as powdered* pumice or finely divided sand, and builders like sodium carbonate and trisodium phosphate. Builders make the soaps act more rapidly.

Why do soaps not work in hard water?

- Hard water contains calcium and magnesium ions.
- These ions form insoluble calcium and magnesium soaps respectively when sodium or potassium soaps are dissolved in hard water.
- These insoluble soaps separate as scum in water and are useless as cleansing agent.



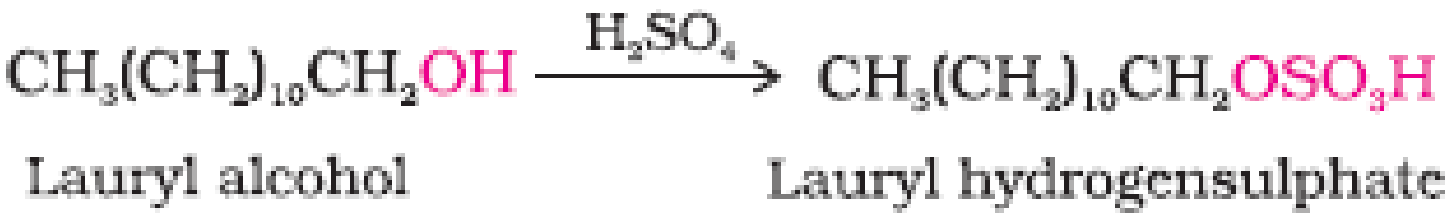
Synthetic Detergents

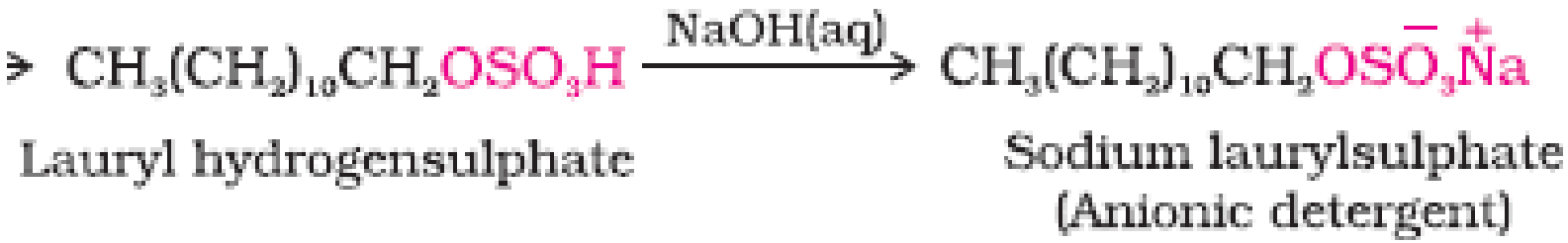
- Synthetic detergents are mainly classified into three categories:
- (i) Anionic detergents
- (ii) Cationic detergents and
- (iii) Non-ionic detergents

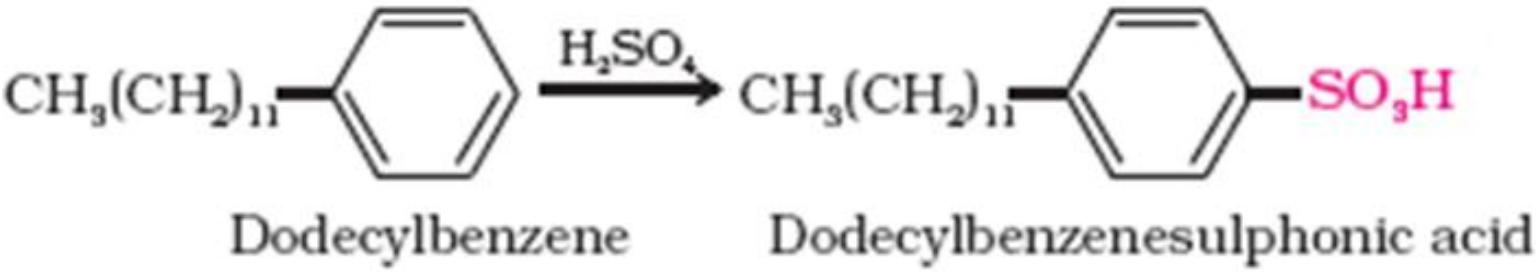
(i) Anionic Detergents:

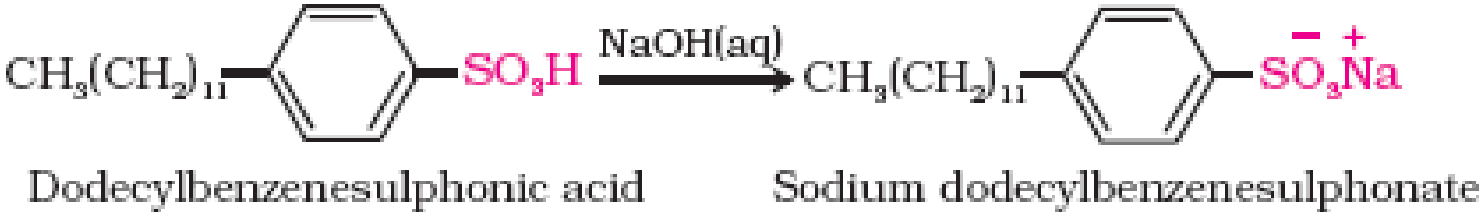
- Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons.
- Alkyl hydrogensulphates formed by treating long chain alcohols with concentrated sulphuric acid are neutralised with alkali to form anionic detergents.
- Similarly alkyl benzene sulphonates are obtained by neutralising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

(i) Anionic Detergents: Examples









In anionic detergents, the anionic part of the molecule is involved in the cleansing action.

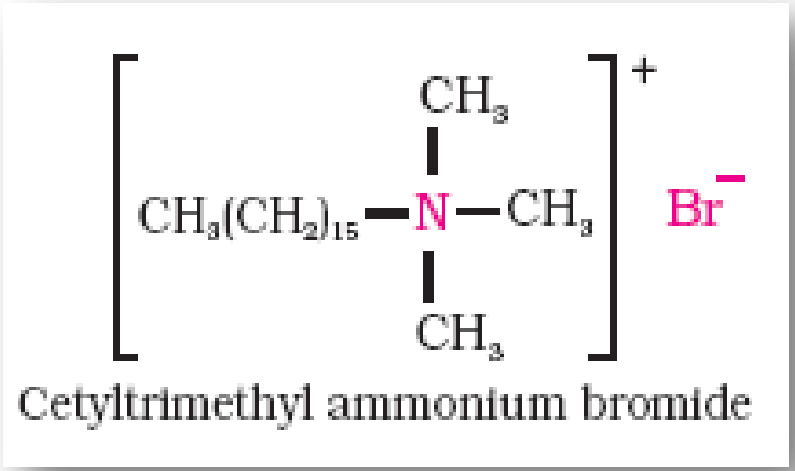
Sodium salts of alkylbenzenesulphonates are an important class of anionic detergents.

(ii) 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

Cationic Detergents

- Cetyltrimethylammonium 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.



Cetyltrimethyl ammonium bromide

(iii) Non-ionic Detergents:

- *Non-ionic detergents do not contain any ion* in their constitution.
- One such detergent is formed when stearic acid reacts with polyethyleneglycol.
- Liquid dishwashing detergents are non-ionic type.

$$CH_3(CH_2)_{16}COOH + HO(CH_2CH_2O)_nCH_2CH_2OH \xrightarrow{-H_2O}$$

Stearic acid Polyethyleneglycol

$$CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$$

Biodegradable detergents

- Main problem that appears in the use of detergents is that if their hydrocarbon chain is highly branched, then bacteria cannot degrade this easily.
- Slow degradation of detergents leads to their accumulation.
- Effluents containing such detergents reach the rivers, ponds, etc. These persist in water even after sewage treatment and cause foaming in rivers, ponds and streams and their water gets polluted.
- These days the branching of the hydrocarbon chain is controlled and kept to the minimum.
- Unbranched chains can be biodegraded more easily and hence pollution is prevented.

Therapeutic Action of Different Classes of Drugs

Type of Drug	Examples
Antacids	Ranitidine (Zantac),
Antihistamines	cimetidine (Tegamet), ranitidine (Zantac), **brompheniramine (Dimetapp)** **Terfenadine (Seldane)**
Neurologically Active Drugs ***(a) Tranquilizers***	Iproniazid phenelzine chlordiazepoxide and meprobamate, Equanil (used in controlling depression and hypertension.) Derivatives of barbituric acid viz., veronal, amytal, nembutal, luminal
(b) Analgesics i) Non-narcotic (non-addictive) analgesics	Aspirin and paracetamol
(ii) Narcotic drugs	Morphine Heroin & codeine

Type of Drug	Examples
Antimicrobials ***(a) Antibiotics*** **Bactericidal** **Bacteriostatic** **broad spectrum antibiotics** **narrow spectrum antibiotics.**	**arsphenamine,** known as **salvarsan** *prontosil azodye and sulphapyridine* Penicillin Aminoglycosides Ofloxacin Erythromycin Tetracycline Chloramphenicol Ampicillin and Amoxycillin *Chloramphenicol, Vancomycin* and *ofloxacin* Penicillin G *dysidazirine*
(b) Antiseptics and disinfectants	dettol is a mixture of **chloroxylenol and terpineol.**
Antiseptics	**furacine, soframicine,** Bithionol **tincture of iodine. Iodoform** Boric acid
Disinfectants	1% phenol , 0.2 to 0.4 ppm Chlorine in SO_2 soln

Type of Drug	Examples
Antifertility Drugs	**Norethindrone** **ethynylestradiol (novestrol).**
Artificial Sweetening Agents	Name……sweetness as that of sugar Aspartame ……...100 Saccharin ……..550 Sucrolose ……600 Alitame……..2000

Type of Drug	Examples
Food Preservatives	Table salt, sugar, vegetable oils and sodium benzoate, C_6H_5COONa. (Sodium benzoate) Salts of sorbic acid and propanoic acid
Cleansing Agents **Soaps**	
Synthetic Detergents	
(i) Anionic detergents	Sodium laurylsulphate Sodium dodecylbenzenesulphonate
(ii) Cationic detergents	Cetyltrimethyl ammonium bromide
(iii) Non-ionic detergents	One such detergent is formed when stearic acid reacts with polyethyleneglycol.

Thank you