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Chemistry plays important role in raising the standards of human life. In this unit we shall learn the applications of chemistry in three areas namely medicines, food materials and cleansing agents.

DRUGS AND MEDICINES

Drugs are chemicals that are capable to produce a biological response. E.g. alcohol, nicotine, aspirin etc

Medicines are chemicals that are used in the diagnosis, treatment and prevention of diseases. In case of medicines, the biological response is therapeutic and useful.

Chemotherapy means use of chemicals for therapeutic effect.

Drug targets (or target molecules)- Drugs usually interact with bio molecules like carbohydrates, proteins, nucleic acids, lipids etc. These molecules are called drug targets.

Enzymes as drug targets:

- Enzyme inhibitors are drugs that inhibit the active site of an enzyme or inhibit the catalytic activity of an enzyme.

Receptors as drug targets:

- Receptors are proteins that are involved in the body's communication system.
- Different receptors interact with different chemical messengers.
- **Antagonists** are drugs that bind to a receptor and inhibit its natural function.
  - Antagonists are useful when blocking of message is required.
- **Agonists** are drugs that bind to a receptor and activate them to produce a biological response. Agonists act like a chemical messenger.
  - Agonists mimic the natural chemical messenger and can be used when there is a lack of chemical messenger.

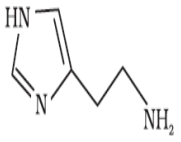
Therapeutic action of different classes of drugs

- 1.1. Antacids
- 1.2. Neurologically active drugs
  - 1.2.1.Tranquilizers
    - 1.2.1.1. Antidepressants
    - 1.2.1.2. Mild tranquilizers
    - 1.2.1.3. Barbiturates
  - 1.2.2.Analgesics
    - 1.2.2.1. Narcotic (Addictive)
    - 1.2.2.2. Non narcotic (non addictive)
- 1.3. Anti microbial
  - 1.3.1.Antibiotics
    - 1.3.1.1. Broad spectrum
    - 1.3.1.2. Narrow spectrum
    - 1.3.1.3. Limitted spectrum
  - 1.3.2.Antiseptics & disinfectants
- 1.4. Antifertility drugs
- 1.5. Antipyretics

Antacids: These are drugs used to treat hyper acidity.

- Until 1970 **$NaHCO_3$** or a mixture of **$Mg(OH)_2$ and $Al(OH)_3$** were used as antacid
- Excessive $NaHCO_3$ make the stomach alkaline and trigger the production of more acids.
- Metal hydroxides ($Mg(OH)_2$ and $Al(OH)_3$)are better antacids than $NaHCO_3$ as they are insoluble and hence do not increase the p^H above 7.
- Later a chemical namely **histamine** is discovered. Histamine stimulates the secretion of pepsin and HCl in stomach.
- Drugs such as **cimetidine (Tegamet) and ranitidine (Zantac)** prevent the interaction of histamine with receptors in stomach wall and result in release of lesser acid.

Histamine: It is a potent vasodilator. It has many functions. It is responsible for the nasal conjestion associated with common cold and allergic response to pollen.



Antihistamine: Antihistamines are antiallergic drugs that inhibit the action of Histamine.

e.g ., **brompheniramine** (Dimetapp) and **terfenadine** (Seldane) act as antihistamines

Note:- Antiallergic drugs and antacids work on different receptors. So antiallergic drugs do not affect the secretion of acid in stomach.

Neurologically active drugs affect the message transfer mechanism from nerve to receptor. These include tranquilizers and analgesics.

Tranquilizers: These are drugs used for the treatment of stress and mild or even severe mental diseases.

- These are neurologically active drugs.
- These relieve anxiety, stress and excitement by inducing a sense of well-being.
- These are present in sleeping pills.

Antidepressant: Drugs for reducing depression. E.g., Iproniazid and phenelzine

Mild tranquilizers: Suitable for relieving tension. . E.g., chlordiazepoxide and meprobamate, equanil

Barbiturates:

- These are derivatives of barbituric acid.
- These are hypnotic (i.e.,sleep producing) agents.
- E.g,. veronal, amytal, nembutal, luminal and seconal

Note:- valium and serotonin are also used as tranquilizers

Analgesics: Analgesics are used to reduce or abolish pain. These include narcotic and non-narcotic analgesics.

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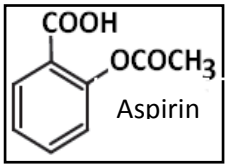
Non narcotic analgesics: Aspirin and paracetamol belongs to this class. These are non-addictive.

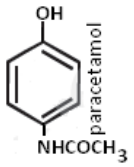
Aspirin (Acetylsalicylic acid): it is a widely used non-narcotic analgesic and antipyretic drug.



Aspirin

- Aspirin inhibits the synthesis of chemical **prostaglandins** which stimulate inflammation in the tissue and cause pain.
- It helps in reducing fever (antipyretic).
- It helps in relieving skeletal pain such as that due to arthritis, head ache, back ache etc.
- It helps in preventing platelet coagulation.
- Because of its anti blood clotting action, aspirin finds use in prevention of heart attacks

paracetamol is a general antipyretic and analgesic.
Over dosage may lead to liver damage.



Narcotic analgesics:

- These are addictive in nature.
- Morphine, Heroine, Codeine etc belongs to this class.
- In medicinal doses, they 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.
- Morphine is obtained from ***opium poppy***, so it is referred to as ***opiates***.

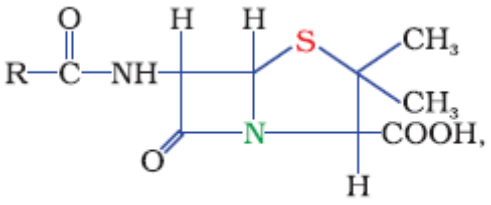
Antimicrobials: Compounds that prevent the action of microbes. These include antibacterial agents, antiviral agents (kills virus), antifungal agents, antiparasitic agents, antibiotics, antiseptics etc.

Salvarsan (arsphenamine) is a medicine developed by Paul Ehrlich for the treatment of syphilis. He got Nobel prize for medicine in 1908. It was the first successful antimicrobial agent. It is effective against the bacteria **spirochete**, that causes syphilis.It is an organoarsenic compound (contains -As=As- bond similar to azo -N=N- bond). Now replaced by pencillin. Salvarsan is toxic to human beings, but its effect on the bacteria, spirochete is much greater than that on human beings.

Antibiotics:- Antibiotics are substances of less toxicity,that destroy or inhibit the growth of microorganisms, by intervening in their metabolic processes.

These are chemicals of less toxicity used to treat infections.

- Antibiotics are produced by microorganisms or by chemical synthesis.
- Antibiotics are capable to destroy or inhibit the growth of microorganisms (pathogens).
- Antibiotics may be **bacteriostatic**(static effect on bacteria) or **bacteriocidal**(cidal effect).
- **Bacteriostatic** antibiotics inhibit the growth of bacteria without killing them. E.g., **Chloramphenicol.**
- **Bacteriocidal** antibiotics inhibit the growth of bacteria by killing them. E.g., **Pencillin**, Ofloxacin.



General Sturcture of Pencillin

Note: The first antibiotic, **Pencillin (found in Pencillium fungus)** was discovered by Alexander Fleming. **Ampicillin** and **Amoxycillin** are synthetic modifications of penicillins.
It is essential to test the patients for sensitivity (allergy) to penicillin before it is administered.

On the basis of their range, antibiotics can be grouped as: broad spectrum, narrow spectrum and limited spectrum antibiotics.

Broad spectrum: Effective against a wide range of gram positive and gram negative bacteria.
E.g.,Chloramphenicol, Amoxycillin, Ampicillin, ofloxacin etc.

Narrow spectrum: Effective against gram positive or gram negative bacteria. E.g., Pencillin G.

Limited spectrum: Effective against a single bacterium.

Note:- ***Chloramphenicol,*** isolated in 1947, is a broad spectrum antibiotic for typhoid, dysentery, acute fever, certain form of urinary infections, meningitis and pneumonia.

Antiseptics & disinfectants: These are chemicals which kill or prevent the growth of micro organisms. These are not ingested like antibiotics. These are used for sterilization purposes.

Antiseptics	Disinfectants
*These are applied to living tissues such as wounds, ulcers etc. *Dettol®, tincture of iodine, iodoform(for wounds), dilute aqueous boric acid sol^{n} (for eyes), phenol(**0.02**%), furacine, soframicine etc are E.gs.	*These are applied only on non-living objects, such as floors, drainage etc *Phenol(**1**%), non diluted Dettol® etc are E.gs.

Note:- Dettol® is a mixture of chloroxylenol and terpineol.

Note:-2-3% solution of iodine in alcohol is known as tincture of iodine.

Antifertility drugs: These are drugs used in family planning and birth control. These are mixture of synthetic estrogen and progesterone derivatives. Estrogen and estrogen derivatives suppress ovulation.

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E.g., Norethindrone(synthetic progesterone derivative), ethynylestradiol (novestrol- progesterone derivative).

Antipyretics: These are drugs that reduce body temperature in fever to normal body temperature. E.g. Paracetamol, aspirin etc.

The two problems associated with the consumption of many drugs include:

- Possible side effects
- Addictive effect(i.e., continuous usage of many drugs result in habit formation)

CHEMICALS IN FOOD

Chemicals are added to food for:

(i) their preservation
(ii) enhancing their appeal(i.e., to make them attractive) and
(iii) adding nutritive value in them

Main categories of food additives are as follows:

(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.

Sweeteners

- Natural sweeteners like sucrose (cane sugar) add to calorie intake. Hence these are not preferred by diabetic patients.
- Artificial sweeteners do not add to calorie intake. Hence these are preferred by diabetic patients.
- Artificial sweeteners are many times as sweet as sucrose. The common artificial sweeteners are:
  - **Saccharin**(Ortho-sulphobenzimide)- the first popular artificial sweetening agent which is about 550 times as sweet as cane sugar
  - **Aspartame**-(100 times) used in cold foods and soft drinks only, because it is unstable at cooking temperature.
  - **Sucralose**-(600 times) tri chloro derivative of sucrose, stable at cooking temperature
  - **Alitame**-(2000 times)

Food preservatives

These are chemicals that prevent the spoilage of food due to microbial growth. Commonly used preservatives include: **sodium benzoate**, table salt, sugar and vegetable oils.

Antioxidants

These are food additives that help in food preservation by retarding the action of oxygen on food. These are more reactive towards oxygen than the food material they are protecting.

Eg: butylated hydroxyl toluene (BHT),
butylated hydroxy anisole (BHA).

The addition of BHA to butter increases its shelf life from months to years.

Some times BHT and BHA along with citric acid are added to produce more effect. Sulphur dioxide and sulphite are useful antioxidants for wine and beer, sugar syrups and cut pealed or dried fruits and vegetables.

CLEANSING AGENTS

These are chemicals that improve the cleansing properties of water. These help in removal of fats, which bind other materials to the fabric or skin.

Soaps: Soaps are potassium or sodium salts of higher fatty acids (like **palmitic acid $CH_3(CH_2)_{14}COOH$, stearic acid $CH_3(CH_2)_{16}COOH$**).

- Soap molecules can be represented as R-COONa or R-COOK
- Potassium soaps are soft to skin.
- Soaps are not suitable for hard water. They are suitable for soft water only
- In hard water they get precipitated as insoluble calcium or magnesium soaps

E.g. **$2CH_3(CH_2)_{16}COONa + CaCl_2 \rightarrow (CH_3(CH_2)_{16}COO)_2Ca + 2NaCl$**

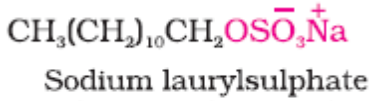
- Soaps are produced by saponification. When fats (i.e., glyceryl ester of fatty acids)are heated with aqueous KOH or NaOH, soaps are formed. This reaction is known as saponification. In this process soap obtained remains in colloidal form. Soap is precipitated from the solution by adding KCl or NaCl.

Synthetic detergents:- Detergents are cleansing agents without any soap.

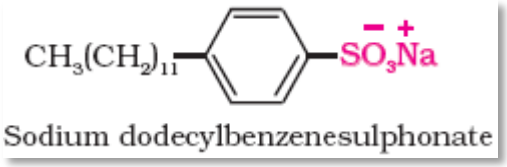
- Detergents give foam even in hard water. So detergents can be used in hard and soft water (and even in ice cold water).

Synthetic detergents are mainly classified into three categories namely anionic detergents, cationic detergents and non onic or neutral detergents.

Anionic detergents: - Anionic Detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons. Their anionic part acts as cleansing agent. They are mostly used for household works and are also present in tooth pastes. Eg.



Sodium laurylsulphate
(Anionic detergent)



Sodium dodecylbenzenesulphonate

Cationic detergents:- Cationic detergents are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Their cationic part acts as cleansing agent. E.g. **Cetyltrimethyl ammonium bromide**

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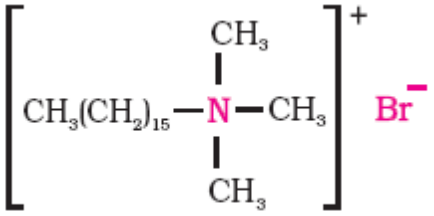
These are expensive and are mainly used in hair conditioners.



Cetyltrimethyl ammonium bromide

Non ionic or neutral detergents: - These have polar groups which can form hydrogen bonding with water. They are present in liquid dish washing detergents. E.g. Stearic acid reacts with Polyethyleneglycol to give a non ionic detergent.

$CH_3(CH_2)_{16}COOH + HO(CH_2\ CH_2O)_n\ CH_2\ CH_2OH \rightarrow$
$CH_3(CH_2)_{16}COO\ (CH_2\ CH_2O)_n\ CH_2\ CH_2OH + H_2O$

Bio degradable detergents have straight chain hydrocarbon. E.g. Sodium lauryl sulphate, Sodiumdodecyl benzene sulphonate.

Non biodegradable detergents have branched chain. If the hydrocarbon part is highly branched, then bacteria cannot degrade them easily. They accumulate in soil and in water. They cause pollution.
E.g.Sodium tetramethyloctylbenzenesulphonate

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