CHEMISTRY IN EVERYDAY LIFE & ENVIRONMENTAL CHEMISTRY

CONTENTS

CHEMISTRY IN EVERYDAY LIFE

Drugs :

Drugs are low molecular mass chemicals which interact with macromolecular targets and produce a biological response.

Medicines :

Medicines are chemicals that are useful in diagnosis, prevention and treatment of diseases.

Therapeutic effect :

Desirable or beneficial effect of a drug like treatment of symptoms and cure of a disease on a living body is known as therapeutic effect.

Enzymes :

Proteins which perform the role of biological catalysts in the body are called enzymes.

Functions of enzymes :

(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.

(ii) The second function of an enzyme is to provide functional groups that will attack the substrate and carry out chemical reaction.

Role of drugs :

Main role of drugs is to either increase or decrease role of enzyme catalysed reactions.

Inhibition of enzymes is a common role of drug action.

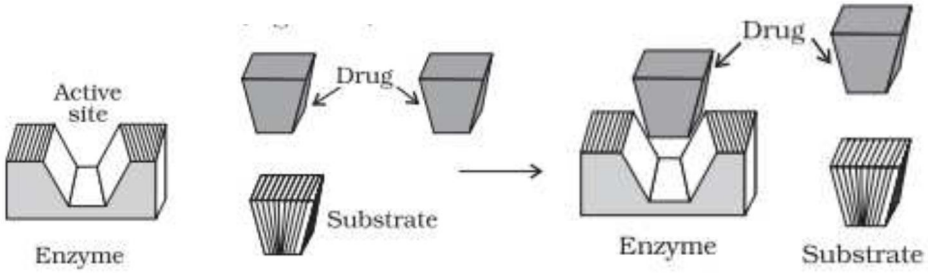
Enzyme inhibitor :

Enzyme inhibitor is drug which inhibits catalytic activity of enzymes or blocks the binding site of the enzyme and eventually prevents the binding of substrate with enzyme.

Drug can inhibit attachment of substrate on active site of enzymes in following ways:

(i) Competitive inhibitor :

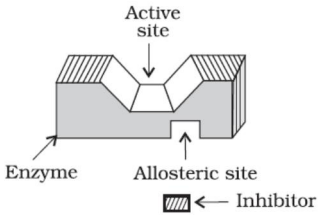
Competitive Inhibitors are the drugs that compete with the natural substrate for their attachment on the active sites of enzymes.



Drug and substrate competing for active site of enzyme Drug blocks the active site of enzyme

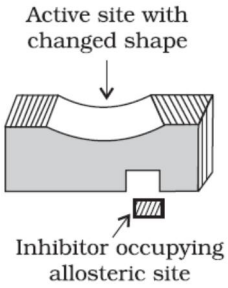
(ii) Non-competitive inhibitor :

Some drugs do not bind to the enzyme's active site, instead bind to a different site of enzyme 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 synthesizes the new enzyme.



Receptors

Proteins which are vital for communication system in the body are called receptors. Receptors show selectivity for one chemical messenger over the other because their binding sites have different shape, structure and amino acid composition.



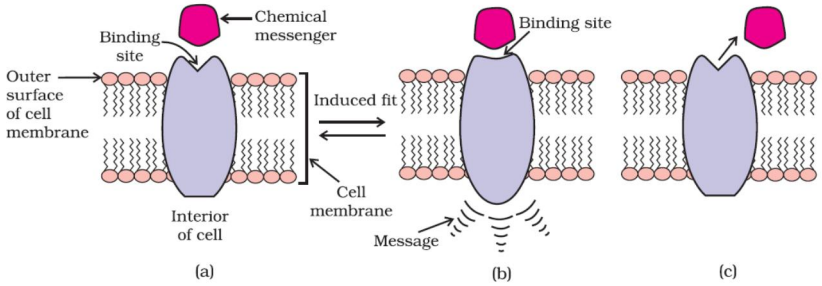
Receptors as drug targets :

In the body, message between two neurons and that between neurons tomuscles is communicated through chemical messengers. They are received at the binding sites of receptor proteins. To accommodate a messenger, shape of the receptor site changes which brings about the transfer of message into the cell. Chemical messenger gives message to the cell without entering the cell.

(a) Receptor receiving chemical messenger.

(b) Shape of the receptor changed after attachment of messenger

(c) Receptor regains structure after removal of chemical



Antagonists and Agonists

Drugs that bind to the receptor site and inhibit its natural function are called **antagonists.** These are useful when blocking of message is required. Drugs that mimic the natural messenger by switching on the receptor are called **agonists.** These are useful when there is lack of natural chemical messenger.

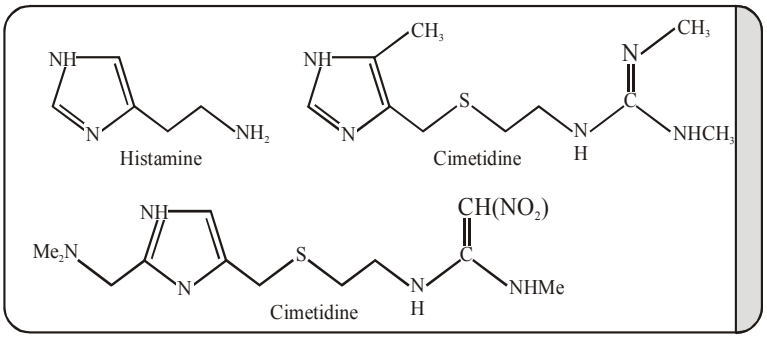
Therapeutic Action of Different Classes of Drugs :

In this Section, we shall discuss the therapeutic action of a few important classes of drugs.

Antacids :

Over production of acid in the stomach causes irritation and pain. In severe cases, ulcers are developed in the stomach. Until 1970, only treatment for acidity was administration of antacids, such as 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. These treatments control only symptoms, and not the cause. Therefore, with these metal salts, the patients cannot be treated easily. In advanced stages, ulcers become life threatening and its only treatment is removal of the affected part of the stomach.

A major breakthrough in the treatment of hyperacidity came through the discovery according to which a 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.

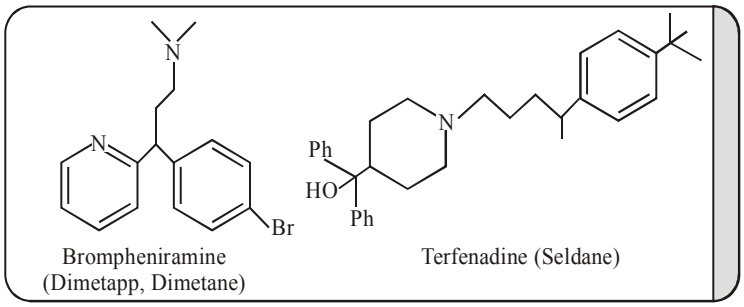


Antihistamine :

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. They interfere with the natural action of histamine by competing with histamine for binding sites of receptor where histamine exerts its effect.

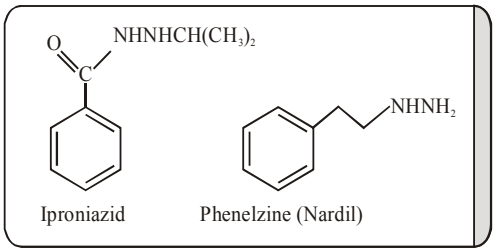
Now the question that arises is, "Why do above mentioned antihistamines not affect the secretion of acid in stomach?" The reason is that antiallergic and antacid drugs work on different receptors.



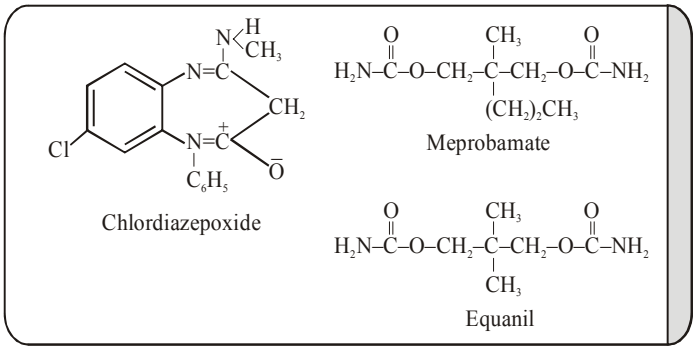
Neurologically Active Drugs

(a) Tranquilizers

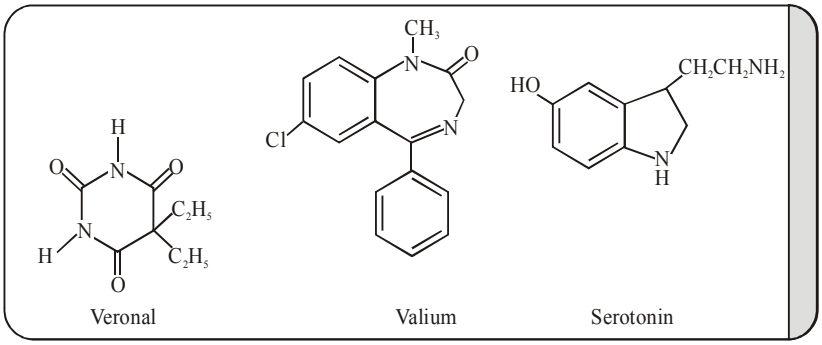
Tranquilizers and analgesics are neurologically active drugs. These affect the message transfer mechanism from nerve to receptor. Tranquilizers are a class of chemical compounds used for the treatment of stress, and mild or even severe mental diseases. These relieve anxiety, stress, irritability or excitement 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, are 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.



(b) 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:

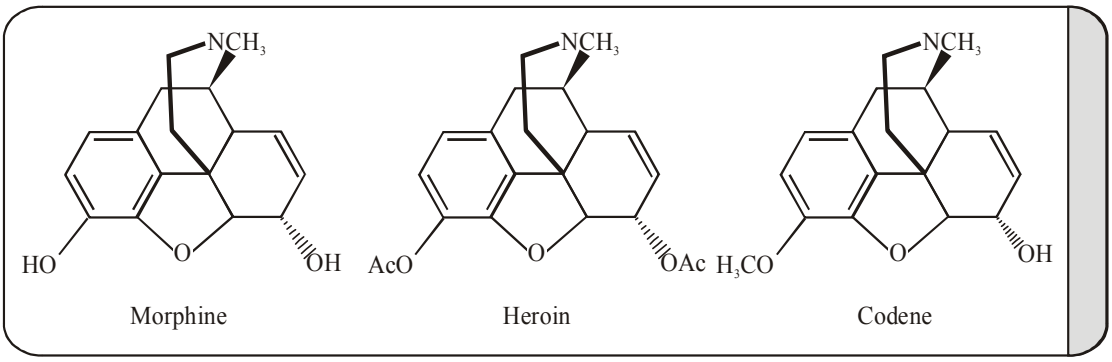
(i) Non-narcotic (non-addictive) analgesics

(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. 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.



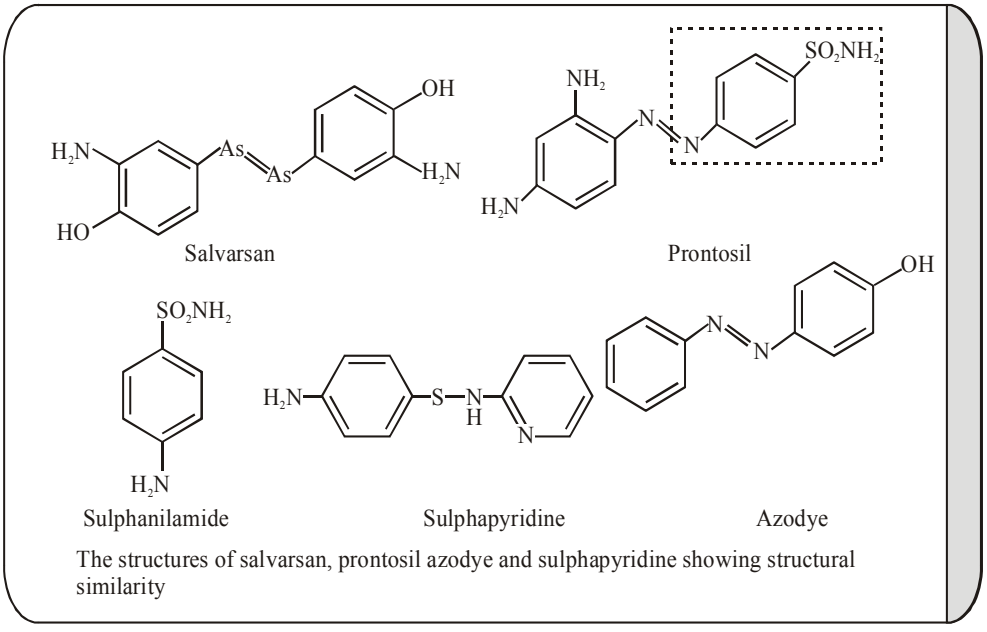
Antimicrobials

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.

(a) 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. The development of synthetic methods has helped in synthesising some of the compounds that were originally discovered as products of microorganisms. Also, some purely synthetic compounds have antibacterial activity, and therefore, definition of antibiotic has been modified. An antibiotic now refers to a substance produced wholly or partly by chemical synthesis, which in low concentrations inhibits the growth or destroys microorganisms by intervening in their metabolic processes.

The search for chemicals that would adversely affect invading bacteria but not the host began in the nineteenth century. Paul Ehrlich, a German bacteriologist, conceived this idea. He investigated arsenic based structures in order to produce less toxic substances for the treatment of syphilis. He developed the medicine, arsphenamine, known as salvarsan. Paul Ehrlich got Nobel prize for Medicine in 1908 for this discovery. It was the first effective treatment discovered for syphilis. Although salvarsan is toxic to human beings, its effect on the bacteria, spirochete, which causes syphilis is much greater than on human beings. At the same time, Ehrlich was working on azodyes also. He noted that there is similarity in structures of salvarsan and



The structures of salvarsan, prontosil azodye and sulphapyridine showing structural similarity

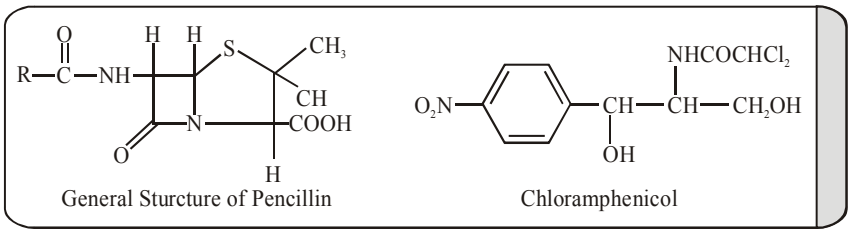
azodyes. The –As = As– linkage present in arsphenamine resembles the –N = N – linkage present in azodyes in the sense that arsenic atom is present in place of nitrogen. He also noted tissues getting coloured by dyes selectively. Therefore, Ehrlich began to search for the compounds which resemble in structure to azodyes and selectively bind to bacteria. In 1932, he succeeded in preparing the first effective antibacterial agent, prontosil, which resembles in structure to the compound, salvarsan. Soon it was discovered that in the body prontosil is converted to a compound called sulphanilamide, which is the real active compound. Thus the sulpha drugs were discovered. A large range of sulphonamide analogues was synthesised. One of the most effective is sulphapyridine.

Despite the success of sulfonamides, the real revolution in antibacterial therapy began with the discovery of Alexander Fleming in 1929, of the antibacterial properties of a Penicillium fungus. Isolation and purification of active compound to accumulate sufficient material for clinical trials took thirteen years. 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

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.

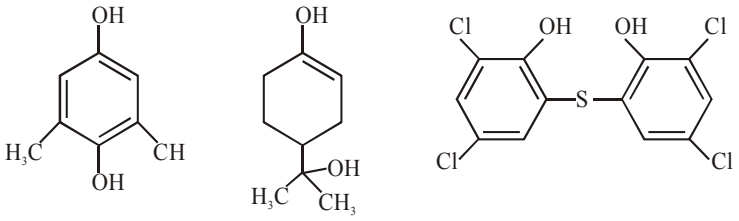
Those effective mainly against Gram-positive or Gram-negative bacteria are narrow spectrum antibiotics. If effective against a single organism or disease, they are referred to as limited spectrum antibiotics. Penicillin G has a narrow spectrum. Ampicillin and Amoxycillin are synthetic modifications of penicillins. These have broad spectrum. It is absolutely essential to test the patients for sensitivity (allergy) to penicillin before it is administered. In India, penicillin is manufactured at the Hindustan Antibiotics in Pimpri and in private sector industry. Chloramphenicol, isolated in 1947, 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.



General Sturcture of Pencillin Chloramphenicol

(b) Antiseptics and disinfectants

Antiseptics and disinfectants are also the chemicals which either kill or prevent the growth of microorganisms.



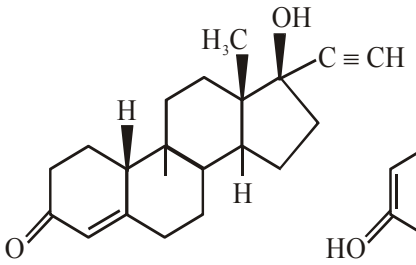
Chloroxylenol Terpineol Bithionol

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

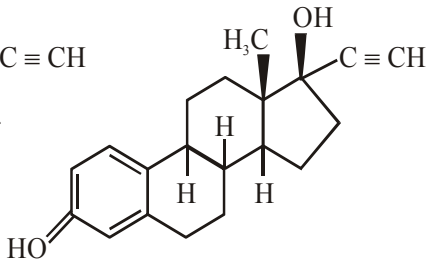
2-3 per cent solution in alcoholwater mixture is known as tincture of iodine. It is applied on wounds. Iodoform is also used as an antiseptic for wounds. Boric acid in dilute aqueous solution is weak antiseptic for eyes. Disinfectants are applied to inanimate objects such as floors, drainage system, 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

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. 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).



Norethindorne



Ethynylestradiol (novestrol)

Summary (Therapeutic action of different classes of drugs)

S.N.	Class of drugs	Examples
1.	**Antacids:** Chemical substances which neutralize excess acid in the gastric juices and give relief from acid indigestion, acidity, heart burns and gastric ulcers.	Eno, gelusil, digene, bakingsoda, cimetidine, ranitidine, lansoprazole, omeprazole, metal hydroxides like $Al(OH)_3$, $Mg(OH)_2$ etc.
2.	**Antihistamines:** Chemical substances which diminish or abolish the effects of histamine released in body and hence prevent allergic reactions.	Brompheniramine (Dimetapp), terfenadine (Seldane), diphenylhydramine (benadryl), pheniramine maleate (avil), chlorpheniramine (zeet).
3.	**Neurologically active drugs:** Drugs which have a neurological effect i.e. affects the message transfer mechanism from nerve to receptor.	
(A) ***	**Tranquilizers:** Chemical substances used for the treatment of stress and mild or severe mental diseases ***Noradrenaline is the neurotransmitters drug***	**Hypnotics:** Derivatives of barbituric acids like veronal, amytal, nembutal, luminal, seconal etc. **Non-hypnotics:** Equanil, Meprobamate, Chlorodiazepoxide. **Antidepressants :** Iproniazid, Phenelzine. **Sedatives** : Valium, Serotonin.
(B)	**Analgesics:** Chemical substances used to relieve pain without causing any disturbances in the nervous system like impairment of consciousness, mental confusion, in coordination or paralysis etc.	**Non-narcotic analgesics:** They are nonaddictive drugs also used as antipyretics. **Examples:** Aspirin, Ibuprofen, Naproxen, Paracetamol, Dichlofenac Sodium.

***	***Narcotic analgesics in poisonous dose produce stupor, coma & ultimately death.***	**Narcotic analgesics:** When administered in medicinal doses, these drugs relieve pain and produce sleep. **Examples:** Morphine,Heroin, Pethidine, Codeine and its derivatives
4.	**Anti-microbials:** Drugs that 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 (anti-parasitic drugs) selectively.	
(A)	**Antibiotics:** Chemical substances produced by microorganisms that kill or prevent the growth of other microbes.	**Arsenic containing drug :** Salvarsan (Arsphenamine) **Azodye containing drug :** Prontosil **Sulpha drug :** Sulphapyridine
(i)	**Bactericidal drugs :** Drugs that kills (cidal effect) organisms in body.	Penicillin, Aminoglycosides, Ofloxacin
(ii)	**Bacteriostatic drugs :** Drugs that inhibits (static effect) growth of organisms.	Erythromycin, Tetracycline, Chloramphenicol.
(iii)	**Broad spectrum antibiotics :** Antibiotics which kill or inhibit a wide range of Gram-positive and Gram-negative bacteria are called broad spectrum antibiotics.	Ampicillin, Amoxycillin, Ofloxacin, Chloramphenicol.
(iv)	**Narrow spectrum antibiotics :** Antibiotics which are effective mainly against Grampositive or Gram-negative bacteria are called narrow spectrum antibiotics.	Penicillin G.
(v)	**Limited spectrum antibiotics:** Antibiotics effective against a single organism or disease	
(B)	**Antiseptics:** Chemical substances that kill or prevent growth of microorganisms and can be applied on living tissues such as cuts, wounds etc., are called antispetics.	Soframicine, Furacine, Dettol, Iodoform, Tincture of Iodine, 0.2% solution of phenol etc.
(C)	**Disinfectants:** Chemical substances that kill microorganisms but cannot be applied on living tissues such as cuts, wounds etc., are called disinfectants.	Aqueous solution of chlorine(0.2 to 0.4 ppm) bithional, 1% solution of phenol, SO_2 solution etc.
5.	**Antimalerial drug**	Chloroquine
6.	**Anti-fertility drugs:** Chemical substances used to prevent conception or fertilization are called anti-fertility drugs.	Norethindrone, ethynylestradiol (novestrol).

Dettol : Mixture of chloroxylenol and terpineol.

Bithionol : Bithionol is added to soaps to impart anticeptic properties.

Iodine : Iodine is a powerful antiseptic, its 2-3% solution in alcohol-water mixture is tincture of iodine.

Iodoform : Iodoform is also used as an antiseptic for wounds.

Boric acid : Boric acid in dilute aqueous solution is weak antiseptic for eyes.

CHEMICALS IN FOOD

- Chemicals which are added to food for their preservation, enhancing their appearance, taste, odour and nutritive value are called food additives.

(1) Food preservatives

Chemical substances which are added to food material to prevent their spoilage due to microbial growth, yeasts and molds.

Examples :

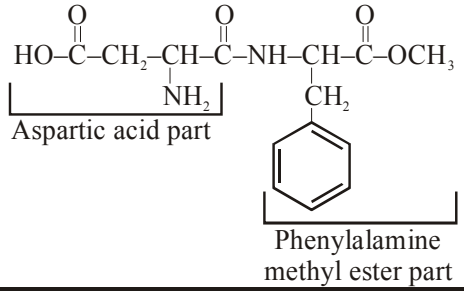
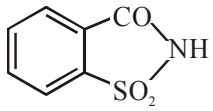
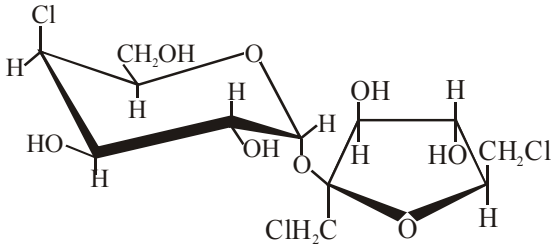
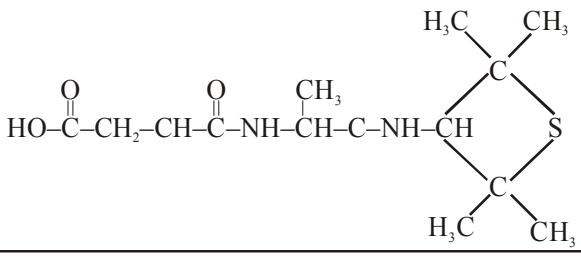
Table salt, sugar, citric acid, sodium benzoate, vegetable oils, salts of propionic acid and sorbic acid etc.

(2) Artificial sweetening agents

Chemical compounds which gives sweetening effect to the food and enhance its flavour.

Examples : Saccharin, Aspartame, Alitame, Sucralose.

*Aspartame is **unstable** at cooking temperature, therefore it is generally used in cold drinks.*

Artificial Sweetner	**Artificial Sweetner**	**Sweetness value in Comparison to cane sugar**
Aspartame		100
Saccharin		550
Sucralose		600
Alitame		2000

(3) Antioxidants

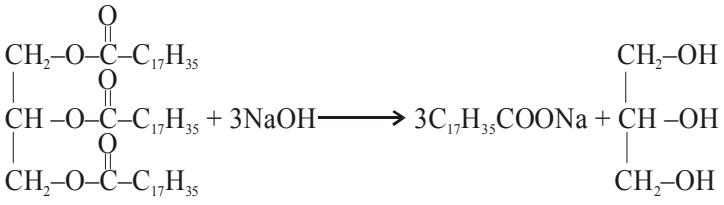
- Substances added to food to prevent oxidation of food materials..

Examples : Butylated hydroxy toluene **(BHT)**, Butylated hydroxy anisole **(BHA)** along with citric acid. SO_2 and sulphite are used as antioxidants for wine, bear, sugar syrup and cut/peeled/dried fruits and vegetables.

CLEANSING AGENTS

(1) Soaps

It is sodium or potassium salts of long chain fatty acids like $C_{15}H_{31}COOH$ (palmitic acid), $C_{17}H_{35}COOH$ (stearic acid), $C_{17},H_{33}COOH$ (oleic acid), $C_{17}H_{31}COOH$ (linoleic acid) etc.



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

(i) Toilet soaps are prepared by using better grades of fats & oils and care is taken to remove excess alkali. Colour and perfumes are added to make these more attractive.

(ii) Transparent soaps are made by dissolving the soap in ethanol and then evaporating the excess solvent.

(iii) In medicated soaps, substances of medicinal value are added. In some soaps, deodorants are added.

(iv) Shaving soaps contain glycerol to prevent rapid drying. A gum called, rosin is added while making them. It forms sodium rosinate which lathers well.

(v) Laundry soaps contain fillers like sodium rosinate, sodium silicate, borax and sodium carbonate.

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.

$$\underset{\text{Soap}}{2C_{17}H_{35}COONa} + CaCl_2 \longrightarrow 2NaCl + \underset{\text{Insolublecalcium stearate (Soap)}}{(C_{17}H_{35}COO)_2Ca}$$

These insoluble soaps separate as scum in water and are useless as cleansing agent. In fact these are hinderance to good washing, because the precipitate adheres onto the fibre of the cloth as gummy mass. Hair washed with hard water looks dull because of this sticky precipitate. Dye does not absorb evenly on cloth washed with soap using hard water, because of this gummy mass.

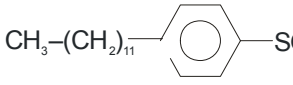
(2) Synthetic detergents

Detergents are sodium salts of long chain of alkyl benzene sulphonic acids or sodium salts of long chain of alkyl hydrogen sulphates.

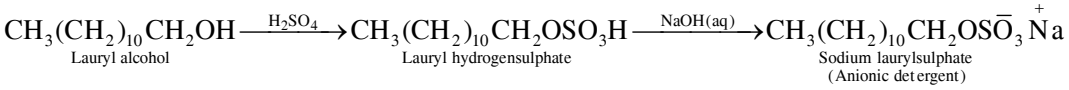
(i) Anionic detergents

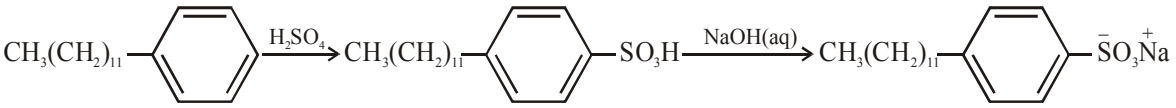
Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons. Alkyl hydrogen sulphates formed by treating long chain alcohols with concentrated sulphuric acid are neutralised with alkali to form anionic detergents. It is used in household work and also used in toothpaste.

Examples : $CH_3(CH_2)_{10}\ CH_2OSO_3^-Na^+$ (Sodium laurylsulphate) &



(Sodium dodecylbenzene sulphonate)

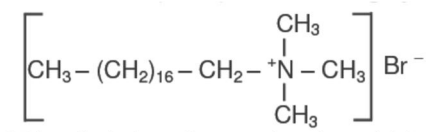




Dodecylbenzene Dodecylbenzenesulphonic acid Sodium dodecylbenzenesulphonate

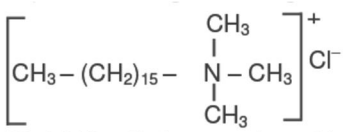
(ii) Cationic detergents

Cationic detergents are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Cationic parts possess a long hydrocarbon chain and a positive charge on nitrogen atom.



(Trimethyl stearylammonium bromide)

&

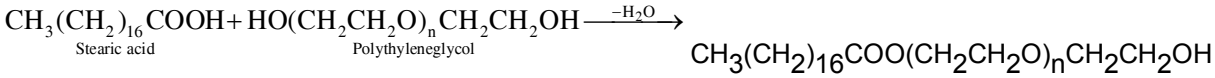


(Cetyl trimethyl ammonium chloride)

They have strong germicidal action and used as germicides but are expensive.

(iii) Non-ionic detergents

They do not contain any ion in their constitution. They are like esters of high molecular mass.



Examples : Detergent formed by condensation reaction between stearic acid and poly ethyleneglycol.
$CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$ (Polyethyleneglycol stearate) &
$CH_3(CH_2)_{10}CH_2(OCH_2CH_2)_8OH$ (Lauryl alcohol ethoxylate)
It is used in making liquid dish washing detergents. They have effective H- bonding groups at one end of the alkyl chain which make them freely water soluble.

(iv) Biodegradable detergents

Detergents having straight hydrocarbon chains that are easily decomposed by microorganisms.
Example: Sodium lauryl sulphate $CH_3(CH_2)_{10}CH_2OSO_3^-Na^+$

(v) Non-biodegradable detergents

Detergents having branched hydrocarbon chains that are not easily decomposed by microorganisms.

(3) Advantages of using soaps

Soap is a good cleansing agent and is 100% biodegradable i.e., micro- organisms present in sewage water can completely oxidize the soap. Therefore, soaps do not cause any pollution problems.

(4) Disadvantages of using soaps

Soaps cannot be used in hard water because hard water contains metal ions like Ca^{2+} and Mg^{2+} which react with soap to form white precipitate of calcium and magnesium salts These precipitates stick to the fibres of the cloth as gummy mass and block the ability of soaps to remove oil and grease from fabrics. Therefore, it interferes with the cleansing ability of the soap and makes the cleansing process difficult. In **acidic medium**, the acid present in solution precipitate the insoluble free fatty acids which adhere to the fabrics and hence block the ability of soaps to remove oil and grease from the fabrics. Hence soaps cannot be used in acidic medium.

(5) Advantages of synthetic detergents over soaps

Detergents can be used both in soft and hard water whereas ordinary soaps cannot be used in hard water. The aqueous solution of detergents are neutral and hence, can be used for washing all types of fabrics without any damage. The solution of ordinary soap is alkaline and thus, cannot be used to wash delicate fabrics. These can be used even in acidic medium as they are salts of strong acids and are not decomposed in acidic medium where as soaps are decomposed into carboxylic acids in acidic medium.

(6) Disadvantages of synthetic detergents over soaps

Slow degradation of detergents leads to their accumulation. Effluents containing such detergents reach the rivers, ponds etc.

These persists in water even after sewage treatment and cause foaming in rivers, ponds & streams and their water gets polluted.

VITAMINS

Definition :

A group of biomolecules which are required in small amounts for normal metabolic process and for the life, growth and health of human beings and animal organisms .

Sources of Vitamins : Human body can synthesize vitamin eg. some members of vitamin B complex synthesized by micro organisms present in the intestinal tract. Most of the vitamins can not be synthesize by our body, Therefore they must be supplied in the food. Plants can synthesize almost all vitamins. Vitamin D may either be supplied in the food or may be produced in the skin by the irradiation of ergosterol (a sterol present in our body) with ultraviolet light.

Classification of Vitamins : There is very little common to the various vitamins, therefore there are usually desiganated by alphabet letters A, B, C, D, E and K. Some of these are classified as sub groups eg. B_1, B_2, B_3, B_4, B_6, B_{12} D_1, D_2 etc. About 25 vitamins are known to date. Vitamins are broadly classified into two catagories

(i) **Water soluble vitamins :** Vitamin B-complex and vitamin C are water soluble vitamins and must be supplied regularly in diet.

(ii) **Fat soluble vitamins :** These are oily substances and soluble in fats These are A,D,E and K. They are stored in liver and adipose (fat storing) tissues.

(iii) **Biotin (Vitamin H) :** It is neither soluble in water nor in fats. Lack of particular vitamin causes a specific deficinecy disease. Some important vitamins Their characteristics, sources and deficiency diseases are summarised in the following table.

S.No.	Vitamines	Characteristics	Sources	Deficiency disease
1	A (Retinal)	Soluble in oils and fats stable to heat. Promote growth and vision and increases resistance to diseases	Milk, Butter, eggs fish, liveroil, rice kidney , green vegetables, angoes sweet potatoes carrots, tomatoes etc	**Xerophthalmia** (hardening of eye) corhea **night blindness** and xerosis (drying of skin)
2	B_1 Thiamine	Soluble in water destroyed by heat above 313 K.	Pulses, nuts, cereals (rice, wheat) rice polishings, yeast, egg yolk, milk green vegetables and fruits.	Beriberi (paralysis of legs and general weakness) loss of appetite
3	B_2 (Riboflavin or lactoflavin)	Soluble in water sensitive to light but stable to heat.	Daily dosage -2-3 mg milk, yeast green vegetables meat, liver kidney, egg white etc	Retards groath general inflammation of tongue i.e darkened tongue dermatitis and cheilosis (racking at corners of mouth and lips).
4	B_6 (Pyridoxin or adermin)	Soluble in water	Rice, bran, yeast molases, meat, fish, egg yolk etc.	Cause specific dermatitis and anaemia in man effects central nervous system.
5	B_{12} (cyanocobalamine	Water soluble, stable to heat.	Milk, egg, liver of animals	Anemia (RBC deficient) inflammation of tongue and mouth
6	H (Biotin)	Neither soluble in water not in fats.	Yeast, liver, kidney and milk	Dermatitis, loss of hairs and paralysis
7	C (Ascorbic acid)	Soluble in water destroyed by cooking.	**Citrus fruits** amla tomatoes green leafy vegetables. Daily dosage 75 mg.	Cause **scurvy** (bleeding of gums pyorrhea bleeding of teath)
8	D (Ergocalciferol)	Soluble in oil, fats stable to heat and resistants to oxidation to controls calcium and Phosphorus meta- bolism.	Milk, butter, eggs, liver & meat. Daily dosage 0.025 mg.	**Rickets** (deformation of bones) **osteomalacia** (soft bones and joint pain)
9	E (It is mixture of 4- vitamins a, b,g d tocoferols)	Soluble in oils and fats, stable to heat and oxidation.	Vegitable oil wheat germ oil cotton seed oil peanut oil, soyabean, eggs, milk, fish. Daily dosage 5 mg.	Loss of sexual power of reproduction (**sterility**) increased muscular weakness.
10	K (phylloquinone mixture of two vitamin K_1 & K_2)	Soluble in oils and fats stable to heat sensible to light and alkali	Vitmain K_1 affalfa leafs vegetables, vit. K_2occurs mainly in bacteria.	**Haemorrhage lengthons** the time of blood clotting. Excessive bleeding in injury. vitamin K_1& K_2) and alkali bacteria.

NUCLEIC ACIDS

Nucleic acids were first discovered by a Swiss biochemist, **Friedrich** Miescher (1869) who called them **nuclein** due to their acidic nature.

Chemical analysis of chromosomes shows presence of two nucleic acids-DNA (Deoxyribo nucleic acid) and RNA (Ribo nucleic acid).

Nucleic acid is a macromolecule & consists of many (polymer) monomeric units, called nucleotides. Each nucleotide is composed of a nucleoside and a phosphate group. Thus nucleotide is a phosphoric ester of nucleoside.

Each nucleoside consists of sugar molecule and a nitrogenous base. The relationship can be shown as given below.

Nucleic acid =many nucleotides

Nucleotide =nucleosides + phosphate

Nucleoside =sugar + nitrogenous base

Thus nucleotide =phosphate + sugar+ nitrogenous base

Nucleic acids bear different components that are briefly discussed below.

1. Phosphoric acid :

The acidic nature of nucleic acids is due to the presence of phosphoric acid. Sugar of nucleoside combines with phosphoric acid by a phosphodiester bond formed at 5th or 3rd carbon of the sugar.

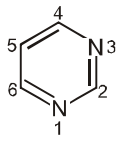
2. Sugar :

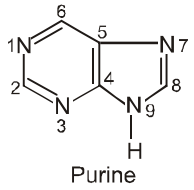
It is a five carbon (pentose) sugar. There are two types of pentose sugars-ribose and deoxyribose. Deoxyribose sugar has one oxygen atom less at second carbon. Ribose sugar is present in RNA while deoxyribose sugar occurs in DNA.

3. Nitrogenous bases : they have two catagories

(a) Pyrimidine : It includes cytosine, thymine and uracil. Pyrimidine bases are made of only one ring of carbon.

(b) Purine : It includes Adenine and guanine. Purine bases are made of two ring of carbon and nitrogen bases of DNA contains adenine, guanine, cytosine and thymine. In RNA, **uracil** is present in place of **thymine.**





Pyrimidines			Purines	
Thymine (T)	Uracil (U)	Cytosine (C)	Adenine (A)	Guanine (G)

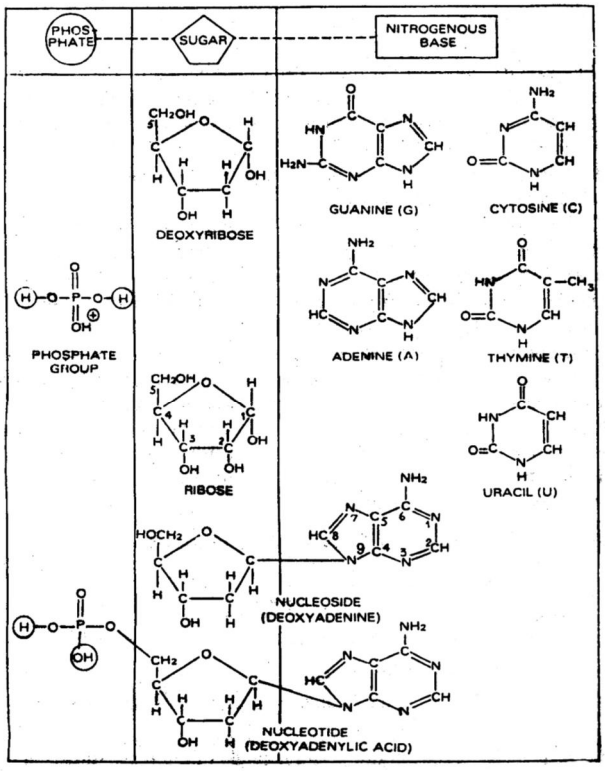


Fig. Building blocks of nuclectides

Many nucleotide monomer units join one another to give rise to polynucleotide chain.

The two adjacent nucleotides are joined by formation of **phosphodiester bond** (a bond that involves two ester bonds). A polynucleotide chain is often written as 5'p 3'OH. This indicates that it is a dinucleotide with phosphate group (p) attached to the 5th carbon of terminal nucleotide and hydroxyl group (OH) is present at 3rd carbon of basal nucleotide.

(a) Structure of DNA (Deoxyribonucleic acid) :

J.D. Watson and F.H.C. Crick (1953) proposed double helical structure of DNA based on the results of **M.H.F.Wilkins and co-workers.** All these three persons were awarded Nobel Prize in 1962 for this work.

The following are some of the characteristic features of double helical structure of DNA.

(i) **Each nucleotide** consists of **sugar, phosphate and a nitrogenous base**. Many such nucleotides are linked by phosphodiester bonds to form a polynucleotide chain or strand.

(ii) **Phospho diester bonds** are formed between 5'carbon of sugar of one nucleotide and 3' carbon of sugar of the next nucleotide.

(iii) **Nitrogenous base** is attached to**1' carbon of sugar**. At this place **purine base** is attached by its **5' position** and **pyrimidine** by its **3' position**.

(iv) Polynucleotide strand is made of backbone of sugar and phosphate forming its long axis and bases at right angles to it.

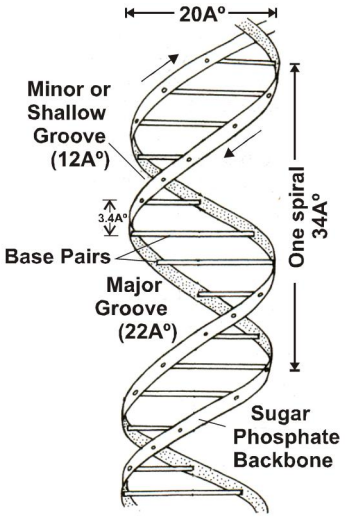


Fig. Structure of DNA- coiling in double helix of DNA

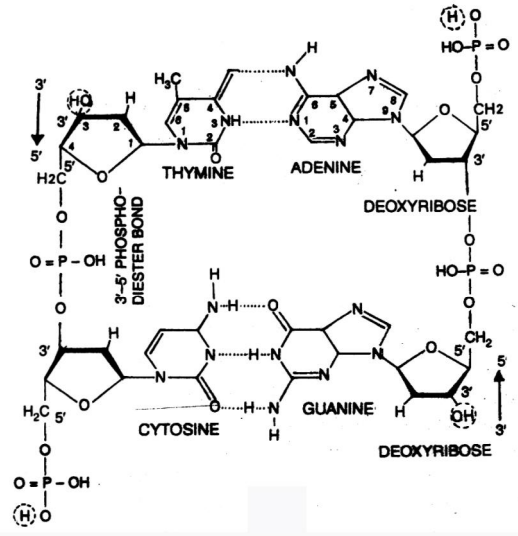


Fig. C. Chemical structure and bonding of different constituents of DNA. In the two chains.

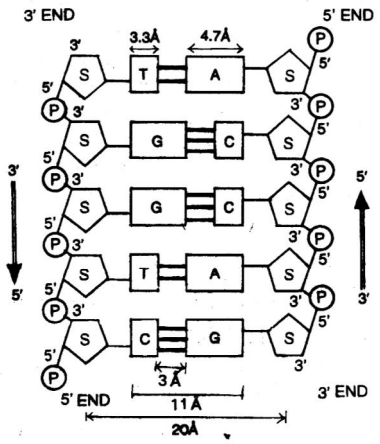


Fig. D. Arrangement of various constituents of DNA duplex. (S = Sugar, P = Phosphate)

Chargaffs rule.

(1) Purine and pyrimidine base pairs are in equal amount, that is, adenine + guanine =thymine + cytosine.

(2) Molar amount of purine-adenine is always equal to the molar amount of pyrimidine thymine. Similarly, guanine is equalled by cytosine.

(3) Sugar deoxyribose and phosphate occur in equimolar proportions.

(4) The ratio of A + T/G + C is constant for a species.

(5) Chargaffs rule states that in natural DNAs the base ratio **A/T** is always close to unity and the **G/C** ratio also to always close to unity. It indicate that **A** always pairs with **T** and **G** pairs with **C**. **A** and **T**, **G** and **C**, therefore,are complementary base pairs.

(6) Thus, if one DNA strand has **A**, the other would have **T** and if it has **G**, the other, would have **C**. Therefore, if the base sequence of one strand is **CAT TAG GAC,** the base sequence of other strand would be **GTA ATC CTG**. Hence, the two poly nucleotide strands are called complementary to one another.

(7) Two such complementary strands are joined with each another by hydrogen bonds between their complementary nitrogenous bases. There are three hydrogen bonds between cytosine and guanine and two hydrogen bonds between adenine and thymine.

(8) The two polynucleotide chains are helically coiled around the same axis in such a way that these can separate from one another only by uncoiling. Helical coiling is supposed to be right handed. Such a form of DNA is now called B-DNA

(9) The two chains or strands are antiparallel, i.e., they run in opposite directions in relation to their sugar molecules. Their 5'p 3' OH phosphodiester linkages are in opposite directions

(10) Double stranded DNA molecule has a diameter of 20Aº.

(11) The helix makes one complete turn every 3.4 Aº along its length.

(12) There are 10 nucleotides per turn of helix.Thus the distance between two neighbouring base pairs is 3.4 A.

RNA : RNA is ribonucleic acid formed in the nucleus and is found in the cytoplasm of the cell.

(b) Types of RNA and their functions :

(1) r-RNA (Ribosomal – RNA) : It is found in the ribosomes and it is usually associated with protein to form the ribosomes. It is synthesised in the nucleus by DNA. It is single stranded, comprising about 80% of the total RNA. It is metabolically stable.

Functions :

(i) This forms the site for protein synthesis.

(ii) It is also supposed to help the binding of m-RNA to the ribosomes during protein synthesis.

(2) m-RNA (Messenger RNA) : It is carries the genetic message code from the D.N.A. to ribosomes. It is produced by the DNA ; m-RNA is also single stranded and constitutes about 15% of total RNA.

Functions : It carries the genetic information from DNA to the ribosomes where protein is synthesised.

(3) t-R.N.A (Transfer–RNA) : It is synthesised in the nucleus by the DNA. It is also called soluble RNA. It is single stranded. There are 20 different kindes of t-RNA and each type has a specificity for a particular amino acid. It constitutes about 5% of total RNA. It has very short life.

Functions : It carries amino acids from different parts of cytoplasm to the ribosomes during protein synthesis.

Differences between DNA and RNA

	DNA		RNA
1.	It usually occurs inside nucleus and some cell	1.	Very little RNA occurs inside nucleus. most organelles . of it is found in the cytoplasm.
2.	DNA is the genetic material.	2.	RNA is not the genetic material except in certain viruses, e.g. Reovirus.
3.	It is double stranded with the exception of itsome viruses (e.g. $\phi \times 174$).	3.	RNA is single stranded except reovirus where is double stranded.
4.	DNA contains over a million nucleotides.	4.	Depending upon the type, RNA contains 70-1200 nucleotides.
5.	DNA is of only two types; intra-nuclear and extra-nuclear.	5.	There are at least three types of RNAs— mRNA, rRNA and tRNA
6.	It contains deoxyribose sugar.	6.	It contains ribose sugar.
7.	Nitrogen base thymine occurs in DNA alongwith three others — adenine, cytosine and guanine.	7.	Thymine is replaced by uracil in RNA The other three are similar — adenine, cytosine and guanine.
8.	It replicates to form new DNA molecules.	8.	It cannot normally replicate itself.
9.	DNA transcribes genetic infromation to RNA.	9.	RNA translates the transcribed message for forming polypeptides.
10.	DNA controls metabolism and genetics Including variations.	10.	It only controls metabolism under instruction from DNA.
11.	Purine and pyrimidine bases are in equal number.	11.	There is no poroportionality between number of purines and pyrmidine bases.

Exercise # 1

PART - I : SUBJECTIVE QUESTIONS

Section (A) : Chemisty in every day life

A-1. Name two semisynthetic modifications of penicilin.

A-2. What is the role of boric acid in talcum powder ?

A-3. Name a phenolic antibacterial used in body deodorants.

A-4. Name the macromolecules that are chosen as drug-targets.

A-5. Define the term chemotherapy.

A-6. What are main constituents of dettol?

A-7. Why is use of aspartame limited to cold foods and drinks?

A-8. Name the medicine which can act both as an analgesic as well as an antipyretic.

A-9. Why is bithional added to the toilet soap ?

A-10. Give one important use of each of the following in pharmacy ?
(i) Equanil (ii) Morphine

A-11. Explain the term, target molecules or drug-targets as used in medicinal chemistry.

A-12. Which forces are involved in holding the drugs to the active site of enzymes?

A-13. What is tincture of iodine? What is its use?

A-14. What problem arises in using alitame as artificial sweetener?

A-15. Give names of two substances used as preservatives.

A-16. Give two examples of synthetic detergents.

A-17. Name the sweetening agent used in the preparation of sweet for a diabetic patient.

A-18. Why do soaps not work in hard water?

A-19. Label the hydrophilic and hydrophobic parts in the following compounds.
(i) $CH_3(CH_2)_{10}CH_2OSO_3^-Na^+$
(ii) $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$
(iii) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH^-$

A-20. Give one important use of each of the following:
(i) Streptomycin (ii) Paracetamol (iii) Anti-fertility drugs

A-21. Antacids and antiallergic drugs interfere with the function of histamines but why do these not interfere with the function of each other?

A-22. Low level of noradrenaline is the cause of depression, what types of drugs are needed to cure this problem? Name two drugs.

A-23. Can you use soaps and synthetic detergents to check the hardness of water?

A-24. Explain the cleansing action of soaps.

A-25. Why do we need to classify drugs in different ways ?

A-26. Why are cimetidine and ranitidine better antacids than sodium bicarbonate or magnesium or aluminium hydroxide.

PART - II : OBJECTIVE TYPE QUESTIONS

Section (A) : Chemisty in every day life

A-1. Morphine is used as an
(A) Antipyretic (B) Antiseptic (C) Analgesic (D) Insecticide

A-2. Which of the following is not an alkaloid ?
(A) Reserpine (B) Morphine (C) Quinine (D) Phenylbutazone

A-3. The antibiotic used for curing tuberculosis is :
(A) Penicillin (B) Streptomycin (C) Tetracycline (D) Chloromycetin

A-4. The drugs used to get relief from pain are called :
(A) Antipyretics (B) Analgesics (C) Antibiotics (D) Antiseptics

A-5. A medicine which promotes secretion of urine is called :
(A) Diuretic (B) Antipyretic (C) Analgesic (D) Sedative

A-6. The antiseptic action of Dettol is due to
(A) Chlorobenzene (B) Chloroxylenol (C) Chloroquine (D) Chloramphenicol

A-7. Which of the following is a hypnotic drug?
(A) Luminal (B) Salol (C) Catechol (D) Aspirin

A-8. Chloroquine is :
(A) an analgesic (B) an antibiotic (C) an antimalarial (D) an antipyretic

A-9. Tranquillizers are the substances used for the treatment of :
(A) cancer (B) AIDS (C) mental diseases (D) physical disorders

A-10. Which of the following are anionic detergents?
(A) Sodium salts of sulphonated long chain alcohol.
(B) Ester of stearic acid and polyethylene glycol.
(C) Quarternary ammonium salt of amine with acetate ion.
(D) Product of stearic acid and polyethylene glycol.

A-11. Which one of the following is employed as a Tranquilizer drug?
(A) Promethazine (B) Valium (C) Naproxen (D) Mifepristone.

A-12. Which one of the following is employed as Antihistamine ?
(A) Chloramphenicol (B) Diphenyl hydramine
(C) Norethindrone (D) Omeprazole

A-13. Chloroamphenicol is an :
(A) antifertility drug (B) antihistamine
(C) antiseptic and disinfectant (D) antibiotic(broad spectrum)

A-14. Antiseptics and disinfectants either kill or prevent growth of microrganisms. Identify which of the following statements is not true?
(A) Chlorine and iodine are used as strong disinfectants.
(B) Dilute solutions of boric acid and hydrogen peroxide are strong antiseptics.
(C) Disinfectants harm the living tissues.
(D) A 0.2 % solution of phenol is an antiseptic while 1 % solution acts as a disinfectant.

A-15. Which of the following statement is wrong ?
(A) Antihistamines are used to prevent allergic reactions.
(B) Tranquilizers are used for treatment of mental diseases.
(C) Analgesics are used as pain killer.
(D) Pencilin G is broad spectrum antibiotic.

Section (B) : Vitamins, Enzymes & Nucleic acids

B-1. Which of the following is a vitamin -
(A) Glucose (B) Keratin (C) Maltose (D) Riboflavin

B-2. Vitamin B_6 is known as
(A) Pyridoxine (B) Thiamine (C) Tocopherol (D) Riboflavin

B-3. The best source of vitamin A is -
(A) Oranges (B) Beans (C) Carrots (D) Wheat

B-4. Vitamin D is called -
(A) Ascorbic acid (B) Calciferol or ergocalciferol
(C) Thaimine (D) Riboflavin

B-5. Which of the following is found in cod-liver oil ?
(A) Vitamin C (B) Vitamin E (C) Vitamin A (D) Vitamin B_1

B-6. Vitamin E is also called :
(A) Cyanocobalamin (B) Tocopherol (C) Lactoflavin (D) Ascorbic acid

B-7. The best source of vitamin C is :
(A) Code liver oil (B) Egg yolk (C) Citrus fruits (D) Fish liver oil

B-8. Milk contains vitamins :
(A) A, D and E (B) A, B_{12} and D (C) C, D and K (D) B_1, B_6 and D

B-9. Nervousness anaemia is caused by the deficiency of vitamin
(A) B_1 (B) B_2 (C) B_6 (D) B_{12}

B-10. Deficiency of vitamin E causes
(A) Scurvy (B) Loss of appetite
(C) Loss of sexual power and reproduction (D) Beriberi

B-11. Which of the following is fat soluble vitamin ?
(A) Vitamin A (B) Pyridoxine (C) Riboflavin (D) Thiamine

B-12. Which one of the following vitamin contains a metal atom ?
(A) Vitamin A (B) Vitamin B_2 (C) Vitamin B_6 (D) Vitamin B_{12}

B-13. The vitamin which is water soluble and antioxidant is :
(A) Vitamin E (B) Vitamin D (C) Vitamin C (D) Vitamin B_1

B-14. Beri-beri is casued due to :
(A) vitamin A (B) vitamin B (C) vitamin C (D) vitamin D

B-15. Which one of the following has magnesium metal ?
(A) Vitamin B12 (B) Chlorophyll
(C) Haemocyanin (D) Carbonic anhydrase

Exercise # 2

PART - I : ONLY ONE OPTION CORRECT TYPE

1. Which statement is incorrrect ?
(A) Aspirin is an antibiotic.
(B) Methyl orange is an azo dye.
(C) Phenyl butazone is considered as a unsafe drug.
(D) The chemical name of aspirin is acetyl salicyclic acid

2. Arsenic drugs are mainly used in the treatment of–
(A) Jaundice (B) Typhoid (C) Syphilis (D) Cholera

3. Aspirin is an acetylation product of –
(A) p-dihyroxybenzene (B) o-hydroxybenzoic acid
(C) o-dihydroxy benzene (D) m-hydroxybenzoic acid

4. Substances which bring body temperature down are known as –
(A) Antipyretics (B) Analagin (C) Antibiotics (D) Hypnotics

5. The drug given during hypertension is –
(A) Streptomycin (B) Chloroxylenol (C) Equanil (D) Aspirin

6. Phenol is used as –
(A) An antiseptic (B) A disinfectant (C) Both (A) and (B) (D) None of these

7. Valium, a barbiturate drug is used as-
(A) Anaesthetic (B) Sedative (C) Antiseptic (D) None of these

8. Which is correct reaction to prepare soap of glyceryl palmitate ?
(A) $(C_{15}H_{31}COO)_3C_3H_5 + 3NaOH \rightarrow (C_{15}H_{31}COONa)_3 + Glycerol$
(B) $(C_{17}H_{35}COO)_3C_3H_5 + 3NaOH \rightarrow (C_{17}H_{35}COONa)_3 + Glycerol$
(C) $(C_{17}H_{32}COO)_3C_3H_5 + 3NaOH \rightarrow (C_{17}H_{32}COONa)_3 + Glycerol$
(D) None of these

9. Mixture of chloroxylenol and terpineol acts as :
(A) Analgesic (B) Antiseptic (C) Antipyretic (D) Antibiotic

10. The sweetest artificial sugar among the following is -
(A) Aspartame (B) Sucralose (C) Alitame (D) Sucrose

11. Which of the following is used for inducing sleep?
(A) paracetamol (B) chloroquine
(C) bithional (D) barbituric acid derivatives

12. **Assertion :** Ranitidine is used to treat hyperacidity and brompheniramine is used to treat hypersensitivity.
Reason : Both of these drugs are antishistamines.
(A) If both assertion and reason are true and reason is a correct explanation of assertion.
(B) If both assertion and reason are true but reason is not a correct explanation of assertion.
(C) If assertion is true but reason is false.
(D) If assertion and reason both are false.

13. Which is incorrect match ?
(A) Novestrol - Antifertility (B) Serotonine - Tranquilizer
(C) Narrow spectrum - Chloramphenicol (D) Rentac- antacid

14. Which of the following compounds is used as a body deodorant ?
(A) Aspirin (B) Omeprazole
(C) Indigosol-O (D) p-Chlorometaxylenol

15. Heroin is a derivative of :
(A) Caffeine (B) Cocaine (C) Nicotine (D) Morphine

16. Penicillin was discovered by :
(A) Alexander Fleming (B) Ziegler and Natta
(C) Walkman (D) Abraham

17. Which of the following statements are correct about barbiturates?
(A) Hypnotics or sleep producing agents.
(B) These are antibiotic.
(C) Non-narcotic analgesics.
(D) Pain reducing without disturbing the nervous system

18. Which of the following is sulpha drug ?
(A) Chloramphenicol (B) Prontosil
(C) Salvarsan (D) Nardil

19. Which of the following statements is correct about receptor proteins?
(A) Majority of receptor proteins are embedded in the cell membranes.
(B) The active site of receptor proteins opens on the inside region of the cell.
(C) Shape of receptor doesn't change during attachment of messenger.
(D) None of these

20. Which of the following statements is/are correct?
(a) Cationic detergents have germicidal properties
(b) Some synthetic detergents can give foam even in ice cold water.
(c) Synthetic detergents are not soaps
(A) a & b only (B) a & c only (C) b & c only (D) a, b & c

PART - II : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Which of the following statements are incorrect about receptor proteins?
(A) Majority of receptor proteins are embedded in the cell membranes.
(B) The active site of receptor proteins opens on the inside region of the cell.
(C) Chemical messengers are received at the binding sites of receptor proteins.
(D) Shape of receptor doesn't change during attachment of messenger.

2. Compounds with antiseptic properties are _____.
(A) $CHCl_3$ (B) CHI_3
(C) Boric acid (D) 0.3 ppm aqueous solution of Cl_2

3. Which of the following statements are correct about barbiturates?
(A) Hypnotics or sleep producing agents.
(B) These are tranquilizers.
(C) Non-narcotic analgesics.
(D) Pain reducing without disturbing the nervous system.

4. Which of the following are antidepressants?
(A) Iproniazid (B) Phenelzine (C) Equanil (D) Salvarsan

5. Which of the following compounds are administered as antacids?
(A) Sodium carbonate (B) Sodium hydrogencarbonate
(C) Aluminium carbonate (D) Magnesium hydroxide

6. Amongst the following antihistamines, which are antacids?
(A) Ranitidine (B) Brompheniramine (C) Terfenadine (D) Cimetidine

7. Which of the following are anionic detergents?
(A) Sodium salts of sulphonated long chain alcohol.
(B) Ester of stearic acid and polyethylene glycol.
(C) Quarternary ammonium salt of amine with acetate ion.
(D) Sodium salts of sulphonated long chain hydrocarbons.

8. Which of the following statements are correct?
(A) Cationic detergents have germicidal properties
(B) Bacteria can degrade the detergents containing highly branched chains.
(C) Some synthetic detergents can give foam even in ice cold water.
(D) Synthetic detergents are not soaps.

PART - III : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1

Antibiotics are the chemical substances which are produced by micro-organisms like bacteria, fungi and moulds. Antibiotics can inhibit the growth or even destroy other micro-organisms. Now a days, synthetic antibiotics are also available. The first successful antibiotic produced was penicillin. The antibiotics may be either bacteriocidal (kills the organism in the body) or bacteriostatic (inhibits the growth of organism). Ampicillin and amoxycillin are modified antibiotics. Broad spectrum antibiotics are effective against several types of harmful micro-organisms.

1. Chloramphenicol is :
(A) antipyretic (B) broad spectrum antibiotic
(C) azo dye (D) tranquillizer

2. Which of the following is/are not an antibiotic ?
(A) Chloramphenicol (B) Sulphadiazine (C) Penicillin (D) Bithional

3. Which among the following antibiotics is bacteriostatic ?
(A) Penicillin (B) Ofloxacin (C) Aminoglycosiders (D) Erythromycin

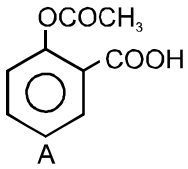
4. Which of the following antibiotics is/are the modification of penicillins ?
(A) Ofloxacin (B) Ampicillin (C) Amoxycillin (D) Tetracycline

5. Which of the following antibiotics is effective against tuberculosis ?
(A) Chloromycetin (B) Tetracycline (C) Penicillin (D) Streptomycin

Exercise # 3

JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. Compound A given below is - **[AIEEE - 2002, 3/225]**



(1) Antiseptic (2) Antibiotic (3) Analgesic (4) Pesticide

2. Which one of the following types of drugs reduces fever ? **[AIEEE - 2005, 1½, 225]**
(1) Tranquiliser (2) Antibiotic (3) Antipyretic (4) Analgesic

3. Aspirin is known as : **[AIEEE-2012, 4/120]**
(1) Acetyl salicylic acid (2) Phenyl salicylate
(3) Acetyl salicylate (4) Methyl salicylic acid

4. Which of the following compounds is **not** an antacid ? **[JEE Main 2015, 4/120]**
(1) Aluminium hydroxide (2) Cimetidine
(3) Phenelzine (4) Ranitidine

5. Which of the vitamins given below is water soluble ? **[JEE Main 2015, 4/120]**
(1) Vitamin C (2) Vitamin D (3) Vitamin E (4) Vitamin K

6. Which of the following is an anionic detergent ? **[JEE Main 2016, 4/120]**
(1) Sodium lauryl sulphate (2) Cetyltrimethyl ammonium bromide
(3) Glyceryl oleate (4) Sodium stearate

7. The correct match between Item(I) and Item(II) is : **[JEE-MAIN-(Jan)-2019]**

	Item-I	**Item-II**
(A)	Nortehindrone	(P) Anti-biotic
(B)	Ofloxacin	(Q) Anti-fertility
(C)	Equanil	(R) Hypertension
		(S) Analgesics

(1) A-R, B-P, C-S (2) A-Q, B-P, C-R (3) A-R, B-P, C-R (4) A-Q, B-R, C-S

8. The correct match between Item -I and Item-II is : **[JEE-MAIN-(Jan)-2019]**

Item – I (drug)		**Item – II (test)**	
(A)	Chloroxylenol	**(P)**	Carbylamine Test
(B)	Norethindrone	**(Q)**	Sodium Hydrogen carbonateTest
(C)	Sulphapyridine	**(R)**	Ferric chloride test
(D)	Penicillin	**(S)**	Bayer's test

(1) A→Q ; B→P ; C→S ; D→R (2) A→R ; B→P ; C→S ; D→Q
(3) A→R ; B→S ; C→P ; D→Q (4) A→Q ; B→S ; C→P ; D→R

9. Noradrenaline is a /an **[JEE-MAIN-(April)-2019]**
(1) Neurotransmitter (2) Antidepressant (3) Antihistamine (4) Antacid

10. Match the following : **[JEE-MAIN-(Jan)-2020]**

(i) Riboflavin	(1) Beriberi
(ii) Thiamine	(2) Scurvy
(iii) Pyridoxine	(3) Cheilosis
(iv) Ascorbic acid	(4) Convulsions

(1) (i)-(3), (ii)-(1), (iii)-(4), (iv)-(2) (2) (i)-(3), (ii)-(4), (iii)-(1), (iv)-(2)
(3) (i)-(4), (ii)-(2), (iii)-(1), (iv)-(3) (4) (i)-(1), (ii)-(4), (iii)-(3), (iv)-(2)

11. The number of sp^2 hybridised carbons present in "Aspartame" is _____. **[JEE-MAIN-(Jan)-2020]**

12. The number of chiral centres in penicillin is _____. **[JEE-MAIN-(Jan)-2020]**

13. The mass percentage of nitrogen in histamine is _____. **[JEE-MAIN-(Jan)-2020]**

14. If you spill a chemical toilet cleaning liquid on your hand, your first aid would be :
(1) aqueous NH_3 (2) vinegar **[JEE-MAIN-(Sept.)-2020]**
(3) aqueous $NaHCO_3$ (4) aqueous NaOH

15. The antifertility drug 'Novestrol" can react with : **[JEE-MAIN-(Sept.)-2020]**
(1) Br_2/water; $ZnCl_2$/HCl; $FeCl_3$ (2) Alcoholic HCN; NaOCl; $ZnCl_2$/HCl
(3) Br_2/water; $ZnCl_2$/HCl; NaOCl (4) $ZnCl_2$/HCl; $FeCl_3$; Alcoholic HCN

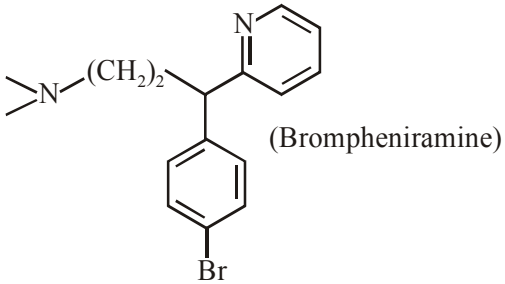
16. Match the following drugs with their therapeutic actions : **[JEE-MAIN-(Sept.)-2020]**

(i) Ranitidine	(a) Antidepressant
(ii) Nardil(Phenelzine)	(b) Antibiotic
(iii) Chloramphenicol	(c) Antihistamine
(iv) Dimetapp(Brompheniramine)	(d) Antacid
	(e) Analgesic

(1) (i)-(a); (ii)-(c); (iii)-(b); (iv)-(e) (2) (i)-(e); (ii)-(a); (iii)-(c); (iv)-(d)
(3) (i)-(d); (ii)-(a); (iii)-(b); (iv)-(c) (4) (i)-(d); (ii)-(c); (iii)-(a); (iv)-(e)

17. The mechanism of action of "Terfenadine" (Seldane) is :- **[JEE-MAIN-(Sept.)-2020]**
(1) Activates the histamine receptor
(2) Inhibits the secretion of histamine
(3) Inhibits the action of histamine receptor
(4) Helps in the secretion of histamine

18. The following molecule acts as an : **[JEE-MAIN-(Sept.)-2020]**



(Brompheniramine)

(1) Antiseptic (2) Anti-bacterial
(3) Anti-histamine (4) Anti-depressant

19. The presence of soluble fluoride ion upto 1 ppm concentration in drinking water, is :
(1) harmful to bones **[JEE-MAIN-(Sept.)-2020]**
(2) harmful for teeth
(3) safe for teeth
(4) harmful to skin

ANSWER KEY

EXERCISE # 1

PART - I

A-1. Ampicillin and amoxicillin.

A-2. Boric acid acts as an antiseptic and as buffering agent.

A-3. Dichlorometaxylenol.

A-4. Proteins, carbohydrates, lipids and nucleic acids.

A-5. "The use of chemicals to destroy infectious micro organisms without causing any injury to the host is called as chemotherapy" .

A-6. Chloroxylenol and terpineol are the main constituents of dettol.

A-7. Aspartame is unstable to heat and therefore it can be used as a sugar substitute in cold drinks and cold foods only.

A-8. Aspirin.

A-9. Bithional is added to soap to reduce undesirable odour, resulting from bacterial decomposition of organic matter on skin.

A-10. (i) Equanil is a tranquiliser and is used for reducing depression.
(ii) Morphine is an alkaloid and is used as an analgesic.

A-11. Target molecules or drug-targets are the macromolecules such as carbohydrates, proteins, lipids, nucleic acids with which the drug interacts in our body to produce therapeutic effect.

A-12. Drug is held to the amino acid residues of the protein present on the active site of the enzyme through forces such as ionic bonding, hydrogen bonding, van der Waals interaction or dipole-dipole interaction.

A-13. A 2-3% solution of iodine in alcohol-water mixture is called tincture of iodine. It is used as an antiseptic.

A-14. Alitame is a high potency sweetener. It is about 2000 times sweeter than sucrose, therefore, the control of sweetness of food is difficult while using it.

A-15. (i) Sodium benzoate (ii) Potassium metabisulphite.

A-16. The two examples of synthetic detergents are :
(i) Sodium lauryl sulphate (ii) Sodium dodecyl benzenesulphonate.

A-17. Ortho-sulphobenzimide, also known as saccharine can be used because it is non-nutritive and is excreted from the body in urine.

A-18. Cleansing action of soaps is because they are soluble in water and can emulsify grease and take it away in the water along with dirt present on grease. Now Ca^{2+} and Mg^{2+} ion present in water react with soap and make it insoluble in water.

$2C_{17}H_{35}COONa + MgCl_2 \longrightarrow (C_{17}H_{35}COO)_2Mg\downarrow + 2NaCl$

Soap (soluble in water) (Hardness of water) White ppt (Insoluble in water)

These insoluble soaps are useless as cleansing agent.

A-19. (i) $\underbrace{CH_3(CH_2)_{10}CH_2}_{\text{Hydrophobic or non-polar part}}-\underbrace{OSO_3^-Na^+}_{\text{Hydrophilic or polar part}}$

(ii) $\underbrace{CH_3(CH_2)_{15}}_{\text{Hydrophobic or non-polar part}}-\underbrace{\overset{+}{N}(CH_3)_3Br^-}_{\text{Hydrophilic or polar part}}$

(iii) $\underbrace{CH_3(CH_2)_{16}}_{\text{Hydrophobic part}}-\underbrace{COO(CH_2CH_2O)_nCH_2CH_2OH}_{\text{Hydrophilic part}}$

A-20. **(i) Streptomycin :** It is an effective broad spectrum antibioctic. It is used for the treatment of tuberculosis, meningitis and pneumonia.
(ii) Paracetamol : These drugs act as antipyretic (reducing fever), and preventing platelet coagulation.
(iii) Anti-fertility drugs : Mifepristone is a synthetic steriod that blocks the effects of progesterone and is used as a "morning after pill" in many countries.

A-21. Antacids and antiallergic drugs do not interfere with the function of each other because they work on different receptors. Thus, antihistamines (antiallergic drugs) do not affect the secretion of acid in stomach because they do not interact with the receptors present in the stomach wall.

A-22. Drugs which can inhibit the enzymes which catalase the degradation of noradrenaline are needed. This will slow down the process of metabolism of noradrenaline and will thus help in counteracting the effect of depression. **Iproniarid and phenelzine** are two such drugs.

A-23. Soaps can be used to check the hardness of water. A sample of soft water will form lather with soap immediately but a sample of hard water will take some time to form lather and also there will be some curdy white precipitates formed in this case.
Synthetic detergents cannot be used to check the hardness of water because they produce lather with soft as well as hard water.

A-24. Hard water contains calcium and magnesium ions.The ions form insoluble calcium and magnesium soaps when sodium soap or potassium soaps are dissolved in hard water

$$2C_{17}H_{35}COONa + CaCl_2 \rightarrow 2NaCl + (C_{17}H_{35}COO)_2Ca$$

insoluble calcium stearate
These insoluble soaps separate as scum in water and are useless as cleaning agent in fact these are hinderance to good washing. Hair washed with hard water become dull because of sticky precipitate. The precipitate adheres on to the fibre of cloth or hairs as gummy mass.

A-25. Drugs are classified in different ways because different types of classification are useful to different persons dealing with drugs. For example, classification of drugs on the basis of pharmacological effect is most useful for doctors because it provides them whole range of drugs available for the treatment of a particular type of health related problem. On the other hand, classification of drugs on the basis of chemical structure or on the basis of molecular targets is useful for medicinal chemists i.e., chemists who are involved in designing and synthesis of drugs.

A-26. Over production of hydrochloric acid in the stomach causes acidity. So, sodium bicarbonate or magnesium or aluminium hydroxide are used as treatment of acidity. However excessive bicarbonate can make the stomach alkaline and trigger the production of even more acid. But the drugs cimetidine and rantidine work in different way. They prevent the interaction of histamine with the receptors present in the stomach wall and this results in release of lesser amount of acid.

PART - II

A-1.	(C)	**A-2.**	(D)	**A-3.**	(B)	**A-4.**	(B)	**A-5.**	(A)
A-6.	(B)	**A-7.**	(A)	**A-8.**	(C)	**A-9.**	(C)	**A-10.**	(A)
A-11.	(B)	**A-12.**	(B)	**A-13.**	(D)	**A-14.**	(B)	**A-15.**	(D)
B-1.	(D)	**B-2.**	(A)	**B-3.**	(C)	**B-4.**	(B)	**B-5.**	(C)
B-6.	(B)	**B-7.**	(C)	**B-8.**	(A)	**B-9.**	(C)	**B-10.**	(C)
B-11.	(A)	**B-12.**	(D)	**B-13.**	(C)	**B-14.**	(B)	**B-15.**	(B)

EXERCISE # 2

PART - I

1.	(A)	**2.**	(C)	**3.**	(B)	**4.**	(A)	**5.**	(C)
6.	(C)	**7.**	(B)	**8.**	(A)	**9.**	(B)	**10.**	(C)
11.	(D)	**12.**	(B)	**13.**	(B)	**14.**	(D)	**15.**	(D)
16.	(A)	**17.**	(A)	**18.**	(B)	**19.**	(A)	**20.**	(D)

PART - II

1.	(BD)	**2.**	(BC)	**3.**	(AB)	**4.**	(ABC)	**5.**	(BD)
6.	(AD)	**7.**	(AD)	**8.**	(ACD)				

PART - III

1.	(B)	**2.**	(B)	**3.**	(D)	**4.**	(BC)	**5.**	(D)

EXERCISE # 3

1.	(3)	**2.**	(3)	**3.**	(1)	**4.**	(3)	**5.**	(1)
6.	(1)	**7.**	(2)	**8.**	(3)	**9.**	(1)	**10.**	(1)
11.	9	**12.**	3	**13.**	13	**14.**	(3)	**15.**	(1)
16.	(3)	**17.**	(3)	**18.**	(3)	**19.**	(3)		

SELF ASSESSMENT PAPER

PART-I : OBJECTIVE TYPE QUESTIONS

1. 2-Acetoxy benzoic acid is used as an :
(A) antimalarial (B) antidepressant (C) antiseptic (D) antipyretic

2. A drug that is antipyretic as well as analgesic is :
(A) chloroquin (B) penicillin
(C) paracetamol (D) chloropromazine hydrochloride

3. Bithional is an example of :
(A) disinfectant (B) antiseptic (C) antibiotic (D) analgesic

4. Which of the following sets of bases is present both in DNA and RNA ?
(A) Adenine, uracil, thymine (B) Adenine, guanine, cytosine
(C) Adenine, guanine, uracil (D) Adenine, guanine, thymine

5. Which base is found only in the nucleotides of RNA ?
(A) Adenine (B) Uracil (C) Guanine (D) Cytosine

6. Medicine which is an antibiotic is –
(A) Ampicillin (B) Aspirin (C) Chloroquine (D) None of these

7. Sulpha drugs are derivatives of –
(A) Benzene sulphonic acid (B) Sulphanillic acid
(C) Sulphanilamide (D) p - aminobenzoic acid

8. Which of the following is an antidiabetic drug –
(A) Insulin (B) Penicillin (C) Chloroquine (D) Aspirin

9. Match List-I with List-II and select the correct answer using the codes given below the lists –

List I	**List II**
I. Iodoform	A. Anaesthetic
II. Methyl salicylate	B. Antiseptic
III. Diethyl ether	C. Insecticide
IV. Hexachlorocyclohexane	D. Detergent
	E. Pain Balm

(A) I–B, II–E, III–C, IV–D (B) I–D, II–B, III–A, IV–C
(C) I–B, II–E, III–A, IV–C (D) I–C, II–A, III–D IV–B

10. Drug which helps to reduce anxiety and brings about calmness is called as :
(A) analgesic (B) diuretioc (C) tranquilizer (D) antihistamine

11. Which of the following vitamins are in water soluble ?
(A) A and E (B) A and E (C) B and C (D) D and E

12. Prosthetic group in Glycoprotein is :
(A) vitamines (B) fats (C) carbohydrates (D) nucleic acid

13. Which of the following is an unsaturated fatty acid ?
(A) Stearic acid (B) Linolic acid (C) Lauric acid (D) Palmatic acid.

14. A person suffered from injury and there was considerable delay in clotting of blood. It may be due to the deficiency of
(A) vitamin A (B) vitamin B (C) vitamin C (D) vitamin K

15. One among the following classes of compounds is not a biopolymer
(A) proteins (B) steroids (C) nucleic acids (D) glycogens.

16. Insulin, a hormone secreted by the pancreas is a
(A) carbohydrate (B) steroid (C) protein (D) nucleic acid

17. Silver iodide is used to produce artificial rain because.
(A) it is stable at high temperature (B) it is insoluble in rain water
(C) it can be easily spread (D) it has a seeding effect.

18. Normally carbohydrates are not present as a part of molecule in the cell.
(A) lipid (B) protein (C) DNA (D) vitamin

19. The biomolecule which does not have a secondary structure is
(A) Protein (B) Lipid (C) DNA (D) RNA

20. Protein and DNA being charged molecule, can be separated by
(A) Electrophoresis (B) Centrifugation (C) Filtration (D) Spectrophotometry

PART-II : NUMERICAL TYPE QUESTIONS

1. How many of the following are antifical sweeteners?
(i) Aspartame (ii) Saccharin (iii) Sucralose
(iv) Bithionol (v) Terpineol (vi) Chloroxylenol
(vii) Alitame (viii) Sodium Benzoate (ix) Sorbic acid

2. In how many of the following drugs, S is present ?
(i) Histamine (ii) Cimetidine (iii) Ranitidine
(iv) Terfenadine (v) Phenelzine (vi) Veronal
(vii) Valium (viii) Sulphonamide (ix) Sulphapyridine

3. From the given set of drugs, how many of them can be used as antibiotics ?
(i) Penicillin (ii) Erythromycin (iii) Ofloxacin.
(iv) Tetracycline (v) Chloramphenicol (vi) Salvarsan
(vii) Prontosil (viii) Bithional (ix) Chloroxylenol

4. Sweetness of artificial sugar alitame as compare to natural sugar is _____times.

5. Number of carbon atoms in anionic detergent sodium lauryl sulphate is _____.

SAP ANSWER KEY

PART-I

1.	(D)	**2.**	(C)	**3.**	(A)	**4.**	(B)	**5.**	(B)
6.	(A)	**7.**	(C)	**8.**	(A)	**9.**	(C)	**10.**	(C)
11.	(C)	**12.**	(C)	**13.**	(B)	**14.**	(D)	**15.**	(B)
16.	(C)	**17.**	(D)	**18.**	(D)	**19.**	(B)	**20.**	(A)

PART-II

1.	4 (i, ii, iii and vii)	**2.**	(ii, iii, viii, ix)	**3.**	7 (i to vii only)
4.	2000	**5.**	12		

SAP SOLUTIONS

PART-I

4. Adenine, guanine, cytosine sets of bases is present both in DNA and RNA.

5. Uracil base is found only in the nucleotides of RNA

19. Lipids does not have a secondary structures.

20. The charged particles/molecules can be seperated by electrophoresis.

PART-II

1. 4 (i, ii, iii and vii) are antifical sweeteners.

2. Cimetidine, Ranitidine, Sulphonamide and Sulphapyridine has "S" present in it.

3. Bithional and Chloroxylenol are antiseptics.

ENVIRONMENTAL CHEMISTRY

Environmental pollution

A substance, which causes pollution, is known as pollutant. Pollutants can be solid, liquid or gaseous substances present in greater concentration than in natural abundance and are produced due to human activities or due to natural happenings.

Degradable pollutants: Which rapidly break down by natural processes. For example, discarded vegetable.

Non-degradable pollutants : These remain in the environment in an unchanged form for many decades. For example dichloro diphenyltrichloroethane (DDT), plastic materials, heavy metals, nuclear wastes etc.

Atmosphere	**Hydrosphere**	**Lithosphere**	**Biosphere**
Layers of air that surrounds the earth.	The portion of water present on the earth is called hydrosphere.	Except hydrosphere rest of the earth space is in the form of land is called lithosphere.	All living organism lies plants, animals and human beings constitute biosphere.

Atmosphere (Atmosphere is protective blanket of gases surrounding the earth)			
Troposphere	**Stratosphere**	**Mesosphere**	**Thermosphere**
Lowest region of the atmosphere in which the human being along with other organisms live. Extends up to the height of 10 KM from sea level. Turbulent, dusty zone containing air, much water vapours and clouds.	Above the troposphere between 10 and 50 KM above sea level. It contains N_2, O_2, O_3, and little water vapours.	Above the Stratosphere between 50 and 85 KM above sea level. It is coldest part of atmosphere. (temp. aapx.–100ºC)	Above the Mesosphere between 85 and 500 KM above sea level. It contains O_2^+, O^+, NO^+ It is also used for satellites orbit.

1. Tropospheric pollution

(a) Particulate pollutants : Particulate refers to minute solid particles & liquid droplets in air. Examples of particulate pollutants are soot, flyash from thermal power plants, cement dust, petrocoke from petroleum refineries.

Non-viable Particulate pollutants	**Description**	**Examples of pollutants**
Smoke	Consist of solid or mixture of solid and liquid particles produced by combustion of organic matter	Cigarette smoke, smoke from burning of fossil fuel, garbage and dry leaves, oil smoke etc.
Dust	Consists of fine solid particles (over 1µm in diameter) produced during crushing, grinding and attribution of solid materials.	Sand from sand blasting, saw dust from wood works, pulverized coal, cement and fly ash from factories, dust storms etc.
Mist	Produced by particles of spray liquids and by condensation of vapours in air	H_2SO_4 mist, herbicides and insecticides that miss their target and travel through air and form mists.
Fume	Produced by the condensation of vapours during sublimation, distillation, boiling and several chemical reactions.	Organic solvents, metals and metallic oxides form fume particles.

*** The viable particulates are bacteria, fungi, moulds, algae etc.**

***Particulate pollutants bigger than 5 microns are likely to lodge in the nasal passage. Particles of about 1.0 micron enter into lungs.**

(b) Gaseous air pollutant : SO_2, H_2S, NO, NO_2, CO, CO_2, Oxidants (O_3, PAN)

Oxides	Source of oxides	Reactions associated with oxides	Toxic effects
Oxides of sulphur (SO_2)	From fossil fuel, paper making, smelting of ore, volcanic eruption	$2SO_2(g) + O_2(g) \xrightarrow[\text{Matter(catalyst)}]{\text{Particulate}} 2SO_3(g)$ SO2(g)+O3(g) ⟶ SO3(g) +O2(g) SO2(g)+H2O2(ℓ) ⟶ H2SO4 (aq)	(i) Causes headache, vomiting, irritation of eyes & respiratory diseases (bronchitis, asthma, emphysema). (ii) Source of acid rain (iii) Defoliation (Stiffness of flower buds)
Oxides Of Nitrogen (NO & NO_2)	In automobile engine, when fossil fuel (i.e. hydrocarbons) is burnt, N_2 and O_2 combine to give significant quantities of nitric oxide (NO) and NO_2.	N2(g) + O2(g) $\xrightarrow[\text{Lightning strikess}]{148K}$ 2NO (g) $SO_2(g) + O_3(g) \longrightarrow 2NO_2(g)$ (slow reaction) $NO(g) + O_3(g) \longrightarrow NO_2(g) + O_2(g)$ (fast reaction)	(i) The irritant red haze in the traffic and congested places is due to oxides of nitrogen. (ii) Higher concentration of NO2 damages the leaves of plants and retard the rate of photosynthesis. (iii) NO2 is lung irritant, toxic to living tissues, harmful for metals and textile fibers.
Hydrocarbons			(i) They are carcinogenic, (cause cancer). (ii) In plants, they cause ageing, break down of tissues and shedding of leaves, flowers and twigs.
Oxides of carbon (CO)	(i) Incomplete combustion of carbon, coal, fire wood, petrol etc. (ii) Automobile exhaust		(i) It binds to haemoglobin to form carboxy haemoglobin. This stable complex [300 times more than oxyhaemoglobin] reduces the oxygen carrying capacity of blood to greater extent. (ii) It forms photochemical smog.
Oxides of carbon (CO_2)	(i) By respiration (ii) Burning of fossil fuels for energy. (iii) Decomposition of lime stone during the manufacture of cement. (iv) Volcanic eruptions.	CO2 is confined to troposphere only (approx. 0.03% of atmosphere)	(i) Increased amount of CO2 in the air is mainly responsible for global warming.

(c) Global warming and Greenhouse effect (Tropospheric phenomenon)

About 75 % of the solar energy reaching the earth is absorbed by the earth's surface, which increases its temperature. The rest of the heat radiates back to the atmosphere. Some of the heat is trapped by gases such as carbon dioxide, methane, ozone, chlorofluorocarbon compounds (CFCs) and water vapour in the atmosphere. Thus, they add to the heating of the atmosphere. This causes global warming.

• Gases such as CO_2, CH_4, O_3, water vapours, nitrous oxide (N_2O), CFCs (chloro fluorocarbons) allow sun rays to pass through them but then absorb and reradiate the heat back towards the earth. These are therefore termed as **greenhouse gases**.

The atmosphere has kept the temperature on earth constant. As the glass in a greenhouse holds the sun's warmth inside, atmosphere traps the sun's heat near the earth's surface and keeps it warm. This is called natural greenhouse effect.

Source of pollutants

Green house gases	Sources
CO_2	Fossil fuel burning.
Nitrous oxide (N_2O)	Chemical fertilizer, automobile exhaust and animal waste.
CH_4	Bacterial decomposition, biogas, flooded rice fields, paddy fields, coal mines, fossil fuels.
CFCs	Freon (a refrigerant), areosol sprays.
HALONS(halocarbons)	Fire extinguishers.

Harmful effect of global warming

(1) Melting of polar ice caps and rise in sea level.
(2) Increase global temperature and climatic change (Drought).
(3) Effect on plant growth and animals.
(4) Increase infectious diseases like dengue, malaria, yellow fever, sleeping sickness etc.

(d) Acid rain (Tropospheric phenomenon)

When the pH of rain water drops below 5.6 (Where as normal rain water pH is 5.6) it is called acid rain.

$H_2O\ (l) + CO_2\ (g) \rightarrow H_2CO_3\ (aq)$

$H_2CO_3\ (aq) \rightarrow H^+\ (aq) + HCO_3^-\ (aq)$

Nowadays, the term acid rain is used to describe the way in which acid from the atmosphere is deposited on the earth's surface. It mainly consists of oxides of sulphur and nitrogen.

Source of pollutants

(1) Burning of fossil fuels (which contain sulphur and nitrogeneous matter) such as coal and oil in power station and furnaces or petrol and diesel in motor engines.
(2) Volcanic eruptions, forest fires and bacterial decomposition of organic matter.

Reactions : $2SO_2(g) + O_2(g) + 2H_2O\ (\ell) \longrightarrow 2H_2SO_4\ (aq)$

$4NO_2(g) + O_2(g) + 2H_2O\ (\ell) \longrightarrow 4HNO_3\ (aq)$

Harmful effect of acid rain

(1) Acid rain is harmful for agriculture, plants and trees because it dissolves and washes away nutrients needed for their growth.
(2) Acid rain affects plants and animal life in aquatic ecosystem.
(3) It causes respiratory ailments in human beings and animals.
(4) It corrodes water pipes resulting in the dissolution of heay metals such as iron, lead and copper into the drinking water.
(5) Building materials such as stone, marble, (for example **Taj Mahal**) dolomite, mortar, slate or metal are corroded and weakened on reaction with acid rain because of the formation of soluble compounds.

$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + CO_2\uparrow + H_2O$

(e) Smog (Tropospheric phenomenon)

- Smog is a combination of smoke and fog.
- NO_2 and hydrocarbons are modified by sunlight to form photochemical smog.
- Pollutants like sulphur dioxide which is released while burning sulphur containing fuels (fossil fuels) and particulate matter like soot present in stagnant air masses, get modified in sunlight and form a sheet called photochemical smog.

Classical smog	Photochemical smog
Occurs in cool humid climate.	Occurs in warm, dry & sunny climate.
Mixture of smoke, fog, SO_2.	Components are unsaturated hydrocarbon and nitrogen oxides (NO).
Reducing in nature so called reducing smog.	Oxidizing in atmosphere so called oxidizing smog.

Source of pollutants

Automobile exhausts give out NO_2 and hydrocarbons. They form PAN (peroxyacetyl nitrate) which along with ozone and SO_2 forms photochemical smog.

Reactions

- When the concentration of these pollutants increases to sufficiently high levels, a chain reaction occurs from their interaction with sunlight in which NO is converted into NO_2. This NO_2 in turn absorbs energy from sunlight and decomposes into NO and free oxygen atom.

$NO_2(g) \xrightarrow{h\nu} NO(g) + O(g)$ _____ (i)

Oxygen atom being very reactive combines with atmospheric oxygen forming ozone.

$O(g) + O_2(g) \rightleftharpoons O_3(g)$ _____ (ii)

The ozone formed in the above reaction reacts rapidly with the NO(g) formed in the reaction (i) to regenerate NO_2. NO_2 is a reddish brown gas and at sufficiently high level can contribute to haze.

$NO(g) + O_3(g) \longrightarrow NO_2(g) + O_2(g)$ _____ (iii)

- Like NO_2, O_3 is a toxic gas and both NO_2 and O_3 are strong oxidising agents. They can react with the unburnt hydrocarbons in the polluted air to produce **components of photochemical smog** (like formaldehyde, acrolein and PAN).

$3CH_4 + 2O_3 \longrightarrow 3CH_2{=}O + 3H_2O$

$CH_2{=}CHCH{=}O$ (acrolein)

$CH_3\overset{\overset{O}{\|}}{C}OONO_2$ Peroxyacetyl nitrate (PAN)

Harmful effect of photochemical smog

Exposure to smog causes respiratory problems, bronchitis, sore throat, cold, headache, chest pain and irritation to eyes (red shot eyes). Smog also damages crops (reduces crop yield) and leads to cracking of rubber, corrosion of metals, stones etc.

Primary precursors → NO_2 and hydrocarbon.

Secondary precursors → O_3 and PAN.

Note : To reduce the formation of photochemical smog control **primary precursors.**

2. Ozone hole (Stratospheric phenomenon)

- The energy of the sun splits some molecular O_2 in this layer to give individual (O) atoms which combine with intact molecular oxygen to give O_3. The layer of O_3 forms a shield as it absorbs UV rays **(λ 200 - 315 nm)** and prevent them from striking the earth.
- The highly energetic ultra violet radiation splits up the CFCs, releasing chlorine radical. The released chlorine radical is responsible for convertion of the ozone into oxygen molecule consequently depletion of ozone layer occurs. The area where the ozone is completely destroyed is known as **ozone hole.**

$$CF_2Cl_2(g) \xrightarrow{UV} \dot{Cl}(g) + \dot{C}F_2Cl(g) \quad .....(i)$$

$$\dot{Cl}(g) + O_3(g) \rightarrow Cl\dot{O}(g) + O_2(g) \quad .....(ii)$$

$$Cl\dot{O}(g) + O(g) \rightarrow \dot{Cl}(g) + O_2(g) \quad .....(iii)$$

Source of pollutants

(1) Chlorofluorocarbons (CFCs) are the heat transfer agents used in refrigerators and air conditioners, and foaming agents in foam cups and cartons. one molecule of CFC is capable of destroying 1,00,000 ozone molecules in the stratosphere.

(2) Halons or halocarbons are anti fire agents used in fire extinguishers.

Reactions :

$$\dot{Cl}O(g) + NO_2(g) \rightarrow ClONO_2(g)$$

$$\dot{Cl}(g) + CH_4(g) \rightarrow \dot{C}H_3(g) + HCl(g)$$

$$ClONO_2(g) + H_2O(g) \rightarrow HOCl(g) + HNO_3(g)$$

$$ClONO_2(g) + HCl(g) \rightarrow Cl_2(g) + HNO_3(g)$$

When sunlight returns to the Antarctica in the spring, the sun's warmth breaks up the clouds and HOCl and Cl_2 are photolysed by sunlight, as given in reactions (viii) and (ix).

$$HOCl(g) \xrightarrow{h\nu} \dot{O}H(g) + \dot{Cl}(g)$$

$$Cl_2(g) \xrightarrow{h\nu} 2\dot{Cl}(g)$$

The chlorine radicals thus formed, initiate the chain reaction for ozone depletion.

Harmful effect of ozone hole

(1) Plants and animals living on the surface will start dying.

(2) UV radiation will fasten the formation of smog.

(3) Temperature of the earth will increase leading to rise in sea level and flooding of low lying areas.

(4) More UV rays will directly fall on the skin of humans causing skin cancer.

(5) Leaves of plants will show chlorosis (loss of chlorophyll and yellowing).

3. Water pollution

Water pollution may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings.

Water may be called polluted when the following parameters stated below reach beyond a specified concentration in water.

(a) Physical parameters. Colour, odour, turbidity, taste, temperature constitute the physical parameters and are good indicators of contamination. For instance, colour and turbidity are visible evidences of polluted water while an offensive odour or a bitter and different than normal taste also makes water unfit for drinking.

(b) Chemical parameters: These include the amount of carbonates, sulphates, chlorides, fluorides, nitrates, and metal ions. These chemicals form the total dissolved solids, present in water.

Pollutants	Concentration		
	Lower limit	Upper limit	
Lead	0	50 **ppb (Parts per billion)**	• Lead can damage kidney, liver, reproductive system.
Fluoride	1 ppm or 1 mg dm^{-3}	2ppm	• Its deficiency in drinking water causes diseases such as tooth decay. • Above 2 ppm causes brown mottling of teeth. • Excess fluoride (over 10 ppm) causes harmful effect to bones and teeth.
Nitrate	0	50 ppm	• Excess nitrate cause disease such as methemoglobinemia ('blue baby' syndrome).
Sulphate	0	500 ppm	• Excessive sulphate (>500 ppm) in drinking water causes laxative effect. Harmless in moderate level.

Maximum prescribed concentration of some metals in drinking water

Metal	Cd	Mn	Al	Fe	Cu	Zn
Maximum concentration (ppm)	0.005	0.05	0.2	0.2	3.0	5.0

Que. Why deficiency of fluoride (F^-) in drinking water is harmful?

Ans. Soluble fluoride is often added to drinking water to bring its concentration up to 1 ppm or 1 mg dm^{-3}.The F^- ions make the enamel on teeth much harder by converting

hydroxyapatite [$3(Ca_3(PO_4)_2.Ca(OH)_2$], enamel on the surface of the teeth, into much harder **fluorapatite [$3(Ca_3(PO_4)_2.CaF_2$].**

(c) Biological parameters:

The biological parameters include matter like algae, fungi, viruses, protozoa and bacteria. Bacteria decomposes organic matter present in water or microorganisms oxidise organic matter. This process reduces dissolved oxygen (DO) in water. The concentration of DO in water is very important for aquatic life. In cold water, DO can reach a concentration up to 10 ppm (parts per million), whereas oxygen in air is about 200,000 ppm.

Sources of water pollutants

Point sources	Non-point sources
Well defined and easily identified sources that emit pollutants into different water bodies	Pollutants sources scattered or spread over larger area.
Point source of pollution can be effectively checked.	It is quite difficult to control non point sources.
Examples : Municipal and industrial discharge pipes.	**Examples :** Run off from agriculture farms, construction sites.

Causes of water pollutants, their sources and effects

Pollutant	Sources of pollutants	Effects and significance
Pathogens	Sewage, human and animal wastes, natural and urban runoff from land, industrial waste	Depletion of dissolved oxygen in water (foul odour) health effects (outbreaks of water borne diseases).
Organic pollutants • Oil and grease • Pesticides and weedicides • Plastics • Detergents • Fertilizers	Automobile and machine waste, tanker spills, offshore oil leakage. Chemicals used for better yield from agriculture. Industrial and household waste	Disruption of marine life, toxic effects (harmful for aquatic life), possible genetic defects kills fish (Eutrophication) and cancer.
• Inorganic pollutants • Fertilizers (Phosphates and nitrates) • PCBs • Acids & alkalies • (Na & Ca chloride) • Cd, Hg, Ni	Agricultural runoff. Mine drainage, industrial wastes, natural and urban runoff	Algal bloom (Algae bloom) and eutrophication, nitrates cause methemoglobenemia, carcinogen. Kill fresh water organisms, unfit for drinking, irrigation and industrial use.

(d) Biological Oxygen Demand (BOD)

- The amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water, is called **Biochemical Oxygen Demand (BOD).**
- The greater the amount of organic waste in the water body, the greater is the amount of oxygen required to break it down biologically and therefore higher is the BOD value of water. This value is a good measure in evaluating the degree of pollution in a water body.
- Clean water would have BOD value of less than **5ppm** whereas highly polluted water could have a BOD value of **17ppm** or more.

Eutrophication

- Eutrophication is a process by which a water body slowly becomes rich in plant nutrients such as nitrates and phosphates.
- This process in which nutrient enriched water bodies support a dense plant population, which kills animal life by **depriving** it of oxygen and results in subsequent loss of biodiversity is known as ***Eutrophication.***

(e) Chemical oxygen demand (COD)

It is calculated as the amount of oxygen required to oxidise the polluting substances. It is measured by treating the given sample of water with an oxidizing agent, generally $K_2Cr_2O_7$ in presence of dilute H_2SO_4.

4. Soil pollution

Insecticides, pesticides and herbicides cause soil pollution.

(a) Pesticides

Pesticides are synthetic toxic chemicals with ecological repercussions.

The repeated use of the same or similar pesticides give rise to pests that are resistant to that group of pesticides thus making the pesticide ineffective. Therefore, other organic toxins such as **Aldrin** and **Dieldrin** were introduced, as insect resistance of DDT increased. Most of them are water **insoluble** and **non-biodegradable**. These high persistant toxins are, therefore,

transferred from lower trophic level to higher trophic level through food chain. Over the time, concentration of the toxins (higher in animals) reach a level which causes serious metabolic and physiological disorders.

(b) Herbicides

Herbicides such as sodium chlorate ($NaClO_3$), sodium arsenite (Na_3AsO_3) and many other are now a days used to kill weeds. However because of their toxic effect to mammals their use have been restricted, some herbicides cause birth effect.

These days, organic compounds such as **triazines** are widely used as herbicides.

(c) Insecticides

These are used to control insects and thus help to curb diseases and protect crops. They include **polychlorinated** hydrocarbons, DDT, BHC and malathion (organophosphate insecticide) etc. However, due to adverse effects, use of DDT has been banned in india.

5. Industrial waste

(a) Biodegradable waste

Generated by cotton mills, food processing units, paper mills and textile factories.

(b) Non-Biodegradable waste

Generated by thermal power plants (fly ash); integrated iron and steel plants (blast furnace slag and steel melting slag); aluminium, zinc and copper manufacture (mud and tailings); Fertilizer industires (gypsum)

Disposal of non-biodegradable waste

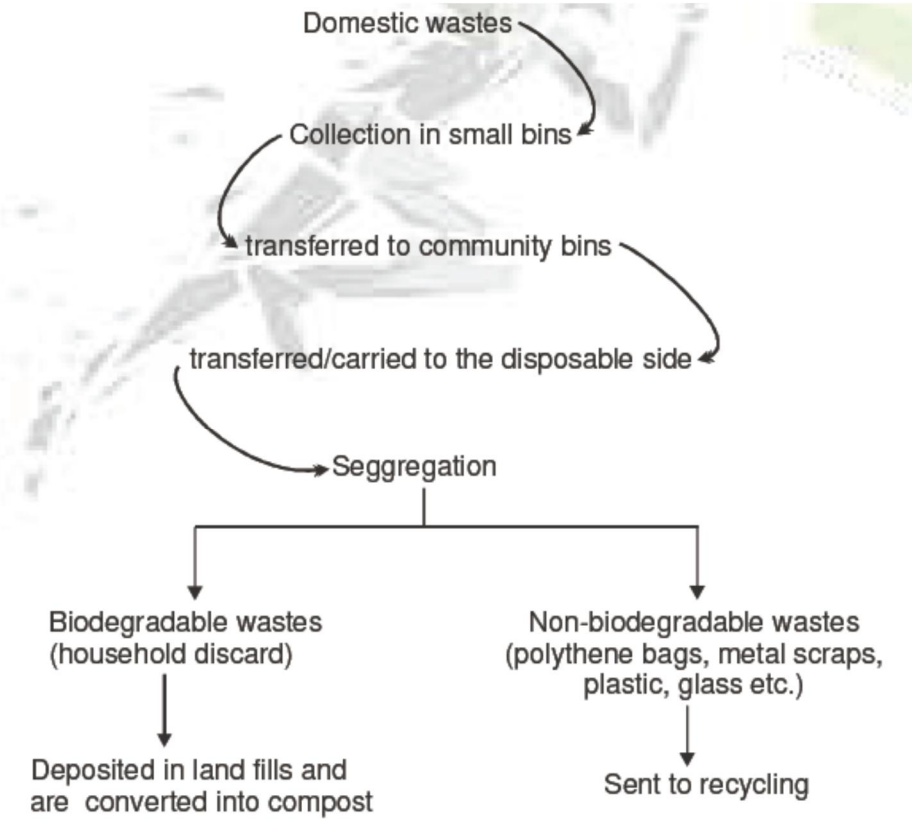
Fly ash and slag from the steel industries are used in the cement industries.

Large quantities of toxic wastes are usually destroyed by controlled incineration, while small quantities are burnt along with factory garbage in open bins.

Waste management

In addition to the improper disposal of the house hold wastes, disposal of medical, agriculture, industrial and mining wastes is one of the major causes of environmental degradation. Therefore, management of wastes is of utmost importance.

Collection and disposal of waste



Note : (1) Non-biodegradable waste like polythene bag, metal scraps, etc choke the sewers and if polythene bags are swallowed by cattle, it can cost their lives also. The poor waste management causes health problems leading to epidemics due to contamination of ground water.

(2) The persons who are directly involved in the collection and disposal of waste should make the use of protective device such as gloves or water proof boots and gas masks etc.

6. Green Chemistry

Adopting methods in day-to-day life, which results in the reduction of environmental pollution which is in its infancy known as **green chemistry**. It utilizes the existing knowledge and practices so as to bring about reduction in the production of pollutants. Green chemistry leads to reduction in-

(i) material (ii) energy consumption (iii) waste generation.

Green chemistry in day-to-day life -

(i) Dry cleaning of clothes : Tetra chloroethene used for dry cleaning was found to contaminate the ground water and is also a suspected carcinogen. This compound has now been replaced by liquefied carbondioxide with a suitable detergent. This will result in less harm to ground water.

(ii) Bleaching of paper : Use of H_2O_2 with suitable catalyst has replaced the use of chlorine gas for bleaching paper.

(iii) Synthesis of chemicals [Ethanal is prepared by one step oxidation of ethene]

$$CH_2 = CH_2 + O_2 \xrightarrow[Pd(II)/Cu(I)(inwater)]{Catalyst} CH_3CHO\ (90\%)$$

Exercise # 1

PART - I : OBJECTIVE QUESTIONS

Section (A) : Gaseous air pollutants

A-1. Burning of fossil fuels is the main source of, which of the following pollutants ?
(A) Nitrogen oxide (B) Nitric oxide (C) Nitrous oxide (D) Sulphur dioxide

A-2. SO_2 and NO_2 produce pollution by increasing :
(A) alkalinity (B) acidity (C) neutrality (D) buffer action

A-3. Air pollutants that produce photochemical oxidants include :
(A) CO_2, CO and SO_2 (B) N_2O, NO and HNO_3
(C) O_2, Cl_2 and HNO_3. (D) O_3, Cl_2 and SO_2

A-4. Carbon monoxide is toxic as it :
(A) inactivates nerves (B) inhibits glycolysis
(C) combines with oxygen (D) combines with haemoglobin

A-5. Acid rains are produced by :
(A) excess NO_2 and SO_2 from burning fossil fuels
(B) excess production of NH_3 by industry and coal gas
(C) excess release of carbon monoxide by incomplete combustion
(D) excess formation of CO_2 by combustion and animal respiration.

A-6. Spraying of DDT produces pollution of the type:
(A) air (B) air and water (C) air and soil (D) air, water and soil

A-7. Ozone layer of upper atmosphere is being destroyed by :
(A) chlorofluorocarbon (B) SO_2
(C) photochemical oxidants/O_2 & CO_2 (D) smog

A-8. Chlorofluorocarbon releases which of the following species which is harmful to ozone layer ?
(A) fluorine radical (B) chlorine radical (C) nitrogen peroxide (D) sulphur dioxide

A-9. Most hazardous metal pollutant of automobile exhausts is :
(A) mercury (B) cadmium (C) lead (D) copper

A-10. Classical smog occurs in places of :
(A) excess CO_2 (B) cool and humid climate
(C) warm, dry and sunny (D) excess NH_3

A-11. Which of the following statements is true about photochemical smog ?
(A) It is reducing in nature.
(B) it is formed in winter.
(C) It is a sulphurous smog.
(D) Components of the smog, NO and O_3, irritate the nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing.

A-12. Besides CO_2, the other green house gas is :
(A) CH_4 (B) N_2 (C) Ar (D) O_2

A-13. Ultraviolet radiation from sun causes a reaction that produces :
(A) fluorides (B) carbon monooxide (C) sulphur dioxide (D) ozone

A-14. Ozone depletion in stratosphere results in :
(A) forest fires (B) increased incidence of skin burns and skin cancer
(C) increase in biological oxygen demand (D) global warming

A-15. Which of the following statements is true ?
(A) London smog is oxidising in nature.
(B) London smog contains H_2SO_4 droplets.
(C) London smog is mixture of smoke, fog and SO_2.
(D) London smog causes bronchitis.

A-16. Which of the following processes does not increase the amount of CO_2 in atmosphere ?
(A) Decay of animals (B) Breathing
(C) Photosynthesis (D) Burning of petrol

A-17. Consider the following statement and select the correct option :
S_1 : Dust is the non-viable particle.
S_2 : Particulates acquire negative charge and are attracted by the positive electrode.
S_3 : O_2 is a green house gas.
S_4 : Algae is a viable particulate.
(A) S_1 and S_2 only (B) S_1, S_2 and S_3 only (C) S_1, S_2 and S_4 only (D) S_2, S_3 and S_4

A-18. Incomplete combustion of petrol or diesel oil in automobile engines can be best detected by testing the fuel gases for the presence of ?
(A) CO and water vapour (B) CO
(C) NO_2 (D) SO_2

Section (B) : Water pollution , soil pollution and waste management

B-1. Which causes water pollution ?
(A) Pathogens (B) Automobile exhausts
(C) PCBs (D) (A) and (C)

B-2. Water pollution is negligible if BOD is :
(A) less than 5 ppm (B) less than 15 ppm (C) less than 50 ppm (D) less than 100 ppm

B-3. Most abundant water pollutant is :
(A) detergents (B) pesticides (C) industrial wastes (D) ammonia

B-4. Drained sewage has biological oxygen demand (BOD) :
(A) more than that of water (B) less than that of water
(C) equal to that of water (D) none of the above

B-5. Eutrophication causes reduction in :
(A) dissolved hydrogen (B) dissolved oxygen (C) dissolved salts (D) dissolved CO_2

B-6. Which of the following will increase the BOD of water supply ?
(A) CO_2 (B) O_3 (C) H_2O (D) C_2H_5OH

B-7. Sewage water is purified by :
(A) microorganism (B) light (C) fishes (D) aquatic plants

B-8. Which of the following is not a herbicide ?
(A) Sodium chlorate (B) Sodium arsenate (C) Phosphate (D) Triazines

B-9. DDT is :
(A) green house gas (B) biodegradable pollutant
(C) non-biodegradable pollutant (D) none of above

B-10. Domestic waste mostly constitutes :
(A) non-biodegradable pollution (B) biodegradable pollution
(C) effluents (D) air pollution

B-11. Measurement of rate oxygen utilisation by a unit volume of water over a period of time is to measure :
(A) fermentation (B) biogas generation
(C) biosynthetic pathway (D) biological oxygen demand.

B-12. Fishes die in water bodies polluted by sewage due to :
(A) pathogens (B) clogging of gills by silt
(C) reduction in oxygen (D) foul smell

B-13. Which of the following statements is false ?
(A) The industrial and domestic sewage discharge is the main reason for river water pollution.
(B) Surface water contains a lot of organic matter and mineral nutrients.
(C) Oil spill in sea water causes heavy damage to fishery.
(D) Oil slick in sea water increases dissolved oxygen.

B-14. Which of the following statements is true ?
(A) The lower the concentration of dissolved oxygen, the more polluted is the water sample.
(B) The tolerable limit of lead in drinking water is 50 ppb.
(C) Water is considered pure if it has BOD less than 5 ppm.
(D) All of these

B-15. Modes of controlliing pollution in large cities includes :
(A) cleanliness and less use of insecticides
(B) proper disposal of organic wastes, sewage and industrial effluents.
(C) use of liquefied carbondioxide with a suitable detergent in place of tetrachloroethene for dry cleaning.
(D) all the above

Exercise # 2

PART - I : OBJECTIVE QUESTIONS

1. If BOD of river is high, it means that the river is :-
(A) Not polluted
(B) Very much polluted with inorganic chemicals
(C) Very much polluted with organic chemicals which are decomposed by micro-organisms
(D) Polluted with pesticides

2. When huge amount of sewage is dumped in a river, the BOD will :-
(A) Increase (B) Remain unchanged
(C) Decrease (D) Increase or decrease

3. By what method the quantity of organic pollutants in water can be determined
(A) By measuring BOD
(B) By pH Measurement
(C) By transparency measurements
(D) By measuring the change of colour/CFC

4. A dental disease characterised by mottling of teeth is due to presence of a certain chemical element in drinking water. Which is the element -
(A) Fluorine (B) Mercury (C) Boron (D) Chlorine

5. Excess of nitrate in drinking water causes :-
(A) Beri-Beri syndrome (B) Rickets syndrome
(C) Laxative effect (D) Methemoglobinemia ('blue baby' syndrome)

6. Eutrophication is caused by
(A) Increase nutrient concentration (B) Petrochemical and fertilizer plant effluents
(C) NO_3^{-1} and SO_4^{-2} present in acid rains (D) Mine effluents

7. Continuous sewage flow into a stream would lead to-
(A) Increase in temperature (B) Algal bloom
(C) Eutrophication (D) Depletion of oxygen

8. Indiscriminate use of DDT is undesirable because -
(A) It is harmful (B) It is dcgradable
(C) It causes mutation (D) It is accumulated in food chain

9. Fluorosis, a bone disease, is caused by the presence of :-
(A) Pesticides in water (B) Fluorides in water
(C) Carbon monoxide in air (D) Sulphur dioxide in air

10. Major source of methane in India is :
(A) fruit orchards (B) sugar cane plantatton
(C) rice fields (D) wheat fields

11. Which oxide of nitrogen is not a common pollutant introduced into the atmosphere both due to natural and human activity?
(A) NO_2 (B) N_2O (C) N_2O_5 (D) NO

12. Which of the following is a sink for CO?
(A) Haemoglobin (B) Micro-organisms present in the soil
(C) Oceans (D) Plants

13. Which of the following statement is correct ?
(A) Lower stratosphere consists of considerable amount of ozone.
(B) Ozone layer protects humans living on earth from the harmful effect of ultraviolet radiations coming from sun.
(C) Ozone is thermodynamically stable.
(D) Smoke clouds play significant role in creating ozone over antarctica.

14. Which of the following compound belong to the class of freons ?
(A) CCl_4 (B) $COCl_2$ (C) C_3O_2 (D) CF_2Cl_2

15. The extensive use of CFC'S as refrigerant fluids and in aerosol is because of :
(A) its high chemical stability (B) good absorber of UV radiation
(C) its polar nature (D) high toxicity

16. In stratosphere, which of the following radical destroy the O_3 ?
(A) $\dot{C}H_3$ (B) $\dot{C}l$ (C) $\dot{F}$ (D) Cl_2

17. Which of the following helps in creating ozone over antractia ?
(A) Radioactive clouds (B) Polar stratospheric clouds
(C) Spring clouds (D) Smoke clouds

18. Which are natural sinks for $\dot{C}lO$ radicals in other parts of stratosphere ?
(A) SO_2 and NO_2 (B) NO and NO_2 (C) CH_4 and NO_2 (D) Cl_2 and F_2

19. Eutrophication is a source of water pollution. It occurs when water :
(A) is low in nutrients (B) is high in nutrients
(C) has high temperature (D) has excess amount of organic matter

20. Which of the following statements is false ?
(A) Absorption of the terresterially radiated heat by the carbondioxide is the main cause of global warming.
(B) The global warming will increases the rate of melting of **polar ice caps** increasing the sea level.
(C) The global warming of the earth surface is mainly due to reforestation.
(D) CO_2, NO, CH_4, O_3, CCl_4 and water vapour are green house gases.

21. Which of the following is the primary precursor of photochemical smog ?
(A) Hydrocarbon (B) Ozone (C) PAN (D) Water vapour

22. Photochemical smog can be reduced by :
(A) using catalytic converter in the automobiles
(B) plantation of certain plants like pinus, juniperus, vitis etc.
(C) both (A) and (B)
(D) None

23. In stratosphere CFCs gets broken down by the action of powerful UV radiation releasing :
(A) $\dot{C}H_3$ (B) $\dot{C}lO$ (C) $\dot{C}l$ (D) $\dot{C}FCl_2$

24. Which of the following statements is false ?
(A) Over antarctica, the depletion of ozone layer is due to the formation of chlorine nitrate.
(B) Both O_3 and NO_2 reacts with unburnt hydrocarbons in the polluted air to give PAN.
(C) Classical smog consists of a mixture of smog, fog and sulphurdioxide.
(D) Gaseous pollutants consist of oxide of carbon, sulphur and nitrogen along with dust, fumes smoke, smog etc.

25. BOD is :
(A) The amount of oxygen required to convert the NO in to NO_2 in a certain volume of a sample of water.
(B) The amount of F^- ions required to convert, one mole of hydroxyapatite into fluorapatite.
(C) The amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water.
(D) The amount of oxygen required to break down the non-biodegradable waste.

PART - II : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Which of the following is/are true?
(A) Green house gases are carbondioxide, methane, water vapours, nitrous oxide, CFCs and ozone.
(B) CO is highly poisonous to living beings because of its ability to block the delivery of oxygen to the organs and tissues.
(C)The troposphere contains dinitrogen, dioxygen, ozone and little water.
(D) The primary source of air borne lead emission is leaded-petrol

2. Which of the following is/are true?
(A) Photochemical smog has high concentration of reducing agents and is, therefore, called as reducing smog.
(B) Non-viable particulates consist of smoke, dust, mist, fumes etc.
(C) Classical smog occurs in cool humid climate and it is mixture of smoke, fog and sulphurdioxide.
(D) Ozone reacts with unburnt hydrocarbons in polluted air to produce peroxyacetyl nitrate (PAN).

3. Photochemical smog causes :
(A) headache (B) cracking of rubber
(C) corrosion of painted surface (D) extensive damage to plant life

4. Choose the wrong statements :
(A) CO_2 is responsible for greenhouse effect.
(B) CO_2 can absorb infrafred radiation but does not allow them to pass through.
(C) NO is more harmful than NO_2.
(D) acid rain contains mainly HNO_3.

5. Which of the following is/are correct about the size of particulates ?
(A) Soot particles have diameter of about 5 nm.
(B) H_2SO_4 fog particles have size of 500–1000 nm.
(C) Fly ash particles have diameter of 5×10^5 nm.
(D) All particulates have same size.

6. Which of the following is/are weedicides ?
(A) Sodium chlorate (B) DDT (C) Sodium arsenate (D) BHC

7. The depletion of ozone layer is caused by :
(A) NO (B) SO_2 (C) C_xH_y (D) CFCs

8. Which of the following is/are proper method(s) to dispose sludge ?
(A) Incineration (B) Dumping
(C) Anaerobic digestion by microbes (D) Filtration

9. Which of the following metal(s) is/are toxic and pollutants ?
(A) Cadmium (B) Lead (C) Mercury (D) Zinc

10. Which of the following is/are greenhouse gases ?
(A) Ozone (B) Methane (C) carbon dioxide (D) Water vapours

PART - III : COMPREHENSION

Read the following comprehension carefully and answer the questions :

Comprehension # 1

Ozone is an unstable, dark blue diamagnetic gas. It absorbs strongly the UV radiation, thus protecting the people on the earth from the harmful UV radiation from the sun. The use of chlorofluorocarbon (CFC) in aerosols and refrigerators, and their subsequent escape into the atmosphere, is blamed for making holes in the ozone layer over the Antarctic, and Arctic.

Ozone acts as a strong oxidising agent in acidic and alkaline medium. For this property ozone is used as a germicide and disinfectant for sterilising water and improving the atmosphere of crowded places.

1. CFCs damage ozone layer by reactions :

(A) $O_3 + h\nu \longrightarrow O + O_2$ (B) $\dot{Cl} + O_3 \longrightarrow Cl\dot{O} + O_2$

(C) $Cl\dot{O} + O \longrightarrow \dot{Cl} + O_2$ (D) all of the above

2. Identify the incorrect statement with respect to ozone ?
(A) Ozone is formed in the upper atmosphere by a photochemical reaction involving dioxygen.
(B) Ozone protects the earth's inhabitants by absorbing UV radiations.
(C) Ozone can also be made by heating O_2 over 2500^0C and quenching
(D) Chlorine gas is preferred over ozone for the purification of drinking water and for water treatment in swimming pools.

3. Which of the following statement is correct ?
(A) The dark blue colour of ozone is due to intense absorption of green light.
(B) Oxides of nitrogen and the halogen cannot damage the O_3 layer.
(C) Ozone oxidises dry iodine to I_2O_5 .
(D) Ozone forms orange coloured compound KO_3 with potassium hydroxide.

Comprehension # 2

Pesticides are synthetic toxic chemicals which are used in agriculture to control the damages caused by insects, rodents, weeds and various crop diseases. Their repeated use give rise to pests that are resistant to that group of pesticides. As a result these pesticides become ineffective for those pests. Examples are DDT, aldrin, dieldrin etc.

Herbicides are the chemicals used to control weeds, earlier inorganic compounds such as sodium chlorate, and sodium arsenite were used but arsenic compounds being toxic to mammals, are no longer preferred instead organic compounds such as triazines, are now considered as better herbicides, especially for the corn-fields.

4. Which of the following is a biodegradable pesticide ?
(A) DDT (B) Aldrin (C) Dieldrin (D) None of these

5. Which of the following compounds belongs to herbicides ?
(A) Sodium arsenite (B) Sodium chlorate (C) Triazines (D) All of these

6. Which of the following statements is false ?
(A) The fly ash and slag of steel industry is being used by the cement industries
(B) Industrial wastes, agricultural pollutants and radioactive pollutants are the sources of soil pollutants.
(C) The recycling of material such as paper, glass and some kinds of plastics would help in the conservation of natural sources.
(D) BHC, malathon and chlorinated hydrocarbon are herbicides.

Exercise # 3

JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. When rain is accompanied by a thunderstorm, the collected rain water will have a pH value
(1) slightly higher than that when the thunderstorm is not there **[AIEEE-2003]**
(2) uninfluenced by occurence of thunderstorm
(3) which depends on the amount of dust in air
(4) slightly lower than that of rain water without thunderstorm

2. The smog is essentially caused by the presence of : **[AIEEE 04]**
(1) O_2 and O_3 (2) O_2 and N_2
(3) Oxides of sulphur and nitrogen (4) O_3 and N_2

3. Regular use of which of the following fertilizers increases the acidity of soil ? **[AIEEE-2007]**
(1) potassium nitrate (2) Urea
(3) Superphosphate of lime (4) Ammonium sulphate

4. Identify the wrong statements in the following : **[AIEEE-2008]**
(1) Chlorofluorocarbons are responsible for ozone layer depletion
(2) Greenhouse effect is responsible for global warming
(3) Ozone layer does not permit infrared radiation from the sun to reach the earth
(4) Acid rains is mostly because of oxides of nitrogen and sulphur

5. Identify the wrong statement in the following : **[AIEEE 08]**
(1) Ozone layer does not permit infrared radiation from the sun to reach the earth.
(2) Acid rain is mostly because of oxides of nitrogen and sulphur.
(3) Chlorofluorocarbons are responsible for ozone layer depletion.
(4) Green house effect is responsible for global warming.

6. Identify the incorrect statement from the following **[AIEEE 2011]**
(1) Ozone absorb the intense ultraviolet rediation of the sun.
(2) Depletion of ozone layer is because of its chemical reaction with chlorofluro alkanes.
(3) Ozone absorbs infrared radiation
(4) Oxides of nitrozen in the atmosphere can cause the depletion of ozone layer

7. What is DDT among the following : **[JEE-MAINS-2012]**
(1) Greenhouse gas (2) A fertilizer
(3) Biodegradable pollutant (4) Non-biodegradable pollutant

8. What is DDT among the following : **[AIEEE-2012, 4/120]**
(1) Greenhouse gas (2) A fertilizer
(3) Biodegradable pollutant (4) Non-biodegradable pollutant

9. The gas leaked from a storage tank of the Union Carbide plant in Bhopal gas tragedy was : **[JEE(Main)-2013, 4/120]**
(1) Methylisocyanate (2) Methylamine (3) Ammonia (4) Phosgene

10. The gas leaked from a storage tank of the Union Carbide plant in Bhopal gas tragedy was : **[JEE-MAINS-2013]**
(1) Methylisocyanate (2) Methylamine
(3) Ammonia (4) Phosgene

11. **Assertion :** Nitrogen and Oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen. **[JEE-MAINS-2015]**
Reason : The reaction between nitrogen and oxygen requires high temperature.
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both the assertion and reason are incorrect

12. The concentration of fluoride, lead, nitrate and iron in a water sample from an underground lake was found to be 1000 ppb, 40 ppb, 100 ppm and 0.2 ppm, respectively. This water is unsuitable for drinking due to high concentration of : **[JEE-MAINS-2016]**
(1) Fluoride (2) Lead (3) Nitrate (4) Iron

13. A water sample has ppm level concentration of following anions $F^- = 10; SO_4^{2-} = 100; NO_3^- = 50$ the anion/anions that make / makes the water sample unsuitable for drinking is / are : **[JEE-MAINS-2017]**
(1) only NO_3^- (2) both SO_4^{2-} and NO_3^-
(3) only F^- (4) only SO_4^{2-}

14. Identify the pollutant gases largely responsible for the discoloured and lustreless nature of marble of the Taj Mahal **[JEE-MAINS-2017]**
(1) O_3 and CO_2 (2) CO_2 and NO_2 (3) SO_2 and O_3 (4) SO_2 and NO_2

15. Which of the following is a set of green house gases ? **[JEE-MAINS-2017]**
(1) O_3, N_2, CO_2, NO_2 (2) CH_4, O_3,N_2, SO_2 (3) CO_2, CH_4, N_2O, O_3 (4) O_3, NO_2, SO_2, Cl_2

16. Biochemical Oxygen Demand (BOD) value can be a measure of water pollution caused by the organic matter. Which of the following statements is correct - **[JEE-MAINS ONLINE-2018]**
(1) Anaerobic bacteria increase the BOD value
(2) Aerobic bacteria decrease the BOD value
(3) Polluted water has BOD value higher than 10 ppm
(4) Clean water has BOD value higher than 10 ppm

17. The recommended concentration of fluoride ion in drinking water is up to 1 ppm as fluoride ion is required to make teeth enamel harder by converting $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$ to : **[JEE-MAINS-2018]**
(1) $[3(CaF_2) \cdot Ca(OH)_2]$ (2) $[3(Ca_3(PO_4)_2 \cdot CaF_2]$ (3) $[3(Ca(OH)_2] \cdot CaF_2]$ (4) $[CaF_2]$

18. A water sample has ppm level concentration of the following metals: Fe= 0.2; Mn = 5.0; Cu = 3.0; Zn = 5.0. The metal that makes the water sample unsuitable drinking is : **[JEE-MAINS-2019]**
(1) Zn (2) Fe (3) Mn (4) Cu

19. Which of the following conditions in drinking water causes methemoglobinemia ?
(1) > 50ppm of load (2) > 100 ppm of sulphate **[JEE-MAINS-2019]**
(3) > 50 ppm of chloride (4) > 50 ppm of nitrate

20. The reaction that is NOT involved in the ozone layer depletion mechanism is the stratosphere is: **[JEE-MAINS-2019]**

(1) $HOCl(g) \xrightarrow{h\upsilon} \dot{O}H(g) + \dot{C}l(g)$ (2) $CF_2Cl_2(g) \xrightarrow{uv} \dot{C}l(g) + \dot{C}F_2Cl(g)$

(3) $CH_4 + 2O_3 \rightarrow 3CH_2 = O + 3H_2OP$ (4) $Cl\dot{O}(g) + O(g) \rightarrow \dot{C}l(g) + O_2(g)$

21. The compound that is NOT a common component of photochemical smog is : **[JEE-MAINS-2019]**
(1) O_3 (2) CH_2=CHCHO (3) CF_2Cl_2 (4) $H_3C-\underset{\underset{O}{\|}}{C}-OONO_2$

22. The upper stratosphere consisting of the ozone layer protects us from the sun's radiation that falls in the wavelength region of : **[JEE-MAINS-2019]**
(1) 600-750 nm (2) 0.8-1.5 nm (3) 400-550 nm (4) 200-315 nm

23. Among the gases (a) - (e), the gases that cause greenhouse effect are : **[JEE-MAIN-(Jan)-2020]**
(a) CO_2 (b) H_2O (c) CFCs (d) O_2 (e) O_3
(1) (a), (b), (c) and (d) (2) (a), (c), (d) and (e) (3) (a) and (d) (4) (a), (b), (c) and (e)

24. Biochemical Oxygen Demand (BOD) is the amount of oxygen required (in ppm): **[JEE-MAIN-(Jan)-2020]**
(1) by anaerobic bacteria to breakdown inorganic waste present in a water body.
(2) for the photochemical breakdown of waste present in 1 m^3 volume of a water body.
(3) by bacteria to break-down organic waste in a certain volume of a water sample.
(4) for sustaining life in a water body.

25. The statement that is not true about ozone is : **[JEE-MAIN-(Sept.)-2020]**
(1) in the stratosphere, it forms a protective shield against UV radiation.
(2) it is a toxic gas and its reaction with NO gives NO_2.
(3) in the atmosphere, it is depleted by CFCs.
(4) in the stratophere, CFCs release chlorine free radicals $(\dot{Cl})$ which reacts with O_3 to give chlorine dioxide radicals.

26. Thermal power plants can lead to : **[JEE-MAIN-(Sept.)-2020]**
(1) Ozone layer depletion (2) Eutrophication
(3) Acid rain (4) Blue baby syndrome

27. The incorrect statement(s) among (a) – (d) regarding acid rain is (are) : **[JEE-MAIN-(Sept.)-2020]**
(a) It can corrode water pipes.
(b) It can damage structures made up of stone.
(c) It cannot cause respiratory ailments in animals.
(d) It is not harmful for trees
(1) (c) and (d) (2) (a), (b) and (d) (3) (c) only (4) (a), (c) and (d)

28. The condition that indicates a polluted environment is **[JEE-MAIN-(Sept.)-2020]**
(1) BOD value of 5 ppm (2) eutrophication
(3) 0.03% of CO_2 in the atmosphere (4) pH of rain water to be 5.6

ANSWER KEY

EXERCISE # 1

PART - I

A-1.	(D)	**A-2.**	(B)	**A-3.**	(B)	**A-4.**	(D)	**A-5.**	(A)
A-6.	(D)	**A-7.**	(A)	**A-8.**	(B)	**A-9.**	(C)	**A-10.**	(B)
A-11.	(D)	**A-12.**	(A)	**A-13.**	(D)	**A-14.**	(B)	**A-15.**	(C)
A-16.	(C)	**A-17.**	(C)	**A-18.**	(B)	**B-1.**	(D)	**B-2.**	(A)
B-3.	(A)	**B-4.**	(A)	**B-5.**	(B)	**B-6.**	(A)	**B-7.**	(A)
B-8.	(C)	**B-9.**	(C)	**B-10.**	(B)	**B-11.**	(D)	**B-12.**	(C)
B-13.	(D)	**B-14.**	(D)	**B-15.**	(D)				

EXERCISE # 2

PART - I

1.	(C)	**2.**	(A)	**3.**	(A)	**4.**	(A)	**5.**	(D)
6.	(B)	**7.**	(C)	**8.**	(D)	**9.**	(B)	**10.**	(C)
11.	(C)	**12.**	(B)	**13.**	(B)	**14.**	(D)	**15.**	(A)
16.	(B)	**17.**	(B)	**18.**	(C)	**19.**	(B)	**20.**	(C)
21.	(A)	**22.**	(C)	**23.**	(C)	**24.**	(D)	**25.**	(C)

PART - II

1.	(ABD)	**2.**	(BCD)	**3.**	(ACD)	**4.**	(CD)	**5.**	(ABC)
6.	(AC)	**7.**	(AD)	**8.**	(ABC)	**9.**	(ABC)	**10.**	(ABCD)

PART - III

1.	(D)	**2.**	(D)	**3.**	(D)	**4.**	(D)	**5.**	(D)
6.	(D)								

EXERCISE # 3

1.	(4)	**2.**	(3)	**3.**	(4)	**4.**	(3)	**5.**	(1)
6.	(3)	**7.**	(4)	**8.**	(4)	**9.**	(1)	**10.**	(1)
11.	(1)	**12.**	(3)	**13.**	(3)	**14.**	(4)	**15.**	(3)
16.	(2)	**17.**	(2)	**18.**	(3)	**19.**	(4)	**20.**	(3)
21.	(3)	**22.**	(4)	**23.**	(4)	**24.**	(3)	**25.**	(4)
26.	(3)	**27.**	(1)	**28.**	(2)				

SELF ASSESSMENT PAPER

PART-I : OBJECTIVE TYPE QUESTIONS

1. Which one of the following is responsible for depletion of the ozone layer in the upper stratosphere of the atmosphere ? **[AIPMT 04]**
(A) polyhalogens (B) ferrocene (C) fullerenes (D) freons

2. Ozone in the stratosphere is deleted by : **[AIIMS 04]**
(A) CF_2Cl_2 (B) C_7F_{16} (C) $C_6H_6Cl_6$ (D) C_6F_6

3. Biochemical Oxygen Demand, (BOD) is a measure of organic material present in water. BOD value less than 5 ppm indicates a water sample to be _____.
(A) rich in dissolved oxygen. (B) poor in dissolved oxygen.
(C) highly polluted. (D) not suitable for aquatic life.

4. In antartica, ozone depletion is due to the formation of the following compound : **[Kerala CEE 05]**
(A) Acrolein (B) peroxy acetyl nitrate
(C) SO_2 and SO_3 (D) chlorine nitrate

5. Pick up the correct statement : **[Kerala CEE 05]**
(A) CO which is a major pollutant resulting from the combustion of fuels in automobiles plays a major role in photochemical smog.
(B) Classical smog has an oxidizing character while the photochemical smog is reducing in character.
(C) The photochemical smog occurs in day time whereas the classical smog occurs in the morning hours.
(D) During formation of smog the level of ozone in the atmosphere goes down.

6. Which of the following is not a green house gas ? **[Kerala PMT 06]**
(A) CO_2 (B) CH_4 (C) O_3 (D) CCl_2F_2

7. An object is located at a height of 5 km from the surface of the earth. The object in located in which part of the atmosphere. **[EAMCET 2006]**
(A) Thermosphere (B) Mesosphere (C) Stratosphere (D) Troposphere

8. The atmospheric gas which can not produce green house effect is : **[WB JEE 07]**
(A) N_2 (B) H_2O (C) CO_2 (D) O_3

9. Green chemistry means such reactions which **[AIPMT 08]**
(A) produce colour during reactions.
(B) reduce the use and production of hazardous chemicals.
(C) are related to the depletion of ozone layer.
(D) study the reactions in plants.

10. The process of 'eutrophication' is due to : **[Kerala PMT 08]**
(A) increase in concentration of insecticide in water.
(B) increase in concentration of fluoride ion in water.
(C) the reduction in concentration of the dissolved oxygen in water due to phosphate pollution.
(D) attack of younger leaves of a plant by peroxyacetyl nitrate.

11. Which of the following is secondary pollutant ? **[DPMT 2008]**
(A) CO_2 (B) N_2O (C) PAN (D) SO_2

12. Which of the following compounds helps in achieving equlibrium between O_2 and CO_2 in atmosphere ? **[EAMCET 2008]**
(A) Chlorophyll (B) Vitamin-12 (C) Porphyrin (D) Ethyl salicylic acid

13. The gaseous envelope around the earth is known as atmosphere. The lowest layer of this is extended upto 10 km from sea level, this layer is _____.
(A) Stratosphere (B) Troposphere (C) Mesosphere (D) Hydrosphere

14. Which one is not correct ?
Greenhouse effect :
(A) is due to high concentration of CO_2 in atmosphere
(B) is influenced by gases such as CH_4, O_3 and chlorofluorocarbons
(C) would result in the warming up of the earth
(D) would result in lowering the level of oceans due to high evaporation

15. If there was no CO_2 in the earth's atmosphere, the temperature of earth's surface would be -
(A) Less than the present
(B) The same
(C) Dependent on the amount of oxygen in the atmosphere
(D) Higher than the present

16. Which of the following statements is correct ?
(A) Ozone hole is a hole formed in stratosphere from which ozone oozes out.
(B) Ozone hole is a hole formed in the troposphere from which ozone oozes out.
(C) Ozone hole is thinning of ozone layer of stratosphere at some places.
(D) Ozone hole means vanishing of ozone layer around the earth completely.

17. Air pollutants that produce photochemical smog -
(A) Ozone, chlorine and sulphur dioxide (B) Oxygen, chlorine and nitric acid
(C) Nitrous oxide, PAN and acrolein (D) CO_2, CO and SO_2

18. Dinitrogen and dioxygen are main constituents of air but these do not react with each other to form oxides of nitrogen because _____.
(A) the reaction is endothermic and requires very high temperature.
(B) the reaction can be initiated only in presence of a catalyst.
(C) oxides of nitrogen are unstable.
(D) N2 and O2 are unreactive.

19. In coming years, skin related disorders will become more common due to -
(A) Airpollution (B) Excessive use of detergents
(C) Depletion of ozone layer (D) Water pollution

20. Often in water bodies subjected to sewage pollution, fishes die because of the-
(A) Foul smell
(B) Reduction in dissolved oxygen caused by microbial activity
(C) Clogging of their gills by solid substances
(D) Pathogens released by the sewage

PART-II : NUMERICAL TYPE QUESTIONS

1. High concentration (in ppm) of fluoride is poisonous and harmful to bones and teeth at levels over

2. The pH of rain water is :

3. How many of the following are green house gases?
CH_4, O_3, O_2, N_2, CO_2, $CHCl_3$, CF_2Cl_2, $H_2O(g)$

4. The maximum concentration of nitrate ion (in ppm) in a water sample is allowed by international standard?

5. BOD of clean water as per standard is

SAP ANSWER KEY

PART-I

1.	(D)	**2.**	(A)	**3.**	(A)	**4.**	(D)	**5.**	(A)
6.	(D)	**7.**	(D)	**8.**	(A)	**9.**	(B)	**10.**	(C)
11.	(C)	**12.**	(A)	**13.**	(B)	**14.**	(D)	**15.**	(A)
16.	(C)	**17.**	(C)	**18.**	(A)	**19.**	(C)	**20.**	(B)

PART-II

1.	5 ppm	**2.**	5.6	**3.**	4	**4.**	50	**5.**	5

SAP SOLUTIONS

PART-I

4. Adenine, guanine, cytosine sets of bases is present both in DNA and RNA.

5. Uracil base is found only in the nucleotides of RNA

19. Lipids does not have a secondary structures.

20. The charged particles/molecules can be seperated by electrophoresis.

PART-II

1. 4 (i, ii, iii and vii) are antifical sweeteners.

2. Cimetidine, Ranitidine, Sulphonamide and Sulphapyridine has "S" present in it.

3. Bithional and Chloroxylenol are antiseptics.