CBS Confident Pharmacy Series

Fifth Edition

Pharmaceutical Chemistry

for First Year Diploma in Pharmacy

Course Code: **ER20-12T**

As per the latest syllabus prescribed by Pharmacy Council of India

Including
Board Examination Question Papers and Specimen Answer Papers

VN Raje





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- Lucid and easy language
- To the point answers
- Remembering the concepts in the simplest way
- Infusing confidence in the reader to appear in the board examinations

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Preface to the Fifth Edition

Fifth edition of this book includes Board Examination Question Papers and Solved Specimen Answer Papers. These additional contents are of great importance to the students which give an exact idea about the framework of question paper pattern and specimen answers as per the format of Pharmacy Council of India (PCI) (ER2020).

This edition of book builds self-confidence in students which helps to get success in the examinations. The book has been written to meet the requirements of students of Diploma in Pharmacy (DPharm) in accordance with the new revised syllabus ER2020 prescribed by Pharmacy Council of India.

This book is small and humble effort has been put in for compiling necessary information on the subject. An attempt has been made to demystify and simplify the basic concepts for the students of pharmacy and to enable them get an evergreen success in all the board examinations.

The salient features of the present book are:

- **Lucid and easy language**
- **To the point answers**
- **Remembering facts in the simplest way**
- **Infusing confidence in the reader to appear in the board examinations**

Hence the series is named

CBS Confident Pharmacy Series

I am confident that this book will be useful to both the students and the teachers of Diploma in Pharmacy as well as the candidates desiring to succeed in competitive examinations for better job opportunities in pharmacy profession such as hospital pharmacists in PHCs, civil hospitals, etc.

Raje Vijay N

to

my beloved family

Acknowledgements

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I am also thankful to Shri Satish Kumar Jain, Chairman and Managing Director, and Shri Shantanu Sarkar, General Manager, Mumbai Branch, CBS Publishers & Distributors Pvt Ltd, for their sustained efforts and keen interest in the publication of this book.

I wish all my beloved students to have a great success in the Board Examinations.

Raje Vijay N

Syllabus

(As per New ER 2020)

Pharmaceutical Chemistry

1. **Introduction to Pharmaceutical Chemistry:** Scope and objectives
   Sources and types of errors: Accuracy, precision, significant figures
   Impurities in Pharmaceuticals: Source and effect of impurities in pharmacopoeial substances, Importance of limit test, Principle and procedures of Limit tests for chlorides, sulphates, iron, heavy metals and arsenic.
2. **Volumetric analysis:** Fundamentals of volumetric analysis, Acid-base titration, Non-aqueous titration, Precipitation titration, Complexometric titration, Redox titration
   Gravimetric analysis: Principle and method.
3. **Inorganic Pharmaceuticals:** Pharmaceutical formulations, market preparations, Storage conditions and uses
   - **Haematinics:** Ferrous sulphate, Ferrous fumarate, Ferric ammonium citrate, Ferrous ascorbate, Carbonyl iron
   - **Gastro-intestinal agents:** Antacids: Aluminium hydroxide gel, Magnesium hydroxide, Magaldrate, Sodium bicarbonate, Calcium carbonate, Acidifying agents, Adsorbents, Protectives, Cathartics
   - **Topical agents:** Silver Nitrate, Ionic silver, Chlorhexidine gluconate, Hydrogen peroxide, Boric acid, Bleaching powder, Potassium permanganate
   - **Dental products:** Calcium carbonate, Sodium fluoride, Denture cleaners, Denture adhesives, Mouth washes
   - **Medicinal gases:** Carbon dioxide, Nitrous oxide, Oxygen
4. **Introduction to nomenclature of organic chemical systems with particular reference to heterocyclic compounds containing up to Three rings.**
5. **Drugs Acting on Central Nervous System**
   - **Anaesthetics:** Thiopental Sodium*, Ketamine hydrochloride*, Propofol

- **Sedatives and Hypnotics:** Diazepam*, Alprazolam*, Nitrazepam, Phenobarbital*
- **Antipsychotics:** Chlorpromazine Hydrochloride*, Haloperidol*, Risperidone*, Sulpiride*, Olanzapine, Quetiapine, Lurasidone
- **Anticonvulsants:** Phenytoin*, Carbamazepine*. Clonazepam, Valproic Acid*, Gabapentin*. Topiramate, Vigabatrin, Lamotrigine
- **Anti-depressants:** Amitriptyline Hydrochloride*, Imipramine Hydrochloride*, Fluoxetine*, Venlafaxine, Duloxetine, Sertraline, Citalopram, Escitalopram, Fluvoxamine, Paroxetine

6. **Drugs Acting on Autonomic Nervous System**
   - **Sympathomimetic Agents:** Direct Acting: Nor-epinephrine*, Epinephrine, Phenylephrine, Dopamine*, Terbutaline, Salbutamol (Albuterol), Naphazoline*, Tetrahydrozoline. ***Indirect Acting Agents:*** Hydroxy amphetamine, Pseudo-ephedrine. Agents with mixed mechanism: Ephedrine, Metaraminol
   - **Adrenergic Antagonists:** Alpha adrenergic blockers: Tolazoline, Phentolamine
   - Phenoxybenzamine, Prazosin. Beta adrenergic blockers: Propranolol*, Atenolol*, Carvedilol
   - **Cholinergic Drugs and Related Agents:** Direct acting agents: Acetylcholine*, Carbachol and pilocarpine. Cholinesterase inhibitors: Neostigmine*, Edrophonium Chloride, Tacrine hydrochloride, Pralidoxime chloride, Echothiopate iodide
   - **Cholinergic Blocking Agents:** Atropine sulphate*, Ipratropium bromide
   - **Synthetic Cholinergic Blocking Agents:** Tropicamide, Cyclopentolate Hydrochloride, Clidinium Bromide, Dicyclomine Hydrochloride*
7. **Drugs Acting on Cardiovascular System**
   - **Anti-arrhythmic Drugs:** Quinidine Sulphate, Procainamide Hydrochloride, Verapamil, Phenytoin Sodium*, Lidocaine Hydrochloride, Lorcainide Hydrochloride, Amiodarone and Sotalol
   - **Anti-hypertensive Agents:** Propranolol*, Captopril*. Ramipril, Methyldopate Hydrochloride, Clonidine Hydrochloride, Hydralazine Hydrochloride, Nifedipine,
   - **Antianginal Agents:** Isosorbide Dinitrate

8. **Diuretics:** Acetazolamide, Frusemide*, Bumetanide, Chlorthalidone, Benzthiazide, Metolazone, Xipamide, Spironolactone
9. **Hypoglycemic Agents:** Insulin and Its Preparations, Metformin*, Glibenclamide*, Glimepiride, Pioglitazone, Repaglinide, Gliflozins, Gliptins
10. **Analgesic and Anti-inflammatory Agents:** Morphine Analogues, Narcotic Antagonists; Nonsteroidal Anti-inflammatory Agents (NSAIDs)—Aspirin*, Diclofenac, Ibuprofen*, Piroxicam, Celecoxib, Mefenamic Acid, Paracetamol*, Aceclofenac
11. **Anti-infective Agents**
    - **Antifungal Agents:** Amphotericin-B, Griseofulvin, Miconazole, Ketoconazole*, Itraconazole, Fluconazole*, Naftifine Hydrochloride
    - **Urinary Tract Anti-infective Agents:** Norfloxacin, Ciprofloxacin, Ofloxacin*, Moxifloxacin
    - **Anti-tubercular Agents:** INH*, Ethambutol, Para amino Salicylic Acid, Pyrazinamide, Rifampicin, Bedaquiline, Delamanid, Pretomanid*
    - **Antiviral Agents:** Amantadine Hydrochloride, Idoxuridine, Acyclovir*, Foscarnet, Zidovudine, Ribavirin, Remdesivir, Favipiravir
    - **Antimalarials:** Quinine Sulphate, Chloroquine Phosphate*, Primaquine Phosphate, Mefloquine*, Cycloguanil, Pyrimethamine, Artemisinin
    - **Sulfonamides:** Sulfanilamide, Sulfadiazine, Sulfametho xazole, Sulfacetamide*, Mafenide Acetate, Cotrimoxazole, Dapsone*
12. **Antibiotics:** Penicillin G, Amoxicillin*, Cloxacillin, Streptomycin, Tetracyclines: Doxycydine, Minocycline, Macrolides: Erythromycin, Azithromycin, Miscellaneous: Chloramphenicol* Clindamycin
13. **Anti-neoplastic Agents:** Cyclophosphamide*, Busulfan, Mercaptopurine, Fluorouracil*, Methotrexate, Dactinomycin, Doxorubicin Hydrochloride, Vinblastine Sulphate, Cisplatin*, Dromostenolone propionate

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Chapter 1

Introduction to Pharmaceutical Chemistry and Quality Control of Drugs and Pharmaceuticals

1 Define Pharmaceutical Chemistry. Give the scope and objectives of it.

☞ **Pharmaceutical Chemistry:**

It is the branch of pharmaceutical science that deals with the study of chemistry of medicinal substances.

☞ **Scope and objectives:**

1. It helps to impart the basic knowledge of the chemical structure, storage conditions and medicinal uses of organic and inorganic chemical substances, used as drugs and pharmaceuticals.
2. It helps to study pharmacological uses, doses and stability of the drugs.
3. It helps to study different formulations available in the market with their brand names.
4. It helps to study impurity testing and basic quality control testing of the drugs and pharmaceuticals.
5. It is focussed on quality aspect of medicine and aims to assure fitness for purpose of medicinal products.

2 Define the term "pharmacopoeia". Give its Importance.

☞ **Pharmacopoeia:**

Pharmacopoeia is the official book of standards published by respective Governments containing, the list of drugs, pharmaceuticals, their formulae, identification, standardisation, dose, uses, etc.

The word pharmacopoeia is derived from the Greek Words:

'*Pharmacon*' means a 'drug'

'*Poeio*' means 'To make''

- **Importance/Object/Need/Purpose/Scope of pharmacopoeia:**
  (i) To ensure uniformity in composition of drug.
  (ii) To ensure purity of drug.
  (iii) To ensure potency of drug.
  (iv) To study official preparations of drugs.
  (v) To refer procedures for testing of drugs.
- **List of Pharmacopoeia Published:**
  (1) First edition in 1955
  (2) Second edition in 1966
  (3) Third edition in 1985
  (4) Fourth edition in 1996
  (5) Fifth edition in 2007
  (6) Sixth edition in 2010
  (7) Seventh edition in 2014
  (8) Eighth edition in 2018

3 Define 'Monograph'. Give the contents of monograph.

☞ **Monograph:**

Monograph means detailed systematic account of the drug with reference to title, synonym, description, category, identification, official preparations, etc.

- **Contents of Monograph:**

The monograph gives following details of an official compound.

1. **Title:** It is an approved name of drug or its preparation.
2. **Synonym:** It is an alternative name of the drug.
3. **Description:** It gives physical description of the substances like crystalline or amorphous nature, colour, odour, taste, etc.
4. **Identification:** Qualitative tests, coloured reactions, precipitating tests, gas evolution are used for identification of drugs.
5. **Test for purity:** The upper and lower limits of purity are expressed numerically.
6. **Dose and dosage:** The usual dose and route of administration are mentioned. Usual strength may be given for pharmaceutical dosage forms.
7. **Storage:** Storage conditions are important to take precautions in relation to effect of atmosphere, moisture heat, light, etc.

Cold	–	Between 2°C and 8°C
Cool	–	Between 8°C and 25°C

Warm – Between 30°C and 40°C
Excessive heat – Any temperature above 40°C

8. **Solubility:** Solubility of the medicinal compounds is expressed as: Approximate solvent volume in ml for 1 g of solute.
   - Very soluble – Less than 1
   - Freely soluble – From 1 to 10
   - Soluble – From 10 to 30
   - Sparingly soluble – From 30 to 100
   - Slightly soluble – From 100 to 1000
   - Very slightly soluble – From 1000 to 10,000
   - Insoluble – More than 10,000
9. **Limit of impurities:** Limit tests are important to determine the permissive limits of tolerance.
10. **Container:** Specifications of container such as light resistant, well closed, tightly closed hermetically sealed containers are mentioned.
11. **Labelling:** Labelling of the drug or pharmaceutical preparations is as per the Drugs and Cosmetics, Act, 1940.
12. **Physical constants:** Physical constants like melting point, boiling point, refractive index, optical rotation, viscosity, etc. are mentioned in pharmacopoeia for standardisation of pharmaceuticals.
13. **Assays:** The estimation of percentage purity of the active chemical constituent is known as assay.
    The methods of quantitative analysis (assay) are mentioned in pharmacopoeia.
14. **Category:** It represents the main pharmacological action/therapeutic use of the drug.

4 Define quality control. Give functions and importance of quality control.

☞ Quality Control

It is the day-to-day process of controlling quality of every incoming material till the finished product quality.

Functions of Quality Control

- Analysis of raw materials
- Analysis of packaging materials
- Analysis of in-process products

- Analysis of final dosage forms
- Analysis of batch products (periodic analysis)
- Recording the results of analysis in a standard format

Importance of Quality Control

- To avoid toxic and unwanted effects of impurities
- To avoid technical difficulties during manufacturing
- To maintain safety and effectiveness of products
- To maintain product with adequate physical and chemical stability
- To ensure quality drugs for consumption to the patients
- To maintain purity of product and thus protect public health
- To help in maintenance of quality of product with better utilization of labours and machines
- It helps in adjustment and setting of machineries
- It helps in product development and in research with control over wastes and scraps
- It helps in decreasing the cost of manufacturing so that cost of final product may be decreased.

5 Define quality assurance. Give its functions.

☞ **Quality Assurance:**

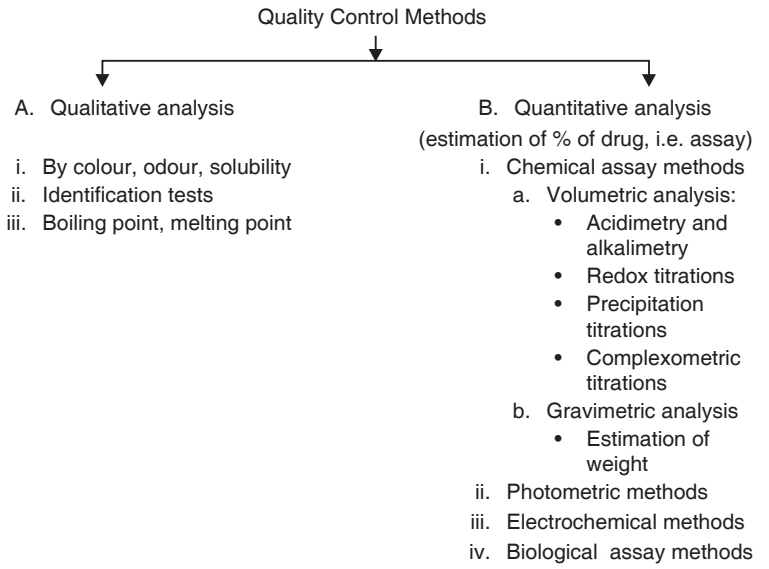
It is the department which includes a total quality control, government regulations, company standards and development of standard operating procedures of analysis.

Functions

- Development of standard operating procedures and supply to every department of the company.
- It has a responsibility of "total quality of the products".
- It gives guidelines during adjustment and setting of the machineries.
- It helps to maintain quality of products with better utilisation of labours and machines.
- It helps in product development and research.

6 What are different methods used for quality control in pharmacy?

Quality control is to analyse a drug for quality and quantity. Following are various methods used for quality control:



7 Write in short about (a) "Significant Figures", (b) Precision, (c) Accuracy, (d) Absolute error, (e) Standard Deviation.

☞ (a) Significant Figures

Significant figures can be defined as the number of digits necessary to express the results of measurement consistent with the measured precision.

- It should be clear that zeros are used to denote the significant part of measurement.
- Thus, zero within a number like 25.05 and 1350 are significant as they express the exact quantity while in the quantity 0.00035 kg the zero before the point, is not significant, but shows the order of magnitude of the other digits.

(b) Precision:

- The precision means the degree of reproducibility or agreement between repeated measurements.
- Precision is the variability among replicate measurements, i.e how close the values of the results of replicate measurements are to each other.
- More the measurements, better is the precision and error will be smaller.

(c) Accuracy:

- An accuracy means closeness of an experimental result with true value or actual result.
- Accuracy is the differences between the true value and the value of experimental result.
- An experimental procedure may be highly precise, but because of some errors, the results could be inaccurate.
- Accuracy expresses the correctness of the measurement.

(d) Absolute Error (Eabs):

- "The absolute error of a determination is the difference between the observed or measured value".
- The absolute error is a measure of the accuracy of the measurement.
- The absolute error may be positive or negative.

  Absolute Error (Eabs) = (X – T),

  where X – measured or observed value

  T – accepted or true value.

(e) Standard Deviation/root mean square deviation (S/SD):

- It is one of the most common statistical terms used in analytical chemistry.
- The standard deviation is a measure of how spread-out numbers is, in other words, it is a measure of precision.
- It is abbreviated as S or SD.

$$SD = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}},$$

where,

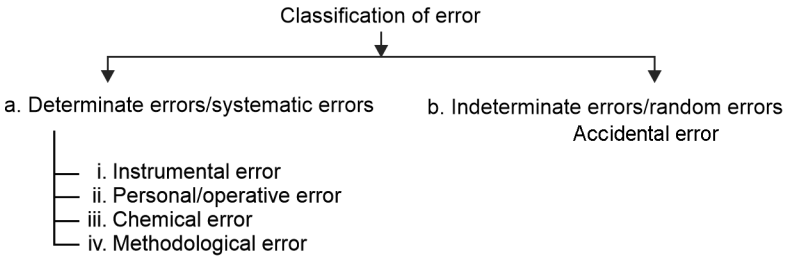
n—Number of measurements.

8 Write a note on "errors in analysis".

☞ **Error:**

Error is the difference between measured value and true value.

- Though the measurements are made by different methods of quality control, systematically and carefully but there is some degree of error.
- An error is associated with every measurement.
- The analyst must try to reduce the magnitude of the error to an accepted level.



a. *Determinate errors/systematic errors*: These types of errors are determinable and can be either avoided or corrected.
   i. *Instrumental error*: It is caused by use of faulty equipment.
   ii. *Personal error*: It is the error made by person doing analysis.
   iii. *Chemical error*: This error is due to impurities in chemicals.
   iv. *Methodological error*: It arises due to faulty method used for analysis, e.g. incomplete reaction, incomplete heating.

b. *Indeterminate errors/random errors*: These errors are also called accidental errors. These errors are fluctuating and do not have a definite value and are difficult to locate. They arise due to unknown and uncertain measurement or may be due to differences in judgment and skill of analyst.
   Hence, elimination of these errors is impossible to the analyst.

9 Define impurity. Discuss various sources of impurities in pharmaceutical substances. (S.22, 23, 24, W.22, 23)

☞ **Impurity:**

Impurity is an undesirable matter which may or may not be toxic but present in the pharmaceutical substances.

Sources of Impurities

- *Raw material used in manufacture*: If raw material contains an impurity, then this impurity gets incorporated into the final product.
  Impurities like lead, arsenic, etc. are present in the raw materials and hence found in substances as impurities, e.g. if copper foils are contaminated with arsenic, the final product $CuSO_4$ may contain arsenic impurity.
- *Reagents used in manufacturing process*: If reagents contain impurity, it is transferred to the final product, e.g. calcium

carbonate is prepared by using calcium chloride and sodium carbonate. Thus, it may contain impurity of sodium carbonate or calcium chloride.

- *The process used in manufacturing*: There are a number of chemicals which are manufactured from different raw materials by different methods or processes. Due to this some impurities get incorporated into the materials during manufacturing process.

  Tap water is generally used in various manufacturing processes. Tap water contains chlorides, calcium, magnesium as impurities thus gets incorporated in the products.
- *Material of plant*: Equipment and vessels used in manufacturing process are made of metals like copper, iron, aluminium, zinc but these metals are introduced as impurities by the solvent action of raw materials. Nowadays, these metals are replaced by stainless steel.
- *Intermediate products*: Incomplete reactions produce unwanted intermediate products which may be the impurity in the final products.
- *Adulteration/accidental substitution*: The cheap substances are added in pure substances as a substitute and, therefore, added substances act as an impurity in pure substance, e.g. sodium bromide is an impurity in potassium bromide as the sodium salt is cheaper.
- *Inadequate storage/defective storage*
  i. Many chemical substances undergo changes due to careless storage, thus may develop impurity in it.
  ii. Stored products may become contaminated with dust, the bodies of insects and even animals and insect excreta.
  iii. Many substances when exposed to light, air and moisture, may change the colour, properties and shelf life of products, e.g.
  - Due to careless storage, ferrous sulphate is slowly converted into insoluble ferrous oxide by air and moisture.
  - Surgical solution of chlorinated soda deteriorates upon exposure to light and heat. Hence, it should be stored in well closed amber-coloured bottles in cool place.
  - Chloroform decomposes in presence of light and air and forms a phosgene gas which is toxic. So, it should be stored in well closed amber-coloured bottle.
  - Bismuth carbonate is blackened on long exposure to sunlight.

- *Manufacturing hazards*: Impurity may get incorporated at various stages of manufacturing.
  i. *Particulate contamination*: It involves the pieces of plastic, threads in the product and also come from improperly cleaned equipment and also due to wear and tear of equipment.
  ii. *Process error*: It involves incomplete reactions during processing.
  iii. *Cross-contamination*: Handling of powders, granules and tablets may produce considerable air-borne dust. This airborne dust may lead to cross-contamination of other products.
  iv. *Microbial contamination*: Liquids or creams may be contaminated due to bacteria and fungi from atmosphere.
  v. *Packing errors*: The products of similar appearance such as tablet of same size, colour and shape may be packed in the similar containers and can cause danger due to mislabelling.

10 What are different types of impurities commonly occurring in pharmaceuticals?

- *Toxic impurity*: If impurity is present above the prescribed limit and produces toxic effect on the body, it is called toxic impurity, e.g. lead, arsenic impurities.
- *Harmless impurity*: Some impurities are harmless but if present above the prescribed limit, they lower active strength of substances, e.g. impurities of sodium salts in potassium salts.
- *Impurity affecting storage property*: For example, presence of small amount of moisture in the drug may reduce flow property and affect the storage.
- *Impurity causing technical difficulties*: Impurities cause many technical problems during manufacturing, e.g. picking and sticking defects may occur in tablet manufacturing.
- Impurities affecting taste, odour and appearance of the product.
- Impurities even when present in traces, may show a cumulative toxic effect after certain period.
- Impurity which lowers the shelf life of the substances.

11 Discuss the effects of impurities.

☞ **Effects of Impurities:**

- Impurities may produce toxic effect if present above certain limits.
- Impurities, even in small quantity, may show cumulative toxic effect after a certain period.
- Impurities may reduce active strength of the substance.
- Impurities may change physical and chemical properties of the substance and thus making it medically useless.
- Impurities may cause technical difficulties in the formulations.
- Impurities may produce incompatibility with other substances.
- Impurities may lower the shelf life of the substance.
- Impurities may affect and change the colour, odour, taste and appearance and make the substance unhygienic.

12 Define the term "limit tests". Explain BSR.

☞ **Limit Tests:**

These are qualitative tests used to identify the small amounts of impurities present in the substances.

BSR (Barium Sulphate Reagent)

It is used in limit tests for sulphate IP 85.

- *Composition of BSR*
  i. $BaCl_2$ solution.
  ii. Sulphate-free alcohol.
  iii. Potassium sulphate solution.
- *Uses of ingredients*
  i. $BaCl_2$ reacts with impurity to form $BaSO_4$.
  ii. Alcohol prevents supersaturation.
  iii. Potassium sulphate increases the sensitivity of test.

13 Describe the limit test for chloride IP.

☞ **Principle/Concept:**

Chloride impurity reacts with silver nitrate to form a white precipitate of silver chloride in the presence of dilute HNO_3. It is observed as opalescence.

Reaction

$$Cl^- + AgNO_3 \xrightarrow{\text{dilute } HNO_3} AgCl \downarrow + NO_3^-$$

Silver nitrate — Silver chloride (opalescence)

Note

- Purified water is used for dilution and it is free from dissolved gas and impurities.
- Standard solution is prepared as it gives maximum permissible limit for comparison.
- Dilute HNO_3 is used as it avoids the reaction of acidic radicals other than chloride with that of $AgNO_3$.
- The opalescence is directly proportional to amount of chloride impurity present in the substance.
- If test substance is coloured ($KMnO_4$), then first it is decolourised and then followed for limit test.

Procedure

Limit test for chloride IP 66

Test solution	*Standard solution*
i. Weight of substance as per monograph. ii. 1 ml of dilute HNO_3. iii. Dilute up to 50 ml with water. iv. Add 1 ml of 5% $AgNO_3$ solution.	i. 1 ml of 0.01 N HCl solution. ii. 1 ml of dilute HNO_3. iii. Dilute with water up to 50 ml. iv. Add 1 ml of 5% $AgNO_3$ solution.

Limit test for chloride IP 85

Test solution	*Standard solution*
i. Weight of substance as per monograph. ii. Add 10 ml of dilute HNO_3. iii. Add water up to 50 ml. iv. Add 1 ml of 1% $AgNO_3$ solution.	i. 1 ml of 0.0585 w/v of NaCl solution. ii. Add 10 ml of dilute HNO_3. iii. Add water up to 50 ml. iv. Add 1 ml of 1% $AgNO_3$ solution.

Limit test for chloride IP 96

IP 96 prescribes use of 1 ml of 0.1 M $AgNO_3$ solution. The chloride impurity is generally 25 parts per million. Standard chloride solution is taken 10 ml for the preparation of standard solution.

Stir both the solutions and keep it aside for 10 minutes.

Remarks

If opalescence produced in test solution is less than standard solution, substance passes the limit test for chloride IP.

14 Describe the limit test for sulphate IP. (S.24)

☞ Principle/Concept:

Sulphate impurity reacts with barium chloride in the presence of dilute HCl to form white precipitation of barium sulphate. It is observed in the form of turbidity.

Reaction

$$\underset{\text{Barium chloride}}{SO_4^{--} + BaCl_2} \xrightarrow{\text{dilute HCl}} \underset{\text{Barium sulphate precipitation}}{BaSO_4 \downarrow} + 2Cl^-$$

Note

- Purified water is used for dilution and it is free from dissolved gas and impurities.
- Standard solution is prepared as it gives maximum permissible limit for comparison.
- Dilute HCl is used as it avoids the reaction of acidic radicals other than sulphate with that of $BaCl_2$.
- Barium sulphate reagent: It is used according to IP 85. It contains $BaCl_2$, K_2SO_4 and alcohol. Barium chloride reacts with sulphate impurity. Alcohol prevents supersaturation. Potassium sulphate increases rate of reaction and sensitivity.

Procedure

Limit test for sulphate IP 66

Test solution	*Standard solution*
i. Weight of substance as per monograph.	i. 2.5 ml of 0.01N H_2SO_4.
ii. 1 ml of dilute HCl.	ii. 1 ml of dilute HCl.
iii. Add water up to 50 ml.	iii. Add water up to 50 ml.
iv. Add 1 ml of $BaCl_2$ solution.	iv. Add 1 ml of $BaCl_2$ solution.

Limit test for sulphate IP 85

Test solution	*Standard solution*
i. Weight of substance as per monograph. ii. Add 2 ml of dilute HCl. iii. Add water up to 45 ml. iv. Add 5 ml of BSR.	i. 1 ml of 0.1089% w/v of K_2SO_4. ii. Add 2 ml of dilute HCl. iii. Add water up to 45 ml. iv. Add 5 ml of BSR..
Limit test for sulphate IP 96	
It prescribes ethanolic sulphate standard solution which gives 10 ppm sulphate impurity and also use of 25% w/v barium chloride solution. Stir well both the solutions and keep it aside for 5 minutes.	

Remarks

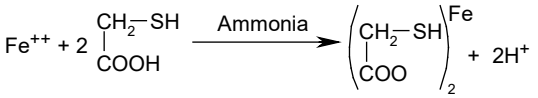
If turbidity produced in test solution is less than standard solution, sample comply with the limit test for sulphate IP.

15 Describe the limit test for iron IP. (W.23)

☞ **Principle/Concept:**

Iron impurity reacts with thioglycolic acid in the presence of dil. ammoniacal alkaline medium to form purple-coloured ferric thioglycate.

Reaction



Thioglycolic acid Ferric thioglycate (purple-coloured)

Note

- Purified water is used for dilution purpose and it is free from dissolved gases and impurities.
- Standard solution is prepared as it gives maximum permissible limit for comparison.
- Ammoniacal alkaline medium is necessary for reaction of thioglycolic acid with iron impurity.
- Citric acid prevents precipitation of iron with ammonia.
- Thioglycolic acid is used because it reacts with ferrous form of iron and converts it into ferric form. Thus, it forms purple colour.

Procedure

Limit test for iron IP 66

Test solution	*Standard solution*
i. Weight of substance as per monograph.	i. 2 ml of standard iron solution (0.173 g of ferric ammonium sulphate + 1.5 ml of HCl).
ii. Add 40 ml of water.	ii. Add 40 ml of water.
iii. Add 2 ml of citric acid (20%).	iii. Add 2 ml of citric acid.
iv. Add ammonia to adjust alkaline pH.	iv. Add ammonia to adjust. alkaline pH.
v. Adjust volume up to 50 ml with water.	v. Adjust volume up to 50 ml with water.

Limit test for iron IP 85

Test solution	*Standard solution*
i. Weight of substance as per monograph.	i. 2 ml of standard iron solution (0.1726 g of ferric ammonium sulphate + 10 ml of 0.1 N H_2SO_4).
ii. Add 40 ml of water.	ii. Add 40 ml of water.
iii. Add 2 ml of citric acid.	iii. Add 2 ml of citric acid.
iv. Add ammonia to adjust alkaline pH.	iv. Add ammonia to adjust alkaline pH.
v. Adjust volume up to 50 ml with water.	v. Adjust volume up to 50 ml with water.

Stir well and keep aside for 5 minutes and observe.

Remarks

If purple colour obtained in test solution is less than standard solution, sample passes limit test for iron IP.

16 Describe the limit test for heavy metals IP.

☞ **Principle/Concept:**

Heavy metal impurity reacts with hydrogen sulphide/sodium sulphide in presence of acidic/alkaline medium respectively to form brown precipitation of metal sulphide.

Reaction

i. $M + H_2S \longrightarrow MS + 2H^+$

ii. $M + NaS \longrightarrow MS + 2Na^{++}$

(Metal sulphides) (brown precipitations)

Note

- Purified water is used for dilution purpose and it is free from dissolved gases and impurities.
- Standard solution is prepared as it gives maximum permissible limit for comparison.
- H_2S and Na_2S solutions are the reactants and require acidic/ alkaline media for their reactions respectively.
- Acidic medium is adjusted by ammonia or acetic acid while alkaline medium is adjusted by NaOH.
- IP 66 does not have limit test for heavy metals.

Procedure

Method 'A'

Limit test for heavy metal IP 85

Test solution	*Standard solution*
i. As per monograph 25 ml solution prepared. ii. Add dilute acetic acid/ ammonia to adjust the pH between 3 and 4. iii. Add water up to 35 ml. iv. Add 10 ml of H_2S solution. v. Dilute it up to 50 ml with water.	i. Take 2 ml standard lead solution and dilute it up to 25 ml. ii. Add dilute acetic acid/ ammonia to adjust the pH between 3 and 4. iii. Add water up to 35 ml. iv. Add 10 ml of H_2S solution. v. Dilute it up to 50 ml with water.

Stir well and keep aside for 5 minutes. Observe and compare the brown colour produced.

Remarks

If brown colour obtained in test solution is less than standard solution, sample passes the limit test for heavy metal IP 85.

17 Describe the limit test for arsenic. (S.22, 23, W.22)

☞ Principle/Concept:

Arsenic impurity is converted into arsine gas which further reacts with mercuric chloride paper to form yellow stain of mercuric arsenide.

Reactions

i. Arsenic is converted into arsenic acid.

$$As \longrightarrow H_3AsO_4$$

ii. Arsenic acid is converted into arsenous acid.

$$H_3AsO_4 \longrightarrow H_3AsO_3$$

iii. Arsenous acid is converted into arsine gas.

$$H_3AsO_3 + 6[H] \longrightarrow AsH_3 \uparrow + 3H_2O$$

(Arsine gas)

iv. Arsine gas is converted into mercuric arsenide.

$$2AsH_3 + HgCl_2 \longrightarrow Hg(AsH_2)_2 + 2HCl$$

Note

- Purified water is used for dilution purpose and it is free from dissolved gases and impurities.
- Standard solution is prepared as it gives maximum permissible limit for comparison.
- Lead acetate cotton plug is used to avoid the interaction of hydrogen sulphide gas with mercuric chloride.
- Stannated zinc is used for slow and steady evolution of nascent hydrogen.
- Time required for the preparation is more therefore, this test should be observed after 40 minutes.
- All reagents should be having AST grade (free from arsenic).

Procedure

Limit test for sulphate IP 85

Test	*Standard*
i. Substance as per monograph.	i. 0.2 to 1 ml standard arsenic solution.
ii. Add 1 g of KI.	ii. Add 1 g of KI.
iii. Add 10 g of stannated zinc	iii. Add 10 g of stannated zinc

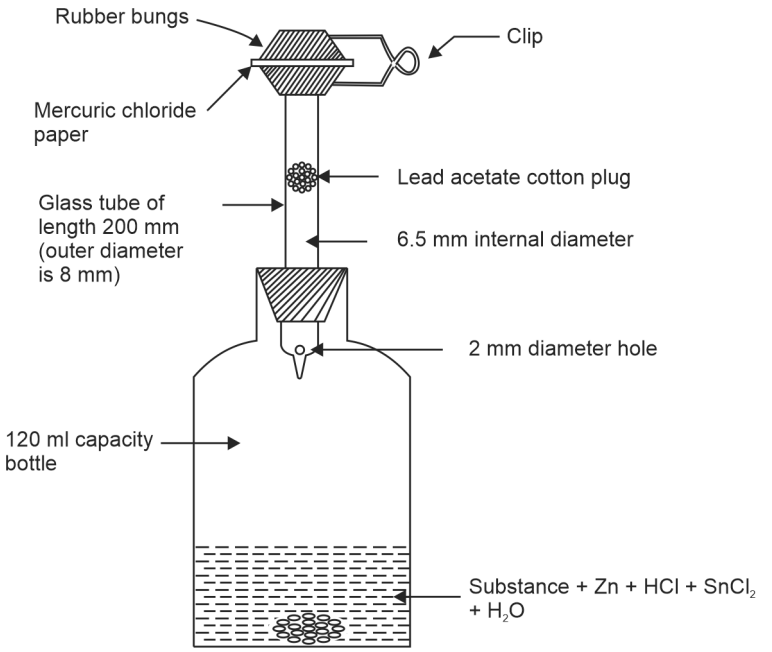
Shake the bottles and keep aside for 40 minutes.

Remarks

If yellow stain obtained in test mercuric chloride paper is less than standard stain, sample passes limit test for arsenic IP 85.

18 Describe apparatus used for limit test for arsenic. Explain Gutzeit test apparatus. (S.22, 23, 24, W.22)

☞ Gutzeit Test Apparatus



Construction

- It consists of a wide-mouthed glass bottle of capacity 120 ml.
- Glass tube of 200 mm length is passed in it through the rubber bungs.
- Glass tube is constricted at lower end.
- It has a 2 mm hole.
- The end of the tube should be above the liquid.
- Mercuric chloride paper is sandwitched between two rubber bungs and fixed by clip.
- Lead acetate cotton plug is inserted into the glass tube before operation.

19 What do you mean by "Test for Purity"? Explain various 'Tests for purity' as per pharmacopoeia.

☞ **Tests for Purity:**

These are the tests used to detect the undesirable impurities in the substance.

☞ **Following are the Tests for Purity:**

1. **Colour and odour:**

   These tests are used only when other tests for purity are not applicable. These tests are valuable to know whether the substance is reasonably aesthetic and hygienic or not.

2. **Physical constants:**

   Melting point, boiling point, refractive index, optical rotation are suitable physical constants. In the presence of impurities variations are observed in these constants.

3. **Humidity:**

   The amount of moisture in the atmosphere is called as humidity. Moisture content of medicinal substances is determined.

4. **Insoluble constituents:**

   It helps to detect the impurities in the substances.

5. **Organic impurities:**

   Organic impurities may be from raw material or intermediate products or by products in the reaction.

6. **Acidity or alkalinity:**

   Excess of acidity or alkalinity has an effect and keeping qualities of the compounds.

   So, some important tests are used to determine the purity of medicinal substances.

7. **Anions:**

   Acids like H_2SO_4 and HCl are widely used in the manufacture of medicinal substances. Therefore, chloride and sulphate are commonly present as impurity in many of the medicinal substances.

   Hence, tests for anions like Cl^-, SO_4^- are prescribed in official books.

8. **Cations:**

   Tests for cations include the tests for sodium, potassium, ammonium radical and heavy metals like iron, lead, copper, etc.

9. **Ash:**
   - The reside left after complete ignition (incineration) of the drug is called as ash.
   - Determination of ash value is performed to have the idea about the contents of foreign cations and heavy metals.
   - In organic compounds, the alkali salts are generally present as impurities. In such cases the determination of ash value is preferable.
   - Ash value is useful to judge the identity or purity of crude drugs.
   - Ash value helps in detecting the adulteration and substitutions in crude drugs.

10. **Arsenic/Lead:**

    Arsenic and lead both impurities are toxic in nature. So, their presence in medicinal compound is controlled by performing the limit test for arsenic and lead.

11. **Loss on drying (LOD):**
    - In this test, absorbed water or water of hydration is determined by drying under specified conditions.
    - Loss in weight due to drying also represents the residual volatile constituents including organic solvents as well as water.

12. **Loss on ignition (LOI):**

    This type of test is applied to stable substances, which are liable to contain thermolabile impurities.

    For example, contamination of light magnesium oxide by carbonate is controlled by performing this test.

    This test is applied to two classes of substances:

    (a) Those which are completely volatile when ignited

    (b) Those which undergo a major decomposition, leaving a residue of definite composition.

20 Give the difference between: "Determinant and Indeterminant errors".

☞

Determinant Errors (systematic errors)	Indeterminant Errors (random errors)
1. These are also know as systematic/non-random/constant errors.	1. These are also/known as non-systematic/random/accidental errors.
2. These errors are determinable and can be eliminated.	2. These errors can never be determined and eliminated but can be minimized by careful work.
3. These errors are recognized by the lack of agreement between the mean of a series of replicate determinations and the correct value.	3. These errors are recognized by variability in the replicate determinations, i.e. by the scatter of result about their mean.
4. These errors are quantified by measure of accuracy such as absolute error or the relative error of the mean.	4. These errors are quantified by a measure of precision such as standard deviation or the relative standard deviation.
5. The sources of these errors may be personal, instrumental, methodological, etc.	5. The sources of these errors may be personal, instrumental, etc.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. In limit test for iron I.P iron impurity react with **thioglycolic acid.**
2. Barium Sulphate Reagent (BSR) is used in **limit test for sulphate I.P.**
3. In limit test for arsenic **Arsine** is converted to arsenous acid/arsine gas.
4. Gutzeit apparatus is used for the **limit test for Arsenic**.
5. Cool storage condition means temperature range between **8°C and 25°C.**
6. The difference between measured value and true value is called as **error**.

7. The residue left after complete agitation of the drug is called as **ash**.
8. Arsine gas is carried and comes in contact with mercuric **chloride** in produces a yellow or brown stain.
9. The lead acetate cotton plug in limit test of arsenic is used to **trap the sulphides**.
10. Silver Nitrate is used in the **limit test of chloride**.
11. Limit test is a quantitative test designed to identify **impurity**.
12. **Buffer system** resists changes in pH of solution.
13. The assay of compound is done to **identify purity**.
14. Silver nitrate reagent is used to **chloride impurity**.
15. Assay of sodium chloride is based on **precipitation titration**.

Chapter
2

Volumetric Analysis

1 Define the terms:

1. **Accuracy:** An accuracy means closeness of an experimental result with true value or actual result.
2. **Precision:** The precision means the degree of reproducibility or agreement between repeated measurements.
3. **Assay:** The estimation of percentage purity (the potency) of the active principle in the unit quantity of a medicinal compound is called as an assay.
4. **Direct titration:** When solution of unknown strength under determination is titrated directly with the titrant and volume of titrant used till end point is directly proportional to the quantity of the substance under determination, it is called as direct titration, e.g. assay of sodium bicarbonate, ferrous sulphate.
5. **Indirect titration:** When of the substance under determination cannot be titrated directly with the standard solution but treatment with some simple chemical treatment is capable of formation a proportional amount of a substance which can be directly titrated with a titrant, it is called as an indirect titration, e.g. assay of ammoniated mercury, copper sulphate.
6. **Back/Residual titration:** When the substance under determination is either unstable or volatile or the rate of reaction is slow, it is treated with the known excess volume of a suitable standard solution for a complete chemical reaction and excess of unreacted standard solution is determined by a suitable titrant, it is called as back/residual titration, e.g. assay of sodium chloride by modified Volhard's method.
7. **Volumetric analysis (titrimetric analysis):** Volumetric analysis involves the determination of volume of standard solution

that reacts quantitatively and completely with the solution of the substance to be determined.

8. **Gravimetric analysis:** The gravimetric analysis means the substance to be analysed is converted into a definite chemical composition, by using a suitable reaction, separated in this dried component, the purity of a substance is found out.
9. **Iodimetry (iodimetric) titration:** Iodimetry is a volumetric analysis involving either titration with a standardized solution of iodine (free iodine solution).
10. **Iodometry (iodometric) titration:** Iodometric is the quantitative analysis of a solution of an oxidizing agent by addition of an iodide that reacts to form iodine. Or iodometric is the quantitative analysis method where the iodine is liberated during the reaction and is titrated.
11. **Titrate:** The substance to be determined is called as the titrate.
12. **Titrant:** The substance of known concentration is called titrant.
13. **Titration:** The process of determining the volume is called titration.
14. **Indicator:** Some auxiliary substance that is used to detect the end point of titration is called as the indicator.
15. **End point:** The point at which the reaction is complete is called the end point.
16. **Standard solution:** The solution of known concentration is known as the standard solution.
17. **Molarity (M):** It can be defined as the number of moles of solute present in one litre of the solution.
18. **Normality (N):** It is the number of gram equivalent of solute present in one litre of solution.
19. **Normal solution:** A solution containing 1 g equivalent weight per thousand ml of solution.
20. **Molar solution:** A solution containing 1 mole per thousand ml of solution.

2 What do you mean by "Qualitative and Quantitative analysis"?

(a) **Qualitative Analysis:** It involves the detection and identification of the constituents of the sample.

(b) **Quantitative Analysis:** It deals with the determination of exact quantity of pure constituent present in a sample or a mixture of substances.

Quantitative analysis is carried out by the following methods:

(a) Volumetric (titrimetric) analysis
(b) Gravimetric analysis
(c) Instrumental analysis
(d) Gasometric analysis

Another method of quantitative analysis based on size of the sample used for analysis:

(i) Macroanalysis – Sample of more than 0.1 gram.
(ii) Semi-microanalysis – 10 to 100 mg of sample.
(iii) Microanalysis – 1 to 10 mg of samples.
(iv) Ultra-microanalysis – Samples of the order of a micro-grams ($\mu g = 10^{-6}$ g).

3 Define volumetric (Titrimetric) Analysis. Classify different methods of volumetric analysis. (S.22, 23, W.23)

☞ **Volumetric Analysis:** It involves the determination of volume of standard solution that react quantitatively and completely with the solution of the substance to be determined.

☞ **Classification/Methods of Volumetric analysis:**

(1) **Acid–base titrations (neutralisation titration):**
When the neutralisation reaction is involved, then the titration is called as acid–base titration or neutralisation titration,
e.g. $NaOH + HCl \rightarrow NaCl + H_2O$.

(2) **Redox titration:**
Chemical reactions involving oxidation–reduction are widely used to analyse the various samples (oxidants and reductants),
e.g. $10\ FeSO_4 + KMnO_4 + 8\ H_2SO_4 \rightarrow 5\ Fe_2(SO_4)_3 + K_2SO_4 + 2\ MnSO_4 + 8\ H_2O$.

(3) **Precipitation titration:**
The formation of the precipitate in the reaction involved,
e.g. $AgNO_3 + NaCl \rightarrow AgCl \downarrow + NaNO_2$

(4) **Complexometric titrations:**
In this type stable complex is formed in the reaction involved. The complexing/chelating agent like EDTA forms complex with various metal ions.

(5) **Non-aqueous titrations:**
These titrations are when the reactoin takes place in non-aqueous solvents, i.e. organic solvents.
This is mainly used for analysis for very weak acids and bases.

4 Define Assay (Quantitative Assay). What are different types of assay?

☞ **Assay:** The estimation of the potency of the active principle in the unit quantity of a medicinal compound is called an assay.

☞ **Type of Assay:**

(a) Chemical assay.
(b) Biological assay.
(c) Immunological assay.
(d) Microbiological assay.

5 Describe in details Acid–base titrations (Acidimetry and Alkalimetry type titrations). (S.24, W.22)

☞ **Acid–base titrations:** The titrations which involve the neutralisation reaction between acid and base forming salt and water are called as acid–base titrations.

$$H^+ + OH^- \rightarrow H_2O$$

- In this case, acids may be defined as the substances, which when dissolved in water, undergo dissociation, forming H^+ ion.
- The base is a substance which when dissolved in water gives OH^- ions.
- Commonly used acids in these titrations are HCl and H_2SO_4 and bases NaOH, KOH, and sodium bicarbonate.
- Indicators used in these titrations are called acid–base titrations, e.g. phenolphthalein, methyl orange, methyl red, and phenol.

• Examples of Acid–Base Titrations:

Assay of sodium bicarbonate (baking powder), boric acid, ammoniated mercury, ammonium chloride.

6 Give the principle, reactions involved, procedure of assay of Sodium Bicarbonate. Write a note on Assay of Sodium Bicarbonate.

☞ **Assay of Sodium Bicarbonate:**

- **Type:** Acidimetric method.
- **Formula:** $NaHCO_3$ (direct titration method).

- **IP Standard:** It contains not less than 99% and not more than 101% of $NaHCO_3$.
- **Principle:**
  - Sodium bicarbonate is titrated by acidimetric method.
  - Sodium bicarbonate is a salt of strong base NaOH and carbonic acid. Hence, it is dissolved in water.
    It gives alkaline solution which is directly titrated with strong acids like HCl using methyl orange as an indicator.
- **Reactions:**
  (a) **For Standardization:**
  $Na_2CO_3 + 2\ HCl \rightarrow 2\ NaCl + H_2O + CO_2\uparrow$
  (b) **For Assay:**
  $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2\uparrow$

• **Procedure:**

(a) **For preparation of 1 M HCl:**
Take about 8.9 ml of commercial grade conc. HCl by burette or measuring cylinder. Add slowly distilled water and stirr it constantly and make the volume up to 100 ml with distilled water. Keep it in a stoppered flask.

(b) **For standardization of Hydrochloric Acid:**
- Weigh accurately 1.5 g of anhydrous sodium carbonate previously heated at about 27°C for 1 hour in an oven.
- Dissolve it in 100 ml of water in 250 ml conical flask.
- Add 0.1 ml of methyl red solution as an indicator.
- Titrate slowly against the acid from burette until solution turns faintly pink.
- Heat the solution to boiling, cool and continue the titration until the faint pink colour remain unchanged.

(c) **For Assay:**
- Weigh accurately 1.5 g of sodium bicarbonate.
- Dissolve it in 50 ml of water in a 250 ml conical flask.
- Add 0.2 ml of methyl orange solution as an indicator.
- Titrate the solution with standardized 1 M HCl until the solution becomes pink.

• **Factor for calculation:**

(a) **For standardization of HCl:**
Each ml of 1 M HCl ≡ 0.05599 g of Na_2CO_3

(b) **For Assay:**
Each ml of 1 M HCl ≡ 0.08401 g of Na_2CO_3.

• **Category:** Electrolyte replenisher, systemic alkaliser

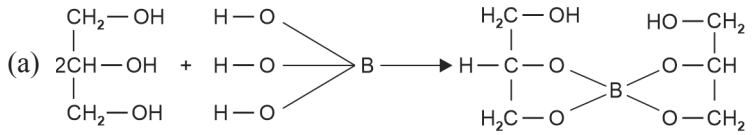
• **Uses:**

1. As a carminative
2. In treatment of crystalluria
3. As a systemic alkaliser
4. In treatment of poisoning.

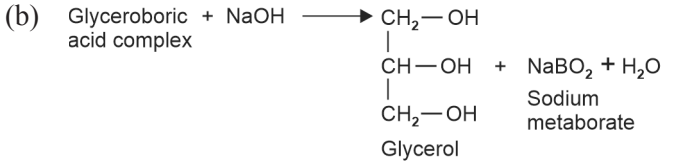
7 Write a note on "Assay of Boric Acid/Boracic Acid".

☞ **Assay of Boric Acid:**

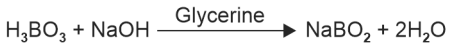
- **Type:** Acid–base titration/alkalimetric method/direct titration.
- **Formula:** H_3BO_3.
- **IP Standard:** It contains not less than 99.5% and not more than 100.5% or H_3BO_3.
- **Principle:**
  - Boric acid is based on alkalimetric method.
  - Boric acid is weak acid, hence it cannot be titrated with strong alkali like sodium hydroxide.
  - When boric acid is dissolved in glycerin–water mixture it acts as a strong monobasic acid and can be titrated with standard alkali using phenolphthalein as an indicator.
- **Reactions:**

(a) 

Glyceroboric acid complex
$+ H_3O^+ + H_2O$

(b) 

(c) **Net Reaction:**



- **Procedure:**
  - (a) **For standardization of sodium hydroxide:**
    - Weigh accurately 5 g of potassium hydrogen phthalate.
    - Dissolve it in 75 ml of carbon dioxide free water.
    - Add 0.1 N of phenolphthalein solution as indicator.
    - Titrate the solution with NaOH till pink colour is produced.
  - (b) **For assay of Boric Acid:**
    - Weigh accurately 2 g of boric acid as a conical flask.
    - Add mixture of 5 ml water and 100 ml glycerin, previously neutralized to phenolphthalein solution and dissolve the sample completely.
    - Add few drops of phenolphthalein indicator and titrate with 1 M sodium hydroxide until the pink colour is produced.
- **Factor for calculation:**
  - (a) **For standardization:**
    Each ml of 1 M sodium hydroxide ≡ 0.02042 g of $C_8H_5KO_4$.
  - (b) **For Assay:**
    Each ml of 1 M sodium hydroxide ≡ 0.06183 g of H_3BO_3.
- **Category: Local anti-infective**
- **Uses:**
  1. Used for cleansing of wounds.
  2. Mild antiseptic.
  3. In mouthwash and gargles.

8 Write a note on "Assay of Ammoniated Mercury".

☞ **Assay of Ammoniated Mercury:**

- **Type:** Acid–Base titration (indirect titration).
- **Formula:** NH_2HgCl.
- **Principle:**
  - It is based upon acid–base titration.
  - It is assayed by an indirect method where the substance is treated to liberate alkali quantitatively.
  - The sample is dissolved in solution of potassium iodide.
  - The precipitate of $HgCl_2$ dissolves in excess of potassium iodide with the liberation of equivalent amount of alkalies as ammonia and KOH, which are titrated against standard hydrochloric acid, using methyl orange as an indicator.

- **Reactions:**

$$NH_2HgCl + 2KI + H_2O \longrightarrow \underset{\text{(Insoluble)}}{HgCl_2} + KCl + \underset{\text{(Liberated alkali)}}{KOH} + NH_3$$

$$HgCl_2 + 2\,KI \longrightarrow \underset{\text{(Soluble)}}{K_2HgI_4}$$

$$NH_3 + H_2O \longrightarrow NH_4OH$$

$$KOH + NH_4OH + 2HCl \longrightarrow KCl + NH_4Cl + 2H_2O$$

- **Procedure:**
  - Weigh accurately about 0.25 g of substance and transfer to a stoppered flask containing 50 ml of water and 3 g of potassium iodide, shaking occasionally, till it dissolves.
  - The liberated alkali is titrated against 0.1 N HCl, using methyl orange as an indicator.
- **Factor:** Each ml of 0.1 N HCl ≡ 0.0126 g of NH_2 HgCl.
- **Category:** Topical antiseptic and disinfectant.
- **Uses:**
  - As topical antiseptic and disinfectant.
  - In treatment of psoriasis.
  - To treat minor skin infections and other skin disorders.

9 Write a note on "Assay of Ammonium Chloride". IP 85.

☞ Assay of Ammonium Chloride

- **Type:** Acid–base titration (indirect titration method)
- **Formula:** NH_4Cl
- **IP Standard:** It contains not less than 99% and not more than 100.5% of NH_4Cl
- **Principle:**
  - It is based an acid–base titration.
  - It is assayed by a new (IP 1985) indirect titration method.
  - A weighed quantity of the sample of ammonium chloride is dissolved in water.
  - The solution is treated with neutralised formaldehyde solution in a titration flask.
  - This results in the quantitative liberation of hydrochloric acid equivalent to ammonium chloride.
  - This liberated HCl is then titrated with a standard solution of sodium hydroxide using phenolphthalein as an indicator.
  - Pink colour produced is an end point of titration.

- **Reactions:**

$$4\ NH_4Cl + 6\ HCHO \longrightarrow (CH_2)_6\ N_4 + 4\ HCl + 6\ H_2O$$

(Ammonium chloride) (Formaldehyde) (Hexamine)

$$4\ HCl + 4\ NaOH \longrightarrow 4\ NaCl + 4\ H_2O$$

- **Procedure:**
  - Weigh accurately 0.1 g of sample, dissolved in 20 ml of water and add a mixture of 5 ml of formaldehyde solution, previously neutralized to dilute phenolphthalein solution and 20 ml of water.
  - Allow the reaction to take place for two minutes and titrate slowly with 0.1 N sodium hydroxide using solution of phenolphthalein as an indicator.
  - Appearance of pink colour is the end point.
- **Factor:** 1 ml of 0.1 N NaOH ≡ 0.005349 g of NH_4Cl.
- **Category:** Expectorant.
- **Uses:**
  1. Used as an acidifying agent.
  2. As a diuretic.
  3. To maintain physiological acid–base balance.

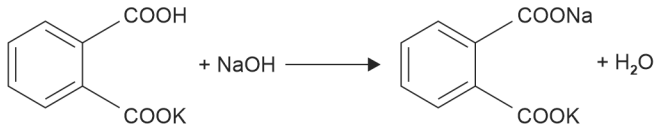
10 Write a note on "Assay of Zinc Oxide".

☞ **Assay of Zinc Oxide:**

- **Type:** Acid–base titration.
- **Formula:** ZnO
- **IP Standard:** It contains not less than 99% and not more than 100.5% of ZnO.
- **Principle:**
  - This assay is based on acid–base type of titration.
  - Zinc oxide reacts with acid very slowly so the back titration is useful for the assay of zinc oxide.
  - In this assay the zinc oxide is added to definite amount of a sulphuric acid, which is taken in excess and is titrated with standard solution of sodium hydroxide.
  - Sulphuric acid solution, which is excess, is back titrated.
  - From the volume of sulphuric acid consumed, percentage of zinc oxide can be calculated.
  - Ammonium chloride is added to prevent the precipitation of zinc hydroxide, which interferes with the end point detection.

• **Reactions:**

(a) **Chemical Reaction for Standardization:**



Potassium hydrogen phthalate Sodium potassium phthalate

(b) **Chemical Reaction for Assay:**

1. $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$
2. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

• **Procedure:**

(a) **Standardization of sodium hydroxide:**

- Weigh accurately 5 g of potassium hydrogen phthalate.
- Dissolve it in 75 ml of carbon dioxide free water in conical flask.
- Add 0.1 ml of phenolphthalein as an indicator.
- Titrate the solution with given sodium hydroxide.
- Continue titration till pink colour appears.

(b) **Assay of zinc oxide:**

- Weigh accurately 1.5 g of zinc oxide.
- Dissolve it with 2.5 g of ammonium chloride in 50 ml of 1 N sulphuric acid with the add of gentle heat, if necessary.
- Add few drops of methyl orange as an indicator.
- Titrate the excess sulphuric acid with 1 N sodium hydroxide.

• **Factor:**

(a) **For standardization:** Each ml of 1 M sodium hydroxide ≡ 0.02042 g of $C_8H_5KO_4$.

(b) **For assay:** Each ml of 1 N sulphuric acid ≡ 0.04069 g of ZnO.

• **Category:** Topical protective

• **Uses:**

1. It is a mild antiseptic and an astringent.
2. In treatment of eczema, urticaria, sunburns, ringworms.
3. In combination with other protective or antimicrobial agents.
4. As a pharmaceutical aid in the manufacture of adhesive tape.

11 What are Redox Titrations/Oxidation–Reduction Titrations?

☞ **Redox Titrations:**

- A redox titration is a titration in which the analyte and titrant react through an oxidation–reduction reaction.
- Oxidation–reduction reactions are used in volumetric determinations.
- Oxidation reaction is the reaction where addition of oxygen or removal hydrogen takes place.
- Reduction reaction is the reaction where addition of hydrogen or removed oxygen.
- The principle involved in redox titrations is that the oxidation process involves loss of electrons, whereas the reduction process involves the gain of electrons.
- Oxidation and reduction usually occur simultaneously in the reaction, i.e. while oxidising the substance, the oxidising agent itself gets reduced.
- The various oxidising agents used in redox reactions are classified as:
  (a) Permanganate titrations: Potassium permanganate is used as an oxidant
  (b) Dichromate titrations: Potassium dichromate is used as an oxidant.
  (c) Iodine titrations: Iodine is used as an oxidising agent.
  (d) Cerimetry: Ceric salts are used as an oxidant.
- Redox titrations are used to determine the concentration of an unknown solution that contains an oxidizing or reducing agent.
- Example of redox titrations: Assay of potassium permanganate, ferrous sulphate, hydrogen peroxide, sodium oxalate, iodine, chlorinated lime, antimony potassium tartrate, copper sulphate.

12 What do you mean by permanganate titrations?

☞ **Permanganate titrations:**

When potassium permanganate is used as an oxidising agent in volumetric reactions, it is called as permanganate titrations.

- **Explanation:**
  - Standard solution of potassium permanganate is used as titrant in this method.

- Potassium permanganate is acidic solution acts as an oxidant.
- Reaction:
  $2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[0]$
- The nascent oxygen thus formed, oxidises the substance.
- Thus, potassium permanganate acts as a self indicator.
- Here potassium permanganate, because of MnO_4^- shows colour change from purple to pink.
- When reduced to Mn^{++}, the colour disappears and when the reaction completes, because of excess concentration of MnO_4^-, it shows a pink colour again.
- The end point is thus detected.
- Potassium permanganate acts as an oxidant in basic and neutral media also.

13 Write a note on "Assay of Ferrous Sulphate". (S.24)

☞ **Assay of Ferrous Sulphate:**

- **Type:** Oxidation–reduction titration (redox/permanganate titration)
- **Formula:** $FeSO_4$.
- **I.P. Standard:** It contains not less than 98% and not more than 105% or $FeSO_4.7H_2O$.
- **Principle:**
  - It is oxidation–reduction type of assay, i.e. redox type of titration.
  - In this titration potassium permanganate acts as an oxidising agent.
  - It reduces $FeSO_4$ and $KMnO_4$, and it self acts as an indicator in this titration.
  - Ferrous sulphate is directly titrated against standard solution of potassium permanganate in presence of acidic medium by sulphuric acid.
  - Ferrous salt can be easily oxidised to ferric form under ordinary condition.
  - The end point becomes faint pink colour.
  - Acidic medium is necessary for the reaction and to prevent precipitation of MnO.

- **Reactions:**
  $2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[0]$
  $5[2FeSO_4 + H_2SO_4 + 5[0] \rightarrow 5Fe(SO_4)_3 + 5H_2O]$

  Net reaction: $2KMnO_4 + 8H_2SO_4 + 10FeSO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2SO_4 + 8H_2O$.
- **Procedure:**
  - Weigh accurately 1 g of sample.
  - Dissolve it in 20 ml distilled water in conical flask.
  - To this add 10 ml dil. sulphuric acid.
  - Titrate this solution against standardized solution of potassium permanganate.
- **Factor:** Each ml of 0.1 N $KMnO_4 \equiv 0.0278$ g of $FeSO_4.7H_2O$.

• Assay of Ferrous sulphate as per I.P. 1985:

Principle:

- According to IP 85, ferrous sulphate can also be estimated by using ceric ammonium sulphate as a titrant (oxidising agent) and ferroin sulphate as an indicator.
- Ceric ammonium oxidises ferrous sulphate in acidic medium preferably in sulphuric acid medium to ferric sulphate.
  $2FeSO_4 + 2(NH_4)_2 Ce(SO_4)_3 \rightarrow Fe_2(SO_4)_3 + 2(NH_4)_2 SO_4 + Ce_2(SO_4)_3$.
- Ferrion sulphate is an indicator used in this titration, which is a solution of O-phenanthroline in aqueous solution of ferrous sulphate.
- 3 moles of O-phenanthroline combines with 1 ferrous ion to form complex $Fe(C_{12} H_8 N_2)_3^{+2}$ having red colour.
- After completion of the reaction with ferrous sulphate, ceric ammonium sulphate oxidises the indicator to ferric form, $Fe(C_{12} H_8 N_2)_2^{+3}$ having blue colour.
  $2Fe(C_{12} H_8 N_2)_3 SO_4 + 2(NH_4)_2 Ce(SO_4)_3 \rightarrow [Fe(C_{12} H_8 N_2)_3]_2 (SO_4)_3 + 2(NH_4)_2 SO_4 + Ce_2(SO_4)_3$.
- Ceric ammonium sulphate in sulphuric acid medium is a strong oxidising agent and considerably more stable than standard potassium permanganate.
- Sufficient sulphuric acid is to be used to prevent hydrolysis and precipitation of basic salts.

- Advantages of this system over permangnate titration are:
  1. It is a simple one electron reaction.
     $Fe^{+2} \Rightarrow Fe^{+3} + e$
     $Ce^{+4} + e \Rightarrow Ce^{+3}$
  2. In place of sulphuric acid, hydrocholoric acid may be used. It does not interfere with analytical application.
- **Procedure of Assay of Ferrous sulphate IP 85:**
  - Weigh accurately about 1 g of substance.
  - Dissolve it in a mixture of 30 ml water and 20 ml of dilute sulphuric acid.
  - Titrate with standard ceric ammonium sulphate. Using ferroin sulphate solution as an indicator.
- **Factor:** Each ml of 0.1 N ceric ammonium sulphate ≡ 0.0278 g of $FeSO_4.7H_2O$.
- **Category:** Haematinic
- **Uses:**
  1. Used as haematinic.
  2. Used in anemias caused due to iron deficiency.

14 Write a note on "Assay of Hydrogen peroxide".

☞ **Assay of Hydrogen Peroxide:**

- **Type:** Oxidation–reduction/redox/permanganate titration.
- **Formula:** H_2O_2.
- **IP standard:** It contains not less than 5% w/v and not more than 7% w/v of H_2O_2, corresponding to about 20 times its volume of available oxygen.
- **Principle:**
  - The assay of hydrogen peroxide is based upon oxidation–reduction reaction.
  - Hydrogen peroxide acts as a oxidising agent and liberates oxygen rapidly.
  - However, hydrogen peroxide is titrated with potassium permanganate solution which acts as a reducing agent.
  - In this reaction potassium permanganate itself acts as self indicator.
- **Reaction:**
  $2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$.
  - A fairly high concentration of sulphuric acid is used to reduce the formation of MnO_2 and which is a catalyst for the decomposition of hydrogen peroxide.

- Usually strength of hydrogen peroxide is represented in terms of volume strength.
- It is defined as the number of ml of oxygen at N.T.P.
  1 g of $H_2O_2 \equiv 329.2$ ml of O_2

- **Procedure:**
  - Dilute 10 ml of sample solution to 250 ml in volumetric flask.
  - To 25 ml of this solution, add 10 ml of 5 N sulphuric acid and titrate with 0.1 N potassium permanganate to obtain faint pink colour as the end point.
- **Factor:**
  Each ml of 0.1 N $KMnO_4 \equiv 0.001701$ g of H_2O_2
- **Category:** Antiseptic
- **Uses:**
  1. Antiseptic and disinfectant.
  2. For cleansing wounds.
  3. In mouthwash and gargles.
  4. Topical anti-infective
  5. As antimicrobial agent.

15 Write a note on "Assay of Sodium Oxalate".

☞ **Assay of Sodium Oxalate:**

- **Type:** Oxidation–reduction/redox/permanganate titration.
- **Formula:** $Na_2C_2O_4$.
- **Principle:**
  - It is based upon redox (permanganate) titration. It is also called as residual titration.
  - Sodium oxalate is allowed to react with sulphuric acid to liberate the equivalent amount of oxalic acid, which is titrated against standard solution of potassium permanganate, till the appearance of permanent pink colour, which is the end point.
  - Potassium permanganate itself acts as an indicator.
  - The titration should be carried out in acidic medium and at 70°C with constant stirring, otherwise formation of the black precipitate of Mn_2O takes place. This precipitate interferes in the accurate detection of end point.
- **Reaction:**
  $Na_2C_2O_4 + H_2SO_4 \rightarrow Na_2SO_4 + H_2C_2O_4$
  $2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$

- **Procedure:**
  - Weigh accurately about 0.3 g of sample.
  - Dissolve it in 25 ml of water and 6 ml of sulphuric acid previosly diluted with water and titrate the solution with 0.1 N potassium permanganate solution.
- **Factor:**
  Each ml of 0.1 N $KMnO_4 \equiv 0.0069$ g of $Na_2C_2O_4$.
- **Category:** Reducing agent
- **Uses:**
  1. As a reducing agent.
  2. Used to remove calcium ions from blood plasma.
  3. Used as chelating agent and anticorrosive agents.

16 Write a note on "Assay of potassium permanganate".

☞ **Assay of Potassium permanganate:**

- **Type:** Oxidation–reduction/redox/permanganate titration.
- **Formula:** $KMnO_4$.
- **IP standard:** It contains not less 99% of $KMnO_4$.
- **Principle:**
  - It is assayed by redox titration/direct titration.
  - The titration is made with a standard solution of oxalic acid in the presence of sulphuric acid at or 70°C throughout the entire titration.
  - The solution of potassium permanganate to be assayed is taken in the burette.
  - The standard solution of oxalic acid and sulphuric acid are taken in the titration flask.
  - Potassium permanganate itself serves as an indicator.
  - End point is appearance of permanent pink colour.
  - Oxalic acid gets oxidised to carbon dioxide by potassium permanganate.
- **Reaction:**
  $2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2\uparrow$
- **Procedure:**
  - Weigh accurately about 0.8 g of sample.
  - Dissolve it in water and dilute to 250 ml with water.

- Titrate this solution with 25 ml. of 0.1 N oxalic acid, mixed with 25 ml of water and 5 ml of sulphuric acid.
- Keep the temperature at about 70°C throughout the titration.

- **Factor:**
  Each ml of 0.1 N $KMnO_4 \equiv 0.00316$ g of $H_2C_2O_4.\ 2H_2O$.
- **Category:** Antimicrobial agents.
- **Uses:**
  1. It is used as antibacterial, antifungal, germicidal, and astringent properties.
  2. It also has a deodourising action.
  3. Useful in cleansing of wounds, ulcers abscesses.
  4. As a gargles or mouthwashes.
  5. 1% solution of $KMnO_4$ is used in bromhidrosis (the secretion of foul smelling perspiration and in mycotic infections such as athlete's foot.)
  6. A 5% solution has a powerful styptic action.

17 Write a note on Iodine Titrations. Explain Iodometric and Iodimetric type titrations. Give the difference between iodometric and iodimetric titrations.

☞ **Iodine Titrations:**

- Titrations involving reaction with iodine makes use of the oxidising power of iodine in aqueous solution
  $I_2 + 2e \rightarrow 2I^-$
- Iodine is practically insoluble in water, the iodine solution is prepared by dissolving it in solutions of KI, forming KI_3, which acts as free iodide.
- This can be easily titrated against standard solution of reducing agents such as sodium thiosulphate.
- Iodine itself can act as self indicator because of its colour.
- But in iodine titrations, generally starch solution is used as an indicator to detect the end point of reaction.
- Generally starch absorbs iodine to give insoluble complex.
- Starch solution should be added near to the end point, rather than at the initial stages of reaction, to prevent formation of complex of amylopectin, which interferes with the reaction.
- End point is bluish to colourless.
- Higher temperature and presence of alkalies should be avoided in the titration to get proper end point.

Types of Iodine Titrations:

1. **Iodimetry (Iodimetric):**
   Iodimetry is a volumetric analysis involving either titration with a standardized solution of iodine, i.e. when free iodine solution is reacting, e.g. assay of iodine.
2. **Iodometry (Iodometric):**
   Iodometry is the quantitative analysis of a solution of an oxidising agent by addition of an iodide that reacts to form iodine, i.e. iodine is liberated during the reaction is titrated, eq. assay of chlorinated lime, assay of antimony potassium tartrate, assay of copper sulphate.

Iodimetry (iodimetric)	Iodometry (iodometric)
1. It is a direct titration method.	1. It is an indirect titration method.
2. The number of redox reaction is one.	2. The number of redox reactions are two.
3. Iodine will get reduced.	3. Iodine will get oxidized initially and then reduced.
4. Less commonly used in experiments.	4. More commonly used in experiments.
5. Free iodine is titrated.	5. Liberated iodine is titrated.
6. It is used to quantify reducing agents.	6. It is used to quantify oxidising agents..

18 Write a note on "Assay of Iodine".

☞ **Assay of Iodine (Iodimetry):**

- **Type:** Iodimetry/iodimetric/redox titration.
- **Formula:** I_2
- **Principle:**
  - Assay of iodine is based upon iodimetry (redox) type of titration in which standard solution of iodine is used.
  - It is directly titrated against the standard solution of sodium thiosulphate.
  - Iodine being practically in soluble in water, hence it is dissolved in a solution of potassium iodide which forms polyiodides (KI_3), where free iodine acts as oxidising agent.
  - This solution is titrated against standard solution of sodium thiosulphate.
  - The end point is determined by colour change from blue to colourless.

- **Reaction:**
  $2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$
- **Procedure:**
  - Weigh accurately about 0.5 g sample.
  - Dissolve it in a solution of 1 g potassium iodide in 5 ml water.
  - Dilute to 50 ml with water.
  - Add 1 ml of dilute acetic acid and titrate with 0.1 N sodium thiosulphate, using starch as an indicator.
- **Factor:**
  Each ml of 0.1 $Na_2S_2O_3 \equiv 0.01269$ g of I (iodine)
- **Category:** Antiseptic
- **Uses:**
  1. In treatment of goitre.
  2. In thyroid deficiency.
  3. As antiseptic.
  4. In fungal infections.
  5. In syphyllis and leprosy.
  6. In asthma.

19 Write a note on "Assay of chlorinated lime".

☞ **Assay of chlorinated lime:**

- **Type:** Iodometry/iodometric titration.
- **Formula:** Ca(OCl)Cl.
- **Principle:**
  - Chlorinated lime is assayed by iodometric titrations.
  - The aqueous solution is treated with acetic acid in presence of potassium iodide.
  - The acetic acid reacts to liberate chloride, which in turn replaces the equivalent amount of iodine.
  - This iodine liberated is titrated against a standard solution of sodium thiosulphate, using starch as an indicator.
  - The end point is disappearance of blue colour.
- **Reaction:**
  $Ca(OCl)Cl + 2CH_3COOH \rightarrow (CH_3COO)_2\ Ca + HCl + HOCl$
  Hypochlorus acid
  $HCl + HOCl \rightarrow H_2O + Cl_2$
  $2KI + Cl_2 \rightarrow 2KCl + I_2$

- **Procedure:**
  - Weight accurately about 4 g of sample.
  - Triturate it in a mortar with successive small quantities of water and transfer it to a volumetric flask.
  - Add sufficient water to produce 1 litre shake thoroughly.
  - To 100 ml of this suspension, add 3 g of potassium iodide, dissolved in 100 ml water, acidify with 5 ml acetic acid and titrate the liberated iodine with 0.1 N sodium thiosulphate, using starch as an indicator.
  - Titration is continued till disappearance of the blue colour.
- **Factor:**
  Each ml of 0.1 $Na_2S_2O_3 \equiv 0.003546$ g of Cl
- **Category:** Bleaching agent.
- **Uses:**
  1. Used as bleaching powder.
  2. Used in disinfection.

20 Write note on "Assay of Antimony potassium tartrate."

☞ **Assay of Antimony potassium tartrate:**

- **Type:** Iodometric/iodometry titration.
- **Formula:** $C_4H_4O_7SbK$
- **Principle:**
  - This assay is based an iodometric titration.
  - It acts as a solution of potassium acid tartrate and antimony trioxide.
  - Antimony is converted to antimony pentoxide with the liberation of hydrochloric acid.
  - The acid brings the reversal of the reaction and hence sodium bicarbonate, sodium potassium tartrate, borax are used.
  - End point is rather slow and therefore, to make sure the end point is reached, shake the solution.
- **Reaction:**
  $2C_4H_4O_7SbK + 2I_2 + 3H_2O \rightarrow 2KHC_4H_4O_6 + Sb_2O_5 + 4HI$
- **Procedure:**
  - Dissolve 0.5 g sample in 50 ml water.
  - Add 5 g of potassium sodium tartrate and 2 g of borax.
  - Titrate with 0.1 N iodine, using starch mucilage as an indicator, which is added at the end point of the reaction.

- **Factor:**
  Each ml of 0.1 N iodine ≡ 0.01625 g of $C_4H_4O_7SbK$.
- **Category:** Emetic
- **Uses:**
  1. Used as an expectorant and emetic.
  2. It acts as anti-schistosomal (in schistosomiasis).
  3. In treatment of kala-azar.

21 Write note on "Assay of copper sulphate".

☞ **Assay of copper sulphate:**

- **Type:** Iodometry/iodometric titration.
- **Formula:** $CuSO_4$
- **IP Standard:** It contains not less than 98.8% and not more than 101% w/w of $CuSO_4$.
- **Principle:**
  - It is based on iodometric titration.
  - In this titration copper sulphate solution is treated with potassium iodide and acetic acid.
  - Acetic acid is used to provide pH 4 to 5.5, at which copper sulphate reacts with potassium iodide to form cupric iodide.
  - Cupric iodide is very unstable and decomposes to cuprous iodide and equivalent amount of iodine.
  - The liberated iodine is titrated against standard solution of sodium thiosulphate.
  - The reaction of decomposition of cupric iodide is reversible and to make it irreversible, potassium thiocyanate is added.
  - Potassium thiocyanate should be added near to the end point to avoid adsorption of iodine by cuprous thiocyanate.
- **Reaction:**
  $CuSO_4 + 2KI \rightarrow CuI_2 + K_2SO_4$
  $2\ CuI_2 \rightleftharpoons 2CuI + I_2$
  $I_2 + 2NaS_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$
  $CuI + KSCN \rightarrow CuSCN + KI$
- **Procedure:**
  - Weigh accurately 1 g of sample.
  - Add 3 g of potassium iodide, 5 ml of acetic acid.
  - Titrate the liberated iodine with 0.1 N sodium thiosulphate, using, starch as an indicator.

- Continue the titration till a faint blue colour remains, add 2 g of potassium thiocyanate, stirr well and continue the titration until the blue colour disappears.

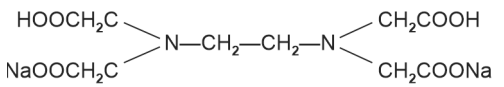
- **Factor:**
  Each ml of 0.1 $Na_2S_2O_3 \equiv 0.02497$ g of $CuSO_4.5H_2O$.
- **Category:** Antimicrobial agent.
- **Uses:** Used as fungicide, bactericide, algaecide, herbicide.

22 Explain the principle of complexometric Titrations. (S.24)

☞ **Complexometric Titrations:**

In this type of titrations, a stable complex is formed in the reaction involved. The complexing/chelating agents like EDTA forms complex with various metal ions.

- Complexing agent is any electron donating ion or molecule, usually called a ligand.
- It forms complex with metal ions due to its ability to form one or more covalent bonds with metal ions.
- Complexes are generally called as coordination compounds.
- Ligands having more than one electron donating group are called as chelating agents, as they form cyclic structures with metal ions in a manner similar to that of crab's claw.
- The solubility of metal chelates in water depends upon the presence of hydrophilic groups such as –COOH, $–NH_2$, –OH.
- The term sequestering agent is applied to chelating agents, which form water-soluble complexes with metal ions.
- Ethylenediamine tetra-acetic acid (EDTA) is a sequestering agent, which reacts with most polyvalent metal ions.
- EDTA is hexadentate ligand having six electron donating groups. But generally disodium salt of EDTA is used as a titrant in the titration.
- EDTA is quadridentate ligand.



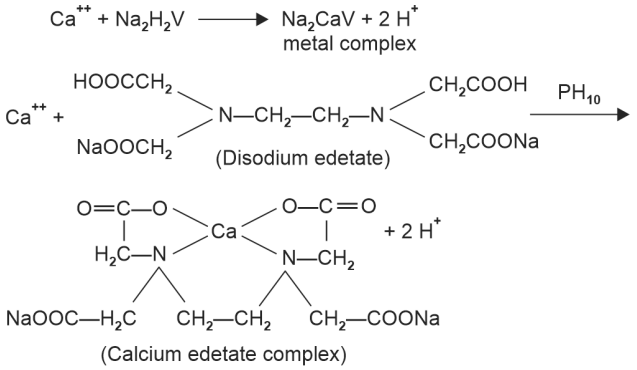
- EDTA forms complex with metal ion at a specific pH only. The reaction takes place as:
  $2\ Na_2H_2V + M \rightleftharpoons Na_2\ (MV) + 2\ H^+$

- This H^+ liberated in the reaction affects the stability of the complex. To remove H^+, generally buffer solution is added.
- The metal ion indicator (metallochromic indicator) is used to detect the end point.
- Indicators used in complexometric titrations, e.g. eriochrome black-T, murexide, xylenol orange, catechol violet, etc. These indicators are also called as pM indicators.
- Complex formation is mainly based upon maintenance of pH and hence the addition of buffer solution is important in analysis.
- **Examples of complexometric titrations:**
  Assay of calcium gluconate, assay of bismuth oxychloride, assay of magnesium sulphate, assay of zinc sulphate.

23 Write a note on "Assay of calcium gluconate".

☞ **Assay of calcium gluconate:**

- **Type:** Complexometric titration.
- **Formula:** $C_{12}H_{22}O_{14}H_2O$
- **I.P. Standard:**
  - It contains not less than 98.5% and not more than 102% W/W of calcium gluconate.
- **Principle:**
  - It is based upon complexometric titration.
  - The sample is treated with hydrochloric acid and to this solution sodium hydroxide is added to maintain pH (about 10).
  - This solution is directly titrated against standard disodium edetate solution, using screened indicator (mixture of murexide and naphthol green).
  - The end point is deep blue in colour.
- **Reaction:**



- **Procedure:**
  - Weigh accurately about 0.8 g sample and dissolve in 150 ml of water containing 5 ml dil. hydrochloric acid.
  - Add 15 ml of solution of sodium hydroxide, 40 mg of murexide and 3 ml of solution of naphthol green.
  - Titrate the solution with 0.05 M disodium edetate until the solution is deep blue in colour.
- **Factor:**
  Each ml of 0.5 M disodium edetate ≡ 0.2242 g of $CaC_{12}H_{22}O_{14}.H_2O$.
- **Category:** Mineral supplement.
- **Uses:**
  1. In treatment of calcium deficiency, hypocalcaemia.
  2. As an antidote.
  3. As a mineral supplement.
  4. In hypocalcemic tetany.

24 Write note on "Assay of magnesium sulphate".

☞ **Assay of magnesium sulphate:**

- **Type:** Complexometric titration
- **Formula:** $MgSO_4$
- **I.P. Standard:** It contains not less than 99% and not more than 100.5% of $MgSO_4$.
- **Principle:**
  - It is based upon complexometric titration.
  - A well-defined simple complex is formed between magnesium and disodium ethylenediaminetetra-acetate.
  - Magnesium sulphate forms a stable complex with disodium edetate in the presence of strong ammonia-ammonium chloride buffer.
  - Direct titration method can be adopted.
  - Mordant black mixture is used as an indicator.
  - The end point is the change of colour from pink to blue.
  - The titration is carried out with 0.05 M solution of disodium edetate which is taken in the burette.
- **Reaction:**
  $Mg^{++} + EDTA \rightarrow Mg\ EDTA$
  complex

- **Procedure:**
  - Weigh accurately about 0.3 g of anhydrous magnesium sulphate.
  - Transfer it to 250 ml conical flask, add about 50 ml of water, 10 ml of ammonia-ammonium chloride buffer, 0.1 g mordant black mixture.
  - Titrate with EDTA until distinct blue colour is appeared.
- **Factor:**
  Each ml of 0.05 M disodium edetate ≡ 0.006019 g of $MgSO_4$.
- **Category:** Saline cathartic
- **Synonym:** Epsom salt
- **Uses:**
  1. As a saline cathartic.
  2. As an anticonvulsant.
  3. As an antidote in heavy metal poisoning.
  4. As a cholegogue.
  5. Locally used as anti-inflammatory agent.

25 Write a note on "Assay of Bismuth oxychloride".

☞ **Assay of Bismuth oxychloride:**

- **Type:** Complexometric titration.
- **Formula:** BiOCl
- **Principle:**
  - It is based an complexometric titration.
  - The sample is ignited with sulphuric acid at temperature not more than 500°C to remove chloride, as this chloride interferes with the titration by forming tetrachlorocomplexes.
  - Sulphamic acid is added to ensure pH between 2–3 and titrated against standard solution of disodium edetate, using catechol violet as an indicator.
- **Reaction:**
  $Bi^{+++} + Na_2H_2V \rightarrow Na_2BiV + 2\ H^+$
  (Disodium edetate)
- **Procedure:**
  - Dissolve 1 g of sample and ignite with sulphuric acid.
  - Dissolve the residue in nitric acid and adjust pH with ammonia until catechol violet is blue.
  - Add 0.2 g sulphamic acid and titrate against 0.05 M disodium edetate, until the colour changes to yellow.

- **Category:** In cosmetic products.
- **Uses:**
  1. Bismuth oxychloride is used in the formulation of making, nail products, cleansing products, fragrances and hair colouring products.
  2. Bismuth oxychloride imparts a white colour to cosmetic and personal care.

26 Explain the principle of precipitation Titrations. Write a note on precipitation Titration. (S.22, W.22, 23)

☞ **Precipitation Titration:**

- In this type of titration precipitate is formed in the reaction involved, e.g.

$$AgNO_3 + NaCl \rightarrow \underset{\text{(ppt)}}{AgCl \downarrow} + NaNO_2.$$

- Most common methods involved the precipitation reactions with silver nitrate with halide ions.
- In this case end point can be detected when after addition of more reagent there is no further precipitation.
- Precipitation titrations are mainly argentometry titrations where silver nitrate solution is used.
- Precipitation of mercury salts also can be used in analysis. This is called as mercurometry.
- Precipitation titration methods are classified:
  (a) Mohr's method.
  (b) Volhard's method.

(a) **Mohr's method:**

- The Mohr's method of assay depends upon the direct volumetric precipitation titration.
- This method is used for analysis of neutral halides.
- Titration takes place against silver nitrate by use of potassium chromate as indicator.
- The end point is when a brick red precipitate of silver chromate is obtained.

$$2Ag^+ + CrO_4^- \rightarrow Ag_2CrO_4 \downarrow$$

(b) **Volhard's method:**

- The volhard method of assay depends upon indirect volumetric precipitation titration.

- In this case, ammonium thiocyanate in conjunction with silver nitrate is allowed to react.
- Excess of silver nitrate is added to the solution in the presence of nitric acid and excess of silver nitrate remaining after the reaction is back titrated with ammonium thiocyanate using ferric ammonium sulphate as an indicator.
- Here, a reddish-brown colour is produced at the end point due to formation of ferric thiocyanate complex.

$$Fe^{3+} + 3SCN^{-} \rightarrow \underset{\text{Ferric thiocyanate complex (reddish-brown colour)}}{Fe(SCN)_3^{4-}}$$

27 Write a note on "assay of sodium chloride" (by Mohr's method).

☞ Assay of sodium chloride (by Mohr's method)

- **Type:** Precipitation titration/argentometric titrations.
- **Formula:** NaCl
- **IP standard:** It contains not less than 99.5% and not more than 100.5% of NaCl.
- **Principle (Mohr's method):**
  - This assay is based upon argentometric type of titration where silver nitrate solution is used as titrant.
  - It is analysed by direct titration of sodium chloride against standard solution of silver nitrate using potassium chromate as the indicator.
  - The end point is when it gives a brick red precipitate due to formation of silver chromate.
- **Reaction:**

$$NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3$$

$$2AgNO_3 + K_2CrO_4 \rightarrow \underset{\text{(brick red ppt)}}{Ag_2CrO_4 \downarrow} + 2KNO_3$$

- **Procedure:**
  - Dissolve 0.25 g of substance in 50 ml of water and titrate the solution against 0.1 N silver nitrate.
  - Brick red precipitate is produced as the end point.
- **Factor:**

  Each ml of 0.1 N $AgNO_3 \equiv 0.005845$ g of NaCl
- **Category:** Electrolyte replenisher

- **Uses:**
  1. As a electrolyte replenisher.
  2. To maintain isotonicity.
  3. As a diuretic.
  4. In bromide and iodine poisoning.

28 Write a note on "assay of ammonium chloride" (IP 1966) (by Volhard's method).

☞ Assay of ammonium chloride (by Volhard's method)

- **Type:** Precipitation titration/argentometry.
- **Formula:** NH_4Cl
- **IP standard:** It contains not less than 99% and not more than 100.5% of NH_4Cl.
- **Principle:**
  - The assay is based upon argentometry (precipitation) type of titration.
  - In this case, the solution of substance acidified with nitric acid is treated with an excess, but known, quantity of nitrobenzene.
  - Nitrobenzene protects the reaction of silver chloride precipitate with ammonium thiocyanate.
  - This reaction mixture (i.e. excess silver nitrate) is now titrated against standard solution of ammonium thiocyanate using ferric ammonium sulphate as an indicator.
  - Appearance of red precipitate is the end point.
- **Reaction:**

$$NH_4Cl + AgNO_3 \rightarrow \underset{(ppt)}{AgCl} + NH_4NO_3 + \underset{(unreacted)}{AgNO_3}$$

$$AgNO_3 + NH_4SCN \rightarrow AgSCN + NH_4NO_3$$

(unreacted)

$$NH_4SCN + Fe^{2+} \rightarrow \underset{\substack{\text{Ferric thiocyanate}\\ \text{(brick-red ppt)}}}{[Fe(SCN)_6]^{2+}}$$

- **Procedure:**
  - Weigh accurately about 0.2 g sample.
  - Dissolve it in 40 ml water and 3 ml nitric acid, 5 ml nitrobenzene and 50 ml 0.1 N silver nitrate.
  - Shake vigorously for 1 minute.
  - Titrate the solution with 0.1 N ammonium thiocyanate, using 2 ml solution of ferric ammonium sulphate as indicator.

- **Factor:**
  Each ml of 0.1 N $AgNO_3$ ≡ 0.00535 g of NH_4Cl
- **Category:** Expectorant.
- **Uses:**
  1. Used as an acidifying agent.
  2. As a diuretic.
  3. To maintain physiological acid–base balance.

29 Write a note on "assay of yellow mercuric oxide" (by Volhard's method).

☞ Assay of yellow mercuric oxide (by Volhard's method)

- **Type:** Precipitation titration (by Volhard's method)
- **Formula:** HgO
- **Principle:**
  - This is assayed by precipitation titration.
  - In this assay mercuric oxide is treated with nitric acid to form mercuric nitrate and this solution is directly titrated against standard solution of ammonium thiocyanate.
  - Ferric ammonium sulphate is used as an indicator.
  - The end point is appearance of brick red colour.
- **Reaction:**

$$HgO + 2HNO_3 \rightarrow Hg(NO_3)_2 + H_2O$$

$$2NH_4SCN + Hg(NO_3)_2 \rightarrow Hg(SCN)_2 + 2NH_4NO_3$$

$$NH_4SCN + Fe^{2+} \rightarrow \underset{\substack{\text{Ferric thiocyanate}\\ \text{(brick-red colour)}}}{[Fe(SCN)_6]^{2+}}$$

- **Procedure:**
  - Weigh accurately about 0.4 g sample.
  - Dissolve it in 5 ml nitric acid and 10 ml of water and dilute with water to 150 ml.
  - Titrate this solution with 0.1 N ammonium thiocyanate using a solution of ferric ammonium sulphate as an indicator.
- **Factor:**
  Each ml of 0.1 NH_4SCN ≡ 0.01083 g of HgO
- **Category:** Antimicrobial
- **Uses:**
  1. It has antibacterial action.
  2. Used in eye infections like conjunctivitis.

30 Write a note on "gravimetric analysis". (S.22)

☞ **Gravimetric analysis**

- The gravimetric analysis means the substance to be analysed is converted into a definite chemical composition, by using a suitable reaction, separated in a pure form and weighed. From the weight of this dried component, the purity of a substance is found out.
- The product to be weighed in this analysis may be obtained by:
  1. Volatilisation or ignition.
  2. Solvent extraction.
  3. Precipitation from solution.
- General method used in gravimetric analysis is precipitation.
- Precipitation method includes following steps:
  1. **Weighing of sample:** Weighing of the same must be accurate as it represents total sample.
  2. **Dissolution:** The weighed sample is now dissolved in a proper solvent to prepare a clear solution.
  3. **Precipitation:** By adding suitable precipitating agent, the substance is converted to a precipitate. Then it is allowed to stand for 2–3 hours. After that the supernatant liquid is tested for completion of precipitation.
  4. **Filtration:** Filter papers and different crucibles are used for filtration and precipitate is obtained.
  5. **Washing of precipitate:** The precipitate obtained for gravimetric analysis are washed to free them from soluble impurities. Washing can be done by cold or hot water. Dilute solutions of electrolytes are also used for washing of precipitate. Organic solvents are also used for washing which reduces time for drying.
  6. **Drying and ignition:** The precipitate obtained is dried first at 105°C to 110°C in oven. If neccessary, they are ignited in crucible. The period and temperature of ignition depend upon the nature of the precipitate.
  7. **Weighing:** The dried precipitate having constant composition is now weighed accurately and from this weight, the purity of original compound can be found out.

31 Write a note on "assay of zinc sulphate" (by gravimetric method).

☞ **Assay of zinc sulphate (by gravimetric method)**

- **Type:** Gravimetric method.
- **Formula:** $ZnSO_4.7H_2O$
- **Principle:**
  - Zinc sulphate is assayed gravimetrically.
  - Zinc sulphate is precipitated as zinc carbonate by addition of sodium carbonate as precipitant.
  - Zinc carbonate is not ignited to constant composition as zinc oxide. It is ignited to constant weight.
- **Reaction:**

  $ZnSO_4 + Na_2CO_3 \rightarrow ZnCO_3 + Na_2SO_4$

  $ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2 \uparrow$
- **Procedure:**
  - Weight accurately about 1 g sample.
  - Dissolve it in about 100 ml water and heat the solution to 90°C.
  - To this hot solution, add solution of sodium carbonate to precipitate zinc completely.
  - Boil for few minutes and set a side to allow the precipitate to settle down.
  - Filter the precipitate in a tared Gooch crucible and wash with water until free from alkali.
  - Dry the residue, ignite and weigh.
- **Factor:**

  Each g of residue ≡ 1.984 g of $ZnSO_4$.
- **Category:** Astringent.
- **Uses:**
  1. Used as an astringent.
  2. Zinc sulphate solution (0.25%) used as opthalmic astringent.
  3. Internally used as an antiemetic.

32 Write a note on "assay of magnesium sulphate" (by gravimetric method).

☞ **Assay of magnesium sulphate (by gravimetric method)**

- **Type:** Gravimetric analysis.
- **Formula:** $MgSO_4.7H_2O$

- **Principle:**
- **Synonym:** Epsom salt.
- **IP standard:** It contains not less than 99% and not more than 100.5% of $MgSO_4$.
- **Principle:**
  - Magnesium sulphate is analysed by gravimetric analysis.
  - Magnesium sulphate is precipitated in alkaline medium to magnesium ammonium phosphate by using solute of ammonium phosphate as precipitant.
  - This precipitate is then ignited to magnesium pyrophosphate at 1100°C and weighed.
- **Reaction:**

  $MgSO_4 + NH_4OH + (NH_4)_2HPO_4 \rightarrow MgNH_4PO_4 \downarrow + (NH_4)SO_3 + H_2O$

  $2MgNH_4PO_4 \rightarrow Mg_2P_2O_7 + 2NH_3\uparrow + H_2O$
- **Procedure:**
  - Weigh accurately about 0.5 g sample and dissolve it in 50 ml of water.
  - Add 10 ml of hydrochloric acid and dilute to 150 ml with water.
  - Cool it to 0°C, add 25 ml solution of ammonium phosphate slowly with constant stirring.
  - Dilute it with ammonia solution, until the solution is just alkaline to a solution of phenol red.
  - Add further 10 ml of dilute ammonia solution.
  - Stirr well, allow it to stand for 4 hours and filter.
  - Wash the precipitate with a mixture of 1 volume of dilute ammonia solution and 19 volumes of water.
  - Discard the filtrate.
  - Dissolve the precipitate in 50 ml 1 N hydrochloric acid and wash the filter with hot 0.1 N hydrochloric acid.
  - Combine the solution and washings and dilute to about 150 ml with water add 2 ml solution of ammonium phosphate, add dilute ammonia solution until the solution is just alkaline to phenol red solution.
  - Add a further 10 ml of dilute ammonia solution, stirr well and allow it to stand for 4 hours and filter.
  - Wash the precipitate with a mixture of 1 volume of ammonia solution and 19 volumes of water until free from chlorides.
  - Dry and ignite to constant weight, at 1100°C.

- **Factor:**
  Each g of residue ≡ 1.082 g of $MgSO_4$.
- **Category:** Saline cathartic
- **Uses:**
  1. Used as saline cathartic.
  2. Parenterally as an anticonvulsant.
  3. Antidote for heavy metal poisoning.
  4. As a cholegogue.
  5. As an enema.

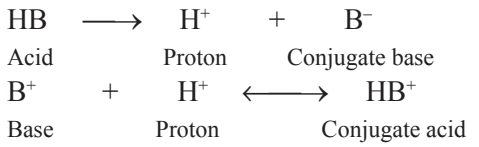
33 Write a note on non-aqueous titrations or give theory/ concept, need, advantages, disadvantages of non-aqueous titrations.

☞ Non-aqueous titrations

The titrations of substances which are carried out using non-aqueous solvents are called non-aqueous titrations.
The solvents used in non-aqueous titrations are:
Benzene, toluene, carbon tetrachloride, acetic acid, ammonia, pyridine

Theory/concept/principle of non-aqueous titrations

- Non-aqueous titrations are mainly based upon the Bronsted-Lowry theory which suggests that an acid is a substance which donates proton while base is a substance which accepts the proton.
- Bronsted-Lowry theory states that an acid dissociates in solution to give a proton and forms a conjugate base and a base combines with the proton from dissociated acid to produce conjugate acid.
- An acid donates proton, only when a base is present to accept this proton and *vice versa*.



Need of non-aqueous titrations

Non-aqueous titrations are needed:

- When the analyte is to weak acid or a base to be titrated in H_2O.
- When the reactants or products are insoluble in H_2O.
- When the reactants and products reacts with H_2O.

- When, titration in H_2O does not allow a sharp end point but in a non-aqueous solvent with stronger base than –OH , it is possible to get a sharpen point.

Advantages of non-aqueous titrations

- Weak acids and base give poor end points in aqueous titrations but in non-aqueous titrations they give good end point.
- The substances which are poorly soluble in water but soluble in non-aqueous organic solvents can be determined by non-aqueous titrations.
- The mixture of two or more acids can be analyzed. The individual acid can give separate end point in different solvents.

Disadvantages of non-aqueous titrations:

1. Temperature, moisture and carbon dioxide should be controlled.
2. Solvents used in non-aqueous titrations are costly.
3. Volatile solvents such as ammonia can pollute solvent.
4. Indicators need to be prepared in non-aqueous medium.
5. Some solvents are harmful if not handled properly.

Examples of non-aqueous titrations

1. Ephedrine preparations
2. Tetracycline
3. Antihistaminics
4. Codeine phosphates in API formation

34 Explain various types of solvents used in non-aqueous titration? What do you mean by levelling effect and differentiating effect of solvents used in non-aqueous titrations?

☞ Types of solvents used in non-aqueous titrations

There are four types of solvents used in non-aqueous titrations.

1. Aprotic solvent:

1. These are chemically neutral and inert substance.
2. These have a low dielectric constant.
3. These are unreactive.
4. These do not cause ionization of solute.
5. These do not have reactions with acids and bases.
6. These are used to dilute reaction mixture, e.g. chloroform, benzene, toluene and carbon tetrachloride.

2. Protophilic solvents:

- These possess high affinity for proton.
- Weak acids are normally used as solute.
- Strong protophilic solvents convert weak acid to strong acid is known as 'leveling effect'.

3. Protogenic solvents:

- These are acidic in nature.
- They readily donate protons.
- Strong protogenic solvents increase the strength of weak bases.
- These solvents exert leveling effect on all bases dissolved in them.
- They have high dielectric constant.
- They are ionized because of their strength and ability to donate proton, e.g. sulphuric acid and acetic acid.

4. Amphiprotic solvents: These are the solvents which are able to donate as well as accept proton, i.e. they posses both protophilic and protogenic properties, e.g. water, alcohol and weak organic acids.

☞ Effects of solvents used in non-aqueous titrations

In non-aqueous titrations two types of effect of solvents are seen:

1. Leveling effect:

- Weak acids act like strong acid in the presence of strong protophilic solvents as well as weak bases act as strong base in the presence of strong protogenic solvents. This effect is known as 'leveling effect'. The solvents are called leveling solvents.
- Weak acids and bases are normally used in the presence of strong protophilic (pyridine, liquid ammonia) and strong protogenic solvents (HF, H_2SO_4) because their strengths are enhanced by these solvents.

2. Differentiating effect:

- In less basic non-aqueous solvents like glacial acetic acid, the dissociation of different acids varies, i.e. dissociation of perchloric acid is more as compared to hydrochloric acid therefore, in glacial acetic acid, perchloric acid acts as a strong acid as compared to hydrochloric acid.
- This effect of differentiating between the strengths of acid is called differentiating effect and solvents like glacial acetic acid, which show the effect is called differentiating solvents.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. The term "**precision**" refers to level of measurement and exactness of description in a database.
2. **Iodimetry** is a volumetric analysis which involves titration with standardized solution of iodine (free iodine solution).
3. The endpoint for an EDTA titration is usually found by using a **metallochromic indicator**
4. EDTA is used as titrant in **complexometric titrations**.
5. Precipitation, digestion of the precipitate, washing and filtering along with drying and ignition steps involved in **gravimetric analysis**.
6. The degree to which information matches true or accepted values are referred to as **accuracy**.
7. A measured variation from the mean in a sample is the **standard deviation**.
8. The point at which the reaction is complete is called as **end point**.
9. Titrations based on the use of silver nitrate are called **argentometric titration**.
10. Replacement of water with other non-aqueous solvent is known as **non-aqueous titration**.
11. These are the basic solvents and used to enhance the acidity of weak acid called as **protophilic solvent**.
12. pH of neutral solution is **7**.
13. Assay of sodium chloride is based on **precipitation titration**.
14. Volumetric analysis is applied to determine the concentration of the **analyte**.
15. Oxidation involves **loss of hydrogen**.
16. Solvents which can accept as well as donate proton is known as **amphiprotic**.
17. The substance to be determined is called as **titrate**.
18. **Titrant** is a substance of known concentration.
19. Assay of calcium gluconate is **complexometric type**.
20. **Potassium permanganate** is used as self indicator.

Chapter
3

Haematinics

1 Define and classify haematinics. Give the uses of haematinics.

☞ Haematinics

The substances which increase the amount of haemoglobin in the blood are called haematinics.

Haematinics are the substances which are required in the formation of blood and used for treatment of anemias.

☞ Classification of haematinics

1. Iron and its compounds, e.g. ferrous succinate, ferrous sulphate, ferrous gluconate, ferrous ammonium citrate, ferrous ascorbate and carbonyl iron.
2. Maturation factor, e.g. cyanocobalamine, hydroxycynocobalamine.
3. Miscellaneous, e.g. copper, cobalt and riboflavine.

2 What is anaemia? Give the official compounds, incompatibility storage, actions and uses of iron compounds.

☞ Anaemia

Anaemia means decrease in percentage of haemoglobin or RBCs in the blood.

☞ Official compounds of iron

The following iron compounds are official in IP 1985:

i. Ferrous fumarate
ii. Ferrous gluconate
iii. Ferrous sulphate
iv. Dried ferrous sulphate
v. Iron and ammonium citrate

vi. Iron sorbitol injection BP
vii. Ferrous succinate BP
viii. Iron dextran injection BP
} Official in BP.

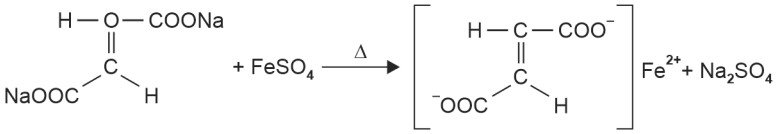
- *Incompatibility*: Iron compounds are incompatible with mineral acids, alkali, alkali-carbonates, tannates.
- *Storage of iron salts*: They undergo oxidation, thus are stored in airtight containers in cool and dark place.
- *Actions and uses of iron compounds*
  i. In iron-deficiency anaemia
  ii. In megaloblastic anaemia
  iii. In haemorrhage condition
  iv. As haematinics

3 Give the formula, synonym, properties, preparation, official preparations, uses of the following haematinic compounds.

(a) Ferrous fumarate
(b) Ferric ammonium citrate
(c) Ferrous sulphate
(d) Ferrous ascorbate
(e) Carbonyl iron.

☞ (a) Ferrous fumarate

- **Synonym:** Iron(II) fumarate
- **Formula:** $C_4H_2FeO_4$.
- **Standard:** It is having not less than 93% of $C_4H_2FeO_4$ which is calculated with reference to the substance dried to constant weight at 105°C.
- **Preparation:** It is obtained by double decomposition in which a hot aqueous solution of ferrous sulphate is added slowly to a solution of sodium fumarate with constant stirring. The sparingly soluble ferrous fumarate gets separated. It is filtered and dried.



Na-fumarate Ferrous fumarate

- **Properties:**
  1. It occurs as a reddish-orange or reddish-brown powder.
  2. It may be having soft lumps which produce yellow streaks when crushed.

3. It is having light odour with astringent taste.
4. It is slightly soluble in water and alochol.

- **Storage:** It is preserved in well-closed containers.
- **Uses:** It is used as haematinic.

☞ (b) Ferric Ammonium citrate

It is a iron and ammonium citrate IP.
It is also known as 'scale preparation' of iron.

- **Formula:** $C_6H_8FeNO_7$.
- **Properties:**
  1. It occurs in the form of bright brownish red scales.
  2. It has a slight astringent taste.
  3. It is freely water soluble and insoluble in alcholol.
- **Uses:**
  (i) It is used as a source of iron in iron deficiency.
  (ii) It is also used as an acidity regulator.

☞ (c) Ferrous sulphate

- **Synonym:** Iron vitriol, green vitriol, ferrosi sulphas.
- **Chemical formula:** $FeSO_4.7H_2O$
- **Preparation:** It is prepared by adding a slight excess of iron to dilute sulphuric acid. When the reaction slackens, the liquid is concentrated by boiling, filtered and allowed to cool. The crystals of ferrous sulphate are separated and dried at room temperature.

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$$

- **Properties:**
  i. It occurs as odourless bluish-green crystals or granules or a pale green crystalline powder.
  ii. It is odourless, and taste is metallic and astringent.
  iii. It is freely soluble in water but is insoluble in alcohol.
  iv. Ferrous sulphate when exposed to air it is oxidised and becomes brown in colour.
- **Reactions:**
  (a) Ferrous sulphate when heated at higher temperature, it decomposes to ferric oxide, SO_2 and H_2SO_4.

$$2(FeSO_4.7H_2O) \xrightarrow{\Delta} Fe_2O_3 + SO_2 + H_2SO_4 + 13H_2O$$

  (b) Ferrous sulphate reduces silver and gold salts to their metals.

$$Ag^+ + Fe^{2+} \rightarrow Ag + Fe^{3+}$$

  (c) Mercuric chloride is reduced to mercurous chloride in light.

$$2HgCl_2 + 2Fe^{2+} \rightarrow Hg_2Cl_2 + 2Fe^{3+} + 2Cl^-$$

(d) Ferrous sulphate reacts with sodium carbonate solution produces effervescence of carbon dioxide.

$FeSO_4 + Na_2CO_3 \rightarrow FeCO_3 + Na_2SO_4$

$FeCO_3 + H_2O \rightarrow Fe(OH)_2 + CO_2 \uparrow$

- **Storage**

It should be stored in tightly closed containers because on exposure to moist air, ferrous sulphate crystals undergo slow oxidation and become coated with brown basic ferric sulphate. Also on exposure to dry air, ferrous sulphate loses some of its water of crystallization.

To retard the oxidation and thus to stabilize the preparation containing ferrous sulphate, dextrose (40%) and dextrose (40%) with hypophospharic acid (0.2%) are used.

☞ **Incompatibility**

It is incompatible with alkalies, benzoates, phosphates, oxidising agents, lead acetate, potassium iodide.

- **Uses**
  1. It is used as a haematinic.
  2. It is used in the treatment of anaemia caused by iron deficiency.
  3. It posses some disinfectant property.
- **Official preparations**
  1. Ferrous sulphate tablets.
  2. Ferrous sulphate syrups.

☞ **(d) Ferrous ascorbate:**

- Ferrous ascorbate is a synthetic molecule of ascorbic acid and iron.
- In India, ferrous ascorbate tablet contains 100 mg elemental iron as ferrous ascorbate with 1 mg of folic acid.
- **Uses:**
  1. It is used for the treatment and prevention of iron deficiency in anaemia.
  2. It is also used for the treatment of anaemia due to chronic kidney failure.
  3. It is also used to treat iron deficiency-related haemoglobin disorders.

Market preparations

1. Ferrous ascorbate + Folic acid tablets.
2. Ferrous ascorbate tablets.
3. Ferrous ascorbate and folic acid and zinc tablets.

☞ **(e) Carbonyl iron:**

- **Formula:** $Fe(CO)_5$
- **Synonym:** Iron pentacarbonyl and iron carbonyl.
- **Properties:**
  1. Carbonyl iron is a highly pure iron.
  2. It occurs as a grey powder.
  3. Under standard condition it is free flowing, straw-coloured liquid with a pungent odour.
- **Uses:**
  1. Carbonyl iron powder is used to treat iron deficiency and as an iron dietary supplement.
  2. It also helps in the oxygen transport in the body.
- **Market preparations:**
  1. Carbonyl iron tablet.
  2. Carbonyl iron powder.
- **Brand names:** Feosol (carbonyl Fe), icar C, irco.

4 Write a note on "role of iron in the body". List out the official compounds and official preparations of iron.

☞ **Iron (Fe)**

- Iron is an essential mineral required for human life.
- Most of the iron in the body is found in RBCs.
- Iron requirement of an adult is 2–6 g per day.
- Iron performs following important functions:
  1. It is involved in the transport of oxygen from lungs to tissue.
  2. It is essential for metabolic processes in the cell.
  3. Iron helps in cell respiration and detoxification.
  4. It is also required for the production of ATP.
  5. It helps to maintain immune system normal.
  6. Iron aids cognitive function.
  7. Iron supports healthy skin, hair and nails.
  8. Iron improves oxygen storage through myoglobin.
- The deficiency of iron in the body may produce iron deficiency anaemia.
- The deficiency of iron can be overcome by supplementing the iron using various official formulations:

☞ Official compounds of iron

1. Ferric amonium citrate.
2. Ferrous fumarate.
3. Ferrous gluconate.
4. Ferrous sulphate.
5. Ferrous succinate.
6. Iron phosphate.

☞ Official preparations of iron

1. Ferrous fumarate tablets.
2. Ferrous sulphate tablets.
3. Iron dextran injection.
4. Ferrous gluconate tablets.
5. Iron sorbitol injection.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Anaemia means **decrease in number of RBCs**.
2. The substance in which increase the amount of haemoglobin in the blood are called **haematinics**.
3. The iron requirement of an adult is **2–6 g per day**.
4. **Bone marrow depression** is a cause of anaemia.
5. Formula for ferrous sulphate is $FeSO_4$.
6. Adult dose for ferrous fumarate **360 mg per day**.
7. Ferrous gluconate is a **haematinics**.
8. The formula of carbonyl iron is **$Fe(CO)_5$**.
9. Green vitriol is synonym of **ferrous sulphate**.
10. Requirement of folic acid in pregnant woman **0.5 mg** per day.

Chapter
4

Gastrointestinal Agents
Acidifying Agents, Protectives and Adsorbents, Antacids, Cathartics

1 What are GIT agents? Classify gastrointestinal agents with examples. Classify inorganic compounds acting as gastrointestinal agents (W.23).

☞ **GIT Agents**

The agents which are used to treat gastrointestinal disorders are called gastrointestinal agents.

Classification

- *Acidifying agents*: Dilute HCl.
- *Antacids*: Sodium bicarbonate, aluminium hydroxide gel, calcium carbonate, magnesium trisilicate, magnesium oxide, magnesium carbonate.
- *Protective and adsorbents*: Bismuth subcarbonate, bismuth subgallate, milk of bismuth, kaolin.
- *Saline cathartics* (purgatives/laxatives): Magnesium sulphate, sodium potassium tartrate.

Acidifying Agents

2 Write a note on "acidifying agents".

☞ **Acidifying Agents**

These substances which increase the acidity in stomach are called acidifying agents.

Mechanism of Action

These substances increase the acidity in stomach by one of the following mechanisms:

i. They increase acidic concentration due to acidic nature.
ii. They increase the acidity in stomach by stimulating the secretory cells of GIT.

Types of Acidifying Agents

- Inorganic acidifying agents increase the acidity because they are acidic in nature, e.g. dilute HCl.
- Organic acidifying agents act by increasing the secretion of gastric acid, e.g. glutamic acid.

Explanation

The epithelial cells of gastric mucosa secrete the endogenous HCl and required enzymes which are necessary for digestion. Acidic drugs are mostly absorbed from stomach. If acidic concentration is below 4.5 pH, only activity of pepsin is observed. Pepsin is active at pH range 3.5–5. If secretion of gastric acid is decreased than normal condition is called "hypochlorhydria". If secretion of gastric acid is totally absent, it is called "achlorhydria."

Symptoms of Achlorhydria

Abdominal pains, loss of appetite, mild diarrhoea, confusion.

3 Explain the term "achlorhydria". Write a note on drug used in the treatment of achlorhydria/monograph of dilute HCl.

☞ Achlorhydria

When the secretion of gastric acid is totally absent, the condition is called achlorhydria.

Symptoms

- Abdominal pains.
- Loss of appetite.
- Mild diarrhoea.
- Confusion.

Dilute HCl

- *Synonym*: Muriatic acid, spirit of salt.
- *Standard*: It contains 10% w/w of HCl.
- *Properties*
  i. It is a clear, colourless, tasteless, odourless liquid.
  ii. It is miscible with water and organic solvents.
  iii. Acidic to litmus.
  iv. Reacts with iron to change its colour.
- *Storage*: It is stored in well closed, inert glass container below 30°C.

- *Incompatibility*: It is incompatible with alkali, alkaline carbonates, metallic oxides and with salts of silver, mercury and lead.
- *Uses*
  1. Dil.HCl is used in the treatment of achlorhydria.
  2. It is used as an acidifying agent.
  3. It is used in the treatment of anemia with iron therapy.
  4. It is also used in the management of metabolic alkalosis.

Protective and Adsorbents

4 What are protectives and adsorbents? Give their actions and uses or write a note on protectives and adsorbents.

☞ Protectives

These are the substances which protect the exposed surfaces from harmful stimuli, e.g. kaolin, bismuth carbonate.

Adsorbents

The substances which are used to adsorb the gases, toxins and bacteria are called adsorbents, e.g. kaolin, activated charcoal.

Mechanism of Action of Protectives and Adsorbents

- These substances are water insoluble and also insoluble in dilute HCl, alkali.
- These substances form a protective layer on innermost wall of GIT. Therefore, contact of bacterial toxins is prevented.
- Thus, stimulation of peristalsis by bacteria is prevented and they are used in diarrhoea.
- Adsorbents have a property to adsorb the bacterial toxins and also gases thus prevent attack of toxins on GIT.
- Frequent elimination of watery stools in diarrhoea can be prevented by protective adsorbents.

Examples

Bismuth subcarbonate, kaolin, activated charcoal.

Applications/Conditions in which Protectives and Adsorbents are used

- They are useful in the treatment of diarrhoea.
- They are useful in poisoning cases to adsorb the poison.
- They prevent GIT irritation.
- They prevent entry of microbes in the body by forming protective layer, over the surfaces of the body.

Bismuth Compounds used as Protectives

- Bismuth subcarbonate.
- Bismuth subnitrate.
- Bismuth subgallate.
- Milk of bismuth.

5 Describe in details following protectives and adsorbents: (a) Bismuth subcarbonate, (b) Kaolin, (c) Talc, (d) Zinc oxide, (e) Calamine.

☞ **(a) Bismuth Subcarbonate**

- *Synonym*: Bismuth carbonate, bismuthyl carbonate, bismuth oxycarbonate.
- *Formula*: $[(BiO_2)\ CO_3]_2$, H_2O
- *Properties*
  i. White odourless, tasteless powder.
  ii. Insoluble in water and alcohol, dilute alkali.
  iii. Dissolves completely in HCl and in HNO_3.
  iv. Affected by light but stable in air.
- *Storage*: Store in well closed light resistant container.
- *Incompatibility*: With KI because it forms brown precipitation of bismuth tri-iodide.
- *Uses*
  i. It is used as protective and adsorbent.
  ii. As antidiarrhoeal.
  iii. Mild antiseptic and astringent.
  iv. In treatment of gastric and duodenal ulcers.
  v. As a mild antacid.
  vi. In treatment of colitis.
  vii. Used in cosmetics (lotions and face powder).

(b) Kaolin:

- *Synonym*: China clay.
- *Kaolin is categorised as*:
  i. Light kaolin.
  ii. Light kaolin (natural).
  iii. Heavy kaolin (kaolin or China clay).
- *Properties*
  i. White odourless, tasteless powder.
  ii. Insoluble in water, dilute alkali and acids.
  iii. Available in two forms—heavy and light kaolin.
  iv. Impure forms of kaolin contain gritty particles.

- *Storage*: It is stored in well closed containers.
- *Incompatibility*: With vitamins, enzymes and alkaloids.
- *Uses*
  i. It is used as an intestinal adsorbent in enteritis.
  ii. In treatment of dysentery and diarrhoea.
  iii. In treatment of alkaloidal poisoning.
  iv. In treatment of colitis.
  v. In treatment of cholera.
  vi. In food-poisoning cases.
  vii. It is also used as a clarifying agent.
  viii. In dusting powders.
  ix. In cosmetic preparations.
  x. As a main ingredient of kaolin poultice.

(c) Talc:

- *Formula*: $3MgO, 4SiO_2.H_2O$
- *Synonym*: Soap stone, French chalk.
- *Description:*
  - Foliated talc is the most desirable form for phamaceutical and cosmetic purposes.
  - Talc is made up to hydrated magnesium silicate.
  - Talc is a softest mineral and has higher degree of free flow than kaolin.
- *Properties:*
  i. It is a very fine, light, homogenous, white or greyish white powder with no odour or taste.
  ii. It is insoluble in water, dilute mineral acids and alkali hydroxide solutions.
- *Chemical properties:* On heating up to 850–1000°C, talc looses water and enstatite ($Mg_4Si_4O_2$), natural mineral is formed.
- *Storage:* Stored in well-closed containers.
- *Uses:*
  1. As a pharmaceutical aid.
  2. As a dusting powder in cosmetics.
  3. As a lubricant in tablet granules.
  4. As a filtering aid for clarifying liquids.
  5. As a distributing medium for elixirs.

(d) Zinc oxide:

- *Formula*: ZnO
- *Synonym*: Philosopher's wool.

- *Properties:*
  i. It is a powder that is soft, very fine.
  ii. It is colourless, odourless and tasteless.
  iii. It is insoluble in water, alcohol and soluble in dilute mineral acids.
- *Storage:* It absorbs carbon dioxide and moisture from the air, it must be kept in a tightly sealed container.
- *Uses:*
  1. As a mild astringent, antiseptic.
  2. Soothing and protective action on the skin.
  3. Used in sunscreens.
  4. It is used as dental cement.
  5. It is found in lotions, powders, and pastes.
  6. It is used to treat ringworm, eczema, psoriasis and pruritis as well as for plaster formation

(e) Calamine:

- *Formula*: $ZnCO_3.Fe_2CO_3$ or ZnO, Fe_2CO_3
- *Synonym*: Prepared calamine.
- *Properties:*
  1. It is a fine pink amorphous powder.
  2. It is odourless and tasteless.
  3. It is insoluble in water and soluble with effervescence in hydrochloric acid.
- *Storage:* Stored in well-closed container.
- *Uses:*
  1. It acts as an antiseptic, mild astringent.
  2. As antipruritic/anti-itching agent due to cooling and soothing effect.
  3. As a sunburn soother.
  4. Topical skin protective.
  5. It is applied to skin as lotions, dusting powders and ointments for its soothing and adsorbent properties.
  6. It is used as a local anaesthetic and antipyretic.

Antacids

6 Define Antacid. Classify antacids. Give properties of an ideal antacid.

☞ **Antacid:**

The substances which neutralize the abnormal or excessive acidity in the stomach are called as antacids.

Antacids are used to relieve pain, heart burn and in the symptomatic management of gastric and duodenal ulcers and reflux oesophagitis.

- **Classification of Antacids:**
  (a) Water-soluble (systemic/absorbable) antacids, e.g. sodium bicarbonate.
  (b) Water-insoluble (non-systemic/non-absorbable) antacids, e.g. aluminium hydroxide gel, magnesium hydroxide, calcium carbonate, magaldrate, magnesium trisilicate.
- **An Ideal requirement of Antacid:**
  1. It should neutralise excessive acidity in stomach.
  2. It should not be absorbable.
  3. It should not interfere with digestion.
  4. It should not act as a laxative or cause constipation.
  5. It should buffer in the pH range 4–6.
  6. It should be non-toxic and non-irritant.
  7. It should be palatable and cheap.
  8. It should be stable and easily available.
  9. It should not evolve gas.
  10. It should not cause alkalosis.

7 Write a note on "Combination of Antacid Preparations".

☞ **"Combination of Antacid Preparations":**

- There is no single antacid which is ideal. Therefore, combinations of antacids are used which reduce side effects and give more benefits.
- Antacid when given singly produces following complications:
  i. Sodium bicarbonate is quick acting but its side effect is systemic alkalosis.
  ii. Sodium-containing antacids may produce hypertension.
  iii. Magnesium compounds are contraindicated in patients with renal disorders.
  iv. Calcium compounds are contraindicated in patients suffering from renal and cardiac disorders.
  v. Aluminium compounds should not be prescribed in patients having hypophosphatemia.
  vi. Aluminium and calcium compounds produce constipation.
  vii. Magnesium compounds may show laxative action.
- Combination of antacid is used because:
  i. Combination reduces constipation effect of antacids.
  ii. Combination produces laxative action.

iii. Some combinations produce specific action and are used for specific purpose.
iv. Combination of drugs produces synergistic action.
v. Combination also reduces the dose of drug required to produce action.

- Examples
  i. Calcium carbonate + aluminium hydroxide gel.
  ii. Calcium carbonate + magnesium trisilicate.
  iii. Magnesium trisilicate + aluminium hydroxide.

8 Write a note on "Sodium Bicarbonate" (Baking Soda).

☞ Sodium Bicarbonate

- *Synonyms*: Baking soda, mitha soda, sodium biocarb, sodium hydrogen carbonate.
- *Chemical formula*: $NaHCO_3$.
- *Standard*: It contains 99 to 100.5% w/w of $NaHCO_3$.
- *Properties*:
  i. It is white crystalline powder with a saline taste.
  ii. It is stable in air, but slowly decomposes in moist air.
  iii. It is soluble in water and insoluble in alcohol.
  iv. Its aqueous solution is alkaline.
  v. The alkalinity increases on storage, agitation or on heating.
  vi. On heating it produces CO_2.

- **Method of preparation (Solvay process):**
  - Sodium bicarbonate is prepared by the solvay process which is also called the ammonia soda process.
  - Strong solution of sodium chloride (strong brine) containing high concentration of ammonia is passed through a carbonating tower where it is saturated with carbon dioxide gas under pressure.
  - The ammonia and carbon dioxide react to form ammonium bicarbonate.
  - This ammonium bicarbonate undergoes double decomposition reaction with sodium chloride to form sodium bicarbonate.

    $NH_3 + CO_2 + H_2O \rightarrow NH_4HCO_2$

    $NH_4HCO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl$

- **Chemical reactions of sodium bicarbonate:**
  1. When sodium bicarbonate is heated in a dry state or in a solution, it decomposes giving sodium carbonate, carbon dioxide and water, which is reversible at room temperature.

     $$2\ NaHCO_3 \underset{\text{Room temperature}}{\overset{\text{Heat}}{\rightleftharpoons}} Na_2CO_3 + H_2O + CO_2 \uparrow$$

  2. A solution of sodium bicarbonate is slightly alkaline due to hydrolysis of the bicarbonate ion.

     $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + H^+$

     The pH of 1% w/v solution of sodium bicarbonate is not greater than 8.6.
  3. Sodium bicarbonate with mercuric chloride solution gives a reddish brown precipitate of (HgO).

     $HgCl_2 + 2\ NaHCO_3 \rightarrow Hg(HCO_3)_2 + 2NaCl$

     $Hg(HCO_3)_2 \rightarrow HgO\downarrow + H_2O + CO_2$

     Reddish brown ppt.
  4. When sodium bicarbonate is treated with acids, carbon dioxide is liberated.

     $NaHCO_3 + HA \rightarrow NaA + H_2O + CO_2 \uparrow$

     (HA-any acid)

     (It is useful in preparation of effervescent tablet or granules)
- **Uses of Sodium Bicarbonate:**
  1. Sodium bicarbonate is used as an antacid as it neutralises the acidity. It is a rapidly acting antacid.
  2. It is used as electrolyte replenisher.
  3. It is used in the treatment of systemic acidosis.
  4. A 3.5% solution in warm water is used as an eye lotion.
  5. 5% solution used to soften and remove ear wax.
  6. It is an important ingredient in effervescent antacid preparations.
  7. It is used as an antidote in various poisoning.
  8. A 1–2% solution is used as rinsing solution for contact lenses.
  9. 1–4% of sodium bicarbonate solution are used as vaginal douches.
- **Storage:** It should be stored in air tight containers.
- **Incompatibility:**

  It is incompatible with acids, acid salts, dopamine hydrochloride, alkaloidal salts, aspirin, bismuth salicylate. Sodium bicarbonate enhances the darkening of salicylates.

9 Write a note on "Aluminium Hydroxide Gel".

☞ **Aluminium hydroxide gel (Aluminium Hydroxide Mixture BP)**

- **Synonym:** Hydrated aluminium oxide.
- **Properties:**
  i. It is a white viscous suspension of hydrated aluminium oxide together with varying quantities of aluminium carbonate and bicarbonate.
  ii. It contains 3.5–4.4% w/w Al_2O_3.
  iii. It may contain peppermint oil or other flavouring agents.
  iv. It contains sweetening agents such as sorbitol, glycerin, sucrose and saccharin with suitable antimicrobial agents.
  v. Aluminium hydroxide gel may exibit thixotropic properties.
  vi. It has a pH range 5.5–8.
- **Uses:**
  i. It is a slow acting antacid.
  ii. It gives symptomatic relief in gastric and duodenal ulcers and reflux oesophagitis.
  iii. It is used in the treatment of hyperchlorhydria.
  iv. It is also given in the management of urinary phosphatic calculi.
  v. Dried aluminium hydroxide gel is used externally as mild astringent and desiccant.
- **Storage:** It is stored in air tight containers and avoid freezing.
- **Incompatibility:** Aluminium hydroxide gel interferes with or reduces the absorption of a number of drugs including anticholinesterase agents, barbiturates, digoxin, quinine, quinidine, warfarin, tetracyclines and vitamins.

10 Write a note on "Calcium Carbonate" (Prepared chalk).

☞ **Calcium Carbonate:**

- **Synonym:** Prepared chalk, precipitated calcium carbonate.
- **Chemical formula:** $CaCO_3$.
- **Standard:** It contains not less than 98.5% of $CaCO_3$.
- **Properties:**
  i. It is a white, odourless, tasteless, microcrystalline powder, stable in air.
  ii. It is practically insoluble in water but its solubility is increased by the presence of any ammonium salt or carbon dioxide.

iii. It occurs as a chalk, lime stone, marble, aragonite and calcite.
iv. It is insoluble in alcohol.

- **Method of preparation of calcium carbonate:**
  For antacid purpose, calcium carbonate is prepared by mixing the boiling solutions of calcium chloride and sodium carbonate and allowing the resulting precipitate to subside on cooling.
  $CaCl_2 + Na_2CO_3 \rightarrow 2NaCl + CaCO_3 \downarrow$
- **Antacid reaction mechanism:**
  The gastric hydrochloric acid consumes solubilised calcium carbonate.
  $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2CO_3 \rightarrow H_2O + CO_2 \uparrow$
  The liberation of carbon dioxide is common discomfort associated with this antacid.
  Calcium carbonate produces constipating effect and so, it is given in combination with magnesium antacid.
- **Uses:**
  1. It is used as an antacid.
  2. It relieves the pain of gastric or duodenal ulcers.
  3. It is used as a chalk and also in the treatment of diarrhoea.
  4. It is also used as a polishing agent in tooth powders.
  5. A preparation of native calcium carbonate is used in homeopathic medicine.
- **Storage:** It is stored in well closed, air tight containers.
- **Incompatibility:** It is incompatible with tetracycline. Administration of large dose of calcium carbonate with large amounts of milk can cause milk-alkali syndrome (Burnett syndrome).
- **Usual dose:** 1 g, 4–6 time daily.

11 Give the details of Magnesium Hydroxide (W.23).

☞ Magnesium Hydroxide (BP)

- **Formula:** $Mg(OH)_2$.
  It is having not less than 95.0% and not more than 100.5% of $Mg(OH)_2$.
- **Preparation:** The magnesium hydroxide obtained in the preparation of milk of magnesia is evaporated to dryness. It is also prepared by treating sea water or other natural brines with sufficient calcium hydroxide to precipitate magnesium as magnesium hydroxide, then washing and drying the precipitate.
- **Properties:** It is a white fine amorphous powder. It is almost insoluble in water yielding a solution which is slightly alkaline.

It dissolves in dilute mineral acids. It slowly absorbs carbon dioxide from atmosphere.

Magnesium hydroxide and its tablets have been official in NF.

- **Assay:** An accurately weighed amount of sample is taken in a flask. To it 25 ml of 1 N H_2SO_4 is added. Now the excess of acid is back titrated with 1 N NaOH using methyl red as an indicator. Each ml of 1 H_2SO_4 = 0.02917 g of $Mg(OH)_2$
  Uses: It is used as an antacid.

12 Write a note on "Magaldrate" as an Antacid.

☞ **Magaldrate (Aluminium containing Antacid):**

- **Synonym:** Monalium hydrate, hydrated magnesium aluminate.
- **Formula:** $Al_2H_{14}Mg_4.2H_2O$.
- **Standard:** It contains the equivalent of 28–39% magnesium oxide and 17–25% aluminium oxide.
- **Magaldrate NF:** It is a chemical combination of aluminium hydroxide and magnesium hydroxide.
- **Properties:**
  1. Magaldrate NF occurs as a white, odourless, crystalline powder.
  2. It is insoluble in water and alcohol.
- **Usual dose:** 400 to 800 mg as required, preferably taken between meals.
- **Official preparations:**
  i. Magaldrate oral suspension NF
  ii. Magaldrate tablets NF
- **Uses:**
  i. As antacid.
  ii. In the treatment of oesophagitis, duodenal and gastric ulcers of gastroesophageal reflux.
  iii. Used to treat heart burn, indigestion or stomach upset.
- **Brand name:** Ron acid, Riopan, Ri-Mag, Losospan.

Cathartics

13 Define cathartics. Classify cathartics/purgatives and laxatives with suitable examples.

☞ **Cathartics (Purgatives):**

- The agents that promote defaecation are called cathartics.

- The agents that facilitate the passage of and elimination of the faeces from the intestinal tract, especially through colon and rectum are called cathartics.
- Cathartics are drastic purgatives.
- Laxatives are mild purgatives.
- Laxatives are the substances that loosen stools and increase bowel movements.
- According to the intensity of action cathartics are categorised as: (i) Laxatives. (ii) Purgatives. (iii) Drastics.
- **Classification of cathartics/purgatives/laxatives**: Cathartics are classified as per mechanism of action:
- **Stimulant/irritant purgatives**: Senna, phenolphthalein, castor oil.
- **Bulk purgatives**: Methyl cellulose, sodium carboxymethyl cellulose.
- **Emollient purgatives:** Liquid paraffin.
- **Saline cathartics:** Magnesium sulphate, sodium potassium tartrate.

14 Write a note on "saline cathartics"/"saline purgatives"/ osmotic laxatives.

☞ Saline Cathartics

Saline cathartics are the agents that quicken and increase evacuation from the bowels, e.g. magnesium sulphate, sodium potassium tartrate.

Mechanism of Action

- Saline cathartics increase osmotic pressure thereby secreting additional fluid in intestinal tract.
- This results in increase in bulk and stimulates peristalsis causing evacuation from the bowel.
- As saline cathartics increase the osmotic pressure and increase in peristalsis of GIT, they are used in the treatment of constipation.

Constipation

Constipation means hardening of stool which can be caused due to decreased peristaltic movements.

- Constipation may be due to intestinal injury, change in food intake, change in food type, change in environment, lack of exercise and due to consumption of medicinal agents.
- Thus, saline cathartics are mainly used in constipation.

Uses of Saline Cathartics

- To treat constipation.
- In hernia to avoid excessive straining.
- In haemorrhoids, boils and rectal disorders.
- To avoid rise in BP during defaecation.
- To remove intestinal contents before X-ray examination.

15 Write a note on (a) magnesium sulphate, (b) sodium potassium tartrate.

☞ (a) Magnesium Sulphate

- **Formula:** $MgSO_4 \cdot 7H_2O$
- **Synonym:** Epsom salt.
- **Preparations:** It is prepared from magnesium carbonate and dil. H_2SO_4.

  $$MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + CO_2 + H_2O$$
- **Properties**
  i. Colourless crystals with cool and saline taste.
  ii. It is soluble in water.
  iii. It shows phenomenon of efflorescence in dry air.
  iv. It is odourless, very soluble in boiling water.
- **Storage:** It should be stored in well closed airtight containers in cool place.
- **Incompatibility:** With alkali, carbonate and bicarbonates, NaI, potassium tartrate.
- **Uses**
  i. As a saline purgative.
  ii. In treatment of heavy metal poisoning as antidote.
  iii. It is used for wet dressing.
  iv. In the treatment of boils.
  v. In hypertensive patients to avoid excessive straining (given as enema).
  vi. It is used parenterally as an anticonvulsant.
  vii. It is also used as cholegogue.
  viii. Because of its osmotic action, it has been used locally in various inflammatory conditions.
  ix. It is a common ingredient of aperient mineral water.

(b) Sodium Potassium Tartrate

- **Synonym:** Rochelle's salt, seignette salt.
- **Formula:** $C_4H_4KNaO_6.4H_2O$

- **Properties**
  i. It is colourless, odourless crystalline powder.
  ii. It has a cooling saline taste.
  iii. It is soluble in water and insoluble in alcohol.
  iv. It shows phenomenon of efflorescence.
- **Storage:** Stored in tightly closed containers.
- **Incompatibility:** With acids, calcium and lead salts.
- **Uses**
  i. As a cathartic, purgative.
  ii. As a stabilizer in cheese and meat products.
  iii. As ingredient of Fehling solution.
  iv. As ingredient of effervescent powders and bath soaps.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Magnesium sulphate** is used as saline cathartic.
2. Absence of Gastric Secretion the condition is termed as **achlorhydria**.
3. 'Muriatic acid and spirit of salt' are the synonyms of **dil.HCl**.
4. Sodium bicarbonate is **water soluble antacid**.
5. **Magaldrate** is aluminium containing antacid.
6. Synonym of magnesium sulphate is **Epsom salt**.
7. Bacteriostatic means inhibit **the growth of bacteria**.
8. Dil.HCl is an **acidifying agent**.
9. **Sodium bicarbonate** is an example of systemic antacids.
10. **Acidifiers** are the drugs which increase the acidity.
11. Antacids are **alkaline** in nature.
12. Gastric acidifier is the drug which is used to **increase the acidity**.
13. Liquid paraffin is an **emollient purgative**.
14. **Prepared chalk** is a synonym of calcium carbonate.
15. The agents that promote defecation are called **as cathartics**.

Chapter
5

Topical Agents
Topical Protectives, Astringents, Antimicrobials

1 What are topical agents? Classify them with examples.

☞ Topical Agents

The agents which are applied on the skin or mucus membrane for their local effects are called topical agents.

Classification

- On the basis of chemical origin
  i. Organic topical agents, e.g. zinc stearate, povidone iodine.
  ii. Inorganic topical agents, e.g. talc, zinc oxide, calamine.
- On the basis of action of drugs
  i. Protectives and adsorbents, e.g. talc, zinc oxide.
  ii. Antimicrobial agents, e.g. potassium permanganate, silver nitrate.
  iii. Astringents, e.g. alum, zinc sulphate.
  iv. Miscellaneous compounds, e.g. sulphur and its derivatives.

Topical Protectives

2 Write a note on "topical protectives".

☞ Topical Protectives

The substances which are used to protect the skin from external environment and applied on skin are called topical protectives.

- *Examples*: Talc, zinc oxide, calamine, titanium dioxide.
- They are available in the form of dusting powder, lotions, liniment, creams, ointment, etc.

Explanation

The substances having capacity to form a layer can protect the skin. These substances reduce mechanical friction, irritation, etc. These

substances adsorb moisture and bacterial toxins and also protect skin from UV rays. These are insoluble in water and available in the form of powder. These are chemically and biologically inert and have good adsorption property, adequate flow property, sufficient covering capacity. These drugs are not adsorbed in circulatory system.

Applications

- To protect skin from sun rays.
- To protect skin from bacterial toxins, dust and dirt particles.
- To protect skin from irritation and infections.
- To protect ulcers and wounds from external hazards.

Astringents

3 Write a note on "astringents".

☞ Astringents

The substances which have a capacity to precipitate superficial proteins are called astringents, e.g. alum, zinc sulphate.

- Dosage forms: They are available in the form of dusting powders, mouthwashes, gargles, topical solutions, etc.

Explanation

Astringents are having less permeability and also very less penetration power. Therefore, when applied on skin, they are not affecting normal functioning of body cell.

- Astringents show following types of actions (mechanism of action):
  i. *Styptic action*: Astringents precipitate surface proteins and blood proteins present at the site of wound. Therefore, diameter of blood capillaries is reduced. Due to constriction of capillaries and small blood vessels they show styptic action, i.e. to stop bleeding from small cuts.
  ii. *Anti-inflammatory action*: Astringents reduce blood supply coming towards the tissue and histamine secretion is also decreased. Thus, anti-inflammatory action is obtained.
  iii. *Antiperspirant action*: Astringents precipitate surface proteins thus decrease the diameter of sweat and sebaceous glands. Thus, perspiration is reduced, i.e. antiperspirant action.
  iv. *Antimicrobial action*: Astringents precipitate cell proteins of microbial cell, therefore, malfunctioning of microbial cell

occurs. Further, microbial cell cannot get multiplied and thus antimicrobial action is achieved.

Applications/Uses of Astringents

- These are used as antimicrobial, anti-inflammatory, antiperspirants and styptic.
- In the treatment of wounds, ulcers, etc.
- In mouthwash and mouth freshener preparations.
- In toothpaste and tooth powder preparations.
- In dusting powders due to its antiperspirant action.

Antimicrobials

4 What are antimicrobial agents? Give the properties/ characteristics of an ideal antimicrobial agent. Mention the examples of antimicrobial agents.

☞ **Antimicrobial Agents:**

These are the chemical agents which are used to destroy or inhibit the growth of pathogenic microorganisms such as bacteria, fungi, protozoans.

☞ **Terms used to describe antimicrobial activity:**

(a) **Antiseptics:** Antiseptics are the chemical agents which destroy or inhibit the growth of microorganisms when applied on living tissues.

(b) **Disinfectants:** Disinfectants are the chemical agents which destroy or inhibit the growth of microorganisms when applied on non-living objects.

(c) **Bacteriostatic:** The chemical agents that stop or inhibit the growth of bacteria are called bacteriostatic.

(d) **Bactericidal:** The chemical agents that kill the bacteria, but not necessarily the bacterial spores are called bactericidals.

(e) **Germicide:** It is a chemical agent that destroys pathogenic microorganisms/germs.

☞ **Examples of various antimicrobial agents:**

1. **Oxidative antimicrobial agents,** e.g. hydrogen peroxide solution, zinc peroxide, potassium permanganate, sodium hypochlorite solution, chlorinated lime.
2. **Iodine preparations and compounds,** e.g. iodine and iodine solutions, povidone iodine.

3. **Protein precipitant antimicrobial agents,** e.g. silver nitrate, mild silver protein.
4. **Mercury compounds,** e.g. yellow mercuric oxide, ammoniated mercury, mercuric chloride.
5. Boric acid and borax.

☞ **Characteristics/properties of an ideal antimicrobial agent:**

1. It should have rapid onset of action.
2. It should have good therapeutic index.
3. It should have sufficient antimicrobial action.
4. It should be compatible with other ingredients.
5. It should be economical and should be required in very less concentration.
6. It should not have any type of toxicity.
7. It should not damage host cell/tissue.
8. It should have sustained action.
9. It should have a broad spectrum action.
10. It should have an adequate "Lipid water distribution coefficient."

5 Explain the mechanism of action of inorganic antimicrobial agents.

☞ **Antimicrobial agents may act by following mechanisms:**

1. Oxidation
2. Halogenation
3. Precipitation

1. *Oxidation*: Antimicrobial substances convert sulfhydryl group to disulphide form. Therefore, disulphide group of proteins cannot work and thus kills microorganisms, e.g. hydrogen peroxide, $KMnO_4$.
2. *Halogenation*: These substances add halogens to peptide linkage of microorganisms thus normal functioning of microbial cell gets disturbed, hence kills the microbes, e.g. iodine, povidone iodine, chlorinated lime.
3. *Precipitation*: Many antimicrobial agents containing metal ions react with polar group of proteins and form a complex thus there is inactivation of protein (precipitation of proteins) and antimicrobial action is achieved, e.g. boric acid, borax, silver nitrate, mercuric compounds.

6 Define and classify antimicrobial/Anti-infective agents with examples. (S.22)

☞ **Antimicrobial Agents:**

The chemical agents which are used to destroy or inhibit the growth of pathogenic microorganisms such as bacteria, fungi, protozoans, are called as antimicrobials.

(A) **Classification of Antimicrobials as per use:**

- *Antiseptics*: The substances which have a capacity to kill microbes and prevent the growth of microbes when applied on living material, e.g. hydrogen peroxide.
- *Disinfectants*: These are the substances having antimicrobial activity but used only for inanimate objects, e.g. cresol with soap solution.
- *Germicides*: Agents which kill the germs.
- *Fungicide*: Agents which kill the fungi.
- *Viricide*: Agents which kill the viruses.
- *Bacteriostatic*: Agents which stop the growth of bacteria.
- *Bacteriocidal*: Agents that kill the bacteria.
- *Preservatives*: These are the agents which prevent the contamination of products from microbes, e.g. methyl paraben.

(B) **Classification of Antimicrobial Agents on Chemical Basis:**

1. **Acids:** Boric acid, salicylic acid.
2. **Aldehyde and alcohols:** Ethanol, formaldehyde, glutaraldehyde, isopropanol.
3. **Halogens and its derivatives:** Chlorinated lime, chlorhexidine, iodine, iodopovidone, povidone iodine, sodium hypochlorite.
4. **Metallic salts:** Copper sulphate, silver nitrate, zinc sulphate.
5. **Oxidizing agents:** Hydrogen peroxide, potassium permanganate.
6. **Phenol derivatives:** Cresol, phenol, resorcinol.

7 Give the formula, synonym, properties, storage, incompatibility, and uses of following antimicrobial agents: (a) Silver Nitrate (b) Hydrogen Peroxide, (c) Boric Acid, (d) Bleaching powder (chlorinated lime), (e) Potassium permanganate, (f) Ionic silver, (g) Chlorhexidine gluconate.

☞ **(a) Silver nitrate (protein precipitant antimicrobial agent):**

- **Chemical formula:** $AgNO_3$.

- **Standard:** It contains not less than 99.8% w/w of $AgNO_3$ when powdered and dried in the dark over sulphuric acid fumes for four hours.
- **Properties:**
  1. It is a colourless or white crystalline, odourless compound with bitter metallic taste.
  2. It becomes grey or greyish black on exposure to light in the presence of organic matter due to liberated silver.
  3. It is very soluble in water, sparingly soluble in alcohol but freely soluble in boiling alcohol.
  4. A 1% solution in water has pH between 4.5 and 6.0.
  5. At higher temperature it slowly decomposes, evolving oxides of nitrogen.
- **Method of preparation:**

  It is prepared by the action of hot nearly concentrated nitric acid for four hours.

  $Ag + HNO_3 \rightarrow AgNO_3 + NO_2 \uparrow + H_2O$
- **Chemical reactions:**
  1. It melts at 208°C and gives a yellowish liquid without decomposition. On heating to red heat it decomposes with evolution of NO_2 and O_2, leaving a residue of metallic silver.

     $$2\,AgNO_3 \xrightarrow[(Red\ hot)]{\Delta} 2\,Ag + 2NO_2 \uparrow + O_2$$
  2. With hydrochloric acid or soluble chlorides it gives a white curdy precipitate of silver chloride.

     $$AgNO_3 + HCl \xrightarrow{HNO_3} AgCl \downarrow + HNO_3$$
     $$AgNO_3 + NaCl \xrightarrow{HNO_3} AgCl \downarrow + NaNO_3$$
  3. Sodium carbonate on addition to silver nitrate solution precipitates silver carbonate which on heating gives silver oxide.

     $$2\,AgNO_3 + Na_2CO_3 \rightarrow Ag_2CO_3 + 2NaNO_3$$
     $$Ag_2CO_3 \xrightarrow{\Delta} Ag_2O + CO_2 \uparrow$$
  4. Silver nitrate precipitates protein and form silver protein compound, which is the basis for the direct antimicrobial action of silver compound.
- **Storage:** It should be stored in air tight amber coloured glass bottles in cool and dark place. Solution should be stored in alkali free bottles.

- **Incompatibility:** It is incompatible with tartaric acid, hydrocyanic acid, alkalies, halogen acids and their salts, phosphates, tannins and astringent preparations.
- **Uses:**
  1. It is primarily used as protein precipitant antimicrobial agent.
  2. It is used for its caustic astringent and antibacterial properties.
  3. It has been used as a caustic to destroy warts and other small skin growths.
  4. A 1% solution has been used as a paint in the treatment of pruritus ani (itching in anal region).
  5. Gauze soaked in a 0.5% of silver nitrate is applied to severe burns to reduce infection.
  6. Its aqueous solution (0.2–0.6%) is used as eye lotions.
  7. Dilute solutions have been used as mouthwashes to help quit smoking.
  8. Ammonical silver nitrate is used in dentistry as a protective of dentin.

(b) Hydrogen peroxide: (W.22)

- **Chemical formula:** H_2O_2.
- **Synonym:** Oxygenated water, oxydol, perhydrol.
- **Properties:**
  1. Hydrogen peroxide solution is a colourless liquid.
  2. It is odourless liquid with slightly acidic taste.
  3. Its specific gravity is 1.463 at 0°C.
  4. It is soluble in water, alcohol and ether.
  5. It can be extracted with solvent ether from its aqueous solution.
- **Method of preparation:**
  Hydrogen peroxide is prepared by the action of sulphuric acid on hydrated barium peroxide.
  $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$
- *Incompatibility*: With reducing agents, oxidising agents, organic matter, heavy metals.
- *Stability storage*: It should be stored in light resistant containers with stoppers resistant to hydrogen peroxide. It should be stored in cool place.

- *Label*: The label should state whether or not the solution contains a stabilising agent.
- **Uses of H_2O_2:**
  1. It is a mild oxidising antiseptic. It destroys most pathogenic bacteria.
  2. Solution of hydrogen peroxide (6%) is used as disinfectant.
  3. It is used for its cleansing action on cuts and wounds.
  4. It is also used to cleanse septic sockets and root canals of teeth.
  5. It is used for loosening of ear wax and also for the removal of sticking surgical dressings from the wounds.
  6. A 1.5% solution of hydrogen peroxide is used as a deodorant, gargle and mouthwash.
  7. Hydrogen peroxide is used as an antidote in phosphorus and cyanide poisoning.
  8. It is used for bleaching the hair.
  9. It is used as antimicrobial agent and topical anti-infective agent.

(c) Boric Acid:

- **Chemical formula:** H_3BO_3.
- **Synonym:** Boracic acid, orthoboric acid, acidum boricum.
- **Standard:** It contains not less than 99.5% of H_3BO_3.
- **Method of preparation:**

It is prepared by boiling the solution of native borates with sulphuric acid.

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \rightarrow Na_2SO_4 + 4H_3BO_3$$

- **Properties:**
  i. It is a white, odourless powder with bitter taste.
  ii. It is soapy to touch.
  iii. Soluble in hot water and freely soluble in glycerine.
  iv. Solution is isotonic with body fluids.
- **Storage:** It should be stored in well closed container. Label should indicate:

  "It should not be taken internally."

  "It should not be applied on broken skin."
- **Incompatibility:** It is incompatible with tannins, benzalkonium chloride and polyvinyl alcohol.

- **Uses of Boric Acid:**
  1. Boric acid has a weak bacteriostatic and fungistatic action.
  2. It is mild antiseptic.
  3. Externally it is used for irrigation of organs.
  4. It is used in dusting powders.
  5. It is an ingradient of mouthwash and eye wash.
  6. It is used as a buffer in ophthalmic preparations.
  7. It is used to reduce inflammation of various skin disorders.
  8. Boric acid is used to impregnate a number of surgical dressings.

(d) Bleaching powder (Chlorinated Lime, Chloride of Lime)

- **Chemical formula:** $CaOCl(Cl), H_2O$.
- **Synonym:** Chlorinated lime, chloride of lime.
- **Standard:** It contains not less than 30% w/w of a available chlorine.
- **Method of preparation:** It is prepared by the action of chlorine on calcium hydroxide, i.e. on slaked lime which must be pure and fairly dry.

  $Ca(OH_2) + Cl_2 \rightarrow Ca(OCl)Cl + H_2O$
- **Properties:**
  1. It is a dull white powder with odour of chloride.
  2. It is slightly soluble in water and less soluble in alcohol.
  3. On exposure to air, it becomes moist and forms chlorine gas.
- **Storage:** It should be stored in air tight containers in a cool place protected from light.
- **Uses:**
  1. It is used as disinfectant and bleaching agent.
  2. It has bactericidal action.
  3. It is used to disinfect faces, urine, sputum, etc.
  4. It is used for disinfecting drainages.
  5. It is used for sterilisation of water.
  6. It is used in the preparation of surgical chlorinated soda solution used as a wound disinfectant.

(e) Potassium permanganate:

- **Chemical formula:** $KMnO_4$.
- **Synonym:** Condy's crystals.
- **Standard:** It contains not less than 99% of $KMnO_4$ as per IP.
- **Method of preparation:** Manganese dioxide is fused with excess of potassium hydroxide in the presence of free supply of air or with

the addition of some suitable oxidizing agent such aspotassium nitrate or potassium chlorate, potassium permanganate is formed.

$2\ KOH + MnO_2 + [O] \rightarrow K_2MnO_4 + H_2O$

- **Properties**
  i. It is an odourless dark purple-coloured crystalline compound.
  ii. It has greenish-blue metallic lustre.
  iii. It has sweet astringent taste.
  iv. It is soluble in water.
  v. Its concentrated solutions are deep voilet.
  vi. When mixed with glycerin, it burns.
- **Incompatibility:** With iodides, reducing agents and organic substances.
- **Storage:** It should be stored in tightly closed container and avoid contact of organic matter. It should be handled with care.
- **Uses**
  i. As antimicrobial agent.
  ii. Powerful cleansing agent for wounds, ulcers.
  iii. In mouthwash and gargles.
  iv. As a deodorant.
  v. Antidote in barbiturate poisoning.
  vi. For gastric lavage treatment.
  vii. It leaves the stains on skin or tissues.

(f) Ionic silver:

- Ionic silver is the silver ions stabilized with other reagent or compounds.
- Ionic silver is produced using electrolysis with water, some wire and a battery.
- Many products being sold as a colloidal silver are actually ionic silver.
- For many years, ionic silver has been used as the "Ultimate" antibiotic, antifungal and antiviral treatment.
- Dietary silver does not have a daily requirement because it is not considered as an essential mineral.
- According to studies the average person consumes between 23 and 88 μg of silver every days.
- **Uses:**
  It is used in:
  1. Eye and ear infections.
  2. In blocked sinuses.

3. Cold and flu.
4. Respiratory problems.
5. Eczema, psoriasis.
6. Skin problems.
7. Cuts and burns.

(g) Chlorhexidine gluconate:

- **Formula:** $C_{34}H_{54}Cl_2N_{10}O_{14}$.
- **Synonym:** Chlorhexidine digluconate.
- **Description:**
  - Chlorhexidine gluconate is used as an antiseptic agent with topical antibacterial activity.
  - Chlorhexidine gluconate is a germicidal mouthwash that reduces bacterial growth in mouth.
  - Chlorhexidine gluconate oral rinse is used to treat gingivitis (swelling, redness, bleeding gums)
  - It is usually prescribed by a dentist.
- **Uses:**
  1. It is found in disinfectants, cosmetics.
  2. In pharmaceuticals.
  3. In dentistry and as antiseptic.
  4. As a germicidal mouthwash.
  5. As a oral rinse to treat gingivitis (swelling, redness, bleeding gums).

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. China clay its synonym of **kaolin**.
2. 'Soap stone and fresh chalk' are synonyms of **talc**.
3. **Calcium carbonate** is called as prepared chalk.
4. Titanium dioxide is a **topical protective**.
5. Synonym of bleaching powder is **chlorinated lime**.
6. **Bacteriostatic** means to inhibit the growth of bacteria.
7. Mild silver protein is an example of **antimicrobial agent**.
8. **Astringents** acts by precipitation of proteins.
9. Hydrogen peroxides is called as "**oxygenated water**"
10. Hydrogen peroxide is used as **antiseptic**.
11. $KMnO_4$ solutions are used as **antifungal**.
12. Sulphur is used in the treatment of **scabies**.
13. Chlorhexidine gluconate is used for topical **antibacterial activity**.
14. H_3BO_3 is a chemical formula of **boric acid**.
15. The agents which inhibit the growth of micro-organisms are called **antimicrobial** agents.

Chapter
6

Dental Products

1 Write a note on dental products. Or Discuss various types of inorganic compounds used in dentistry and in dental products.

- Dental caries (tooth decay) is a disease of teeth which gives decalcification of tooth and bad odour of the mouth.
- To prevent dental caries and to maintain clean and healthy teeth, it is necessary to use dentifrices.
- Dentifrices may be toothpaste or tooth powder are used to clean dirty surface of teeth.
- Dental products are used in dentistry.
- Dental products are available in several dosage forms as toothpaste, tooth powders, silver polishes, oils, etc.
- Dental products contain:
  i. *Anticaries agents*: The agents which are used in the treatment of dental caries are called anticaries agents, e.g. sodium fluoride, stannous fluoride.
  ii. *Cleansing agents/abrasives*: These are the substances used to remove stain from the teeth, e.g. calcium phosphate, di-calcium phosphate, sodium phosphate.
  iii. *Polishing agents*: The substances which give whiteness to teeth by their abrasive action are called polishing agents, e.g. stannous fluoride, calcium carbonate.
  iv. *Desensitizing agents*: The substances which reduce the sensitivity of teeth to heat and cold are known as desensitizing agents, e.g. zinc chloride, strontium chloride.
  v. *Sweetening agent*: It gives sweet taste.
  vi. *Colouring agent*: It gives attractive colour to the preparation.
  vii. *Flavouring agent*: It provides pleasant flavour.
  viii. *Humectant*: It prevents drying of toothpaste preparation, e.g. glycerin.

2 Discuss the role of fluorides as anticaries. What is dental fluorosis?

☞ **Anticaries**

The substances which can prevent the formation of cavities in teeth are called anticaries agents.

Anticaries agents are fluorides, phosphates and ammoniated compounds.

Role of Fluorides

- Role of fluorides in preventing dental caries is well accepted.
- Administration of small quantity of fluorides in dental product may produce good results.
- Fluorides act as anticaries by two mechanisms:
  i. Fluorides decrease the solubility of enamel in lactic acid and also act against bacterial growth.
     Lactic acid is formed during the partial digestion of carbohydrates. This acid has ability to dissolve the enamel. Therefore, bacteria can localise on surface of teeth and thus cavities can be formed.
  ii. Fluorides act by inhibiting bacterial growth.
- Fluorides are having toxicity when they are taken in large quantity.
- When more quantity of fluoride is ingested, it is carried to bones and teeth and produces mottled enamel which is known as dental fluorosis.
- Fluorides are carcinogenic when deposited on teeth.
- When a fluoride-containing solution is taken (orally) internally it gets readily absorbed, transported and deposited in the bone or teeth and remainder is excreted by the kidneys.
- The deposited fluoride on the surface of teeth prevents the action of acids.

3 Give the formula, synonym, properties storage, uses, incompatibility of following inorganic compounds used in dental products. (a) Sodium fluoride, (b) Calcium carbonate.

☞ **(a) Sodium fluoride:**

- **Formula:** NaF
- **Preparation:** It is prepared by evaporating a solution of stannous oxide, in hydrofluoric acid in the absence of oxygen.

- **Properties:**
  - It occurs as a white, odourless powder with slight bitter taste.
  - It is freely soluble in water and practically insoluble in alcohol, ether and chloroform.
- **Storage:** It is stored air tight containers to avoid hydrolysis and oxidation.
- **Incompatibility:** It is incompatible with magnesium and calcium salts. Aqueous solution of sodium fluoride attacks glass slowly.
- **Uses:**

1. Sodium fluoride is used for the prophylaxis of dental caries (anticaries agent)
2. It is used in dental products.
3. A 2% solution of sodium fluoride in water may be applied to children's teeth.
4. It is used to treat abnormal development of teeth.
5. It is a constituent of some insecticides and rodenticides.

(b) Calcium carbonate:

- **Formula:** $CaCO_3$.
- **Synonym:** Precipitated chalk, precipitated calcium carbonate.
- **Standard:** It contains not less than 98.5% of $CaCO_3$.
- **Description:**
  - Calcium carbonate is the most abundant and widely distributed calcium salt.
  - It occurs as a chalk, lime stone, marble, aragonite and calcite.
- **Method of preparation:**

  Calcium carbonate is prepared by precipitation by mixing the boiling solution of calcium chloride and sodium carbonate and allowing the resulting precipitate to subside on cooling.

  $$CaCl_2 + Na_2CO_3 \rightarrow 2NaCl + CaCO_3 \downarrow$$
- **Properties:**

1. It is white odourless, tasteless, microcrystalline powder stable in air.
2. It is practically insoluble in water, but its solubility is increased by the presence of any ammonium salt or carbon dioxide.

- **Storage:** It is stored in well closed air-tight containers.
- **Incompatibility:** It is incompatible with tetracycline. Administration of large dose of calcium carbonate with large amount of milk can cause milk-alkali syndrome (Brunette syndrome).

- **Uses:**
  1. Calcium carbonate is used as a dental cleaning-polishing agent for most of toothpastes and tooth powders.
  2. It is used as an antacid.
  3. It is used as a chalk and also in the treatment of diarrhoea.
  4. A preparation of native calcium carbonate is used in homoeopathic medicine.

4 Write a note on: (a) Mouthwashes, (b) Denture cleaners. (c) Denture adhesives

☞ **(a) Mouthwashes:**

A mouthwash is an aqueous solution like a gargle but used to wash the mouth cavity.

Explanation

- Mouthwashes are used for their deodorant refreshing or antiseptic effects.
- They may contain alcohol, glycerin, surfactants, sweeteners, flavouring and colouring agents.
- Generally mouthwash contains:
  i. **Antibacterial agent:** Phenol, hydrogen peroxide.
  ii. **Astringent:** Zinc chloride, zinc sulphate.
  iii. **Simple preparation:** Sodium chloride solution.
  iv. Flavours.
  v. Humectants.
  vi. Buffers.

Label

- For external use only.
- Dilute with equal volume or specified volume of warm water before use.

Container

Mouthwashes should be dispensed in a clear flutted glass bottles, closed with a plastic screw cap.

Examples

- Alkaline phenol mouthwash BPC.
- Hydrogen peroxide mouthwash BPC.
- Compound sodium chloride mouthwash BPC.
- Zinc sulphate and zinc chloride mouthwash BPC.

(b) Denture cleaners:

- Denture is a removable replacement for missing teeth and surrounding tissues.
- Conventional dentures are removable.
- When dentures are removed from the mouth, a denture cleaner (denture cleanser) is used to clean them.
- The main purpose of denture cleaner is to prevent denture related stomatitis by controlling the growth of bacteria on the dentures, particularly *Candia albicans*.
- When dentures are worn in the mouth, a biofilm forms that looks and feels like dental plaque. It can solidify and mineralize, forming dental calculus.
- Denture cleaners are also used to remove stains, and other debris generated by a variety of factors such as diet, tobacco usage, coffee, tea and other beverages.
- Chemical denture cleaners are available in both cream and liquid form. They may be effervescent or non-effervescent.
- Dental brushes and ultrasonic denture cleaners are mechanical denture cleaners that use ultrasonic cleaning, some of which are combined with UV radiation.
- **Formula for Denture Cleaner:**
  1. Dilute sodium hypochlorite (a weak bleach) (principle ingredient)
  2. Sodium bicarbonate (baking soda): It is an alkalizing agent that cleans denture by alkalinizing the water.
  3. Citric acid: It removes spots.
  4. Potassium monopersulphate: It is used as cleaning and bleaching agent.
  5. Sodium perborate, sodium polyphosphate, and EDTA.
- **Uses of Denture Cleaners:**
  1. To prevent growth of bacteria on dentures.
  2. To remove stains and spots on the dentures.
  3. To remove the dental plaque/calculus.

(c) Denture Adhesives:

Definition: Denture adhesive is a paste, powder or strip made from a non-toxic water-soluble material that goes between the denture and the gum line.

- **Types of Denture Adhesives:**
  1. Denture adhesive cream.

2. Denture adhesive powder.
3. Denture adhesive strips.

Composition of Denture Adhesive:

The composition of denture adhesives is as following:

(a) **Zinc:** This mineral helps the adhesive create that grip you need.
(b) **Mineral oil:** This ingredient delivers the right denture cream consistency.
(c) **Petrolatum:** Like mineral oil, this helps with consistency.
(d) **Cellulose gum:** This ingredient helps the dentures stick in place.
(e) **Silica:** Also works to help create the right consistency.
(f) **Red 27 Lake:** This ingredient gives the adhesive its color.

- **Mechanism of Denture Adhesives:**
  - Denture adhesives work by "gluing" (fast joining) the denture to the tissue through the saliva.
  - Mouth's natural moisture transforms the adhesive into an elastic like membrane that sticks to both the gum and the denture.
  - Denture adhesives hold dentures tight and improve natural retention after well fitting denture.
- **Uses of Denture Adhesives**

1. Denture adhesives help to enhance the natural forces that hold denture in place and help to stop any movement between the denture and the gum, so that person can eat, talk, smile and live with more confidence.
2. Denture adhesives can also help to give more confidence since dentures are held firmly in proper place.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Stannous fluoride and calcium carbonate are used as **polishing agents**.
2. Strontium chloride is an example of **desensitizing agent**.
3. Deposition of fluorine produces mottled enamel which is known as **dental fluorosis**.
4. **Denture** is a removable replacement for missing teeth and surrounding tissue.
5. Sodium fluoride is used in the treatment of **dental caries**.
6. **Chlorhexidine** is used as mouth wash.
7. **Dental caries** is a medical term of tooth decay.
8. **Zinc chloride** is example of desensitizing agent.
9. Calcium phosphate is used as **cleansing agent**.
10. Abrasive is used to remove **stain from the teeth**.

Chapter
7

Medicinal Gases (Inhalants)

1 Define inhalants. What is the role of oxygen and carbon dioxide in biological system?

☞ Inhalants

The substances which are in vapour or gas form are inhaled through nose, are called inhalants, e.g. O_2, N_2O, CO_2.

Role of Oxygen (O_2)

- Oxygen is necessary in normal oxidative metabolism for the production of useful energy.
- This energy is used by the cell to synthesize ATP.
- After inhalation, O_2 enters into blood and combines with haemoglobin to form oxyhaemoglobin (HbO_2).
- This oxyhaemoglobin readily dissociates and releases oxygen in the medium of cell.
- Deficiency of oxygen in tissues is called hypoxia.
- Absence of oxygen in the tissues is called anoxia.
- When more oxygen is needed the condition is termed as asphyxia.
- For the treatment of hypoxia, anoxia and asphyxia, O_2 is needed.
- In the treatment of poisoning, O_2 is useful for maintenance of normal respiratory and circulatory functions.

Role of Carbon Dioxide (CO_2)

- CO_2 plays an important role in maintaining acid–base balance of the body.
- It is found in large quantity in plasma.
- It is readily absorbed and transported by blood both in cells and in plasma. It is also produced in the body during metabolic process.
- Carbonate buffer is physiological buffer which is useful in maintenance of acid–base balance of several body fluids.

- A large quantity of carbon dioxide produced is eliminated by lungs in expired air.
- Respiratory acidosis and respiratory alkalosis are the disorders produced due to imbalance of CO_2 level in the body.
- CO_2 stimulates respiratory centre and hence useful in treatment of carbon monoxide poisoning.

2 Write a note on "oxygen" as a Medicinal gas.

☞ **Oxygen**

- **Formula:** O_2
- **Standard:** Oxygen contains not less than 99% w/v of O_2.
- **Preparations:** By two methods:
  i. By electrolysis of water.
  ii. By fractionation of liquid air.
- **Properties:**
  i. Colourless, odourless, tasteless gas.
  ii. It is a good oxidising agent.
  iii. It dissolves in about 32 volumes of water.
- **Storage and labelling**
  i. It is stored under the pressure in metallic cylinder which is painted by black and white colour. The body of the cylinder is painted by black and shoulder is painted with white colour.
  ii. Name and symbol of oxygen (O_2) is stenciled on cylinder and also on cylinder valve.
- **Actions and uses**
  i. In treatments of hypoxia, anoxia and asphyxia.
  ii. In carbon monoxide poisoning.
  iii. In cardiac arrest.
  iv. As a fuel in rocket technology.
  v. In the preparation of acetylene flame used for welding.

3 Write a note on "carbon dioxide" as a medicinal gas. (W.22)

☞ **Carbon Dioxide**

- **Formula:** CO_2
- **Standard:** It contains not less than 99% w/v of CO_2.

- **Preparation:** Compounds containing carbon, e.g. coal, coke are burned in excess of O_2 to produce CO_2.

  $$C + O_2 \rightarrow CO_2$$

- **Properties**
  i. Colourless, odourless gas with faintly acidic taste.
  ii. Soluble in water and heavier than air.
- **Storage and labelling**
  i. It should be stored under pressure in a strong metallic cylinder.
  ii. The cylinder is painted grey colour at shoulder and remaining part may be of green or white colour.
- **Actions and uses**
  i. Respiratory stimulant.
  ii. In carbon monoxide poisoning.
  iii. In treatment of drug addiction.
  iv. Regulation of acid–base balance.
  v. Its salts are used in effervescent powders.
  vi. In preparation of soft drinks.
  vii. To prepare dry ice.
  viii. With O_2 for artificial respiration.

4 Write a note on "nitrous oxide" as a medicinal gas.

☞ **Nitrous Oxide**

- **Synonym:** 'Laughing gas', Happy gas, Nitrous monoxide.
- **Formula:** N_2O
- **Standard:** It contains not less than 99% w/v of N_2O.
- **Preparation:** It is prepared by thermal decomposition of ammonium nitrate.

  $NH_4NO_3 \rightarrow 2H_2O + N_2O$
- **Properties**
  i. It is colourless, odourless gas with slightly sweet taste.
  ii. It is soluble in water and alcohol.
- **Storage and labelling**
  i. It should be stored under pressure in a strong metallic cylinder below 37°C.
  ii. The cylinder is painted by blue colour.
  iii. The name and symbol of nitrous oxide (N_2O) are stenciled on cylinder and on the cylinder valve.

- *Actions and uses*
  i. In minor operations of boils (as anaesthetic).
  ii. In dentistry.
  iii. In mental patients (to calm).
  iv. It produces nervous excitement and hysterical laughter, hence it is known as laughing gas.
  v. It is also used as propellant in aerosol pack.
  vi. It also produces muscle relaxation.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. The laughing gas is a synonym of **nitrous oxide**.
2. **Carbon dioxide** has faint odour and sour taste.
3. Absence of oxygen in the tissues is called **Anoxia**.
4. Oxygen cylinders are painted by **black and white** colour.
5. The **CO_2** gas is used in preparation of soft drinks and dry ice.
6. **Nitrous oxide** is known as 'laughing gas' or 'Happy gas'.
7. At a higher temperature (500ºC) nitrous oxide gets decomposed into **N_2 and O_2**.
8. The colour of CO_2 gas cylinder is **green**.
9. **Nitrous oxide** inorganic gas is used as anaesthetic.
10. **Carbon dioxide** inhalant is most widely used in "fire extinguishers".

Chapter 1

Heterocyclic System and Nomenclature

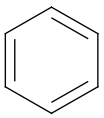
1 Define the terms carbocyclic compounds and heterocyclic compounds.

☞ 1. Carbocyclic Compounds

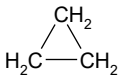
The cyclic compounds containing all the carbon atoms along with hydrogen atoms are called carbocyclic compounds.

Examples

Benzene



Cyclopropane

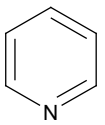


2. Heterocyclic Compounds

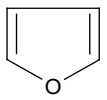
The cyclic compounds containing one or two different kinds of atoms (hetero atoms like, N, S, O) including carbon atoms are called heterocyclic compounds.

Examples

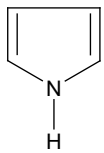
Pyridine



Furan

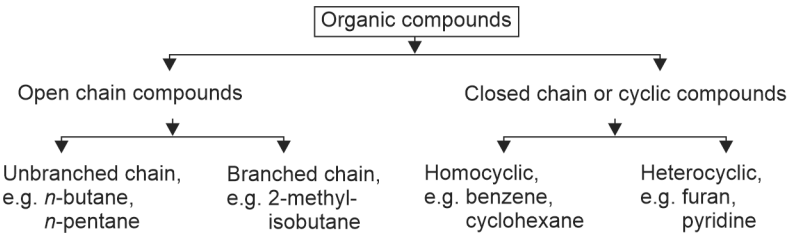


Pyrrole



2 Classify organic compounds giving suitable examples.

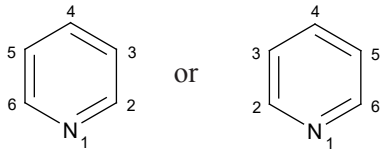
On the basis of carbon skeleton, organic compounds are classified as follows:



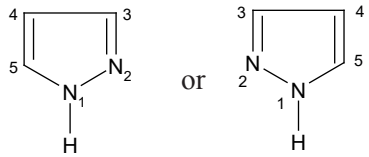
3 Give the rules for numbering of the heterocycles/rings. Or Write a note on nomenclature of the heterocyclic rings.

Numbering of the heterocyclic systems can be done as per the following rules:

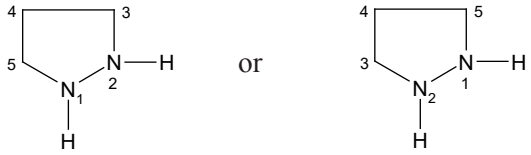
1. If the two heterocyclic rings contain only one hetero atom (N, S, O) then first number is given to hetero atom and other atoms are numbered either in clockwise or anticlockwise direction, **e.g. pyridine**



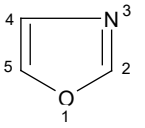
2. If the heterocyclic ring contains two or more nitrogen atoms, then the saturated nitrogen should be numbered as 1 and other nitrogen atom should be given least possible number, **e.g. pyrazole**



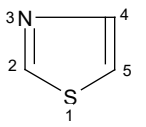
3. If the heterocyclic ring contains two or more saturated nitrogen atoms then any one nitrogen is numbered as 1 and other nitrogen should come to least possible number, **e.g. pyrazolidine**



4. If the heterocyclic ring contains two different hetero atoms, then the order of preference for position 1 is oxygen, sulphur and then nitrogen and other hetero atoms are given lowest possible numbers, **e.g. oxazole and thiazole**

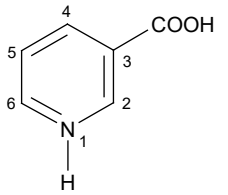


Oxazole

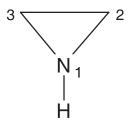
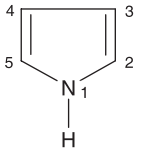
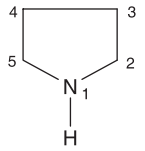
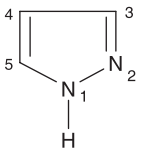
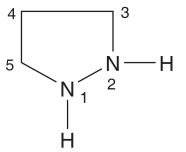
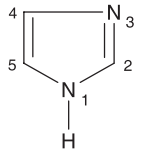


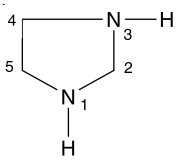
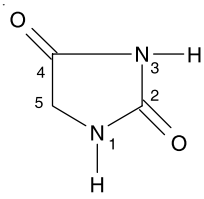
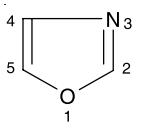
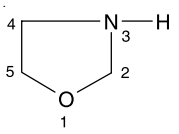
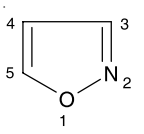
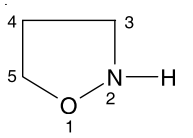
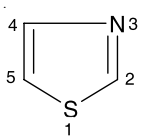
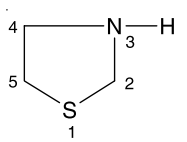
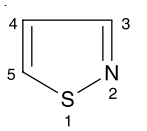
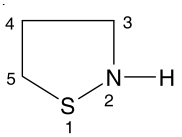
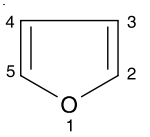
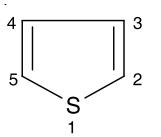
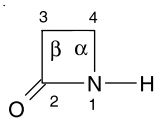
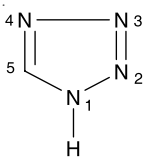
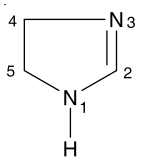
Thiazole

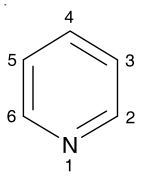
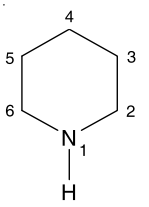
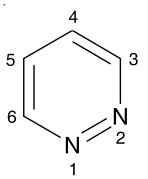
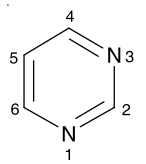
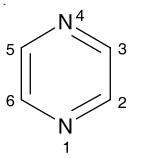
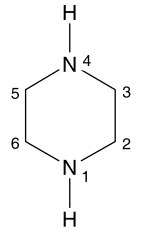
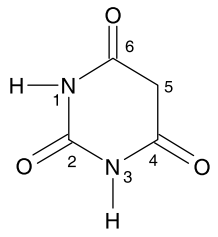
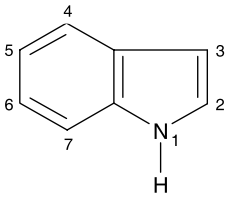
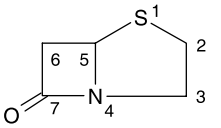
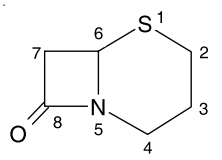
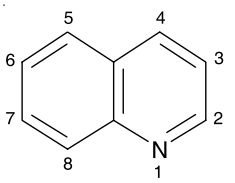
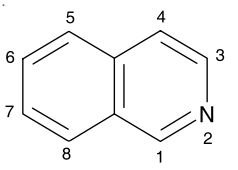
5. If heterocyclic ring having one of the substituents then it should bear least possible number, **e.g. nicotinic acid**



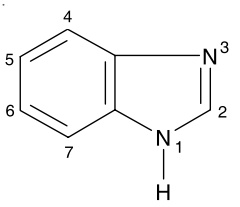
4 Give the numbering and one example of each of the following heterocycles.

1. Aziridine  e.g. Mitomycin	**2. Pyrrole**  e.g. Viprynium	**3. Pyrrolidine**  e.g. Ethosuximide
4. Pyrazole  e.g. Sulphaphenazole	**5. Pyrazolidine**  e.g. Phenylbutazone	**6. Imidazole**  e.g. Metronidazole

7. Imidazolidine  e.g. Phenytoin	**8. Hydantoin**  (Imidazolidine 2, 4-dione) e.g. Phenytoin, ethoin	**9. Oxazole** 
10. Oxazolidine  e.g. Troxidone	**11. Iso-oxazole**  e.g. Sulphamethoxazole	**12. Iso-oxazolidine**  e.g. Cycloserine
13. Thiazole  e.g. Thiamine	**14. Thiazolidine**  e.g. Penicillin	**15. Isothiazole** 
16. Isothiazolidine 	**17. Furan**  e.g. Frusemide, nitrofurantoin	**18. Thophene (Thiol)**  e.g. Cephalothin
19. β-Lactam  e.g. Penicillin	**20. Tetrazole**  e.g. Leptazole	**21. 2-Imidazoline**  e.g. Tolazoline

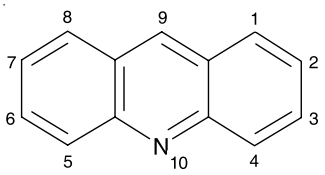
22. Pyridine  e.g. Isoniazid	**23. Piperidine**  e.g. Pethidine	**24. Pyridazine**  e.g. Sulphamethoxy pyridazine
25. Pyrimidine  e.g. Sulphadiazine	**26. Pyrazine**  e.g. Pyrazinamide	**27. Piperazine**  e.g. DEC
28. Barbituric acid  e.g. Phenobarbitone	**29. Indole**  e.g. Indomethacin	**30. Penam**  e.g. Penicillin
31. Cepham  e.g. Cephalexin	**32. Quinoline**  e.g. Chloroquine	**33. Isoquinoline**  e.g. Papaverine

34. Benzimidazole



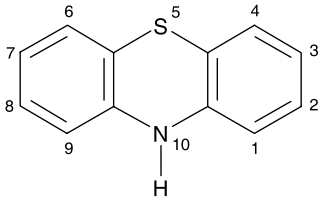
e.g. Mebendazole

35. Acridine



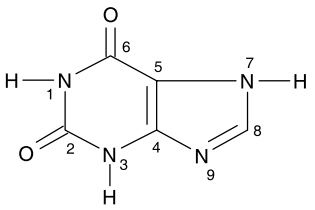
e.g. Proflavin

36. Phenothiazine



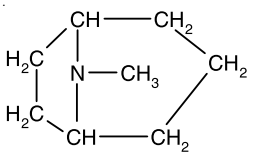
e.g. Chlorpromazine

37. Xanthine



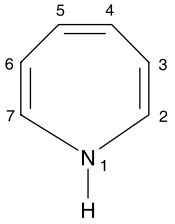
e.g. Caffeine

38. Tropane



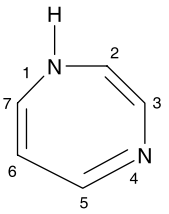
e.g. Atropine

39. Azepine

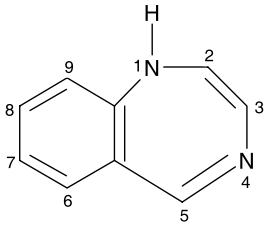


e.g. Carbamazepine

40. 1, 4 Diazepine

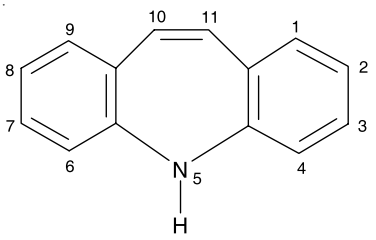


41. 1, 4 Benzodiazepine



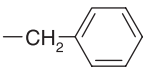
e.g. Diazepam

42. Dibenzazepine

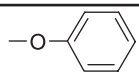
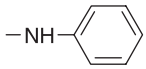
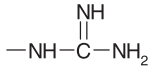
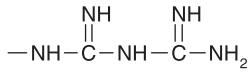
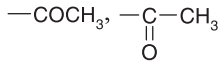
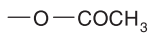
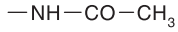
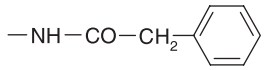
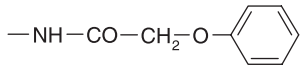
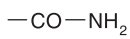
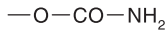
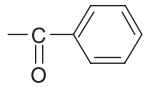
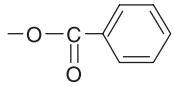
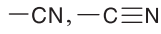


e.g. Imipramine

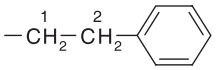
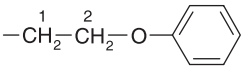
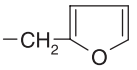
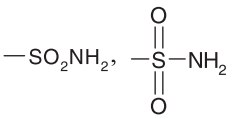
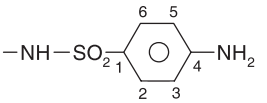
5 Give the structure/composition of the following organic groups/functional groups.

	Organic groups	Structure/composition
1.	Methyl	$-CH_3$
2.	Ethyl	$-CH_2-CH_3$, $-C_2H_5$
3.	n-Propyl	$-CH_2-CH_2-CH_3$
4.	n-Butyl	$-CH_2-CH_2-CH_2-CH_3$
5.	Iso-propyl	$-CH(CH_3)-CH_3$
6.	Oxy/oxo	$=O$
7.	Methoxy	$-OCH_3$
8.	Ethoxy	$-O-CH_2-CH_3$
9.	Propoxy	$-O-CH_2-CH_2-CH_3$
10.	Butoxy	$-O-CH_2-CH_2-CH_2-CH_3$
11.	Amino	$-NH_2$
12.	Methyl amino	$-NH-CH_3$
13.	Ethyl amino	$-NH-CH_2-CH_3$, $-NH-C_2H_5$
14.	Propyl amino	$-NH-CH_2-CH_2-CH_3$
15.	Isopropyl amino	$-NH-CH(CH_3)-CH_3$
16.	Diethyl amino	$-N(C_2H_5)-C_2H_5$
17.	Dimethyl amino	$-N(CH_3)-CH_3$
18.	Phenyl	
19.	Benzyl	

Contd.

	Organic groups	Structure/composition
20.	Phenoxy	
21.	Anilino	
22.	Guanidino	
23.	Biguanidino	
24.	Acetyl	
25.	Acetoxy	
26.	Acetamido	
27.	Phenyl acetamido	
28.	Phenoxy acetamido	
29.	Carbonyl	
30.	Carbamoyl	
31.	Carbamoyloxy	
32.	Benzoyl	
33.	Benzoyloxy	
34.	Thio	
35.	Cyano/nitrile	
36.	Hydroxy	

Contd.

	Organic groups	Structure/composition
37.	Carboxy/carboxyl	$-COOH$
38.	Formyl/aldehyde	$-CHO$
39.	Mercapto	$-SH$
40.	Chloro	$-Cl$
41.	Bromo	$-Br$
42.	Fluoro	$-F$
43.	Iodo	$-I$
44.	Hydroxymethyl	$-CH_2-OH$
45.	Hydroxyethyl	$-CH_2-CH_2-OH$
46.	Nitro	$-NO_2$
47.	2-Phenylethyl	
48.	2-Phenoxyethyl	
49.	Trifluoromethyl	$-CF_3$
50.	Furfuryl	
51.	Vinyl	$-CH=CH_2$
52.	Vinyloxy	$-O-CH=CH_2$
53.	Allyl	$-CH_2-CH=CH_2$
54.	Allyloxy	$-O-CH_2-CH=CH_2$
55.	Sulphamoyl/sulphonamido	
56.	Sulphanilamido	 (p-Aminobenzene sulphonamido)

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Pyridine is **six membered** heterocyclic ring.
2. Caffeine contains heterocyclic ring **xanthine**.
3. Acetamido group is **CH_3CONH–**.
4. **Pyrrole** is an example of five membered Heterocyclic compounds with one nitrogen hetero atom.
5. Structure of anilino group is **$–NHC_6H_5$**.
6. 5 membered unsaturated heterocyclic rings with oxygen as a heteroatom is **furan**.
7. Tetrazole contains **four nitrogen** atoms.
8. Imidazolidine 2, 4 dione means **Hydantoin**.
9. Saturated 5 membered heterocyclic ring with nitrogen as a hetero atom is **pyrrolidine**.
10. Structure of ethyl amino group is **$–NH-C_2H_5$**.
11. Structure of mercapto group is **–SH**.
12. Metronidazole contains **imidazole** heterocyclic ring.
13. **Aziridne** is a 3 membered heterocyclic ring.
14. Name of $–CH_2-CH=CH_2$ group is **allyl**.
15. General Formula for alkene **CnH_{2n}**.

Chapter
2

General Anaesthetics

1 What is Anaesthesia? Describe various stages of general anaesthesia/Explain mechanism of action of general anaesthetics. (S.24)

☞ Anaesthesia

Anaesthesia is a state of controlled, temporary loss of sensation, that is induced for medical purposes. Anaesthesia includes stages like analgesia, paralysis, amnesia and unconsciousness.

☞ Stages of Anaesthesia/Mechanism of Anaesthesia

(a) Stage of Analgesia: This stage from begining of inhalation of anaesthetics agent up to loss of consciousness. It involves sensation of falling, remoteness and feeling of warmth is observed in some patients. Analgesia is produced before consciousness is lost.

(b) Stage of Delirium: This stage starts with loss of consciousness to beginning of surgical anaesthesia. This stage involves marked excitement, shouting, laughing, increased muscular activity, vomiting, pupils may dilate and patient shows development of marked hypertension and tachycardia.

(c) Stage of Surgical Anaesthesia: As the more drug gets in, deep breathing starts and patient passes into the third stage. This gives gradual loss of reflexes, regular respiration and relaxation of skeletal muscle.

This stage is divided into four different planes:

Plane 1: The pupils are normal and eyeballs are moving. The pupils dilate and attain normal size. The respiration is full and regular. BP and pulse rate is normal.

Plane 2: Eyeballs are fixed and amplitude of respiration is diminished. Adequate muscular relaxation.

Plane 3: The BP begins to fall. Intercostal muscles are paralysed slowly. The pupillary light reflex is lost. Muscles relax completely.

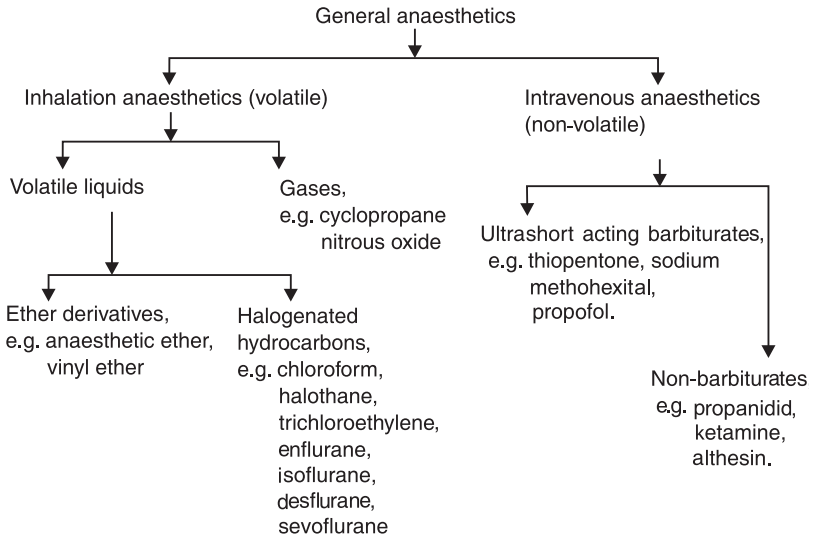
Plane 4: Intercostal muscles completely paralysed. The pupils are further dilated. BP is low. All secretions are completely abolished.

(d) Stage of Respiratory Paralysis: This stage is characterised by severe depression of vital medullary centres, initially the diaphragmatic contractions are irregular. Respiratory arrest also leads to vasomotor collapse.

2 Define and classify general anaesthetics with examples.

General anaesthetics are the CNS depressant drugs, which produce a partial or total loss of pain accompanied by loss of consciousness.

☞ Classification



3 Differentiate between General Anaesthetics and Local Anaesthetics.

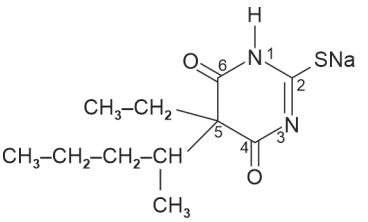
General Anaesthetics	Local Anaesthetics
1. General anaesthetics are the agents which bring about loss of all modalities of sensation, particularly pain, along with a reversible loss of consciousness.	1. It may be defined as any substance applied topically or by localized injection or infiltration to dull or block pain sensation.
2. General anaesthesia is induced either by inhalation of volatile and gaseous anaesthetics like diethyl ether, halothane or parenteral administration of intravenous anaesthetics like thiopentone.	2. Local anaesthesia is induced by topical application of drug to skin or mucous membrane or by injection into area subjected to surgical operation or injection into dural membrane of spinal cord.
3. General anaesthesia is carried out before carrying out surgical operation or in obstetrics.	3. Local anaesthesia is produced in short surgical operations and in dentistry.
4. Care of vital organs is essential.	4. Care of vital organ is not essential.
5. In this case consciousness is lost.	5. In this case effect is in limited area of the body.
6. In this case site of action is on CNS.	6. In this case site of action is on peripheral nerves.
7. Examples: Ether, halothane, cyclopropane.	7. Examples: Lignocaine, procaine, orthocaine.

4 Give the structure, chemical Name, properties, storage, uses, official preparation of Brand names of the following general anaesthetics:

1. Thiopentone sodium 2. Ketamine 3. Propofol.

1. Thiopentone sodium/Thiopental sodium:

☞ **Structure:**



☞ **Chemical Name:**

Sodium, 5-ethyl-4, 6-dioxo-5-pentan-2yl 1H-pyrimidine-2-thiolate.

OR

5-ethyl-5 (1-methyl butyl)-2-thiobarbiturate sodium.

Properties:

- It is yellowish white powder.
- It has characteristic odour and has bitter taste.
- It is freely soluble in water and practically insoluble in ether.
- It is hygroscopic.

Stability and Storage:

It is hygroscopic and is decomposed by atmospheric O_2. Hence, it is stored in tightly closed containers.

Uses:

It is used:

- To induce general anaesthesia.
- As an anticonvulsant.
- For prevention and treatment of cerebral ischaemia.
- It has poor analgesic and muscle relaxant property.
- It is also used as sedative and hypnotic.

☞ **Phamaceutical Formulations:**

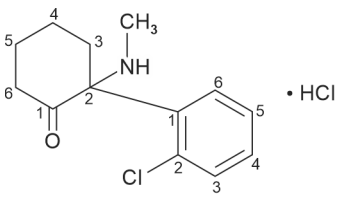
Thiopentone sodium injection IP, BP.

• Brand Names:

Pentothal Sodium, Intraval Sodium, Thipen, Thiosol, Anesthal.

2. Ketamine:

☞ **Structure:**



☞ **Chemical Name:**

2-(2-chlorophenyl)-2-(methyl amino) cyclohexane-1-one, hydrochloride.

OR

2-(2-chlorophenyl)-2-(methyl amino) cyclopentanone hydrocloride.

• **Properties:**

i. It is a white or white crystalline powder.
ii. It is freely soluble in water, methanol and ethanol.

• **Stability and Storage:**

Ketamine solutions were chemically stable for periods ranging from 7 to 180 days when stored at 4°C or 25°C in plastic or glass containers.

• **Uses:**

i. It is a dissociative anaesthetic.
ii. Ketamine induces sedation, immobility, amnesia and marked analgesia.
iii. It is a rapidly acting non-barbiturate general anaesthetic.
iv. Ketamine is a phencyclidine analogue with anaesthetic and analgesic properties.
v. Ketamine is a anaesthetic agent used for diagnostic and surgical procedures.
vi. Ketamine produces an anaesthetic state characterized by profound analgesia.

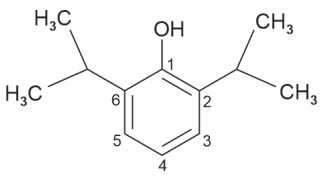
☞ **Phamaceutical Formulations: Ketamine injection**

• **Brand Names:**

Ketalar, GB-ket, Keta, Hypnoket, Aneket.

3. Propofol:

• **Structure:**



• **Chemical Name:**

2,6.-di-isopropyl phenol

• **Properties:**

i. It is lightly straw coloured liquid.
ii. It is insoluble in water and soluble in alcohol and toluene.

• **Storage:**

It undergoes oxidative degradation in the presence of oxygen and therefore packaged under nitrogen to eliminate this degradation path. It is stored in the temperature ranging between 4°C and 25°C.

• **Uses:**

i. It is used as parenteral anaesthetic agent.
ii. It is used in intensive care units (ICUs) for maintenance of coma.
iii. It induces the sedation and hypnosis during anaesthesia.
iv. It is used for general anaesthesia in major surgery.
v. In low doses it is also used for "conscious sedation" of patients getting procedures on an outpatient basis at ambulatory surgery centres.

☞ **Pharmaceutical Formulations: Propofol injection**

• **Brand Names:**

Profol, Neorot, Celofol, Diprivan, Hypro.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Thiopentone is given by IV as **anaesthetic**.
2. Nitrous oxide and cyclopropane are **gaseous anaesthetics**.
3. Halothane is the **inhalation** form of general anaesthetic.
4. $C_{12}H_{18}O$ is the molecular formula of **propofol**.
5. In the **stage of surgical anaesthesia** the patient passes through four plans.
6. Chloroform and halothane are **volatile anaesthetics**.
7. Intraval is a popular brand name of **thiopentone sodium**.
8. **2, 6-di-isopropyl phenol** is a chemical name of propafol.
9. General anaesthesia usually uses a combination of **intravenous and inhaled** gases.
10. Thiopentone sodium is an example of **ultra short acting barbiturate**.

Chapter
3

Sedatives and Hypnotics

1 What is Insomnia? Define and classify sedatives and hypnotics with examples. (S.23)

☞ Insomnia

Insomnia means lack of sleep or inability to sleep.

Classification of Sedatives and Hypnotics

1. Barbiturates:

(a) Long acting: Barbital, phenobarbitone, mephobarbital.

(b) Short acting: Amobarbital, butabarbital, pentobarbital, secobarbital.

(c) Ultrashort acting: Thiopentone, methohexitone.

2. Benzodiazepines: Diazepam, chlordiazepoxide, oxazepam, chlorazepate, lorazepam, alprazolam, zolpidem.

3. Miscellaneous:

(a) Amides and imide: Glutethimide.

(b) Alcohols and their derivatives: Meprobamate, ethchlorvynol.

(c) Aldehydes and their derivatives: Triclofos sodium, paraldehyde.

(d) Acetylated carbinols: For example, ethionamate.

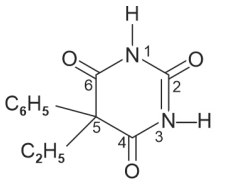
(e) Inorganic ions: For example, bromides.

2 Give the details of following sedative and hypnotic drugs. (S.23)

☞ 1. PHENOBARBITONE

It is a derivative of barbituric acid.

Structure:



5-ethyl-5-phenyl barbituric acid

Properties

- It is a white crystalline powder.
- It is odourless and has slightly bitter taste.
- It is very slightly soluble in water and soluble in alcohol.
- It is hygroscopic.
- It is lipophillic in nature thus soluble in benzene and acetone.

Stability and Storage

It is hygroscopic in nature, hence it is stored in tightly closed contaier.

Uses

- It is used as a hypnotic and sedative.
- It is used to treat insomnia, anxiety, dysmenorrhoea and thyro-toxicosis.
- It is used to treat neonatal jaundice.
- It is used as antiepileptic for grand mal and Petit mal epilepsy.

☞ Pharmaceutical Formulations:

- Phenobarbitone tablet.
- Phenobarbitone and theobromine tablet.
- Phenobarbitone capsules.
- Phenobarbitone elixir.
- Phenobarbitone sodium tablets.
- Phenobarbitone sodium injection.

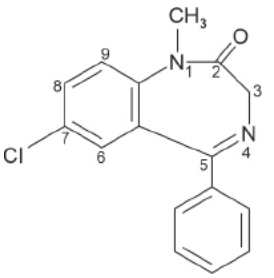
Brand Names

Garoin, Garnenal, Luminal, Fenobarb, Phenetone, Epitan, Beetal.

2. DIAZEPAM (W.22)

It is a benzodiazepine derivative.

Structure:



Chemical Name:

7-chloro, 2,3-dihydro, 1-methyl, 1-4 benzodiazepine, 2-one

Properties

- It occurs as white or pale yellow crystalline powder.
- It is odourless and tasteless.
- It is sparingly soluble in water and soluble in alcohol.
- It is lipophillic in nature, thus soluble in benzene and acetone.

Stability and Storage

It should be stored in a tightly closed light resistant container.

Therapeutic Uses

- It is used as antianxiety agent.
- It has a good muscular relaxation property.
- It is used as an anticonvulsant agent.
- It is used as preanaesthetic medication.
- It is used in the management of acute alcoholic withdrawal.
- It is used as hypnotic and sedative.

☞ Pharmaceutical Formulations:

- Diazepam tablet.
- Diazepam capsule.
- Diazepam injection.
- Diazepam elixir.
- Diazepam oral solution.

Brand Names:

Calmpose, Valium, Diazep, Alzepam, Calmod, Dizac, Q-pam.

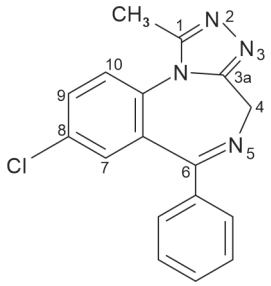
Dose:

The standard dosage in 2–10 mg 2–4 times per day.

3. ALPRAZOLAM

It is a benzodiazepine derivative.

Structure:



Chemical Name:

8-chloro, 1-methyl-6-phenyl-4 H-1, 2, 4-triazolo [4, 3a] [1, 4] benzodiazepine.

Properties:

i. It is a white crystalline odourless solid powder.
ii. It is practically insoluble in water, freely soluble in methylene chloride, sparingly soluble in acetone and alcohol.

Stability and Storage:

It should be stored in a tightly closed container in a dry and well-ventilated place. It should be stored in light resistant container at 15–30°C.

☞ Pharmaceutical Formulations:

i. Alprazolam tablet.
ii. Alprazolam injection.

Brand Names:

Xanax, Aaram, Abirox, Niravam, Agcalm.

Uses:

i. It is useful in the short-term management of insomnia.
ii. It is used as sedative and hypnotic.
iii. It is used as an antianxiety agent.
iv. It is used in panic disorders (sudden unexpected attacks of extreme fear and worry about these attacks)

4. NITRAZEPAM

It is a benzodiazepine derivative.

Properties:

i. It is a yellow, crystalline and odourless powder.
ii. It is soluble in alcohol, acetone, chloroform and ethyl acetate.
iii. It is insoluble in water, ether, benzene and hexane.

Stability and Storage:

It should be stored at room temperature and protected from light and moisture.

☞ Pharmaceutical Formulations:

i. Nitrazepam tablet.
ii. Nitrazepam injection.

Brand Names:

Nitravet, Insomine forte, Hypnotex, Nitrosun, Nitraz-5.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Diazepam is used as an **antianxiety agent**.
2. The agent or drugs which reduce the excitement and calm to the patient without inducing sleep called as **sedatives**.
3. The compound 1-Metyl 5, 5 diethyl barbituric acid is **long acting barbiturate**.
4. Diazepam is used as **muscle relaxant**.
5. Insomnia means **lack of sleep**.
6. Phenobarbitone is a derivative of **Barbituric acid**.
7. 5-ethyl, 5-phenyl barbituric acid is a chemical name of **phenobarbitone**.
8. Calmpose and Valium are popular brand names of **diazepam**.
9. **Alprazolam** is used in the short-term management of insomnia.
10. **Diazepam** is used in pre-anaesthetic medication.

Chapter
4

Antipsychotics (Tranquilizers/Neuroleptics)

1 What are different Psychic disorders/Psychological disorders/Mental disorders?

☞ **Types of Psychic/Mental disorders:**

Psychosis: It means a mental condition characterised by disturbances in mental functions.

- It is a psychic condition, which involves marked impairment of behaviour with a serious inability to think.
- Mental diseases have always been puzzling and frightening things.
- Psychosis can be defined as the psychotic illness with serious distortion of thought, behaviour and capacity to recognize reality and of perception and patient unable to meet the ordinary demand of life.

Psychoses may be of two categories:

(a) Organic Psychosis: It involves memory disturbances, clouding of consciousness, congestive disorders, like delirium, and dementia with psychotic features.

Prominent features are confusion, disorientation, defective memory, disorganized thoughts and behaviour. They may be due to endocrinal abnormalities or head injuries.

(b) Functional Psychosis:

(i) Maniac: Disturbance of mood, reduced sleep, hyperactivity, uncontrollable thoughts and speech, violent behaviour.

(ii) Schizophrenia: It is also known as split mind condition. It involves splitting of perception and interpretation from reality and inability to think. Disturbed emotions and motor behaviour.

(iii) **Hallucination:** A sensation of false perception without sensory stimulus.

(iv) **Anxiety:** It involves feeling of fear, apprehension.

(c) **Neurosis:** It is a termed used to denote less severe form of psychosis.

(d) **Depression:** It is a common psychiatric disorder characterized by a feeling of misery, apathy, hopelessness, ugliness, loss of appetite, insomnia, anorexia, alternation in moods and activities, etc.

2 Define the terms with examples.

☞ **Definitions:**

a. Antipsychotics/Psychotropics/Psychoactive Drugs

The drugs which are used in the treatment of psychic disorders are called antipsychotics or psychoactive drugs. For example, chlorpromazine, reserpine, haloperidol.

b. Antianxiety Agents/Anxiolytics/Minor Tranquillizers

The drugs which are used to reduce anxiety states and nervousness are called antianxiety agents. For example, diazepam, nitrazepam, oxazepam.

c. Antidepressants (Mood Elevators)/Thymoleptics

The drugs which improve the moods of depressed individuals are called antidepressants. For example, imipramine, desipramine, amitriptyline, nortriptyline.

d. Tranquillizers

The drugs which produce calming and quietening effect on the individuals are called tranquillizers. For example, chlorpromazine, haloperidol.

3 Define and classify Antipsychotics/Psychoactive drugs/Psychotropic drugs/Tranquillizers with suitable examples.

☞ **Psychotropic/Antipsychotic drugs:**

The drugs which are used to treat psychiatric disorders are called psychotropic drugs.

Classification of Psychotropic/Antipsychotic drugs:

A. Typical antipsychotics: These drugs act on the dopaminergic system, blocking the dopamine type 2 (D_2) receptors.

(a) Phenothiazines, e.g. chlorpromazine, trifluoperazine, thioridazine, fluphenazine.

(b) Butyrophenone derivatives, e.g. haloperidol, droperidol, penfluridol.

(c) Thiothixene derivatives, e.g. thiothixene, flupenthixol, chlorprothixene.

(d) Miscellaneous, e.g. reserpine (Rauwolfia alkaloids), loxapine, molindone.

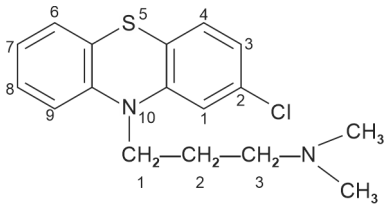
B. Atypical antipsychotics: For example, olanzapine, clonazepine, quetiapine, lurasidone, risperidone, sertindole, sulpiride.

4 Give the structure, chemical name, properties, stability and storage, uses, formulations and brand names of following Antipsychotics agents. (1) Chlorpromazine, (2) Haloperidol, (3) Risperidone, (4) Sulpiride, (5) Olanzapine and (6) Quetiapine.

☞ 1. CHLORPROMAZINE (S.24)

It is a phenothiazine derivative.

Structure:



Chemical Name:

2-chloro,10(3-dimethyl amino propyl) phenothiazine.

Properties

- It is a white or cream-coloured powder with slight odour.
- It is very soluble in water and freely soluble in alcohol.
- It is decomposed on exposure to light becoming yellow-pink and finally violet.

Stability and Storage

It is discoloured when exposed to light and hence it is stored in a well closed light-resistant container.

Uses

- It is an antipsychotic agent and used to treat schizophrenia, mania, etc.
- It is used to control nausea and vomiting.
- It is used to produce pre- and postoperative sedation.
- It is a vasodilator and reduces blood pressure.
- It also reduces salivary and gastric secretions.
- It has a local anaesthetic property.
- It produces hypothermia condition.
- It produces tranquillizing effect.

☞ Pharmaceutical Formulations:

- Chlorpromazine tablet.
- Chlorpromazine injection.
- Chlorpromazine elixir.
- Chlorpromazine suppositories.

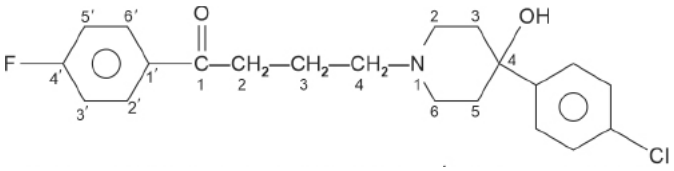
Brand Names

Largactil, Megatil, Sunprazin, Chlorozine, Clozine, Talentil-T, Talentil forte.

2. HALOPERIDOL (S.22, W.23)

It is a butyrophenone derivative.

Structure:



Chemical Name:

4 [4 (p-chlorophenyl) 4-hydroxy piperidine] 4′-fluoro-butyrophenone.

Properties

- It is a white to faint yellowish, amorphous powder.
- It is odourless and tasteless.
- It is practically insoluble in water.
- It is sparingly soluble in alcohol.

Storage

It is stored in a well-closed container and protected from light and do not freeze.

Uses

- It is a major tranquillizer and is used to treat acute schizophrenia, mania, severe anxiety, etc.
- It is used as antiemetic.
- It potentiates the actions of CNS depressants like analgesics, barbiturates.

☞ Pharmaceutical Formulations:

- Haloperidol tablet.
- Haloperidol injection.
- Haloperidol capsule.
- Haloperidol elixir.
- Haloperidol oral suspension.
- Strong haloperidol oral suspension.

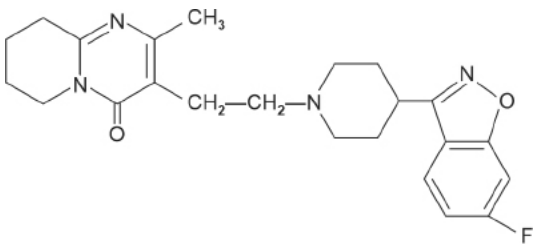
Brand Names

Halidol, Trancodol, Peridol, Mindwel, Senorm, Cizoren.

3. RISPERIDONE (BENZISOXAZOLE DERIVATIVE)

Risperidone is a member of the class pyridopyrimidine

Structure:



Chemical Name:

3-[2-[4-(6-fluoro-1,2-benzoseazol-3-yl)-1-piperidinyl] ethyl]-2-methyl - 6,7,8,9 tetrahydropyrido [1,-2-a] pyrimidine-4-one

Properties

i. It is a white slightly beige powder.
ii. It is practically insoluble in water, freely soluble in methylene chloride
iii. It is soluble in methanol and 0.1 NHCl.

Stability and Storage

It should be stored in a well-closed container at temperature not more than 25°C for not more than 7 days.

Uses

i. It is widely used in the treatment of mania and schizophrenia.
ii. It is used as antipsychotic.
iii. Risperidone is used to treat bipolar disorders or instability associated with acoustic disorder.
iv. It helps to decrease the negative (e.g. withdrawl, apathy) as well as the positive (e.g. delusions, hallucinations) symptoms of schizophrenia.

☞ Pharmaceutical Formulations:

i. Risperidone tablet
ii. Risperidone oral solution
iii. Risperidone injection

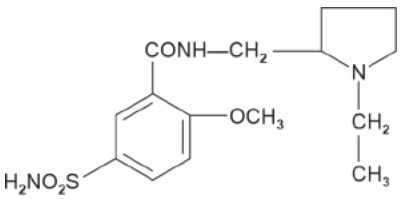
Brand Names

Riperdal, Respolept, Donforte, Risperdal M.

4. SULPIRIDE

It is a derivative of benzamides.

Structure:



Chemical Name:

RS-5-(Aminosulphonyl), N-[(1-ethyl, 2-pyrrolidinyl) methyl] 2-methoxy benzamide.

Properties

i. It is a white-yellowish crystalline, solid powder with lemon odour.
ii. It is sightly soluble in water.
iii. It is soluble in ethanol and 0.1 NHCl.

Stability and Storage

It should be stored in tightly closed container in cool, dry and well ventilated place.

Uses

1. Used in the management of symptoms of schizophrenia.
2. As a antipsychotic/psychotropic and antiemetic.
3. Used in the treatment of dysthymia (depressive disorder).
4. It accelerate antidepressant response in patients with major depressive disorders.
5. Used in the treatment of panic disorders.

☞ Pharmaceutical Formulations:

i. Sulpiride tablets.
ii. Sulpiride oral solutions.
iii. Sulpiride injection.

Brand Names

Sulpiride, Aiglonyl, Dogmatil, Eglonyl, Espiride, Sulpor.

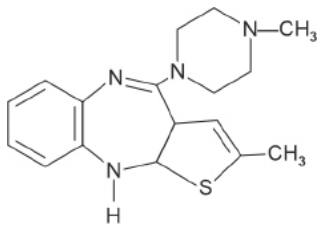
Dose

400 to 800 mg daily.

5. OLANZAPINE

It is a benzodiazepine derivative.

Structure:



Chemical Name:

2-methyl-4-(4-methyl-1-piperazinyl)-10-H-thieno [2,3-b], [1,5] benzodiazepine.

Properties

i. It is a yellow crystalline powder.
ii. It is practically insoluble in water.
iii. It is sparingly soluble in acetonitrile, ethyl acetate and soluble in chloroform

Stability and Storage

It should be stored in well closed container protected from light and moisture at room temperature.

Uses

1. Used as antipsychotic.
2. To treat the symptoms of schizophrenia.
3. Olanzapine rebalances dopamine and serotonin to improve thinking, mood and behaviour.
4. It is useful for the treatment of anxiety and depression.
5. It is added to mood stabilizers to enhance their antimanic efficacy.

☞ **Pharmaceutical Formulations:**

i. Olanzapine tablets.
ii. Olanzapine injection.

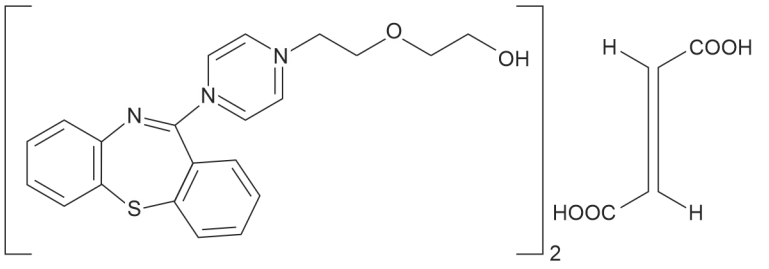
Brand Names

Cinol Plus, Dopin, Cypine, Oleanz, Zyprexa, Dopine-F.

6. QUETIAPINE FUMARATE

Quetiapine is a second-generation atypical antipsychotic used in schizophrenia, major depression, and bipolar disorder. Quetiapine demonstrates a high level of therapeutic efficacy and low risk of adverse effects during long-term treatment. It is well-tolerated and a suitable option for some patients with high sensitivity to other drug.

Structure:



Chemical Name:

2-[2-(4-dibenzo (b,f) [1,4] thiazepin-11-yl-1-piperazinyl) ethoxy]-ethanol furmarate.

Properties

i. It is white to off-white powder.
ii. It is odourless.
iii. It is slightly soluble in ethanol, very slightly soluble in acetone, water and insoluble in acids.

Stability and Storage

It should be kept in well-closed container and well-ventilated placed at room temperature.

Uses:

1. It is used to treat certain mental/mood disorders such as schizophrenia, bipolar disorder, sudden episodes of mania or depression.
2. To treat depression that can help to prevent suicidal thoughts/attempts and provide other important benefit.
3. It is used as psychotropic/antipsychotic agent.

☞ **Pharmaceutical Formulations:**

- Quetiapine tablet.
- Quetiapine pills.

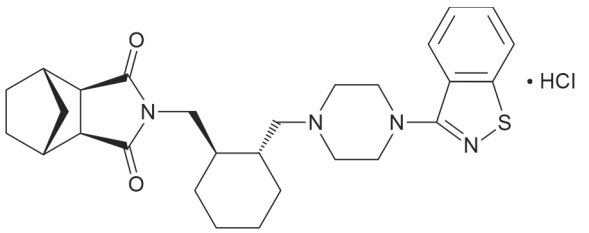
Brand Names

Seroquel, Q-Pin, Pincalm, Adequet, Placidin, Queviz-100.

7. LURASIDONE

It is a 1,2-benzisothiazole derivative.

Structure:



Chemical Name:

(3aR, 4S, 7R, 7aS)-2-{(1R,2R)-2-[4-1,2-benzisothiazol-3-yl] piperaz-in-1-y1-methyl cyclohexy methyl} hexahydro-4,7-methano-2H-isoin-dole-1,3-dione hydrochloride.

Properties

i. It is a white to off-white powder.
ii. It is odourless.
iii. It is sparingly soluble in methanol, slightly soluble in ethanol.
iv. It is very slightly soluble in acetone, water and practically insoluble in 0.1NHCl and toluene.

Stability and Storage

It should stored in a tightly closed container in a dry and well ventilated place at a temperature 25°C.

Uses

1. Lurasidone is used to treat psychic disorders (as antipsychotic)
2. It is used to treat the symptoms of schizophrenia (a mental illness that causes disturbed or unusual thinking loss of interest in life) in adults and children 13 years of age and older.
3. It may also help to decrease hallucinations.
4. Lurasidone rebalances, dopamine and serotonin to improve thinking mood and behaviour.
5. It is also used to treat bipolar disorders.

☞ Pharmaceutical Formulations:

1. Lurasidone tablet.
2. Lurasidone injection

Brand Names

Latuda, Luratrend, Atlura, Tablura.

Dose

40 mg once daily.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Schizophrenia** is a psychiatric disorder.
2. Chlorpromazine is a derivative of **phenothiazine**.
3. Risperidone is a member of the class **pyridopyrimidine**.

4. **Quetiapine** is a second generation a typical anti-psychotic used in schizophrenia.
5. Neuroleptics also known as **antipsychotics**.
6. **Chlorpromazine** is popularly called as "Largactil".
7. Antipsychotic drugs block the receptor in brain is **dopamine D_2 receptor**.
8. **Risperidone** is an example of atypical antipsychotic drug.
9. Haloperidol is an antipsychotic drug which is **butyrophenone derivative**.
10. **Psychosis** means a mental condition characterised by disturbances in mental functions.

Chapter
5

Anticonvulsants/ Antiepileptics

1 What is epilepsy? Explain various types of epilepsy.

☞ **Epilepsy/Seizures:**

It is a chronic convulsive disorder characterised by sudden disturbance of consciousness usually but not always with characteristic body movements and sometimes with autonomic hyperactivity.

- The term epilepsy is derived from the Greek word "Epilabanein" which means to seize (i.e. to take sudden possession).
- Epilepsy is the most common neurological disorders characterized by paroxysmal cerebral dysrhythmia.
- Seizures are symptoms of disturbed electrical activity in the brain characterized by episodes of abnormal, excessive and synchronus discharge of a group of neurons within the brain that causes involuntary movement, sensation or thought.

☞ **Types of Epilepsy**

1. **Grand mal epilepsy:** It involves a sudden loss of consciousness and major convulsions consisting of spasms of the whole body followed by jerky movements. Convulsions are followed by generalised CNS depression.
2. **Temporal lobe epilepsy:** It consists of sudden attacks of altered behaviour and emotions. Convulsions are absent
   The entire attack consists of abnormalities of behaviour.
3. **Focal cortical epilepsy:** It consists of convulsions of single limb or a group of muscles.
4. **Minor epilepsy:** It consists of loss of consciousness without convulsions.
5. **Petit mal epilepsy:** It consists of impairment of consciousness associated with eyelid blinking (insensitivity of light).
6. **Myoclonic epilepsy:** It consists of isolated clonic jerks.

7. **Infantile epilepsy:** It occurs in infants and consists of mental deterioration.
8. **Motor epilepsy:** It involves involuntary movements of thumb, angles of mouth, movements of half side of the body may be affected like paralysis.

2 Define and classify antiepileptics/anticonvulsants with suitable examples. (S.23)

The drugs which are used in the treatment of various types of epilepsy are called antiepileptics/anticonvulsants.

☞ **Classification**

- Hydantoin derivative, e.g. phenytoin, ethoin, methoin.
- Barbiturates, e.g. phenobarbitone, mephobarbitone.
- Benzodiazepine, e.g. diazepam, nitrazepam.
- Iminostilbene/Dibenzazepine derivative, e.g. carbamazepine.
- Carboxylic acid derivative, e.g. sodium valproate (valproic acid).
- Succinimides, e.g. ethosuximide, phensuximide.
- Oxazolidine dione derivative, e.g. paramethadione.
- Deoxy barbiturates, e.g. primidone
- Phenyltriazine, e.g. lamotrigine
- Cyclic GABA analogue, e.g. gabapentin.
- Newer drugs: Vigabatrin, topiramate, zonisamide, tiagabine.

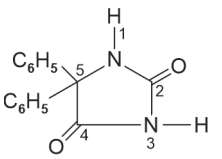
3 What is hydantoin? Name any three drugs which belong to hydantoin. Explain any one.

Hydantoin is imidazolidine 2,4-dione. For example, phenytoin, ethoin, methoin.

☞ **PHENYTOIN (W.22)**

It is a hydantoin (i.e. imidazolidine 2,4-dione) derivative.

Structure:



Chemical Name:

5,5-diphenyl imidazolidine 2,4-dione or 5,5-diphenyl hydantoin

Properties

- It is a white crystalline powder and is odourless.
- It is very slightly soluble in water.
- It is slightly hygroscopic.

Stability and Storage

It should be stored in a tightly closed container.

Uses

- It is used as an antiepileptic.
- It is used to control status epilepticus.
- It is used as an antiarrhythmic agent.
- It is used in the treatment of migraine.
- It is used in the treatment of myotonia.
- It is used to treat trigeminal neuralgia.

☞ **Pharmaceutical Formulations:**

- Phenytoin tablet.
- Phenytoin capsules.
- Phenytoin injections.
- Phenytoin oral suspension.
- Phenytoin and phenobarbitone tablets.

Brand Names

Eptoin, Epileptin, Garoin, Epanutin, Phenytek.

Dose

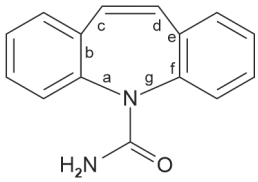
0–15 mg/kg or 15–20 mg/kg at 25–50 mg/min.

4 Give the structure, chemical name, properties, stability and storage, uses, formulation, brand names of following anticonvulsant drugs. (a) Carbamazepine, (b) Clonazepine, (c) Valproic acid (d) Gabapentin, (e) Topiramate, (f) Vigabatrin, (g) Lamotrigine.

☞ **(a) Carbamazepine**

It is a dibenzazepine derivative.

Structure:



Chemical Name:

5H-dibenz [b,f] azepine-5-Carboxamide.

Properties

- It occurs as a white or yellowish white crystalline powder.
- It is odourless with slightly bitter taste.
- It is practically insoluble in water and soluble in alcohol, chloroform and acetone.

Storage

It should be stored in a well tightly closed container and protected from light.

☞ Pharmaceutical Formulations:

1. Carbamazepine tablet IP, BP.
2. Carbamazepine injection
3. Carbamazepine suppositories

Brand Names

Tegretol, Epitol, Tegretol XR.

(b) Clonazepam

It is a dibenzazepine derivative.

Properties

(i) It is off-white to light yellow crystalline powder.
(ii) It has faint odour.
(iii) It is insoluble in benzene.
(iv) It is slightly soluble in acetone, methanol, and chloroform.

Stability and Storage

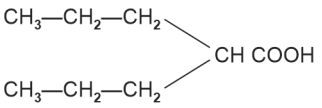
It is kept in tightly closed container in a dry and well-ventilated place, in light-resistant containers at 25°.

Uses

1. It is used as an anticonvulsant/antiepileptic.
2. It is used to control seizures or fits due to epilepsy, involuntary muscle spasms, panic disorders and sometimes restless legs syndrome.

(c) Valproic Acid

Structure:



Chemical Name:

2-propyl pentanoic acid

Properties

i. It is hygroscopic in nature.
ii. It is clear colourless liquid with characteristic odour.
iii. It is freely soluble in 1N sodium hydroxide, methanol, alcohol, acetone, chloroform, benzene, ether and slight soluble in 0.1N hydrochloric acid.

Stability and Storage

It should be stored in tightly closed container and stored between the temperature range of 15°C and 30°C.

Uses

i. It is used as an anticonvulsant.
ii. It is used to treat bipolor disorder.
iii. It is used to prevent migraine headache and to treat epilepsy.
iv. It works by restoring the balances of neurotransmitters in the brain.

☞ Pharmaceutical Formulations:

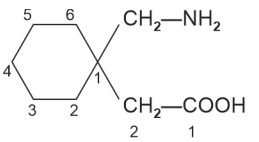
i. Valproic acid tablet
ii. Valproic acid injection
iii. Valproic acid syrup

Brand Names

Depacan, Epilim, Stavzor, Depakene.

(d) Gabapentin

Structure:



Chemical Name: 2-(1-(aminomethyl) cyclohexyl) acetic acid

Properties

i. It is a white to off-white crystalline solid crystals.
ii. It has bitter taste.
iii. It is freely soluble in water, alkaline and acidic solutions.

Stability and Storage

It should be kept in tightly closed container in dry and well-ventilated place in two temperature ranges between 15°C and 30°C. Oral solution must be refrigerated at 2–8°C.

☞ **Pharmaceutical Formulations:**

i. Gabapentin tablet.
ii. Gabapentin oral solution.
iii. Gabapentin capsule
iv. Gabapentin injection

Brand Names

Gabarone, Neurontin, Fanatrex, FusePaq, Gralise.

Dose

Maximum dose is 2400–3600 mg/day, in divided doses.

(e) Topiramate

It is a carbonic anhydrase inhibitor.

Properties

i. It is a white crystalline powder.
ii. It has a bitter taste.
iii. It is soluble in most alkaline solutions containing sodium hydroxide and having pH 9–10.
iv. It is freely soluble in acetone, chloroform, ethanol.

Stability and Storage

It should be stored in tight, light-resistant container. It should be stored at controlled room temperature or in a refrigerator.

Uses

i. It is used to treat epilepsy.
ii. It is used to treat migraine headache.
iii. It is used to treat generalized or focal seizures.

☞ **Pharmaceutical Formulations:**

i. Topiramate tablet
ii. Topiramate injection
iii. Topiramate oral suspension

Brand Names

Topamax, Trokendi XR, Qudexy XR.

(f) Vigabatrin

It is a structural anologue of GABA.
It works by inhibiting the breakdown of γ-aminobutyric acid.
It is also known as γ-vinyl-GABA.

Properties

i. It is a white to off-white powder.
ii. It is freely soluble in water.
iii. It is slightly soluble in methanol, alcohol.
iv. It is very slightly soluble in ethyl alcohol and chloroform.
v. It is insoluble in toluene and hexane.

Stability and Storage

It should be stored in amber coloured glass and PET bottles which are stored under three different conditions is at room temperature (15–30°C), under refrigeration (2–8°C) and oven (40°C).

Uses

i. It is used to treat epilepsy.
ii. It controls infantile spasms.
iii. As anticonvulsant.
iv. In combination with other medications it is used to treat complex partial seizures in adults.

☞ **Pharmaceutical Formulations:**

i. Vigabatrin tablet.
ii. Vigabatrin syrup

Brand Names

Sabril, Vigadrone.

(g) Lamotrigine

It is a synthetic phenyltriazine.

Properties

i. It is a white to pale cream coloured powder.
ii. It is very slightly soluble in water
iii. It is slightly soluble in 0.1 M HCl.

Stability and Storage

It should be kept in tightly closed container in dry and well-ventilated place.

Uses

i. It is used to treat epilepsy.
ii. It is used to prevent recurrence of depressive episodes in bipolar disorders.
iii. It is used to treat anxiety, depression, migraine.

☞ **Pharmaceutical Formulations:**

i. Lamotrigine tablet.
ii. Lamotrigine oral suspension.

Brand Names

Lamictal, Lamictal XR, Subvenite, Lamictal CD.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Focal cortical epilepsy** consists of convulsions of single limb or group of muscles.
2. 5, 5-diphenyl hydantoin is a chemical name of **phenytoin**.
3. The drug used to treat epilepsy is known as **anticonvulsants**.
4. Carbamazepine drug is used to treat **convulsions**.
5. Diazepam is used as **muscle relaxant**.
6. Valproic acid is used as **anticonvulsant**.
7. **Eptoin** is brand name of phenytoin.
8. Carbamzepine is a **dibenzazepine derivative**.
9. Valproic acid is used as **antiepileptic**.
10. Vigabatrin and lamotrigine are used as **anticonvulsants**.

Chapter
6

Antidepressants

1 What is depression? Name the drugs used in the treatment of depression?

☞ **Depression:**

Depression is a mental illness characterized by pathological changes in mood.

- Depression is a sadness, though possibly intense, it is usually of short duration.
- **Symptoms of Depression:**
  i. Fatigue.
  ii. Headache
  iii. Insomnia
  iv. GIT disturbances
  v. Anorexia
  vi. Skeletomuscular complaints
  vii. Loss of sexual desire.
- **Drugs used in treatment of depression are:**
  Antidepressants/mood elevators/Thymoleptics
  For example: Imipramine, amitriptyline, doxepin fluoxetine, duloxetine, sertraline, citalopram, fluvoxamine, paroxetine, phenelzine, tranylcypromine, dibenzepin.

2 Define and classify antidepressants (mood elevators/ thymoleptics) with examples. (S.24)

☞ **Antidepressants:**

The drugs which counteract or overcome the mental depression are called antidepressants.

- The drugs which elevate/improve the mood of depressed individuals are called antidepressants.

- The drugs which are used in the treatment of depression are called antidepressants.

☞ **Classification of Antidepressants:**

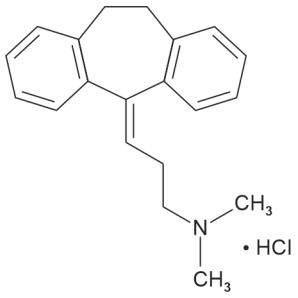
1. **Tricyclic Antidepressants:**
   For example: Imipramine, desipramine, doxepin, Amitriptyline, nor-triptyline.
2. **Mono-Amino-Oxidase Inhibitors (MAOIs):**
   For example: Phenelzine, tranylcypromine, isocarboxazid, moclobemide.
3. **Selective Serotonin Reuptake Inhibitors (SSRIs):**
   For example: Fluoxetine, sertraline, citalopram, escitalopram.
4. **Dopamine and Norepinephrine Reuptake Inhibitors (DNRIs):**
   For example: Bupropion.
5. **Mood Stabilizers:**
   For example: Lithium Carbonate.
6. **Miscellaneous:**
   (a) β-adrenorecepter agonist, e.g. salbutamol.
   (b) Thyrotropin releasing hormone (TRH)

3 Give the structure, chemical names, properties, stability and storage, uses, pharmaceutical formulations, brand names of following antidepressants. (a) Amitriptyline (b) Imipramine (c) Fluoxetine.

☞ **(a) Amitriptyline**

It is a tricyclic antidepressant.

Structure:



Chemical Name:

N, N-dimethyl-3-(2-tricyclo [9.4.0.0$^{3.8}$] pentadeca-1 (15), 3, 5, 7, 11, 13-hexaenylidene) propan-1-amine; hydrochloride.

Properties

i. It is a white or off-white solid, brownish crystal.
ii. It is slightly basic in nature.
iii. It is freely soluble in water and alcohol.
iv. It is insoluble in other organic solvents.

Stability and Storage

It should be kept in a tightly closed container in a dry and well-ventilated place temperature 2°–8°C and keep in a dry place.

Uses

- It is used as antidepressant.
- It is used to treat nerve pain, backpain.
- It has sedative property.
- It is also used as anticholinergic.
- It is used to treat:
  i. Endogenous depression.
  ii. Anxiety.
  iii. Nocturnal enuresis (bed wetting in children)
  iv. In migraine pain.

Pharmaceutical Formulations:

i. Amitriptyline tablet.
ii. Amitriptyline injection.
iii. Amitriptyline and perphenazine capsules.
iv. Amitriptyline oral suspension.

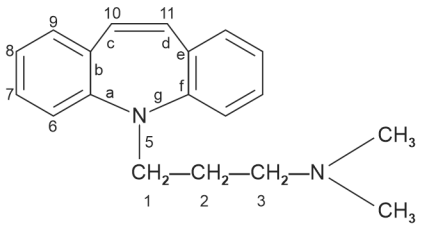
Brand Names

Tryptanol, Amiline, Quietal, Amitone, Amitor, Eliwel.

(b) Imipramine

It is a tricyclic antidepressant and is a dibenzazepine derivative.

Structure:



Chemical Name:

10,11 dihydro, 5 (3-dimethyl amino propyl) 5[H] dibenz (b, f) azepine.

Properties

- It is a white or slightly yellow crystalline powder.
- It is odourless and has bitter taste.
- It is freely soluble in water.
- It is less soluble in alcohol, sparingly soluble in a acetone.

Stability and Storage

It is affected by moist, air and light. Hence, it is stored in tightly closed light-resistant containers.

Uses

- It is used to treat chronic depression.
- It is used to treat anxiety disorders.
- It is used to treat pains due to its analgesic property.
- It is used to treat hyperactivity and disturbed attention.
- It is used to treat allergic conjunctivitis.
- To treat enuresis (bed wetting in children)

Preparations

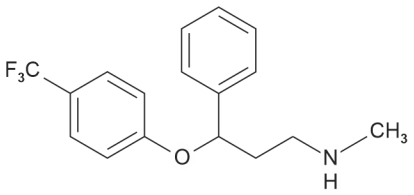
- Imipramine tablet.
- Imipramine injection.
- Imipramine mixture.
- Imipramine capsule.

Brand Names

Antidep, Depranil, Depsonil, Impratab.

(c) Fluoxetine

Structure:



Chemical Name:

N-methyl-3-phenyl-3-[4-(trifluoromethyl) phenoxy] propan-1-amine

Properties

i. It is a white to off-white crystalline solid powder.
ii. It is soluble in methanol, ethanol.
iii. It is partially soluble in acetone, chloroform, sparingly soluble in dichloromethane.
iv. It is insoluble in ethyl acetate, toluene, cyclohexane and hexane.

Stability and Storage

It should be stored in tight, light-resistant container at 15°–30°C.

Uses

i. It is used as antidepressant.
ii. It is used to treat obsessive-compulsive disorder and bulimia nervosa (eating disorder).
iii. Fluoxetine helps many people recover from depression and it has fewer unwanted effects than older anti-depressants.

Pharmaceutical Formulations:

i. Fluoxetine tablet.
ii. Fluoxetine capsule.
iii. Fluoxetine oral solution.

Brand Names

Flunil, Dawnex, F-Tin, Prodep, Prozac.

4 Write a note on following antidepressant drugs.

☞ (a) Venlafaxine:

Physical Properties:

i. It is a white or off-white crystalline solid.
ii. It is soluble in water and methanol.

Stability and Storage

It should be stored at controlled room temperature of 20–50°C.

Uses

i. Venlafaxine is used to treat depression.
ii. It may improve the mood and energy level and may help to restore the interest of the individual in daily living.
iii. Venlafaxine is known as a serotonin-norepinephrine reuptake inhibitor.
iv. It is also used to treat anxiety and panic attacks.

Pharmaceutical Formulations:

i. Venlafaxine tablet.
ii. Venlafaxine capsule.
iii. Venlafaxine injection

Brand Names

Envelaf-XR, Venlor, Ventab, Sentosa, Flavix, Effexar, Venlift.

(b) Duloxetine:

Properties:

i. It is a white to slightly brown colour solid crystals.
ii. It is acid labile, soluble in water, and methanol.
iii. It is insoluble in other neutral organic solvents.

Stability and Storage

It should be stored in a tightly closed container in a dry and well ventilated place.

Pharmaceutical Formulations:

i. Duloxetine tablet.
ii. Duloxetine capsule.
iii. Duloxetine injection.

Brand Names

Cymbalta, Cambac, Dulane, Irenka, Delok, Ambidext.

(c) Sertraline:

Properties:

i. It is a white solid crystal or powder.
ii. It is soluble in water and slightly soluble in isopropyl alcohol.

Stability and Storage

It should be stored in a tightly closed container at room temperature.

Uses

i. It is used as antidepressant.
ii. It is used to control panic attacks.
iii. It is used to treat obsessive-compulsive disorder (OCD).
iv. Is is used to treat post-traumatic stress disorder (PTSD).

Pharmaceutical Formulations:

i. Sertraline Tablet.
ii. Sertraline oral concentrate.

Brand Names

Serdep, Inosert, Serlift, Sertima, Asert, B-Sert, Censir, Atline, Aderta.

(d) Citalopram:

Properties:

i. It is a solid, fine white to off-white crystals with fart odour.
ii. It is freely soluble in water, ethanol, chloroform.
iii. Citalopram, when heated to decomposition, it emits very toxic fumes of nitrogen oxides, hydrogen fluoride and hydrogen bromides.

Stability and Storage

It should be stored in a well-closed container in a dry and well-ventilated place.

Uses

i. Citalopram is used as antidepressant drug.
ii. It is also used to control panic attacks.
iii. It is a selective serotonin reuptake inhibitor.

Pharmaceutical Formulations:

i. Citalopram tablet.
ii. Citalopram capsule.
iii. Citalopram injection

Brand Names

C-Talo, Celica, Citadep, Akarin, Celepra, Celexa, C-Pram.

(e) Escitalopram:

Properties:

i. It is a fine white to slightly yellow powder.
ii. It is freely soluble in methanol and dimethylsulfoxide (DMSO).
iii. It is soluble in isotonic saline solution.
iv. It is sparingly soluble in water and ethanol.
v. It is slightly soluble in ethylacetate and insoluble in heptane.

Stability and Storage

It should be stored in a well closed container at room temperature, and kept away from heat, moisture and direct light.

Uses

i. It is used as antidepressant.
ii. It is used for treatment of anxiety.
iii. It is used to treat obsessive-compulsive disorder or panic attacks.

Pharmaceutical Formulations:

Escitalopram tablet.

Brand Names

Stalopam, S-Citadep, Szetalo, Nexito.

(f) Fluvoxamine:

Properties:

i. It is a solid, fine white-yellowish, odourless crystals.
ii. It is sparingly soluble in water.
iii. It is freely soluble in ethanol and chloroform.
iv. It is practically insoluble in diethyl ether.

Stability and Storage

It should be stored in a tightly closed container protected from high humidity and stored at 20–25°C.

Pharmaceutical Formulations:

(i) Fluvoxamine tablet.
(ii) Fluvoxamine capsule.

Brand Names

Fluvoxin-CR, Fluvator, Uvox, Voxamin, Frext.

(g) Paroxetine:

Properties:

(i) It is a off-white powder.
(ii) It is a odourless.
(iii) It has an inherently bitter taste.
(iv) It is having a melting point range of 120–138°C.

Stability and Storage

It should be stored in a well-closed container at room temperature from 15° to 30°C.

Pharmaceutical Formulations:

(i) Paroxetine tablet.
(ii) Paroxetine capsule.

Brand Names

Paxil-CR, Pexeva, Brisdelle.

Uses

Antidepressant

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Depression** is a mental illness characterized by pathological changes in mood.
2. Imipramine and amitriptyline are **mood elevators**.
3. MAOIs stands for **monoamine-oxidase inhibitors**.
4. Venlafaxine, duloxetine, citalopram, escitalopram are the drugs used in the treatment of **depression**.
5. For the treatment of mania and depression **antidepressants** are used.
6. Carbamazepine is a tricyclic antidepressant. It is classified as **Iminostilbenes**.
7. **Imipramine** is an antidepressant drug used to treat allergic conjunctivitis.
8. Antidepressant is also called as **mood elevators**.
9. **Antidep** is a popular brand name of imipramine.
10. **Citalopram** is a selective serotonin reuptake inhibitor.

Chapter
7

Drugs Acting on Autonomic Nervous System

A Sympathomimetics/Adrenergic Agents

B Anti-adrenergics/Sympatholytics/ Adrenergic Antagonists

C Parasympathomimetics/Cholinergics Drugs

D Cholinergic Blocking Agents/ Anticholinergics/Parasympatholytics

Introduction to ANS:

- ANS means autonomic nervous system.
- ANS controls the activities of involuntary/internal organs of the body like heart, blood bessels, bronchioles, smooth muscles, etc.
- ANS consists of two divisions: (a) Sympathetic nervous system (SNS) and (b) parasympathetic nervous system (PSNS).

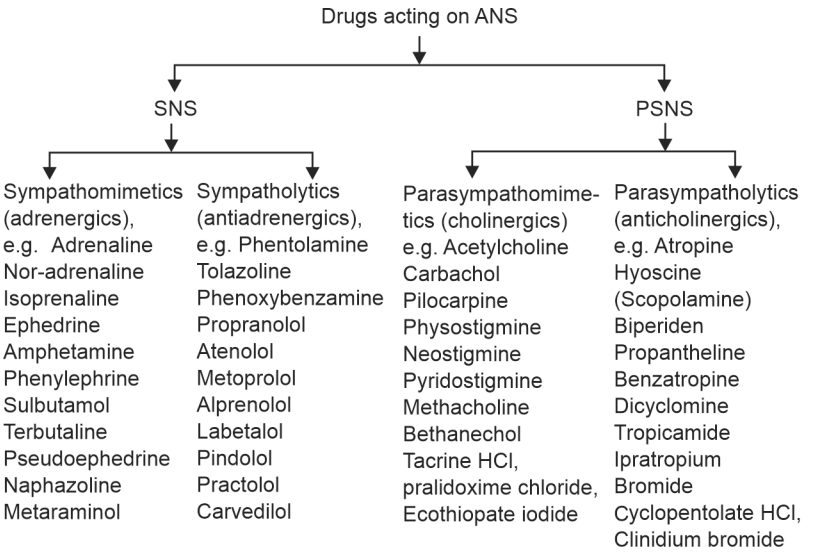
(a) Sympathetic Nervous System (SNS):

i. It enhances heart rate and force of contraction and dilates the bronchi.
ii. It helps to release the stored energy.
iii. It shows down the digestion and urination activities

(b) Parasympathetic Nervous System (PSNS):

i. It conserves and restores the energy from the processed food which is used to build tissues.
ii. It slows the heart rate and decreases blood pressure.

- **Neurotransmitters/chemical transmitters:**
  i. Acetylcholine is a chemical transmitter of PSNS.
  ii. Adrenaline is a chemical transmitter of SNS.
- **Classification of the drugs acting on ANS:**



A
Sympathomimetics/ Adrenergic Agents

1 Define and classify sympathomimetics with examples. (S.22, 23, W.22)

☞ **Sympathomimetics**

"The drugs which produce actions similar to stimulation of sympathetic nerve stimulation are called sympathomimetics or adrenergics."

Classification of Adrenergics:

(A) Classification on chemical basis

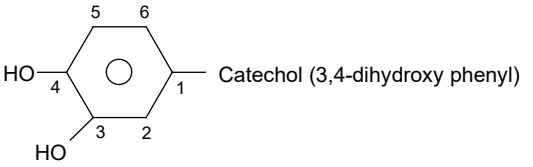
- Catecholamines, e.g. adrenaline, nor-adrenaline, isoprenaline.
- Noncatecholamine, e.g. amphetamine, ephedrine, phenylephrine pseudoephedrine, terbutaline.
- Imidazolidine derivative, e.g. naphazoline.

(B) Classification on the Basis of Mechanism of Action:

1. **Direct Acting Drugs:**
   For example: Norepinephrine (noradrenaline), epinephrine (adrenaline), dopamine, methyldopa, clonidine, dobutamine, isoproterenol, terbutaline, salbutamol, bitolterol, naphazoline, oxymetazoline, xylometazoline.
2. **Indirect Acting Drugs:**
   For example: Hydroxyamphetamine, pseudoephedrine, propyl-hexedrine,
3. **Agents with mixed mechanism:**
   For example: Ephedrine, metaraminol.

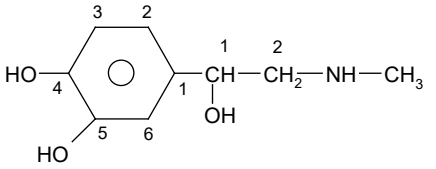
2 What are catecholamines? Name any two catecholamines and describe them along with structures.

Catecholamines: The drugs which contain catechol nucleus with alkylamine are called catecholamines, e.g. adrenaline, nor-adrenaline, isoprenaline.



(1) Adrenaline/Epinephrine

Structure



Chemical Name

1(3,4-dihydroxyphenyl) 2-methyl amino ethanol

Properties

- It is white or creamy white microcrystalline powder.
- It is odourless and bitter in taste.
- It is very slightly soluble in water but practically insoluble in alcohol.
- It is levorotatory.

Stability and Storage

It darkens on exposure to light and air. Hence, it is stored in tightly closed light-resistant container.

Uses

It is used:

- In the treatment of bronchial asthma.
- To treat heart block.
- To treat acute allergic conditions.
- To control superficial haemorrhage of nose and throat.
- With local anaesthetic to prolong local anaesthetic effect.
- Used to treat open angle glaucoma.

Pharmaceutical formulations

- Adrenaline tartrate injection.
- Adrenaline eyedrops/solutions.
- Adrenaline and atropine spray.
- Zinc sulphate and adrenaline eyedrops BP.
- Adrenaline bitartrate IP.

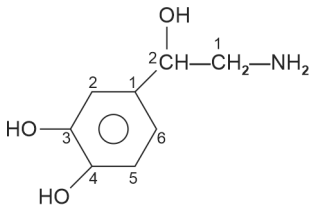
Brand Names

Adrenar, Nordrin, Medicreme, Epipen, Epinal, Epifrin, Rephon.

(2) Norepinephrine (Nonadrenaline):

It is a naturally accuring catecholamine

Structure:



Chemical Name:

L-1(3,4 dihydroxy pheny) 2-amino ethanol.
OR
4-(2 amino-1-hydroxy methyl) benzene-1, 2-diol.

Properties:

- It is a white or creamy white microcrystalline powder.
- It is odourless and bitter in taste.
- It is very slightly soluble in water but practically insoluble in alcohol.
- It is levorotatory.

Stability and storage:

It darknes an exposure to light air. Hence, it should be stored in tightly closed light-resistant containers.

Uses:

It is used.

1. To treat heart block (cardiac arrest).
2. To control superficial haemorrhage of nose and throat.
3. With local anaesthetics, to prolong local anaesthetic effect.
4. Used in peripheral vascular collapse.
5. To maintain blood pressure in acute hypotensive states.
6. Used during CPR.

Pharmaceutical formulations:

- Norepinephrine injection.
- Sterile strong norepinephrine solution.

Brand Names:

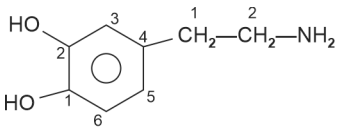
Levophed, Levarterenol.

3 Draw the structure and give chemical name, properties, stability, storage, uses, pharmaceutical formulations, brand names of following adrenergic drugs: (a) Dopamine, (b) Naphazoline.

☞ **(a) Dopamine:**

- Dopamine is a naturally occurring catecholamine formed by decarboxylation of dihydroxy phenylalanine and a precursor of norephinephrine and epinephrine.
- Dopamine is a monoamine compound with positive ionotropic activity.

Structure:



Chemical Name: 4-(2-aminoethyl) benzene-1, 2, diol.

Properties:

i. It is a white crystalline solid particles.
ii. It is freely soluble in water, methanol and hot 95% ethanol.
iii. It is practically insoluble in ether, petroleum ether, chloroform, benzene and toluene.

Stability and storage:

Dopamine hydrochloride 0.5 mg/ml in isotonic glucose solution is stable when protected from light for 1 week at 25°C/60% relative humidity and for 3 months at 4°C/ambient humidity in Codan and Braun syringes.

Uses:

1. Dopamine is used to treat low blood pressure (hypotension)
2. It is used to treat low cardiac ouptut and improves blood flow to the kidneys.
3. Dopamine is frequently administered in the ICU to critically ill patients.
4. Dopamine is used to treat reduced perfusion of body organs due to shock, trauma and sepsis.
5. Dopamine is used as prophylaxis for the improvement of kidney and bowel perfusion.
6. Dopamine is a neurotransmitter that plays several important roles in the brain and body.

Pharmaceutical formulations:

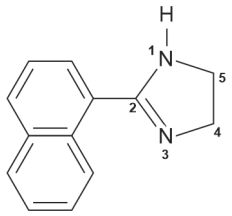
Dopamine hydrochloride injection USP.

Brand Names:

Komidop, Dopastat, Intropin, Revimine Dopacard, Dopinga.

(b) Naphazoline: (S.22)

Structure:



Chemical Name: 2-(naphthalene-1-yl)- 4, 5-dihydro-1 H-imidazole.

Properties:

i. It is a white crystalline powder.
ii. It is odourless with bitter in taste.
iii. It is hygroscopic in nature.
iv. It is freely soluble in water, soluble in ethanol.

Stability and storage:

It should be stored in dropper bottle upright at room temperature between 20°C and 25°C away from moisture and sunlight and do not store in moist place. Discard if drops become discoloured or cloudy and keep all medicines away form children.

Uses:

i. Naphazoline is used as ophthalmic decongestant.
ii. It is used for temporary relief of eye redness, puffiness, itching and watering that commonly occurs with allergies.
iii. It has a vasoconstrictor action.
iv. It works by narrowing of swollen blood vessels in the eyes to reduce eye redness.

Pharmaceutical formulations:

1. Naphazoline ointment.
2. Naphazoline eyedrops.
3. Naphazoline nasal drops.

Brand Names:

Napzol, N-zolin, N-cool, Naphcon, Privine, Ocucel. Mezol, E-Norm, Clearine.

4 Write a note on the following adrenergic drugs. (a) Phenylephrine, (b) Terbutaline, (c) Salbutamol (albuterol), (d) Tetrahydrozoline, (e) Hydroxy amphetamine, (f) Ephedrine, (g) Pseudoephedrine and (h) Metaraminol.

☞ **(a) Phenylephrine:**

Properties

- It is a white crystalline powder.
- It is odourless and has bitter taste.
- It is freely soluble in water.

Stability and Storage

It is stored in tightly closed light-resistant containers.

Uses

It is used:

- In bronchial asthma.
- In heart block, mydriatic.
- Locally in nasal congestion.
- To relieve nasal discomfort caused by colds, allergies and hay fever.
- To relieve sinus congestion and pressure.
- Topically to prevent symptoms of haemorrhoids.
- As a eyedrop to dialate the pupil.

Preparations

- Phenylephrine injection.
- Phenylephrine eyedrops.

Brand Name

Biomydrin, Deconasal CT, Histinextic, Neo-synephrine, Vicoryl, Codylex.

(b) Terbutaline:

Properties:

i. It is a white to gray-white crystalline powder.
ii. It has slightly bitter taste.
iii. It is soluble in water, slightly soluble in alcohol, methanol.
iv. It is practically insoluble in chloroform and ether.

Stability and storage:

It should be kept in a tightly closed container at room temperature and away from excess heat and moisture.

Uses:

i. It is used to treat bronchospasm in bronchial asthma and chronic bronchitis.
ii. In emergency, it is used to treat cardiotoxic shock states, heart block or severe bradycardia.
iii. Terbutaline is used to prevent and treat wheezing shortness of breath and chest tightness caused by asthma, chronic bronchitis and emphysema.
iv. It works by relaxing and opening the airways, making it easier to breathe.

Pharmaceutical formulations:

1. Terbutaline tablet.
2. Terbutaline syrup.
3. Terbutaline injection.
4. Terbutaline inhaler.

(c) Salbutamol (Albuterol)

Properties

- It is a white crystalline powder.
- It is odourless and tasteless.
- It is sparingly soluble in water.
- It gives reddish orange colour with $FeCl_3$ solution.
- It is insoluble in chloroform and ether.

Stability and Storage

It is light sensitive and hence it is stored in a well-closed light-resistant container.

Uses

It is used:

- In bronchial asthma.
- In heart block.
- In locally nasal congestion.
- In prevention of premature labour.
- In chronic bronchitis.
- In chronic bronchopulmonary disorders.
- To prevent coughing, wheezing and feeling breathless.

Preparations

- Salbutamol tablet.
- Salbutamol injection.

- Salbutamol aerosol.
- Salbutamol inhalation.
- Salbutamol syrup.
- Salbutamol inhaler.
- Salbutamol rotacap.

Brand Names

Asthalin, Ventolin, Salbetol, Asmanil, Aerotaz Disk, Bronkotab.

(d) Tetrahydrozoline:

Properties:

1. It is colourless, odourless and tastless crystalline powder.
2. It is very soluble in water and ethanol slightly soluble in chloroform and insoluble in diethyl ether.

Stability and storage:

The drops should generally be stored in a cool dry place.

Uses:

1. It is used to prevent redness in the eyes caused by minor eye irritations.
2. It works by temporarily narrowing the blood vessels in the eye.

Pharmaceutical formulations:

1. Tetrahydrozoline eye drops.
2. Tetrahydrozoline ear drops.

Brand Names:

Eyesine, Murine Tears Plus, Tyzine, Geneye.

(e) Hydroxyamphetamine:

Properties:

1. It is a white to yellowish crystalline solid and strongly basic compound.
2. It is more soluble in water.
3. It is slightly soluble in methanol.

Stability and storage:

It should be stored in well-closed container at room temperature and protected from light.

Uses:

1. In ophthalmics used for relaxation of eye muscles.
2. It dilates the pupils in an inflammatory condition or in postsurgery situations.

Pharmaceutical formulations:

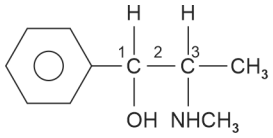
1. Hydroxyamphetamine eye drops.
2. Hydroxyamphetamine ointment.

Brand Names:

Paremyd, paredrine.

(f) Ephedrine

Ephedrine is an alkaloid obtained from the species of Ephedra.



2-methyl amino, 1-phenyl 1-propanol

Properties

- It is a white crystalline powder.
- It is odourless and has bitter taste.
- It is sparingly soluble in water.
- It is levorotatory.

Stability and Storage

It gradually decomposes on exposure to light. Hence it should be stored in tightly closed light-resistant container.

Uses

It is used:

- In bronchial asthma.
- In nocturnal enuresis.
- As a nasal decongestant.
- In the treatment of narcolepsy.
- As a bronchodialator.
- For temporary relief of shortness of breath, chest tightness and wheezing due to bronchial asthma.

Pharmaceutical formulations

- Ephedrine tablet.

- Ephedrine elixir.
- Ephedrine nasal drops.
- Ephedrine sulphate syrup.
- Ephedrine hydrochloride tablet BP.
- Ephedrine capsule.

Brand Name

Ephedrex, Akovaz, Corphedra.

(g) Pseudoephedrine:

Properties:

i. It is white, odourless crystals or powder with bitter in taste.
ii. It has a slight aromatic odour.
iii. It is acidic in nature.
iv. It is completely soluble in water, methanol and partially soluble in chloroform.

Stability and Storage

It should be stored at room temperature and kept away from moisture and heat. It should be kept in tightly closed container away from the reach of the children.

Uses:

1. It is used in the treatment of common cold, flu, etc.
2. It is used in breathing illnesses such as hay fever, allergies, bronchitis.
3. It is used to prevent ear pain and blockage caused by pressure changes during air travel or underwater diving.
4. It works by narrowing the blood vessels to decrease swelling and congestion.

Pharmaceutical formulations:

1. Pseudoephedrine tablet.
2. Pseudoephedrine capsule.
3. Pseudoephedrine syrup.
4. Pseudoephedrine cream.
5. Pseudoephedrine gel.
6. Pseudoephedrine ointment.
7. Pseudoephedrine injection.

Brand Names:

Sudafed, Tylenol, Advil, Aleve, Claritin, Mucinex, Alavert, Triaminic.

(h) Metaraminol:

Properties:

1. It is hygroscopic compound.
2. It is a white crystalline powder.
3. It is freely soluble in water.
4. It is slightly soluble in alcohol.
5. It is practically insoluble in chloroform and ether.

Stability and Storage

It should be stored in a container in carton until contents have been used and should be protected from light and freezing.

Uses:

1. It is used to prevent and treat acute hypotensive state occurring with spinal anaesthesia.
2. In treatment of hypotension caused due to haemorrhage, surgical complications and shock associated with brain damage due to trauma.
3. Metaraminol is the vasoconstrictor of choice for the short-term management of acute hypotension.

Pharmaceutical formulations:

Metaraminol injection.

Brand Names:

Aramine, Metaramin, Pressonex.

B

Anti-adrenergics/Sympatholytics/ Adrenergic Antagonists

1 Define and classify anti-adrenergics with suitable examples. (S.24)

The drugs which block the actions produced by stimulation of sympathetic nervous system are called sympatholytics or anti-adrenergics.

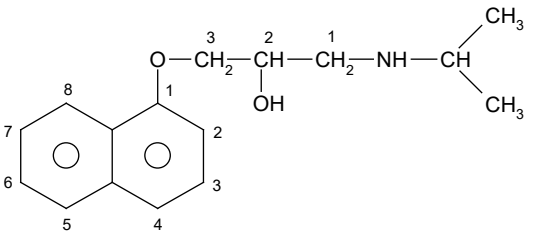
Classification

- α-adrenergic blockers (α-blockers), e.g. tolazoline, phentolamine, prazosin, phenoxybenzamine, ergotamine, ergotoxin.
- β-adrenergic blockers (β-blockers), e.g. propranolol, atenolol, labetalol, practolol, pindolol, metoprolol, carvedilol.
- Adrenergic neuron blockers, e.g. guanethidine.

2 Write a note on propranolol. (S.24, W.23)

☞ **Propranolol (β-blocker)**

Structure



Chemical Name

1-isopropyl amino, 3 (1-naphthyloxy) propan-2-ol

Properties

- It is a white powder.
- It is odourless and has bitter taste.
- It is soluble in water.

Stability and Storage

It is affected by light and hence it is stored in a well-closed light-resistant container.

Uses

It is used to treat:

- Cardiac arrhythmia.
- Angina pectoris.
- Arterial hypertension.
- Hyperthyroidism in children.
- Symptoms of anxiety.

Preparations

- Propranolol tablet.
- Propranolol injection.

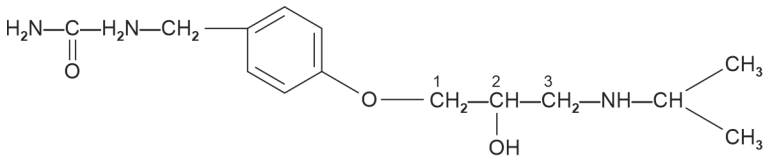
Brand Names

Inderal, Ciplar, Innopran XL, Hemangeol.

3 Write a note on Atenolol. (W.22)

☞ **Atenolol:**

Structure:



Chemical Name:

2-(4-[2 hydroxy-3-(isopropylamino) propoxy) phenyl] acetamide.

Properties:

i. It is a white crystalline powder.
ii. It is odourless and has slightly bitter taste.
iii. It is freely soluble in HCl and less soluble in chloroform.

Stability and Storage:

It is should be stored in a cool and dry place, keep away from light.

Uses:

1. It is used to treat hypertension and arrhythmia.
2. It is used in the treatment of angina pectoris.

3. It helps to prevent future heart disease, heat attacks and strokes.
4. It is used in the treatment of essential hypertension.

Pharmaceutical formulations:

1. Atenolol tablet.
2. Atenolol suspension.
3. Atenolol injection.

Brand Names: Aten, Betacard, Tenormin, Tenolol, Hipres.

4 Give the properties, stability, storage, uses, pharmaceutical formulations, Brand names of the following adrenergic antagonists. (a) Tolazoline, (b) Phentolamine, (c) Prazosin, (d) Carvedilol, (e) Phenoxy benzamine.

☞ (a) Tolazoline

Properties

- It is a white or creamy-white crystalline powder.
- It is odourless and has bitter taste.
- It is very slightly soluble in water.
- It is freely soluble in alcohol.

Stability

It is affected by light and hence it is stored in tightly closed lightresistant containers.

Uses

- It is used to treat peripheral vascular disorder.
- In Raynaud's disease.
- Used in persistent pulmonary hypertension of the newborn.
- It also stimulates gastric secretion.
- In treatment of iritis (eye drops).

Pharmaceutical formulations

- Tolazoline tablet BP.
- Tolazoline eye drops IP.

Brand Names:

Priscol, Tolazolin, Benzazoline, Vasimid, Vasodil, Priscoline.

(b) Phentolamine:

Properties:

1. It is a white crystalline powder with bitter taste.
2. It is soluble in water and alcohol.

3. It is sparingly soluble in chloroform.
4. It is practically insoluble in acetone and ethyl acetate

Stability and storage:

It should be stored under controlled room temperature of about 15°–30°C, in the refrigerator at 4°C and in the freezer at 20°C for 6 months.

Uses:

1. It is used in treatment of hypertension.
2. It is used in pheochromocytoma.
3. It is used to treat vasospasm of Raynaud's disease.
4. It is used to prevent hypertensive episodes that occur in patients with pheochromocytoma.
5. Used in combination with papaverine to treat impotence.

Pharmaceutical formulations:

1. Phentolamine injection.
2. Phentolamine tablet.
3. Phentolamine capsule.
4. Phantolamine syrup.
5. Phentolamine cream.
6. Phentolamine ointment.

Brand Names:

Rogitine, Fentanor, Fentosol.

(c) Prazosin

Properties:

i. It is a solid white or yellow crystalline powder.
ii. It has bitter taste.
iii. It is a derivative of piperazine.

Stability and storage:

It should be stored at room temperature, i.e. 15°–30°C and kept away from direct sunlight.

Uses:

i. Used in the treatment of hypertension.
ii. It produce peripheral vasodialation.
iii. It helps to prevent strokes, heart attack, and kidney problems.

Pharmaceutical formulations: Prazosin capsules.

Brand Names:

Prazocip, Minipress, Minizide, Cyber CR, Czopress XL.

(d) Carvedilol

Properties:

1. It occurs as a colourless solid crystals.
2. It has unpleasant taste and odour.
3. It is a hydrophobic compound.
4. It is freely soluble in dimethyl sulfoxide.
5. It is soluble in methylene chloride and methanol.
6. It is sparingly soluble 95% ethanol and isopropanol.
7. It is slightly soluble in ethyl ether, and practically insoluble in water.

Stability and storage:

It should be stored in well-closed container at 20°–25°C and kept in dry place.

Pharmaceutical formulations: Carvedilol tablet

Brand Names:

Caditone, Cadomos, Carloc, Cardivas, Carca, Cardinom.

(e) Phenoxybenzamine

Properties:

1. It is white crystalline compound.
2. It has bitter taste and slightly aromatic odour.
3. It is soluble in methanol, chloroform and insoluble in diethyl ether.

Stability and storage:

It should be stored in a room temperature of 20°–25°C.

Uses:

1. It is used to treat high blood pressure and heavy sweating due to certain tumour of adrenal glands (pheochromocytoma).
2. Phenoxybenzamine belongs to a class of drugs known as alpha blockers.
3. It works by relaxing and widening blood vessels so that blood can flow more easily.

Pharmaceutical formulations:

1. Phenoxybenzamine tablet.
2. Phenoxybenzamine capsule.
3. Phenoxybenzamine injection.

Brand Names:

Fenoxene, Dibenzylene, Fenoben.

C

Parasympathomimetics/ Cholinergic Drugs

1 Define and classify parasympathomimetics/cholinergics. (S.23)

☞ **Cholinergics**

The drugs which produce pharmacological actions similar to actions produced by stimulations of parasympathetic nervous system are called cholinergics/cholinomimetics.

The drugs which exert pharmacological actions like acetylcholine or drugs which brings about stimulation of cholinergic nerves are known as cholinergic drugs.

Classification of cholinergic drugs

(a) **Direct acting agents/cholinergic agonists:**

1. Ester of choline, e.g. acetylcholine, carbachol, bethanechol muscarine, pilocarpine.

(b) **Indirect acting agents/cholinesterase inhibitors:**

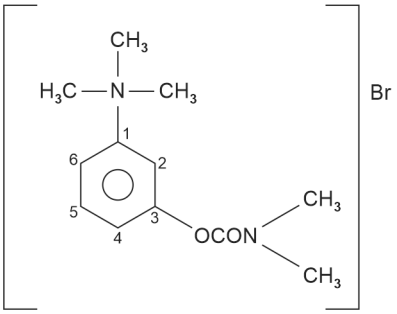
1. Reversible, e.g. physostigmine, neostigmine, pyridostigmine, edrophonium, tacrine hydrochloride.
2. Irreversible e.g. echothiophate iodide, parathion, malathion.

(c) **Cholinesterase reactivators**

e.g. Pralidoxime chloride.

2 Give the structure, chemical name, properties and uses of neostigmine.

☞ **Neostigmine**



3-(dimethyl carbamoyloxy) N,N,N-trimethyl anilinium bromide

Properties

- It is a white crystalline powder.
- It is odourless and has bitter taste.
- It is hygroscopic.
- It is soluble in water, alcohol and chloroform.

Stability and Storage

It is affected by light and atmospheric oxygen. Hence, it should be stored in tightly closed light-resistant containers.

Uses

- To treat myasthenia gravis.
- To treat paralytic ileus.
- To treat postoperative urinary retention.

Pharmaceutical formulations

- Neostigmine tablet BP, IP.
- Neostigmine injection BP, IP.

Brand Name

Prostigmine. Bloxiverz.

3 Give the structure, chemical name, properties, storage, uses, brand names, pharmaceutical formulations of acetylcholine. What do you mean by muscarinic and nicotinic actions of acetylcholine? (S.23)

☞ **Acetylcholine**

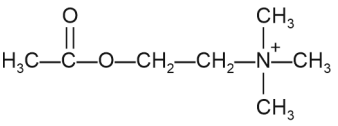
- Acetylcholine is an ester of choline with acetic acid.
- It has two actions.

(a) **Muscarinic actions:** These are produced by stimulation of muscarinic receptors, which are similar to mushroom alkaloid muscarine.
- Cardiac inhibition.
- Peripheral vasodilation.
- Constriction of pupil.
- Increase salivary secretion.
- Constriction of smooth muscles of GIT and urinary bladder.

(b) **Nicotinic actions:** These are produced by stimulation of nicotinic receptors which are similar to nicotine alkaloid from tobacco.
- Stimulation of skeletal muscle.

Acetylcholine

Structure:



Properties

1. It is a small, polar, hydrophillic compound with the deliquescent liquid.
2. It is soluble in ethanol.
3. It is insoluble in diethyl ether and chloroform.
4. It is a choline molecule that has been acetylated at the oxygen atom.

Stability and storage

Acetylcholine is hygroscopic in nature. Acetylcholine solution is stored at 25°C and is stable for about 28 days. At a temperature of 50°C, acetylcholine showed a rapid breakdown after 1 day.

Uses

1. It is used as miotic (during ophthalmic surgery).
2. Acetylcholine is a direct acting parasympathomimetic.
3. It is a naturally occurring neurohormone that helps to transmit nerve impulses at all cholinergic sites including somatic and autonomic nerves.
4. Acetylcholine is used to give signal to muscle movement.
5. It is intended for intraocular use.
6. It contracts the smooth muscles, dilates the blood vessels, increases bodily secretions and slows heart rate.

Pharmaceutical formulations

1. Acetylcholine eye drops.
2. Acetylcholine powder for injection.
3. Acetylcholine gel.
4. Acetylcholine syrup.
5. Acetylcholine lozenges.
6. Acetylcholine strips.

Brand Names

Miochol E, N-Acetylcysteine, Mucomyst.

4 Write a note on following cholinergic drugs: (a) Carbachol, (b) Pilocarpine, (c) Edrophonium, (d) Tacrine hydrochloride, (e) Pralidoxime chloride, (f) Echothiophate iodide.

☞ (a) Carbachol

Properties

1. It occurs as a prismatic crystal of an ammonium salt and carbamate ester.
2. It is soluble in ethanol, methanol, and dimethyl sulfoxide (DMSO).
3. It is insoluble in acetone, chloroform and ether.
4. It is a quaternary ammonium chloride and shows the muscarinic and nicotinic actions.

Stability and storage

It should be stored in a refrigeration at a temperature of 4°C. The stock solutions are stable for up to 6 months at 4°C.

Uses

1. It is a cholinergic agent.
2. It induces miosis.
3. Used in treatment of glaucoma.
4. Carbachol is also used to stimulate micturition.

Pharmaceutical formulations

1. Carbachol ophthalmic solutions/drops.
2. Carbachol ointments.

Brand Names

Carbastat, Carboptic, Miostat, Isopto.

(b) Pilocarpine

It is an alkaloid obtained from dried leaves of pilocarpus species.

Properties

- It occurs as colourless crystals or white crystalline particles.
- It is odourless and has faintly bitter taste.
- It is hygroscopic.
- It is very soluble in water.

Stability and Storage

It is hygroscopic and affected by light; hence it is stored in tightly closed light-resistant containers.

Uses

It is used:

- As a miotic.
- To reduce intraocular pressure in glaucoma.
- For accommodation of near vision of eye.
- To counteract anticholinergic side effects.

Pharmaceutical formulations

- Pilocarpine eye drops BP.
- Pilocarpine HCl BP.
- Pilocarpine tablet.
- Pilocarpine ointment.

Trade Name

Pilocar, Opthocarpine, Salagen.

(c) Edrophonium chloride

Properties

i. It is a crystalline solid.
ii. It is bitter in taste.
iii. It is fully soluble in water and alcohol.
iv. It has rapid onset of action.

Stability and storage

It should be stored at controlled room temperature of range 15°–30°C.

Uses

1. Used as an antidote for over dose of d-tubocurarine.
2. It is a specific anti-curare agent.
3. It stimulates sketetal muscles.
4. It brings about rapid increase in muscle strength.

Pharmaceutical formulations

1. Edrophonium injection.
2. Edrophonium ointment.

Brand Names

Tensilon, Reversol, Enlon.

(d) Tacrine hydrochloride

Properties

1. It occurs as a white solid crystal.
2. It is freely soluble in distilled water, 0.1 N HCl.
3. It is a pale yellow crystal known chemically as 1, 2, 3, 4-tetra-hydro-9-acridinamine monohydrochloride monohydrate.

Stability and storage

It should be stored at a temperature of 20°–25°C and protected from moisture.

Uses

1. Used in Alzheimer's disease.
2. Used in patient with dementia to improve memory, thinking and reasoning.
3. Used to increase the level of acetylcholine in the brain.

Pharmaceutical formulations

1. Tacrine hydrochloride tablet.
2. Tacrine hydrochloride capsule.

Brand Names

Cognex.

(e) Pralidoxime chloride

Properties

1. It coccurs as a white crystalline non-hygroscopic powder.
2. It is freely soluble in water.
3. It is a quaternary ammonium compound.

Stability and storage

It shoule be stored under controlled room temperature of 15°–30°C.

Uses

1. Used as an antidote for poisoning of parathion and related pesticides.
2. As an effective antagonist for carbamates.
3. Used to treat muscle disorders.

Pharmaceutical formulations

1. Pralidoxime tablet
2. Pralidoxime injection.

Brand Names

Toxipam, Aldopam, Clopam, Neopam, 2-Pam-I.

(f) Echothiophate Iodide

Properties

1. It occurs as a white, crystalline, hygroscopic solid.
2. It is a quaternary ammonium salt.
3. It is soluble in water and dehydrated alcohol.
4. Its aqueous solution have a pH of about 4.

Stability and storage

It is stable at room temperature for about 1 month. It should be kept away from light and moisture. It should be stored in refrigerator at 2°–8°C.

Uses

1. Used in the treatment of glaucoma.
2. In ophthalmic used to treat open angle glaucoma.
3. Used to treat certain eye focussing disorder.

Pharmaceutical formulations

1. Echothiophate eye drops.
2. Echothiophate eye ointment.

Brand Name

Phospholine iodide.

D

Cholinergic Blocking Agents/Anticholinergics/Parasympatholytics

1 What are anticholinergics? Classify anticholinergics with examples. (S.22, W.23)

☞ **Anticholinergics**

The drugs which block the actions produced by stimulation of parasympathetic nervous system are called anticholinergics.

Classification

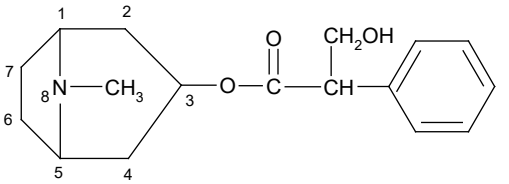
On Chemical basis and Origin:

1. Natural alkaloids, e.g. atropine, hyoscine (scopolamine)
2. Semisynthetic derivative, e.g. homatropine, ipratropium bromide.
3. Synthetic compounds:
    i. Amino alcohol esters, e.g. tropicamide, cyclopentolate hydrochloride, clindinium bromide, dicyclomine hydrochloride, glycopyrrolate, propantheline bromide, methantheline bromide.
    ii. Amino alkyl ethers, e.g. benztropine mesylate, orphenadrine citrate.
    iii. Amino alcohols, e.g. biperidine hydrochloride, procyclidine hydrochloride, tridihexethyl chloride.
    iv. Amino amides, e.g. isopropamide iodide.
    v. Miscellaneous, e.g. ethopropazine.

2 Write a note on 'Atropine.'

☞ **Atropine (natural alkaloid obtained from Atropa belladonna)**

Structure



Chemical Name

(1R, 3R, 5S) tropan 3yl (±) tropate

Properties

- It occurs as a colourless crystal.
- It has a bitter taste.
- It is sparingly soluble in water.
- It is freely soluble in chloroform.

Stability and Storage

It is affected by light. Hence it is stored in tightly closed light resistant containers.

Uses

- As antispasmodic.
- In peptic ulcer.
- In biliary colic.
- As a preanaesthetic medication.
- In parkinsonism.
- As a mydriatic.
- To treat sialorrhoea.
- To treat insecticidal poisoning.

Preparations

- Atropine sulphate tablet.
- Atropine eye ointment.
- Atropine sulphate injection.
- Morphine and atropine injection.
- Atropine methonitrate BP, IP.
- Compound adrenaline and atropine spray BP.

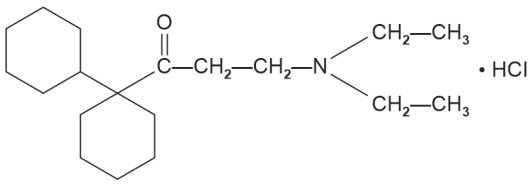
Brand Names

Lomoten, Lomotil, Eumydrin, Atrocin, Atrisolon, Atron, Atrosulph.

3 Give the structure, chemical name, properties, uses, stability and storage, and uses of dicyclomine hydrochloride.

☞ **Dicyclomine Hydrochloride**

Structure



Chemical Name

2-(diethylamino)ethyl bicyclohexyl-1-carboxylate hydrochloride.

Properties

i. It occurs as a white crystalline powder with bitter taste.
ii. It is soluble in water and chloroform.
iii. Dicyclomine is a muscarinic receptor antagonist.
iv. It is freely soluble in ethanol.
v. It is practically insoluble in ether.

Stability and storage

It should be stored at room temperature between 15°C and 30°C and kept away from light.

Uses

1. It is used as antimuscarinic and a non-specific antispasmodic agent (spasmolytic).
2. It is used in dysmenorrhoea, pylorospasm and biliary dysfunction.
3. It is used in motion sickness.
4. Used for treatment of functional bowel disorder and irritable bowel syndrome.

Pharmaceutical formulations

1. Dicyclomine tablet.
2. Dicyclomine capsule.
3. Dicyclomine injection.
4. Dicyclomine oral solution.

Brand Names

Meftal Spas, Spasil, Cyclospas-D, Cyclopam, Colimex, Diclospas, Colirid.

Dose

30–60 mg daily in divided doses.

4 Give details of following Anticholinergic drugs: (a) Ipratropium bromide, (b) Tropicamide, (c) Cyclopentolate hydrochloride, (d) Clidinium bromide.

☞ (a) Ipratropium Bromide

Properties

1. It is a white or almost white crystalline powder.
2. It is tastless and odourless.
3. It is a quaternary ammonium derivative.
4. It is freely soluble in water and ethanol.
5. It is insoluble in chloroform and ether.

Stability and storage

It should be stored in the foil pouch and protected from light and moisture.

Uses

1. It is used in the treatment of acute asthmatic attack.
2. It is a bronchodilator.
3. It is used for the symptomatic relief of rhinorrhoea.
4. It inhibits ACh-enhanced release of chemical mediators.
5. It is used for the treatment of sialorrhoea.

Pharmaceutical formulations

1. Ipratropium bromide aerosol.
2. Ipratropium bromide spray.
3. Ipratropium bromide capsule.
4. Ipratropium bromide solution.

Brand Names

Impravent, Tropum, Duolin, Iprex, Combivent, Tiova.

Dose

40–80 mg by inhalation.

(b) Tropicamide

Properties

1. It is a white or almost white crystalline powder.
2. It is odourless.
3. It is soluble in alcohol and methylene chloride but slightly soluble in water.
4. It is freely soluble in chloroform and solutions of strong acids.

Stability and storage

It should be stored in well-closed container and stored below 25°C. It should be protected from light and stored in sealed, conical-shaped container fitted with a twist and pull-off cap.

Uses

1. It is used to induce mydriasis and cycloplegia for ophthalmoscopy.
2. For the treatment of acute iritis, iridocyclitis, and keratitis.

Pharmaceutical formulations

Tropicamide eye drops.

Brand Names

Tropicamet, Tropac-P, Eytrop, Alcon, Tromide, Optimide, Mydriacyl.

(c) Cyclopentolate Hydrochloride

Properties

1. It occurs as a white crystalline powder.
2. It is odourless.
3. It is soluble in water, methanol and ethanol.
4. It insoluble in toluene.

Stability and storage

It should be stored in a tightly closed container protected from light.

Uses

1. It is used to produce cycloplegia and mydriasis.
2. It is an anticholinergic agent.
3. In the management of iritis.
4. In iridocyclitis.
5. In keratitis and choroiditis.
6. To treat cycloplegic refraction.

Pharmaceutical formulations

1. Cyclopentolate hydrochloride eye drops.
2. Cyclopentolate hydrochloride solutions.

Brand Names

Pentolate, Cyclopan, Tropexp, Cyclopent, Cyclogyl, Cyclomid, AK-Pentolate, Cyclomydril.

(d) Clindinium Bromide

Properties

1. It occurs as a white or nearly white crystalline powder.
2. It is odourless.
3. It is optically inactive.

Stability and storage

It should be stored in tightly closed container, in cool and well ventilated place at room temperature and kept away from light and children.

Uses

1. In the treatment of peptic ulcer.
2. In the treatment of hyperchlorhydria.
3. In ulcerative or spastic colon.
4. In anxiety states.
5. Used as bronchodialator in asthmatic conditions.
6. To relieve abdominal or stomach spasms.
7. Used in diverticulitis.
8. Used to treat irritable bowel syndrome.

Pharmaceutical formulations

1. Clindinium tablet.
2. Clindinium capsule.

Brand Names

Colinom, Clipoxt, Cibis, Spasril, Chlorax, Vasorex, Libtrax, QIBS.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Neostigmine is a drug of choice in **Myasthenia Gravis**.
2. Acetylcholine is an ester of choline with **acetic acid**.
3. Tacrine hydrochloride is used in **Alzheimer's disease**.
4. **2-Acetoxy-N, N, N-trimethylethanaminium** is a chemical name of acetyl choline.
5. Selective Beta 1 antagonist drugs are used to act on **Heart**.

6. Adrenergic drugs or adrenergic amines also known as **Sympatho-mimetic agents**.
7. Naphazoline drug is **imidazolidine derivative**.
8. Propranolol is a **Beta adrenergic blockers**
9. Chemical name of Adrenaline is **1(3,4 dihydroxyphenyl) 2-methyl amino ethanol**.
10. Pralidoxime is the **Cholinesterase reactivator**
11. Cholinergic agents are also known as **Parasympathomimetic agent**
12. 2-methyl amino, 1-phenyl 1-propanol is a chemical name of **ephedrine**.
13. The **heart** is activated by sympathetic system.
14. The catechol ring contains (-OH) groups at **Second and third positions**.
15. Ephedrine alkaloid is obtained from **Ephedra sinica**
16. (1R, 3R, 5S) tropan-3-yl (+-) tropate is a chemical name of **atropine**.
17. Beta 2 receptors are predominantly found in **Respiratory system**.
18. Tyramine is **indirect acting** type of agonist.
19. The chemical transmitter of SNS is **adrenaline**.
20. Dopamine comes under the category **Catecholamines**.
21. **Tysrosine** is the first precursor of adrenaline formation.
22. Beta blockers are structurally similar to **Beta agonist**.
23. Muscarinic sub receptors are **05 types**.
24. Chemical transmitter of PNS is **acetyl choline**.
25. Pilocarpine is a drug of choice in **Glaucoma**.
26. Acetyl choline produce stimulation of skeletal muscles by its **Nicotinic action**
27. Tacrine hydrochloride is used in Alzheimer's disease.
28. COMT stands for **Catecholamine-o-methyl-transferase**.
29. Dopamine is a monoamine compound with **positive ionotropic effect**.
30. Salbutamol is used in **Bronchial asthma**.

Chapter
8

Drugs Acting on Cardiovascular System/CVS Agents

A **Anti-arrhythmic Agents**

B **Antihypertensive Agents**

C **Antianginal Agents (Vasodilators)**

A

Anti-arrhythmic Agents

1 Define and classify cardiovascular agents with suitable examples.

The drugs which are used to treat various cardiovascular disorders are known as CVS agents.

☞ Classification of CVS Agents

- Cardiotonics (cardiac glycosides), e.g. digoxin, digitoxin, gitoxin, ouabain, Lanatoside C.
- Antiarrhythmic agents, e.g. quinidine, procainamide, propranolol, verapamil.
- Antianginal agents (vasodilators), e.g. glyceryl trinitrate, ethyl nitrate, amyl nitrite, tolazoline, isosorbide dinitrate, pentaerythritol, sodium nitroprusside.
- Antihypertensive drugs, e.g. methyl dopa, guanethidine, reserpine, clonidine, hydralazine, nifedipine, mecamylamine, captopril, enalapril.
- Lipid lowering agents (antihyperlipidaemic agents), e.g. clofibrate, nicotinic acid.
- Other drugs:
  i. Diuretics, e.g. frusemide, hydrochlorothiazide.
  ii. Anticoagulants, e.g. warfarin, dicoumarol.

2 What is Arrhythmia/Cardiac arrhythmia? Define and classify anti-arrhythmic agents. (S.24)

☞ Arrhythmia/Cardiac arrhythmia

It means disturbance in cardiac rhythm or heart beat. Arrhythmia can be caused by disturbance in conduction of impulse throughout the myocardium of heart.

Types of Arrhythmias

1. Tachycardia: Heart rate above 100 beats per minute.

2. Bradycardia: Heart rate lower than 60 beats per minute.
3. Atrial fibrillation.
4. Atrial flutter.
5. Ventricular flutter.
6. Extra systole.

Symptoms of Arrhythmia

- Fatigue
- Dizziness
- Fainting
- Rapid heart beat
- Shortness of breath
- Chest pain
- Anxiety

☞ Anti-arrhythmic Agents

The drugs which are used in the treatment of cardiac arrhythmias are called anti-arrhythmic agents.

Classification

- Membrane stabilising agent, e.g. quinidine, procainamide.
- β-adrenergic blockers, e.g. propranolol, practolol.
- Calcium channel blockers, e.g. verapamil, nifedipine.
- The drugs that prolong duration of action potential, e.g. bretylium.

3 Write a note on quinidine as anti-arrhythmic agent.

☞ Quinidine

Properties

- It occurs as white needle-like crystals.
- It is odourless and has bitter taste.
- It is sparingly soluble in water but soluble in alcohol.
- It is dextrorotatory.

Stability and Storage

It darkens on exposure to light and hence it is stored in tightly closed light-resistant container.

Uses

- For treatment of ventricular tachycardia.
- Cardiac arrhythmia.
- Extrasystolic atrial tachycardia.
- In thyrotoxicosis.
- To treat malaria
- To maintain sinus rhythm.

Pharmaceutical formulation

Quinidine tablet.

Brand Name

Phenipam, Natcardine, Cardioquin, Quinaglute, Quinalan.

Dose

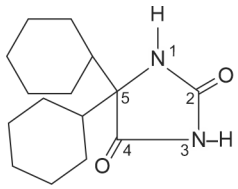
100–200 mg thrice daily.

4 Give the details of phenytoin as an anti-arrhythmic drug.

☞ Phenytoin (Dilantin)

Phenytoin is a hydantoin derivative (imidazolidine 2,4-dione)

Structure:



Chemical Name:

5,5-diphenyl imidazolidine 2,4-dione, OR
5,5-diphenyl hydantoin.

Properties:

i. It is a white crystalline powder and is odourless.
ii. It is very slightly soluble in water.
iii. It is slightly hygroscopic.

Stability and Storage

It should be stored in a tightly-closed containers protected from light.

Uses

i. It is used for the treatment of refractory ventricular arrhythmia.
ii. It is useful for prevention of tonic–clonic seizures.

iii. To control status epileticus
iv. To treat myotonia
v. To treat trigeminal neuralgia
vi. To treat migraine
vii. Used as an anti-arrhythmic agent

Pharmaceutical Formulations:

- Phenytoin tablet
- Phenytoin capsule
- Phenytoin injection
- Phenytoin oral suspension
- Phenytoin and phenobarbitone tablets

Brand Names

Dilantin, Eptoin, Epileptin, Garoin, Phenytek.

5 Give the details of following anti-arrhythmic drugs: (a) Procainamide hydrochloride, (b) Verapamil, (c) Lidocaine, (d) Lorcainide hydrochloride, (e) Amiodarone (f) Sotalol.

☞ (a) Procainamide Hydrochloride

Properties

- It occurs as a white or yellowish-white crystalline powder which odourless and hygroscopic.
- It is very soluble in water and freely soluble in alcohol.

Stability and Storage

It is stable in air but is hygroscopic hence it is stored in tightly closed container.

Uses

1. For the treatment and prevention of:
   – Ventricular tachycardia.
   – Cardiac arrhythmia.
   – Atrial tachycardia.
   – To maintain sinus rhythm.
2. In thyrotoxicosis.
3. To maintain sinus rhythm.

Pharmaceutical Formulations

- Procainamide HCl BP, IP.
- Procainamide injection BP, IP.
- Procainamide tablet BP.

Brand Names

Pronestyl, Procan, Procanbid.

(b) Verapamil Hydrochloride

Verapamil is a calcium channel blocker.

Properties:

i. It occurs as a white crystalline powder.
ii. It is soluble in organic solvents like ethanol.
iii. It is odourless and has bitter taste.
iv. It is soluble in water.

Stability and Storage

It should be stored at controlled room temperature and protected from light and freezing.

Uses

i. It is a calcium channel blocker used as anti-arrhythmic agent.
ii. It is also used to treat hypertension
iii. It is used for controlling ventricular rate in supraventricular tachycardia.
iv. To control ventricular rate in patients with atrial fibrillation and flutter.

Pharmaceutical Formulations:

i. Verapamil tablet.
ii. Verapamil capsule.
iii. Verapamil injection IP
iv. Verapamil solution

Brand Names

Isoptin, Verelan, Covera, Calan, Cardilox.

(c) Lidocaine Hydrochloride (Lignocaine/Xylocaine)

Chemically it is an amide type of local anaesthetic

Properties

- It is a white or creamy-white powder.
- It is odourless.

- It is practically insoluble in water.
- It is very slightly soluble in alcohol but freely soluble in chloroform.

Storage

It is stored in tightly closed containers.

Uses

- It is mainly used for its local anaesthetic activity.
- It is used for:
  i. Topical use.
  ii. Infiltration anaesthesia.
  iii. To produce dental analgesia.
  iv. For nerve block.
- It is also used for treatment of cardiac arrhythmia.

Pharmaceutical formulations

- Lignocaine injection.
- Lignocaine eye drops.
- Lignocaine gel.

Brand Names

Xylocaine, Otek, Otosil-C, Trox, Lidoject, Zingo, Kebutacaine.

(d) Lorcainide Hydrochloride

Properties:

1. It is hydrochloride salt.
2. It is soluble in water, ethanol and DMSO.
3. Chemically, it is an acetamide derivative.

Stability and Storage

It should be stored in tightly closed container and kept under dry and dark place.

Uses

1. As an anti-arrhythmic agent
2. To treat ventricular arrhythmias
3. It has local anaesthetic activity
4. It helps to restore normal heart rhythm and conduction in patients with premature ventricular contraction, ventricular tachycardia and Wolff-Parkinson-White syndrome.

Pharmaceutical Formulations:

1. Lorcainide HCI tablet.
2. Lorcainide HCI injection.
3. Lorcainide HCI solution.

Brand Names

Remivox, Lorivox.

(e) Amiodarone Hydrochloride

It is a potassium channel blocker and is class III anti-arrhythmic drug.

Properties:

1. It is white to slightly yellow crystalline powder.
2. It is slightly soluble in water.
3. It is freely soluble in dichloromethane.
4. It is soluble in methanol.
5. It is sparingly soluble in ethanol and very slightly soluble in water.
6. It is a benzofuran derivative.

Stability and Storage

It should be stored in a tightly closed container and protected from light at a temperature not exceeding 30°C.

Uses

1. It is a potent anti-arrhythmic agent.
2. Used to treat atrial fibrillation, supraventricular tachycardia, recurrent ventricular fibrillation.
3. To treat recurrent hemodynamically unstable ventricular tachycardia.

Pharmaceutical Formulations:

1. Amiodarone tablet IP
2. Amiodarone injection
3. Amiodarone solution
4. Amiodarone liquid
5. Amiodarone IV infusion IP

Brand Names

Aldarone, Nexterone, Pacerone, Cordarone.

(f) Sotalol Hydrochloride

It is a β-adrenergic blocker (antagonist). It is a class III anti-arrhythmic drug.

Properties

1. It is a white cystalline powder.
2. It is freely soluble in water.
3. It is available as sotalol hydrochloride.

Stability and Storage

It should be stored in a tightly closed container at room temperature, away from excess heat and moisture.

Uses

1. It is a anti-arrhythmic agent
2. It is used for the treatment of both atrial and ventricular arrhythmias.

Pharmaceutical Formulations:

1. Sotalol tablet
2. Sotalol injection
3. Sotalol solution

Brand Names

Sotagard, Betapace, Sotacor, Sorine, Sotylize.

Dose

160–480 mg per day.

B

Antihypertensive Agents

1 What is Hypertension? Give the causes, symptoms and drugs used in hypertension.

☞ Hypertension

The WHO defined hypertension in adult as "a systolic pressure equal to or greater than 160 mm Hg and a diastolic pressure equal to or greater than 95 mm Hg."

- Hypertension means high systemic blood pressure due to defect in the haemodynamic function.

Types of Hypertension

(a) Primary Hypertension (Essential hypertension):

Here the exact cause is not known. But there is generally narrowing of blood vessels. It may be benign hypertension or malignant hypertension.

(b) Secondary Hypertension:

It may be caused due to secondary disorders like renal disorders, endocrine disorders or toxaemia of pregnancy

Causes/Reasons of Hypertension:

Obesity, aging, modern lifestyles, stress, high alcohol intake, high salt intake, fatty diet as well as secondary reasons.

Symptoms of Hypertension:

Headache, fatigue, vision problems, chest pain, difficulty in breathing, irregular heart beats.

Drugs used in Hypertension:

Propranolol, Captopril, Ramipril, Methyldopate, Clonidine, Nifedipine

Types of Hypertension:

Types of Hypertensions	Pressure range (systolic/diastolic BP in mm Hg)
Normal	120/75–80
Borderline	140/90–95
Mild	140–160/95–105
Moderate	>140/105–120
Severe	>140/>120

2 Define and classify Antihypertensive drugs with examples. (S.22, 23, W.22)

☞ **Antihypertensives**

The drugs which reduce elevated blood pressure to normal level are called antihypertensives.

☞ **Classification**

1. Centrally acting, e.g. clonidine, α-methyldopa.
2. Catecholamine depleter, e.g. reserpine.
3. Adrenergic receptor blockers, e.g. propranolol, metoprolol.
4. Adrenergic neuron blocker, e.g. guanethidine.
5. Ganglionic blockers, e.g. mecamylamine.
6. Diuretics, e.g. chlorthiazide, frusemide.
7. Calcium channel blockers, e.g. verapamil.
8. Vasodialators, e.g. hydralazine.
9. Angiotensin converting enzyme inhibitors, e.g. captopril, enalepril.
10. Aldosterone antagonists, e.g. spironolactone.

3 What are the properties of an ideal antihypertensive agent?

☞ **The Properties of an Ideal Antihypertensive Agent:**

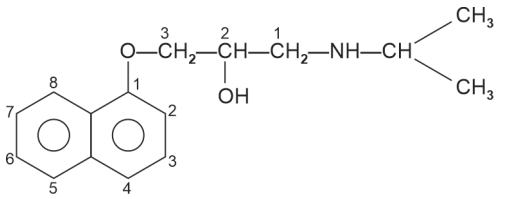
- It should cause gradual blood pressure lowering in all body positions.
- It should lower precapillary resistance without decreasing cardiac output.
- It should be absorbed orally.
- It should have slow detoxication to improve efficiency.

- It should be effective in considerable low dose so as to avoid side effects like nausea, diarrhoea, constipation, headaches, etc.
- It should not produce tachycardia or postural hypotension.
- Tolerance should not be developed with chronic administration.

4 Describe 'Propranolol' as an Antihypertensive Agent.

☞ **Propranolol:** It is a beta-adrenergic blocker.

Structure:



Chemical Name:

1-isopropyl amino,3(1-naphthyloxy) propan-2-ol

Properties

- It is a white powder.
- It is odourless and has bitter taste.
- It is soluble in water.

Stability and Storage

It is affected by light and hence it is stored in a well-closed light-resistant container.

Uses

It is used to treat:

- Cardiac arrhythmia.
- Angina pectoris.
- Arterial hypertension.
- Hyperthyroidism in children.
- Symptoms of anxiety.

Pharmaceutical Formulations:

- Propranolol tablet.
- Propranolol injection.

Brand Names

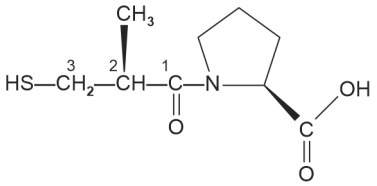
Inderal, Ciplar, Innopran XL, Hemangeol.

5 Give the structure, chemical name, properties, uses, stability storage, pharmaceutical formulation, brand names of captopril.

☞ Captopril: (S.22, W.23)

It is an angiotensin converting enzyme inhibitor.

Structure:



Chemical Name:

1-[(2S)-3-mercapto-2-methyl-1-oxopropionyl] praline.

Properties:

1. It occurs as a white crystalline powder.
2. It has a slight sulphur like odour.
3. It is freely soluble in water and alcohol.
4. It melts at 88°C which resolidify and melts again at about 105°C.

Stability and Storage

It should be stored in a tightly closed container under cool and dry place at room temperature and should be kept away from light and moisture.

Uses

1. It is used to treat high blood pressure and congestive heart failure.
2. It is used to treat renal hypertension.
3. It is used to treat diabetic proteinuria.
4. It also improve the mood of depressed patient.

Pharmaceutical Formulations:

Captopril tablets IP.

Brand Names

Captoril, Capoten, Aceten.

6 Give the details of following Antihypertensive agents:
(a) Ramipril
(b) Methyldopate Hydrochloride
(c) Clonidine Hydrochloride
(d) Hydralazine Hydrochloride
(e) Nifedipine.

(a) Ramipril

- Ramipril is an ACE inhibitor.
- Ramipril is a prodrug of ramiprilate.
- Ramiprilate is the active metabolite of ramipril.

Properties:

1. It is a white crystalline powder.
2. It is sparingly soluble in water.
3. It is freely soluble in polar organic solvents.
4. It melts between temperature 105°C and 112°C.

Stability and Storage

It should be stored in tightly closed container, protected from light and moisture.

Uses

1. In treatment of hypertension (antihypertensive)
2. In heart failure.
3. In treatment of myocardial infarction.
4. To prevent heart strokes.
5. To treat kidney problems.
6. It helps in relaxation of blood vessels.

Pharmaceutical Formulations:

1. Ramipril tablet IP.
2. Ramipril capsule IP.

Brand Names

Altace, Ramipril, Corpril, R Pril, Tritace, Cardace.

Dose

1.25–10 mg per day.

(b) Methyldopate Hydrochloride (α-methyl dopa)

- It is a central acting α-2-adrenergic agonist.
- It is a salt form of methyldopa.
- Methyldopa is a prodrug which is metabolized in the CNS.

Properties:

1. It is a white crystalline powder.
2. It is freely soluble in water.
3. It is very soluble in dil. HCI.

Stability and Storage

It should be stored in a tightly closed light resistant container. It becomes brownish yellow colour when exposed to moisture or water.

Uses

- Antihypertensive agent
- To treat hypertension in pregnancy
- To control primary hypertension
- To reduce hot flushes in postmenopausal women
- To treat pheochromocytoma

Pharmaceutical Formulations:

1. Methyldopate hydrochloride tablet.
2. Methyldopate hydrochloride capsule.

Brand Names

Aldepa, Emdepa, Almet, Dopagyt, Meldopa

(c) Clonidine Hydrochloride

It is a central acting alpha adrenergic agonist

Properties:

1. It is a white to off-white crystalline powder.
2. It is odourless with bitter taste.
3. It is soluble in water.
4. It is stable in light, air and heat.

Stability and Storage

It should be stored in tightly closed containers.

Uses

1. As antihypertensive agent
2. To treat primary hypertension
3. In prevention of migraine
4. To treat dysmenorrhoea
5. To treat postmenopausal Vasomotor instability.
6. It is a vasodialator.
7. It is used for the management of opiate addiction.

Pharmaceutical Formulations:

1. Clonidine tablet IP.
2. Clonidine injection IP.
3. Clonidine hydrochloride and chlorthalidone tablet IP

Brand Names

Catapres, Arkamine, Hyperdine, Kapvay, Nexiclon, Jenlaga.

(d) Hydralazine Hydrochloride

It is a peripheral vasodilator.

Properties:

1. It occurs as a white crystalline powder.
2. It is odourless and has a bitter saline taste.
3. It is soluble in water but slightly soluble in alcohol.
4. It is a hydrazinophthalazine derivative.

Stability and Storage

It should be stored in a tightly closed containers protected from light, at a temperature not exceeding 30°C.

Uses

1. As an antihypertensive agent.
2. In the management of essential hypertension.
3. To control hypertensive emergencies.
4. To improve congestive heart failures

Pharmaceutical Formulations:

1. Hydralazine tablet.
2. Hydralazine injection IP.

Brand Names

Alazine, Corbetazine, Aresoline, Mepresol, Hyperazine.

(e) Nifedipine

- It is a calcium channel blocker.
- It is a 1,4-dihydropyridine derivative.

Properties:

1. It occurs as a white crystalline powder.
2. It is odours and tasteless.
3. It is insoluble in water.
4. It is slightly soluble in alcohol.

Stability and Storage

It should be stored in tightly-closed container protected from light.

Uses

1. As an antihypertensive agent
2. It is used to prevent chest pain caused by angina.
3. Used in ischaemic heart disease and myocardial infarctions.
4. Used in arteriosclerosis, Raynaud's syndrome.
5. It is used to treat excercise-induced asthma.

Pharmaceutical Formulations:

1. Nifedipine tablet IP.
2. Nifedipine prolonged release tablets IP.
3. Nifedipine capsules IP.
4. Nifedipine prolonged release capsules IP.

Brand Names

Nifediac, Nicardia, Nefedin, Myogard, Procardia, Afeditab, Adalat, Calciguard.

C
Antianginal Agents (Vasodilators)

1 What is angina pectoris? Mention the drugs used in treatment of angina pectoris.

☞ **Angina Pectoris**

- Angina pectoris is a heart disease in which there is a paroxysmal pains in the chest, usually due to interference with the supply of oxygen to the heart muscle and precipitated by excitement.
- Angina pectoris refers to the chest pain towards left arm shoulder due to less supply or more demand of oxygen.
- Angina is due to imbalance between myocardial oxygen requirement and oxygen supply.

Signs and Symptoms:

Chest pains, shortness of breath, sweating, fainting

Drugs used in Angina pectoris:

Isosorbide dinitrate, glyceryl trinitrate, propranolol, verapamil, nifedipine, amlodipine, diltiazem.

2 Define and classify antianginal drugs/vasodilators with examples.

☞ **Antianginals/Vasodilators:**

The drugs are used in the treatment of angina pectoris by dilating the blood vessels are called antianginals or vasodilators.

☞ **Classification of Antianginals/Vasodilators:**

(A) On the Basis of Mode of Action:

1. **Nitrates,** e.g. glyceryl trinitrate, isosorbide dinitrate.
2. **B-blockers,** e.g. propranolol, metoprolol, atenolol.
3. **Calcium channel blockers,** e.g. verapamil, diltiazem, nifedipine, amlodipine.
4. **Potassium channel opener,** e.g. nicorandil.

(B) Peripheral vasodialators, e.g. tolazoline.

(C) Coronary vasodialators, e.g. glyceryl trinitrate, ethyl nitrite, amyl nitrate.

3 Give the details of "Isosorbide dinitrate" as an anti-anginal agent.

☞ Isosorbide dinitrate:

It is a vasodilator.

Properties:

1. It is a white crystalline, colourless compound.
2. It is freely soluble in organic solvents such as acetone, alcohol ether.
3. It is only sparingly soluble in water.
4. It is odourless.
5. Its melting point is 70°C.

Stability and Storage

It should be stored in tightly-closed container, protected from light.

Uses

1. For the prevention and treatment of angina due to coronary artery disease (CAD) and congestive heart failure (CHF)
2. It is an antianginal/vasodilator agent.

Pharmaceutical Formulations:

1. Isosorbide dinitrate tablet IP.
2. Isosorbide dinitrate capsule.
3. Dilute isosorbide dinitrate IP.

Brand Names

Sorbitrate, Cardicap, Isordil, Ditrate, Bidil, Olvisol, Anzidin.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. The drugs which increase the activity of heart are called as **cardiotonics**.
2. Verapamil and nifedipine are **Calcium channel blockers**.
3. **Enalapril** is angiotensin converting enzyme inhibitor.
4. Clonidine is a central acting **alpha-adrenergic agonist**.
5. Lasix is a popular brand name of **Frusemide**.
6. **Repaglinide** drug should be taken before meals.

7. Prazosin is used exclusively in the treatment **Hypertension**.
8. **Digoxin** is cardiotonic drug.
9. The antianginal drug that inhibits phosphodiesterase is **Nifedipine**
10. The most common diuretics used as an antihypertensive agent is **Thiazide diuretics**
11. Mecamylamine is a **Ganglionic blocker**.
12. **Clofibrate** is a lipid lowering agent.
13. Isosorbide dinitrate is **Antianginal drug**.
14. Amiodarone hydrochloride is **Potassium channel blocker**.
15. Mecamylamine is a **ganglionic blocker**.
16. Spironolactone is a **potassium sparing diuretic**.
17. Angina pectoris refers to **pains in the chest**.
18. Glyceryl trinitrate is given by **Sublingual route**.
19. Atenolol belongs to **beta blocker class**.
20. Hypertension is generally considered as **silent killer**.

Chapter
9

Diuretics

1 Define and classify diuretics giving suitable examples. (W.23)

"The drugs which increase rate of formation and excretion of urine are known as diuretics."

Classification

- Cyclic polynitrogen compounds.
  - i. Xanthine derivative, e.g. aminophylline, theophylline, caffeine.
  - ii. Pteridine derivative, e.g. triameterene.
  - iii. Pyrazine derivative, e.g. amiloride.
- Organomercurials, e.g. mersalyl, mercaptomerin.
- Sulphonamides
  - i. 1,3,4-thiadiazole derivative, e.g. acetazolamide (carbonic anhydrase inhibitor).
  - ii. Containing furan ring, e.g. frusemide.
  - iii. Thiazides and chlorthiazides, e.g. hydrochlorothiazide, chlorothiazide.
- Steroidal aldosterone antagonist, e.g. spironolactone.
- Phenoxy acetic acid derivative, e.g. ethacrynic acid.
- Acidifying salts, e.g. ammonium chloride.
- Water and osmotic agents, e.g. mannitol urea.

2 What do you mean by Low Ceiling and High Ceiling (Loop diuretics)? Give examples.

☞ **(a) Low ceiling diuretics:**

They have longer duration of action, medium potency and are useful in long-term therapy, e.g. chlorthiazide.

(b) High ceiling diuretics (loop diuretics):

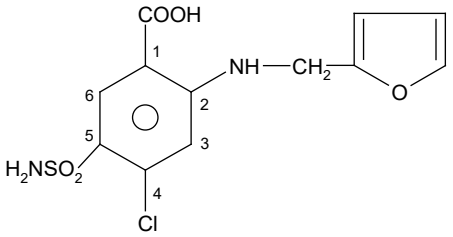
They have rapid onset but shorter duration of action. As they mainly act on ascending limb of loop of Henle, they are called as loop diuretics. They have high potency and produce intense diuresis, e.g. frusemide, ethacrynic acid.

3 Give the details of "frusemide/furosemide"/Loop diuretic. (S.22, 23, 24, W.22, 23)

☞ Frusemide (anthranilinic acid/furan derivative)

It is a high ceiling/loop diuretic.

Structure



Chemical Name

4-chloro, N-furfuryl amino, 5-sulphamoyl anthranilic acid
or
4-chloro, 2-furfuryl amino, 5-sulphamoyl benzoic acid

Properties

- It occurs as a white to slight yellow crystalline powder.
- It is odourless and tasteless.
- It is practically insoluble in water and ether.

Stability and Storage

It should be stored in a well tightly closed container and protected from light.

Uses

- It is used as diuretic.
- It is used for management of hypertension.
- It is used to treat oedema associated with congestive heart failure, cirrhosis of liver.
- To treat renal disease.

Pharmaceutical Formations

- Frusemide BP, IP.
- Frusemide injection BP, IP.
- Frusemide tablet BP, IP.

Brand Names

Lasix, Salinex, Frusenex, Salurex, Frisix, Tebemid.

4 Give the details of following diuretics: (a) Acetazolamide, (b) Bumetanide, (c) Chlorthalidone, (d) Benzthiazide, (e) Metolazone, (f) Xipamide and (g) Spironolactone.

☞ (a) Acetazolamide:

It is a carbonic anhydrase inhibitor.

Properties:

1. It is a white to faintly yellowish white crystalline powder.
2. It is odourless.
3. It is weakly acidic.
4. It is slightly soluble in water.

Stability and storage:

It should be in tightly closed container, protected from light and moisture.

Uses:

1. It is used to reduce edema.
2. In the treatment glaucoma.
3. In the treatment of epilepsy and hypertension.
4. Used to treat acute mountain sickness.
5. To treat periodic paralysis.

Pharmaceutical formulations:

1. Acetazolamide tablet IP.
2. Acetazolamide extended release capsule.
3. Acetazolamide powder for solution.

Brand Names:

Diamox, Zolamide, Synomax, Iopar-SR, Acetazolam.

Dose:

Initial dose, 500 mg, subsequent doses, 250 mg every six hours.

(b) Bumetanide:

It is a potent loop diuretic with a rapid onset and short duration of action.

Properties:

1. It is a white crystalline powder.
2. It is soluble in acetone and in ethanol.
3. It is slightly soluble in dichloromethane.
4. It practically insoluble in water.

Stability and storage:

It is stored in airtight container and is protected from light.

Uses:

1. As a diuretic.
2. Used to reduce oedema associated with CHF, liver and kidney disease.

Pharmaceutical formulations:

1. Bumetanide injection IP.
2. Bumetanide oral solution IP.
3. Bumetanide tablets IP.

Brand Names:

Bumex, Burinex, Bumet.

Dose:

1–5 mg oral, 2–4 mg IM/IV

(c) Chlorthalidone:

- It is a long acting thiazide diuretic.
- It is a sulfamoyl benzamide derivative.

Properties:

1. It is a white to yellowish white crystalline powder.
2. It is insoluble in water, ether and chloroform.
3. It is slightly soluble in alcohol and soluble in methanol.
4. It is soluble in alkali hydroxide solution.

Stability and storage:

It is stored in a tightly-closed container protected from light at controlled room temperature.

Uses:

1. As a diuretic.
2. Used to treat hypertension.
3. Used to treat edema associated with cardiac failure, liver failure and nephrotic syndrome.
4. It is effective in nephrogenic diabetes insipidus.

Pharmaceutical formulations:

Chlorthalidone tablets.

Brand Names:

Thalitone, Thalizide, Hygroton, Hythalton, Hydrazide.

Dose:

Intial dose is 15 mg once daily.

(d) Benzthiazide:

It is a thiazide diuretic.

Properties:

1. It occurs as a fine white, crystalline powder.
2. It has characteristic odour with bitter taste.
3. It is practically insoluble in water.
4. It is soluble in alkaline solution.

Stability and storage:

It is stored in a tightly-closed container protected from light and air.

Uses:

1. As a diuretic.
2. Used for the treatment of hypertension and oedema.
3. It is given in combination with potassium sparing diuretics.
4. It is used to prevent renal stone formation.

Pharmaceutical formulations:

Benzthiazide tablets.

Brand Names:

Edemax, Dihydrex, Exna, Aquatag.

(e) Metolazone:

- It is a thiazide like diuretic.
- Metolazone is a quinazoline derivative.

Properties:

1. It occurs as a white crystalline powder.
2. It is odourless and tasteless.
3. It is sparingly soluble in water and alcohol.
4. It is insoluble in organic solvents such as ethanol, DMSO and dimethyl formamide (DMF).
5. Chemically it is quinazoline derivative.

Stability and storage:

It is a light sensitive drug, hence it is stored in a tight light resistant container and protected from moisture.

Uses:

1. As a diuretic.
2. For the treatment of congestive heart failure and high blood pressure.
3. Used along with loop diuretics such as furosemide or bumetanide.
4. For the treatment of oedema.

Pharmaceutical formulations:

Metolazone tablets.

Brand Names:

Mykrox Metoz, Zaroxolyn, Zytanix.

Dose:

5–20 mg by oral route for the treatment of edema.

(f) Xipamide:

It is a sulfonamide diuretic.

Properties:

1. It is a yellowish white crystalline powder.
2. It is odourless.
3. It is soluble in water and alcohol.
4. It is freely soluble in solutions of alkali hydroxides.

Stability and storage:

It is stored in an airtight container at room temperature.

Uses:

1. As a diuretic.
2. For the treatment of oedema and hypertension.

Pharmaceutical formulations:

Xipamide tablet.

Brand Names:

Diurex, Diurexan, Aquophor, Aquaphoril.

Dose:

40 mg/day.

(g) Spironolactone:

- It is a potassium sparing diuretic.
- It is an aldosterone receptor antagonist.
- It is a weak diuretic.

Properties:

1. It occurs as light cream coloured crystalline powder with mercaptan like odour.
2. It is insoluble in water.
3. It is slightly soluble in methanol.
4. It is soluble in ethylacetate and ethanol.
5. It exibits polymorphism.

Stability and storage:

It is stored in tightly closed light resistant container.

Uses:

1. As a diuretic.
2. Used in the management and treatment or hypertension and heart failure.

Pharmaceutical formulations:

1. Spironolactone tablet IP.
2. Spironolactone suspension.
3. Spironolactone capsule.

Brand Names:

Aldactone, Aldactazide, Carospir.

Dose:

100–200 mg daily, in divided doses.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Diuretic agents** accelerates rate of urine formation.
2. Diuretic belongs to anthranilic acid derivative is **Frusemide**.
3. Spironolactone is **Aldosterone antagonist**.
4. **Acetazolamide** used to reduce oedema.
5. Ethacrynic acid is a diuretic drug which acts on **Loop of Henle**.
6. Diamox is a popular brand name of **Acetazolamide**.
7. The reabsorption of **sodium** is inhibited by most diuretics and causes diuresis.
8. Spironolactone is **Potassium sparing diuretic**.
9. The diuretic used to treat glaucoma by reducing intraocular pressure is **Acetazolamide**.
10. **Chlorthalidone** is a long-acting thiazide diuretic.
11. Benzthiazide is used for the treatment of **Oedema**.
12. Bumetanide belongs to **loop diuretic class**.
13. **Spironolactone** diuretic competes with aldosterone.
14. Thiazide diuretics act on **Distal tubule**.
15. Ethacrynic acid act on **loop of Henle**.
16. The most appropriate diuretic for treatment of acute pulmonary oedema is **loop diuretic**.
17. **Acetazolamide** is carbonic anhydrase inhibitor.
18. Frusemide drug have **furfural moiety**.
19. Potassium sparing diuretics inhibits the **Sodium reabsorption**.
20. Diuretic containing furan heterocycle is **Frusemide**.

Chapter
10

Hypoglycemic Agents/ Antidiabetic Agents

1 What is hypoglycemia? Write a note on diabetes mellitus. Mention the drugs used in diabetes mellitus.

☞ **Hypoglycemia:**

Hypoglycemia is a condition in which blood sugar (glucose) level is lower than normal.

Diabetes Mellitus:

- Diabetes mellitus is a condition caused due to raised glucose concentration in the blood due to deficiency of insulin.
- Diabetes is a group of diseases characterized by a state of chronic hyperglycemia.
- The hyposecretion of insulin from the β cells of islets of Langerhans leads to increased blood sugar level. The sugar passes through urine, the condition is called diabetes mellitus.
- The "diabetes" means large volume of urine is passed. The term "mellitus" means sweet.
- In diabete mellitus the blood glucose level exceeds normal renal threshold level (180/100 ml) hence glucose is found in the urine.

Types of Diabetes Mellitus:

• Type 1. Insulin Dependent Diabetes Mellitus (IDDM):

- It is also called Juvenile-onset diabetes mellitus.
- It occurs in children and adolescents.

• Type 2. Non-insulin Dependent Diabetes Mellitus (NIDDM):

- It is also called maturity onset diabetes mellitus.
- It develops in middle ages or in elderly patients who are often obese.

• Type 3. Malnutrition-related Diabetes Mellitus (MRDM):

• Type 4. Secondary Diabetes:

It may be due to certain pancreatic disorders or genetic syndrome or may be drug-induced.

Signs and Symptoms of Diabetes Mellitus:

Excessive thirst, excessive urination, fatigue, dryness of mouth, weight loss.

Drugs Used in Diabetes Mellitus:

Insulin, glibenclamide, tolbutamide, phenformin, metformin, chlorpropamide.

2 What are hypoglycemic agents? Classify hypoglycemic agents with suitable examples. (W.22)

☞ Hypoglycemic agents/antidiabetic agents:

The drugs which lower the blood sugar level and are used in the treatment of diabetes mellitus are known as hypoglycemic agents.

Classification

- Hormones (parenteral): Insulin and its derivatives.
- Oral hypoglycemic agents.
  i. Sulphonyl urea derivatives, e.g. chlorpropamide, tolbutamide, glibenclamide.
  ii. Biguanide derivatives, e.g. phenformin, metformin.
- Plant source, e.g. guar gum.

3 What is insulin? Give the storage, uses and official preparations of insulin.

☞ Insulin

Insulin is a protein hormone secreted by β cells of the islets of Langerhans of pancreas.
Commercial source of insulin is the pancreas of ox and pig.

Properties

- It is a white powder.
- It is slightly soluble in water.
- It dissolves in dilute solution of mineral acids.
- It is also soluble in alkali hydroxides in which it is hydrolysed.
- It is inactivated by proteolytic enzymes.
- It is sensitive to heat and light.

Stability and Storage

It is sensitive to heat and light. Hence it should be stored in a temperature between 2°C and 8°C and should not be allowed to freeze. Insulin injection is stored in multidose container.

Uses

It is used:

- To control diabetes mellitus.
- To regulate carbohydrate metabolism.
- To treat hyperkalemia.
- To treat severe ketosis or diabetic coma.

Official Preparations of Insulin (Stable Preparations)

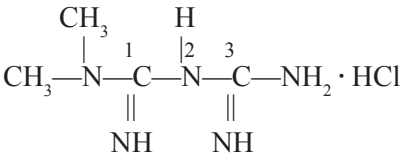
- Insulin injection BP, IP
- Neutral insulin injection BP.
- Globin zinc insulin injection BP, IP.
- Isophane insulin injection BP, IP.
- Biphasic insulin injection BP.
- Protamine zinc insulin injection BP, IP.
- Insulin zinc suspension (crystalline) BP, IP.
- Insulin zinc suspension BP, IP.

4 Give the details of following hypoglycemic agents: (1) Metformin and (2) Glibenclamide.

☞ 1. Metformin (biguanidine derivative): (S.23, 24, W.23)

It is a biguanidine derivative.

Structure:



Chemical Name:

1,1-dimethylbiguanidine hydrochloride.

Properties:

1. It is a white crystalline powder.
2. It is odourless and bitter in taste.
3. It is freely soluble in water.
4. It is insoluble in chloroform.

Stability and Storage:

It is a hygroscopic and hence it is stored in tightly-closed containers.

Uses:

1. As hypoglycemic agent.
2. Used as first-line medication for the treatment of type-2 diabetes.

3. To treat non-insulin dependent diabetes mellitus.
4. To treat insulin dependent diabetes mellitus in combination with insulin.
5. To treat diabetes associated with hyperlipoproteinaemia.

Pharmaceutical formulations:

1. Metformin tablets IP.
2. Metformin oral solution IP.
3. Metformin hydrochloride prolong release tablet IP.

Brand Names:

Glucophage, Diabex, Fortamet, Glycomet, Diaformin, Glumetza, Riomet.

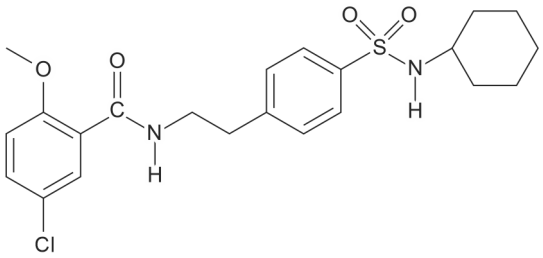
Dose:

0.5–2.5 g in divided doses.

2. Glibenclamide:

- It is a sulphonyl urea derivative.
- It is a second generation hypoglycemic agent.
- It is also known as glyburide.

Structure:



Chemical Name:

5-chloro-N-[4-(cyclohexyl carbamoylsulfamoyl)phenyl]ethyl]- 2-methoxy benzamide.

Properties:

1. It is a white crystalline powder.
2. It is odourless.
3. It is slightly soluble in water.
4. It is sparingly soluble in chloroform.

Stability and storage:

It is stored in tightly closed container protected from light.

Uses:

1. As a hypoglycemic agent.
2. To treat non-insulin dependent diabetes mellitus.
3. To treat type-2 diabetes.

Pharmaceutical formulations:

Glibenclamide tablet.

Brand Names:

Diabeta, Daonil, Euglucon, Betanase, Bionil, Afdiex.

Dose:

1–6 mg per day.

5 Give the properties, stability and storage, uses, formulations, brand names of following hypoglycemic agents: (a) Glimepiride (b) Pioglitazone, (c) Repaglinide, (d) Gliflozins and (e) Gliptins.

☞ (a) Glimepiride:

- It is a sulfonyl urea derivative.
- It is a long acting third generation hypoglycemic agent.

Properties:

1. It a white powder.
2. It is soluble in dimethyl formamide.
3. It is sparingly soluble in dichloromethane.
4. It is slightly soluble in methanol.
5. It is practically insoluble in water.

Stability and storage:

It is stored in a cool, dry place at room temperature and kept away from light and moisture.

Uses:

1. Used for the treatment of type 2 diabetes.
2. Used with a proper diet and exercise to control high blood glucose level.

Pharmaceutical formulations:

Glimepiride tablet IP.

Brand Names:

Amaryl, Glypride, Glimer, Avandaryl, Duetact, Tandemact.

Dose:

1–6 mg per day.

(b) Pioglitazone:

- It is a thiazolidinedione derivatives.
- It is also called insulin sensitizing agent.

Properties:

1. It is white crystalline powder.
2. It is odourless.
3. It is slightly soluble in anhydrous ethanol.
4. It is very slightly soluble in acetone and acetonitrile.
5. It is practically insoluble in water.

Stability and storage:

It is stored in well-closed containers protected from light and moisture.

Uses:

1. Used for the treatment of type 2 diabetes mellitus.
2. As a hypoglycemic agent.

Pharmaceutical formulations:

1. Pioglitazone tablets IP.
2. Pioglitazone hydrochloride tablets.

Brand Names:

Pionorm, Piorest, Bioglita, Diavista, Actos, Actoplus Met.

(c) Repaglinide:

- It is a meglitinide analogue.
- It is a oral hypoglycemic agent.
- It has a rapid onset and a short duration of action.

Properties:

1. It is a white to off-white crystalline powder.
2. It is odourless.
3. It is poorly water soluble.
4. Its melting point is 126°–128°C.

Stability and storage:

It is stored in an airtight container at room remperature between 15°C and 25°C and kept a way from light and moisture.

Uses:

1. Used as hypoglycemic agent.
2. To control high blood sugar level with a proper diet and exercise.

Pharmaceutical formulations:

Repaglinide tablet IP.

Brand Names:

Raplin, Prandin, Novonorm, Eurepa, Prandimet, Enyglid, Gluconorm.

Dose:

1–8 mg daily.

(d) Gliflozins:

- Gliflozins are newly developed class of oral hypoglycemic agents.
- Gliflozins include canagliflozin, dapagliflozin and empagliflozin.

These are sodium-glucose co-transporter-2 (SGLT2) inhibitors.

Properties:

These are soluble in water.

Stability and storage:

It should be stored in a cool and dry place protected from light.

Uses

1. Used for the treatment of type 2 diabetes mellitus.
2. As a hypoglycemic agents.
3. Sometimes can be used along with insulin to treat type-1 diabetes.

Pharmaceutical Formulations

- Canagliflozin tablet.
- Dapagliflozin tablet.
- Empagliflozin tablet.

Brand Names

Farxiga, Invokana, Qtern.

Dose:

5 mg orally once daily.

(e) Gliptins

- Gliptins are the new class of hypoglycemic agents.
- Gliptins includes: Sitagliptin, Vildagliptin, Saxagliptin.

Properties

i. Sitagliptin is a white to off-white crystalline powder.
ii. It is non-hygroscopic powder.
iii. These drugs are soluble in water and organic solvents such as ethanol, DMSO and DMF.

Stability and Storage

These are stored in tightly closed container at 20–25°C

Uses

1. As hypoglycemic agents.
2. Used as adjunct to diet and exercise to improve glycemic control in adults with type 2 diabetes mellitus.

Pharmaceutical Formulations

Sitagliptin tablet.
Vildagliptin tablet.
Saxagliptin tablet.

Brand Names

Eucreas, Galms, Janumet, Januvia, Xelevia.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Hypoglycemia** is a condition in which blood sugar levels is lower than normal range.
2. IDDM and NIDDM are the types of **Diabetes**.
3. The hormone insulin is secreted by **Beta cells** of Islets of Langerhans
4. Insulin is a **parenteral** hypoglycemic agent.
5. **Guar Gum** is a hypoglycemic agent obtained from plant source.
6. Insulin should be stored at temperature ranges between **2ºC and 8ºC**.
7. 1,1-dimethyl biguanide is a chemical name of **Metformin**.
8. Diabetes is a **Chronic endocrine** disease.
9. A chain of Insulin is composed of **21 Amino Acids**.
10. Insulin was prepared from cow is also names as **Bovine**.

Chapter
11

Analgesics and Anti-inflammatory Agents

A Narcotic Analgesics (Opioid Analgesics)

B Non-steroidal Anti-inflammatory Drugs (NSAIDs)

Introduction

1. **Analgesics:** The drugs which relieve the pains are called analgesics.
2. **Antipyretics/Febrifuge:** The drugs which reduce elevated body temperature to normal level are known as antipyretics, e.g. paracetamol, analgin, phenacetin.
3. **Anti-inflammatory:** The drugs which reduce inflammation are known as anti-inflammatory agents.
4. **Narcotic analgesics/Opioid analgesics:** The drugs which reduce pain sensation along with loss of consciousness and sleep are known as narcotic analgesics, e.g. morphine, heroine, codeine, pethidine, methadone.
5. **Inflammation:** Inflammation is a complex biological response which occurs when the body is exposed to infective agents or to a physical or chemical injury.

A
Narcotic Analgesics (Opioid Analgesics)

1 Define and classify Narcotic Analgesics with examples. Mention the uses of Narcotic Analgesics. (S.23)

☞ Narcotic Analgesics

The drugs which produce narcosis along with analgesic effect are called narcotic analgesics.

☞ Classification

1. **Naturally occuring**:
   Morphine and its analogues
   e.g. morphine, codeine, hydromorphine, oxymorphine, diamorphine, ethylmorphine.
2. **Synthetic drugs:**
   (a) Morphanion analogues, e.g. levorphanol.
   (b) Benzomorphan analogues, e.g. pentazocin.
   (c) 4-phenylpiperidine analogues, e.g. pethidine.
   (d) Phenyl propylamine analogues, e.g. methadone, dextropropoxyphone.

☞ Uses of Narcotic Analgesics

1. To relieve moderate to severe pain.
2. To suppress non-productive cough (antitussive)
3. To induce sleep in the presence of pain.
4. To control diarrhoea.

2 Give the details of "Morphine" as Narcotic Analgesic.

☞ Morphine

- It is a principal alkaloid obtained from opium. It belongs to phenanthrene class of alkaloids.
- It was the first narcotic analgesic discovered.

☞ Properties

- It occurs as white needle-like crystals.

- It has bitter taste.
- It is very slightly soluble in water.
- It is levorotatory and is monophasic liquid.
- It is practically insoluble in ether and chloroform.

The solution is sterilised by maintaining at 98–100°C for 30 minutes with bactericide or by filtration.

☞ Stability and Storage

It should be stored in a well-tight closed container and protected from light.

Uses

It is used:

- As narcotic analgesic.
- To treat diarrhoea.
- To suppress cough.
- As a pre-anaesthetic medication.
- As a hypnotic when insomnia is due to pain.
- To relieve anxiety due to pain.
- To relieve pain in biliary colic.
- To relieve pains associated with neoplastic diseases.

Pharmaceutical Formulations

- Morphine injection IP.
- Morphine and atropine injection.
- Morphine and ammonium chloride mixtures.
- Morphine and ipecacaunha mixture.
- Morphine and kaolin mixture.
- Morphine hydrochloride solution.
- Morphine suppositories.

Brand Names

Zephrol, Duromorph, Astramorph, Morcontin.

Dose

10–50 mg oral/IM
2–3 mg by IV

3 Describe the following analogues of morphine: (a) Codeine, (b) Diamorphine, (c) Methadone, (d) Pentazocin, (e) Pethidine

☞ (a) Codeine

It is an alkaloid obtained from opium.

Properties

- It occurs as a white crystalline or colourless powder.
- It is odourless and has bitter taste.
- It is slightly soluble in water and freely soluble in alcohol.
- It is very soluble in dilute acids.

Stability and Storage

It should be stored in a well tightly closed container and protected from light.

Uses

It is used:

- As narcotic analgesic.
- To suppress cough.
- To treat diarrhoea.
- As a sedative and hypnotics.
- Also used in combination with aspirin.

Pharmaceutical Formulations

- Codeine phosphate BP, IP.
- Codeine linctus BP.
- Codeine phosphate syrup IP.
- Codeine phosphate tablet BP.
- Codeine and aspirin tablet.
- Aspirin, phenacetin codeine tablet BP.

Brand Names

Codlin, Cosaka, Kefex., Corex, Codistar, Glycodin, Powerin.

Dose

10–30 mg per day.

(b) Diamorphine (Heroin)

- It is diacetyl morphine.
- It is commonly known as heroin.

Properties

1. It appears as white crystalline powder.
2. It is soluble in water and alcohol.
3. It is produced by acetylation of morphine.

Stability and Storage

It is stored in a tightly closed container at controlled room temperature and protected from light.

Uses

1. Used for the treatment of severe pain.
2. As a narcotic analgesic.
3. To treat severe pain associated with surgical procedures, myocardial infarction.

Pharmaceutical Formulations

1. Diamorphine hydrochloride tablet.
2. Diamorphine hydrochloride injection.
3. Diamorphine hydrochloride nasal spray.
4. Diamorphine hydrochloride powder for reconstitution.

Brand Names

Diagesil, Udidyne, Ayendi, Diaphin.

(c) Methadone

It is a substitute of morphine.

Properties

1. It occurs as a white crystalline powder.
2. It is odourless and has a bitter taste.
3. It is soluble in water and freely soluble in alcohol.

Stability and Storage

It is stored in a well-closed container protected from moisture and light.

Uses

1. Used as morphine substitution.
2. To relieve moderate to severe pain.
3. For the management of opioid dependance.
4. To suppress cough.

Pharmaceutical formulations

1. Methadone tablets IP
2. Methadone oral solution IP
3. Methadone injection IP
4. Methadone linctus IP
5. Methadone hydrochloride oral concentrate IP

Brand Names

Dolophine, Methadose, Physeptone, Diskets.

Dose

2.5–10 mg oral/IM

(d) Pentazocin

It is 2,6-methanobenzazocin derivative.

Properties

- It is white or creamy white powder.
- It is odourless and has slightly bitter taste.
- It is very slightly soluble in water and soluble in alcohol.

Uses

It is used:

- As narcotic analgesic.
- As preanaesthetic medication.
- As analgesic during labour pains.

Stability and Storage

It is stored in well-closed light-resistant container.

Pharmaceutical Formulations

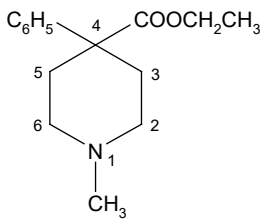
- Pentazocin tablet.
- Pentazocin injection.
- Pentazocin tablet BP.

Brand Names

Pentaron, Fortwin.

(e) Pethidine

It is a piperidine derivative.



Ethyl, 1-methyl, 4-phenyl-piperidine 4-carboxylate

Properties

- It is a white crystalline powder.
- It is odourless and has bitter taste.

- It is soluble in water, alcohol and chloroform.
- Its solutions are sterilised by autoclaving or filtration.

Storage

It should be stored in a well tight closed container and protected from light.

Uses

It is used:

- To relieve moderate to severe pains.
- As preanaesthetic medication.
- As analgesic during labour.
- In treatment of morphine addiction as substitute.

Pharmaceutical Formulations

- Pethidine tablet BP, IP.
- Pethidine HCl injection BP, IP.

Brand Names

Pethilorfan, Dolantin.

4 What are Narcotic Antagonist? Explain any three Narcotic Antagonists.

☞ Narcotic Antagonists

Narcotic antagonists are the drugs which block the euphoric effects of opiates by attaching to opiate receptors.

- Narcotic antagonists are used as antidote to treat poisoning of narcotic analgesics.
- Examples: Naloxone, Nalorphine, Naltrexone.

(a) Nalorphine

- It was the first clinical useful narcotic antagonist.
- It is a mixed opioid agonist–antagonist.
- Nalorphine has less analgesic effect than morphine.
- It is also known as N-allylnormorphine.

Properties

1. It is a white crystalline powder.
2. It is odourless.
3. It is insoluble in chloroform and ether.
4. It is soluble in dilute alkali hydroxide solution.
5. It is sterilized by autoclaving or by filtration.

Stability and Storage

It slowly darkens on prolonged exposure to light and air. Hence it is stored in a tightly closed container at controlled room temperature and protected from light.

Uses

1. As an antidote for morphine poisoning.
2. Used to reverse the opioid overdose.

Pharmaceutical Formulations

Nalorphine injection.

Dose

Usually administered IV in the dose of 3–5 mg repeatedly within half an hour, if necessary, (in morphine poisoning).

Brand Names

Nalline, Lethidrone.

(b) Naloxone

- It is a narcotic/opioid antagonist.

Properties

1. It occurs as a white crystalline powder.
2. It is freely soluble in water, dilute acids and strong alkali.

Stability and Storage

It is stored in a tightly closed container protected from light.

Uses

1. As a narcotic/opioid antagonist.
2. To block or reverse the effects of opioid drugs.
3. Antidote for acute morphine poisoning.

Pharmaceutical Formulations

Naloxone hydrochloride injection.

Dose

0.4–0.8 mg by IV repeated every 10–15 minutes in morphine poisoning.

Brand Names

Narcon, Evzio, Narcotan.

(c) Naltrexone

It is a noroxymorphone derivative with competitive opioid antagonistic activity.

Properties

1. It is white crystalline compound.
2. It is very hygroscopic.
3. It is soluble in water.

Stability and Storage

It is stored at room temperature away from light and moisture.

Uses

1. It is used for the management of alcoholism and addiction to opioid drugs.
2. It is used to treat cholestatic pruritus.
3. It is used in obesity.
4. It is used to treat opioid dependance.
5. It is used to treat severe pains.

Pharmaceutical Formulations

1. Naltrexone hydrochloride tablet.
2. Naltrexone tablet IP.
3. Naltrexone implantable pellet.

Brand Names

Nalorex, Adepend, Antaxone, Celupan, Contrave, Embeda, Vivitrol, Naltima, Revia.

B

Non-steroidal Anti-inflammatory Drugs (NSAIDs)

1 What are non-steroidal anti-inflammatory drugs (NSAIDs)? Classify NSAIDs with suitable examples. OR Classify analgesics and antipyretics giving examples. (S.24, W.23)

☞ **NSAIDs**

These are the drugs which are used to relieve pain, reduce inflammation and also lower the elevated body temperature.

The NSAIDs act by inhibition of the cyclo-oxygenase (COX) enzyme.

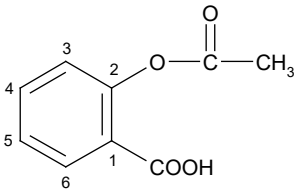
☞ **Classification of NSAIDs**

1. Salicylates, e.g. aspirin, sodium salicylate.
2. P-aminophenol derivatives, e.g. paracetamol, phenacetin.
3. Pyrazolone derivative, e.g. phenylbutazone, oxyphenbutazone metamizole.
4. Indole acetic acid derivative, e.g. indomethacin, sulindac.
5. Phenylacetic acid derivative, e.g. diclofenac, aceclofenac.
6. Propionic acid denvative, e.g. ibuprofen, ketoprofen, fenoprofen.
7. Oxicam derivatives, e.g. piroxicam, tenoxicam.
8. Selective COX-2 inhibitors, e.g. celecoxib, etoricoxib.
9. Anthranillic acid derivative, e.g. mefenamic acid.

2 Write a note on Aspirin. Describe the salicylic acid derivative used as anti-inflammatory agent. (W.23)

☞ **Aspirin (Acetylsalicylic Acid) [ASA]**

Structure



Chemical Name

Ortho-acetoxy benzoic acid or 2-acetoxy benzoic acid

Properties

1. It occurs a white crystalline powder.
2. It is colourless.
3. It is odourless and has slightly bitter taste.
4. It is soluble in water, freely soluble in alcohol.

Stability and Storage

It should be stored in a well tightly closed container and protected from light and kept in a cool, dry place.

Uses

- It is used as analgesic to relieve moderate pains like headache, toothache.
- It is used as antipyretic.
- It has an anti-inflammatory action and is used in the treatment of rheumatoid arthritis.
- It is used to treat gout.
- In high doses, it is used to reduce risk of myocardial infarction.

Brand Names

Disprin, Aspro, Anacin, Coldarin, Powerin, Codopyrin, Ecosprin, Zorprin, Asatab, Durlaza.

Pharmaceutical Formulations

- Aspirin tablet BP, IP.
- Soluble aspirin tablet.
- Aspirin and caffeine tablet.
- Dispersible aspirin and caffeine tablet.
- Pediatric dispersible aspirin tablet BP.
- Dispersible aspirin and codeine tablet BP.

Dose

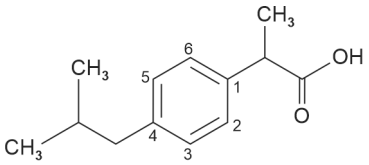
0.5–2 g per day.

3 Write a note on Ibuprofen. OR Give details of propionic acid derivative used as anti-inflammatory agent. (S.22)

☞ Ibuprofen

It is a propionic acid derivative.

Structure



Chemical Name

(RS)-2-(4-isobutyl phenyl) propionic acid.

Properties

- It occurs as white crystals or white crystalline powder.
- It has a characteristic odour.
- It is very slightly soluble in water.
- It is soluble in aqueous solution of alkali.

Storage

It is stored in a tightly closed container, protected from light and temperature.

Uses

It is used to treat:

- Rheumatoid arthritis.
- Osteoarthritis.
- Dysmenorrhoea.
- Neck pains.
- Pains in malignant disease.
- Dental pains.
- Muscle aches.

Pharmaceutical Formulations

- Ibuprofen tablet IP, BP.
- Ibuprofen and paracetamol tablet IP.
- Ibuprofen cream IP.

Brand Names

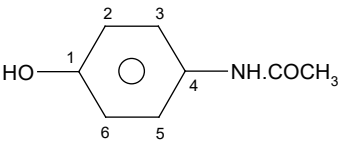
Brufen, Ibugesic plus, Alfam, Advil, Genpril, Ibular, Acifen, Emflam.

4 Describe the details of paracetamol. OR Give the details of analgesic antipyretic drug which is a p-aminophenol derivative.

☞ **Paracetamol (Acetaminophen)**

It is a p-aminophenol derivative.

Structure



Chemical Name

P-acetamido phenol OR 4-acetamido phenol OR P-hydroxy acetanilide.

Properties

- It occurs as white crystals or white crystalline powder.
- It is odourless and has bitter taste.
- It is sparingly soluble in water.
- It is insoluble in ether and chloroform.

Stability and Storage

It should be stored in a well tightly closed container and protected from light.

Uses

- It is analgesic and antipyretic agent.
- It is used to relieve the pain of headache, and other pains arising from muscles and joints.

Brand Names

Crocin, Metacin, Calpol, Paramol, Albinol, Cipmol, Cofamol, Panadol.

Pharmaceutical Formulations

- Paracetamol tablet IP, BP.
- Paracetamol elixir.
- Paracetamol oral suspension.
- Paracetamol syrup.
- Paediatric paracetamol elixir BP.
- Acetaminophen tablet USP.
- Acetaminophen elixir USP.

Dose

325–625 mg 3–4 times daily.

5 Give the properties, stability and storage, uses, pharmaceutical formulations, brand names of following NSAIDs.

(a) Diclofenac (b) Piroxicam (c) Celecoxib (d) Mefenamic acid (e) Aceclofenac.

☞ **(a) Diclofenac (W.22)**

- It is a phenylacetic acid derivative of non-selective COX inhibitor class.
- It inhibits both COX-1 and COX-2.

Properties

1. It is a white to slight yellowish crystalline powder.
2. It is a weak acid.
3. It is poorly soluble in water.
4. It is slightly hygroscopic.
5. It is freely soluble in methanol.
6. It is practically insoluble in ether in chloroform and in toluene.

Stability and Storage

It is stored in a well-closed container protected from moisture and light.

Uses

1. Used for the treatment of rheumatoid arthritis.
2. Used in the treatment of osteoarthritis and ankylosing spondylitis.
3. To treat postoperative ocular inflammation or ocular pain.
4. Used in toothache, dysmenorrhoea.
5. To treat gout.
6. To treat renal colic, post-traumatic and postoperative inflammatory conditions.

Pharmaceutical Formulations

1. Diclofenac prolong release tablets IP
2. Diclofenac gastro resistant tablet IP
3. Diclofenac gel IP
4. Diclofenac injection IP

Brand Names

Arthrotec, Diclonac, Movonac, Diclomax, Voltaren, Voveran, Voltaflam, Catatlam.

Dose

Orally or by intramuscular injection, 25–75 mg.

(b) Piroxicam (W.22)

- It is oxicam derivative of non-selective COX inhibitor class.
- It works by preventing the production of prostaglandins which are involved in the mediation of pain, stiffness, tenderness and swelling.

Properties

1. It is a white or slightly yellow odourless powder.
2. It is poorly soluble in water.
3. It is soluble in organic solvents such as DMSO and dimethyl formamide.

Stability and Storage

It is stored in a well-closed container under dry place and is kept away from light, heat and moisture.

Uses

1. As analgesic antipyretic.
2. As antinflammatory in rheumatoid arthritis.
3. In the treatment of gout.
4. Used in treatment of musculoskeletal injuries.
5. Used in dentistry.

Pharmaceutical Formulations

1. Piroxicam tablet IP
2. Piroxicam capsule IP
3. Piroxicam injection.
4. Piroxicam gel.

Brand Names

Pirox, Piricam, Minicam, Dalonex, Axicam, Feldene.

Dose

10–20 mg daily.

(c) Celecoxib

- It is a selective COX-2 inhibitor.
- It is a diaryl substituted pyrazole derivative.

Properties

1. It is off-white to pale yellow powder.
2. It is practically insoluble in water.
3. It is soluble in organic solvents such as ethanol, DMSO and dimethyl formamide.

Stability and Storage

It is stored at room temperature and is kept away from light and moisture.

Uses

1. It has analgesic, antipyretic and anti-inflammatory actions.
2. It is used to treat pain and inflammation in osteoarthritis, rheumatoid arthritis and ankylosing spondylitis.
3. To treat acute pain from various sources, juvenile rheumatoid arthritis in children.
4. Used to treat primary dysmenorrhoea.

Pharmaceutical Formulations

Celecoxib capsule.

Brand Names

Celebrex, Celact, Celecap, Cetedol, Revibra, Colcibra.

Dose

100–200 mg twice daily.

(d) Mefenamic Acid

- It is an anthranillic acid derivative.
- It is a COX-1 and COX-2 inhibitor.
- It has analgesic, antipyretic and anti-inflammatory actions.

Properties

1. It is a white to greyish white crystalline powder.
2. It is odourless.
3. It has poor solubility in water.
4. It is soluble in acetone, chloroform, dichloromethane methanol.

Stability and Storage

It is stored in a well-closed container protected from moisture and light.

Uses

1. It has analgesic, antipyretic, anti-inflammatory action.
2. It is used to relieve mild to moderate pains.

3. Used in treatment of rheumatoid arthritis and osteoarthritis.
4. In inflammation and fever.
5. For the treatment of primary dysmenorrhoea.

Pharmaceutical Formulations

Mefenamic acid capsules.

Brand Names

Biospas, Ponstel, Lenagesic, Ponstan, Dotra-M.

Dose

250–500 mg thrice daily.

(e) Aceclofenac

- It is a phenyl acetic acid derivative.
- It is a non-selective COX inhibitor.
- It inhibits both COX-1 and COX-2.

Properties

1. It is a white crystalline powder.
2. It is freely soluble in acetone.
3. It is soluble in ethanol.
4. It is practically insoluble in water.

Stability and Storage

It is kept in an air-tight container in a cool and dry place, protected from light.

Uses

1. It is used to treat rheumatoid arthritis.
2. It is used to treat osteoarthritis.
3. It is used to treat ankylosing spondylitis.

Pharmaceutical Formulations

1. Aceclofenac tablet IP
2. Aceclofenac SR tablet.

Brand Names

Aceloc, Aceclo, Dolokind, Acerap, Aceact, Aceroc, Acent, Clanza.

Dose

100 mg twice daily.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Analgesics** are the drugs which relive the pains.
2. The drugs which reduce elevated body temperature to normal level are called as **Antipyretics**.
3. Morphine is a principle alkaloid obtained from **Opium**.
4. Ethyl, 1-mehtyl, 4-phenyl-piperidine 4-carboxylate is a chemical name of **Pethidine**.
5. Nalorphine and Naloxone are used in **Morphine Poisoning**.
6. The NSAID's act by inhibiting of the **COX enzyme**.
7. Ortho-acetoxy benzoic acid is a chemical name of **Aspirin**.
8. Ibuprofen drug is a **propionic acid derivative**.
9. Mefenamic acid is the inhibitor of **COX-1 and COX-2**.
10. **Nalorphine and Naloxone** are Narcotic Antagonists.
11. Celecoxib is the inhibitor of **COX-2**.
12. Voveran is the brand name of **Diclofenac**.
13. Diclofenac is a **phenylacetic acid derivative**.
14. Aspirin is **Salicylic acid derivative**.
15. Salicylates are useful in treatment of **Arthritis**.

Chapter
12

Antifungal Agents

1 Enlist various fungal infections. Define and classify antifungal agents giving suitable examples.

☞ **Fungal infections**

- Any disease caused by fungus is known as fungal infection.
- Fungi are heterotropic microorganism.
- A fungal infection is also called mycosis, a skin disease caused by a fungus.
- Mycotic infections of human are:
    1. Dermatophytoses is a contagious superficial skin infections. The diseases produced are ringworm of foot, ringworm of skin, hair, nails.
    2. Candidiasis can affect the skin and mucous membrane.
    3. Saprophytes invade skin and penetrate deep causing lymphatic, pulmonary and systemic mycoses.
- **Fungal infections are:**
    i. Candidiasis: Caused by yeast, *Candida*.
    ii. Blastomycosis: Caused by the fungus, blastomyces.
    iii. Ringworm: A common fungal infection.
    iv. Vaginal candidiasis.
    v. Fungal nail infections.
    vi. Mucormycosis: Caused by mucormycetes.
    vii. Onchomycosis.
    viii. Histoplasmosis.
- **Antifungal Agents**
  The drugs which are used in the treatment of fungal infections are called antifungal agents.
- **Classification of Antifungal Agents:**

1. Antibiotics, e.g. amphotericin-β, griseofulvin, nystatin.
2. Pyrimidine derivatives, e.g. 5-flucytosine.
3. Azoles/Imidazoles, e.g. clotrimazole, miconazole, ketoconazole.

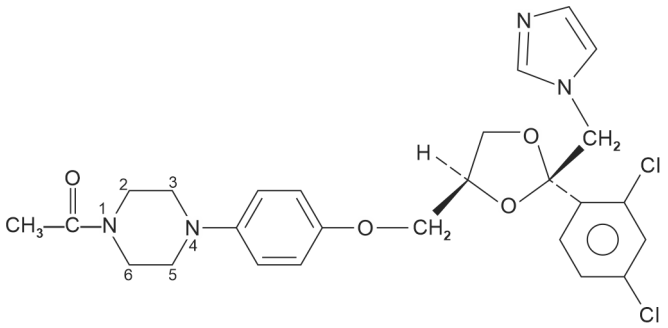
4. Allylamines, e.g. terbinafine.
5. Thiocarbanilic acid derivatives, e.g. tolnaftate.
6. Phenolic compounds, e.g. salicylic acid.
7. Diamidines, e.g. stilbamidine.
8. Dyes, e.g. Gentian violet, malachite green.
9. Unsaturated fatty acid: undecylenic acid.

2 Give the structure, chemical name, properties, stability and storage an uses of the following antifungal drugs: (a) Ketoconazole, (b) Fluconazole

☞ (a) Ketoconazole

- It is a imidazole derivative.
- Ketoconazole was first approved as an oral formulation for systemic use by the FDA in 1981.

Structure



Chemical Name

1-Acetyl-4-[4-[[2-(2,4-dichlorophenyl)-2(1H-imidazole-1-ylmethyl)-1, 3-dioxolan-4-yl] methoxy] phenyl] piperazine.

Properties

1. It is a white to off-white crystalline powder.
2. It is freely soluble in dichloromethane.
3. It is soluble in chloroform and in methanol.
4. It is sparingly soluble in ethanol.
5. It is practically insoluble in water and in ether.

Stability and Storage

It is stored in a well closed container protected from light and at controlled room temperature.

Uses

1. It is a broad spectrum antifungal.
2. It is used to treat seborrheic dermatitis and fungal skin infections.
3. It is used orally to treat severe refractory cutaneous dermatophytic infections.
4. Ketoconazole is used for the treatment of systemic fungal infections such as candidiasis, coccidioidomycosis, blastomycosis, histoplasmosis, chromomycosis, paracoccidioidomycosis.

Pharmaceutical Formulations

1. Ketoconazole tablets IP
2. Ketoconazole lotion.
3. Ketoconazole cream.
4. Ketoconazole ointment.
5. Ketoconazole antidandruff shampoo.

Brand Names

Ketovate, Funginoc, Danruf, Nizrol, Funazole, Antanazol, Ketazole.

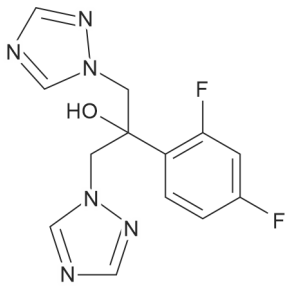
Dose

Adult dose, 200–400 mg once daily.

(b) Fluconazole (Diflucan)

- It is commonly known as "Diflucan".
- It is used for both systemic and superficial fungal infections.

Structure



Chemical Name

α-(2, 4-Difluorophenyl)-α-(1H-1, 2, 4-triazol-1-ylmethyl)-1H-1, 2, 4-triazole-1-ethanol.

OR

2,4-difluoro-α, α- bis(1H-1, 2, 4-triazol-1-ylmethyl) benzyl alcohol.

Properties

1. It is a white crystalline powder.
2. It is slightly soluble in water.
3. It is soluble in organic solvents such as chloroform, propylene glycol.

Stability and Storage

It should be stored in a tightly closed container at a temperature less than 30°C.

Uses

1. Fluconazole shows fungistatic activity.
2. It is used in the treatment of candidiasis.
3. Used to control oesophageal and oropharyngeal candidiasis.
4. An eye drop is useful in fungal keratitis.
5. Useful to treat vaginal candidiasis.

Pharmaceutical Formulations

1. Fluconazole tablets IP
2. Fluconazole capsules IP
3. Fluconazole oral suspension IP
4. Fluconazole eye drops.

Brand Names

Fluka, Fumycin, Diflucon, Wycon, Syscan, Zocon, Forcan, Fluzon.

Dose

100–200 mg per day.

3 Give the details of following antifungal agents: (a) Amphotericin-B, (b) Griseofulvin, (c) Itraconazole, (d) Naftifine hydrochloride, (e) Miconazole

☞ (a) Amphotericin-B

It is a polyene microlide antifungal agent.

Properties

- It occurs as a yellow to orange powder.
- It is almost odourless and tasteless.
- It is practically insoluble in water and in alcohol.

Stability and Storage

It is affected by light, air and even at room temperature.
Hence, it is stored in tightly closed light-resistant containers at a temperature of 2°–10°C.

Uses

- It is effective in candidiasis, blastomycosis.
- In cryptococcal meningitis.
- For suppression of oral or intestinal candidiasis.

Pharmaceutical Formulations

- Amphotericin-B cream.
- Amphotericin-B lotion.
- Amphotericin lozenges.
- Amphotericin-B ointment.
- Amphotericin-B injection.
- Amphotericin mixture.

Brand Names

Fungizone, Fungilin, Ambilip, Ambisome, Amfitas.

Dose

50–100 mg four times daily.

(b) Griseofulvin

Griseofulvin is obtained from the mold penicillium griseofulvin.

Properties

1. It occurs as a white or pale cream coloured powder.
2. It is tasteless and odourless.
3. It is very slightly soluble in water.
4. It is soluble in acetone and freely soluble in tetrachloroethane.

Stability and Storage

It is stored in tightly closed containers and kept away from oxidizing materials.

Uses

1. As an antifungal agent.
2. Used to treat dermatophytoses.
3. Used to treat ringworm infections.
4. Used to treat tinea infections.

Pharmaceutical Formulations

1. Griseofulvin tablets.
2. Griseofulvin capsules.
3. Griseofulvin oral suspension.

Brand Names

G-fulvin, Grisovin, Bifulvin, Grifulvin-V, Gris-PECT, Grisoral, Walavin.

Dose

125–250 mg four times daily.

(c) Itraconazole

Itraconazole is an orally active broad spectrum antifungal agent. It is a triazole derivative.

Properties

1. It is a white crystalline powder.
2. It is practically insoluble in water and in acidic solution.
3. Its melting point is 166.2°C.

Stability and Storage

It should be stored at room temperature and should be protected from light and moisture.

Uses

1. Used for the treatment of systemic fungal infections including blastomycosis, histoplasmosis (including patients infected with HIV)
2. Used to treat dermatophytosis.
3. Used to treat vaginal candidiasis.
4. Used to treat sporotrichosis.

Pharmaceutical Formulations

1. Itraconazole oral solution.
2. Itraconazole capsule.
3. Itraconazole injection.
4. Itraconazole concentrate, sterile BP

Brand Names

Candistat, Canditral, Flucover, Suntran, Ibitra.

Dose

200 mg once/twice daily with meals.

(d) Naftifine Hydrochloride

- Naftifine is a synthetic, broad spectrum antifungal agent.
- It is allylamine derivative.
- It is mainly used for topical treatment of tinea pedis, tinea cruris and tinea corpori.

Properties

1. It is a white crystalline powder.
2. It is soluble in polar solvents such as ethanol and methylene chloride.

Stability and Storage

It is stored in a well-closed container in cool and dark place, i.e. protected from light.

Uses

1. As topical antifungal agent.
2. For the treatment of tinea pedis, tinea cruris, tinea corpori.
3. Treatment of ringworm, athletes foot and jock itch.
4. Used in the treatment of ringworm of beard, ringworm of scalp and tinea versicolor.

Pharmaceutical Formulations

1. Naftifine cream.
2. Naftifine gel.

Brand Names

Naftin Gel, Tinaderm, Tinavate, Tolnaderm.

(e) Miconazole

- Miconazole is a broad spectrum azole/inidazole antifungal agent.
- It is widely used to treat mucosal yeast infections.

Properties

1. It occurs as a white crystalline or microcrystalline powder.
2. It is sparingly soluble in methanol.
3. It is slightly soluble in ethanol and chloroform.
4. It is very slightly soluble in water and in ether.

Stability and Storage

It is stored at room temperature and protected from light and moisture. Miconazole vaginal suppositories should be stored at 15°C–30°C.

Uses

1. As antifungal agent.
2. Used to treat fungal infections affecting the vagina, mouth and skin including candidiasis.
3. Used for the local treatment of oropharyngeal candidiasis in adult patients.

4. Used for the treatment of cryptococcosis, mucocutaneous candidiasis, coccidioidomycosis, cutaneous and vulvovaginal candidiasis.

Pharmaceutical Formulations

1. Miconazole tablets.
2. Miconazole gel.
3. Miconazole powder and solution.
4. Miconazole nitrate pessaries.
5. Miconazole cream (2%).
6. Miconazole nitrate vaginal tablets.
7. Miconazole ointments.
8. Miconazole spray.
9. Miconazole buccal tablet (50 mg)

Brand Names

Monistat Derm, Daktarin, Gynodaktarin, Zole, Orgvig.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Onychomycosis is a fungal infection of **nails**.
2. Candidiasis is caused by ***C. albicans***.
3. **Amphotericin B** is a Gold Standard of Anti-fungal treatment.
4. UTIs are most commonly caused by ***E. coli*** **bacteria**.
5. The drugs which are used to treat the fungal infections are called as **antifungal drugs**.
6. **Ketoconazole** is an imidazole derivative used as an antifungal drug.
7. Fluconazole is commonly known as **Diflucan**.
8. Itraconazole is used to treat **fungal infections**.
9. The adult dose of fluconazole is **100–200 mg per day**.
10. Unsaturated fatty acid used as antifungal is **Undecylenic acid**.

Chapter
13

Urinary Tract Anti-infective Agents

1 What are urinary tract anti-infective agents? Classify the urinary tract anti-infective agents with examples.

☞ **Urinary Tract Anti-infective Agents/Urinary Antiseptics**

The drugs which are used to treat or prevent infections of urinary tract are called urinary tract anti-infective agents.

Classification

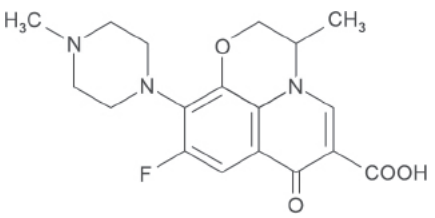
1. **Quinolone derivatives**
   For example, norfloxacin, ciprofloxacin, moxifloxacin, ofloxacin, lomefloxacin.
2. **Naphthyridine derivatives**
   For example, nalidixic acid, enoxacin
3. **Cinnoline derivatives**
   For example, cinoxacin.
4. **Miscellaneous**
   For example, methenamine, nitrofurantoin, furazolidine.

2 Give the details of 'ofloxacin' as urinary tract anti-infective agent.

☞ **Ofloxacin**

Ofloxacin is a synthetic fluonoquinolone antibiotic.

Structure



Chemical Name

9-Fluoro-2,3-dihydro-3-methyl-104(4-methyl-1-piperazin-yl)-7-oxo-7H-pyrido[1, 2, 3-de]-1,4,-benzoxazine-6-carboxylic acid.

Properties

1. It occurs as a pale yellow or bright yellow, crystalline powder.
2. It is soluble in glacial acetic acid.
3. It is slightly soluble in water, dichloromethane and methanol.

Stability and Storage

It should be stored at room temperature and should be kept away from light and moisture.

Uses

1. It is useful in the treatment of genitourinary, respiratory, gastrointestinal infections.
2. It is used in the treatment of bronchitis and pneumonia.
3. It is used for the treatment of pelvic inflammatory disease.
4. It is useful for the treatment of acute gonococcal urethritis.
5. Used for the treatment of prostatitis caused by *E. coli.*
6. It is used for infections of skin and soft tissues.

Pharmaceutical Formulations

1. Ofloxacin tablets IP
2. Ofloxacin oral suspension IP
3. Ofloxacin ophthalmic solution IP
4. Ofloxacin infusion IP

Brand Names

Oflox, Exocin, Zenflox, Zanocin, Tarivid.

Dose

200–400 mg daily.

3 Give the properties, stability and storage, uses, formulations, brand names of the following drugs: (a) Norfloxacin (b) Ciprofloxacin (c) Moxifloxacin.

☞ (a) Norfloxacin

Norfloxacin is a quinolone derivative.

Properties

1. It is a white to pale yellow, crystalline powder.
2. It has melting point of 221°C.
3. Its molecular weight is 319.34.

Stability and Storage

It is stored in a tightly closed light resistant container.

Uses

1. It is used as antibacterial agent.
2. It is used to treat urinary tract infections.
3. It is used to treat gynaecological infections.
4. It is used for the treatment of inflammation of prostate gland, gonorrhoea and bladder infection.
5. It is used to treat bacterial diarrhoea.

Pharmaceutical Formulations

1. Norfloxacin tablets IP
2. Norfloxacin suspension.
3. Norfloxacin eye drops IP

Brand Names

Norflox, Uroflox, Actiflox, Alflox, Bacigyl, Norilet, Norbactin.

Dose

400–800 mg daily in divided doses.

(b) Ciprofloxacin

Ciprofloxacin is an antibiotic used to treat a number of bacterial infections.

Properties

1. It is a pale yellow, crystalline in nature.
2. It is slightly hygroscopic powder.
3. It is slightly soluble in methanol.
4. It is very slightly soluble in ethanol but insoluble in acetone, ethyl acetate and methylene chloride.
5. It dissolves in acetic acid.

Stability and Storage

It should be stored in tight and light resistant containers at 2–25°C.

Uses

1. It is used for the treatment of urinary tract infection, prostatis and acute diarrhoeal disease caused by *E. coli*, *Shigella*, *Salmonella*.
2. It is used for the treatment of gonococcal urethritis, chancroid.
3. Used to treat infections of skin, soft tissues, bones and joints.
4. Used for the treatment of respiratory tract infections.
5. Also used for controlling bronchitis and pneumonia.

Pharmaceutical Formulations

1. Ciprofloxacin tablets IP.
2. Ciprofloxacin injection IP.
3. Ciprofloxacin eye drops IP.

Brand Names

Cilox, Cifran, Ciprobid, Ciprolet, Alcipro, Zoxan

Dose

250–750 mg twice daily.

(c) Moxifloxacin

It is a synthetic fluoroquinolone antibiotic.

Properties

1. It is a slightly yellow crystalline powder.
2. It is soluble in water.
3. It is slightly hygroscopic.

Stability and Storage

It is stored in tightly closed containers protected from light and moisture.

Uses

1. Moxifloxacin is primarily used for pneumonia.
2. It is used in the treatment of conjunctivities endocarditis, tuberculosis and sinusitis.

Pharmaceutical Formulations

1. Moxifloxacin tablet.
2. Moxifloxacin eye drops (0.5%).

Brand Names

Moxicip, Moxeza, Moxoft, Avetox, Vigamox, Staxom, Milflox.

Dose

400 mg once daily.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. UTIs are most commonly caused by ***E. coli* bacteria**.
2. Ciprofloxacin is a **quinolone derivative**.
3. **Oflox** is a popular brand name of ofloxacin.
4. The daily dose of Norfloxacin is **400–800 mg daily in divided doses**.
5. Ciprofloxacin is an antibiotic used to treat number of **bacterial infections**.

Chapter
14

Antitubercular Agents

1 Name the causative organism of tuberculosis. Define and classify Antitubercular agents with examples. (W.23)

☞ **Tuberculosis**

Tuberculosis is a parasitic disease caused by *Mycobacterium tuberculosis.*

Antitubercular Agents

The drugs which are used for the treatment of tuberculosis are called antitubercular agents.

Classification of antitubercular agents

(A) **On chemical basis:**

1. P-amino salicylic acid and analogues, e.g. p-amino salicylic (PAS) acid.
2. Pyridine derivative, e.g. isoniazid, ethionamide.
3. Pyrazine derivative, e.g. pyrazinamide.
4. Ethylene diamine derivative, e.g. ethambutol.
5. Antibiotics, e.g. cycloserine, streptomycin, rifampicin.

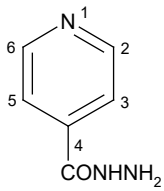
(B) **On the basis of clinical utility:**

1. **First-line drugs (standard drugs/primary drugs):** These are highly effective bactericidal agents, e.g. isoniazid, rifampin, pyrazinamide, ethambutol, streptomycin.
2. **Second-line drugs (reserve drugs/secondary drugs):** These drugs have either low antitubercular efficacy, e.g. capreomycin, kanamycin, cycloserine, ethionamide, PAS, thioacetazone.

2 Write a note on 'isoniazid' as antitubercular agent. (S.24, W.23)

☞ **Isoniazid (INH)**

Structure



Chemical Name

Iso-nicotinic acid hydrazide (INH) or pyridine 4-carboxazide

Properties

- It occurs as a white crystalline powder.
- It is odourless and has sweet taste.
- It is soluble in water.
- It is incompatible with aldehyde and ketone.

Stability and Storage

It is affected by light-hence it is stored in tightly closed light-resistant containers.

Uses

- It is used in the treatment of pulmonary tuberculosis.
- It is used in the treatment of meningitis and genitourinal infections.

Pharmaceutical Formulations

- Isoniazid tablet.
- Isoniazid elixir.
- Isoniazid and ethambutol tablets.
- Isoniazid and rifampicin tablets.
- Sodium salicylate and isoniazid granules/powder.
- Isoniazid injection.

Brand Names: Isonex, Isokin, Tubizid, Isovit, Cadizide, Isocadipas.

Dose: 300 mg once daily.

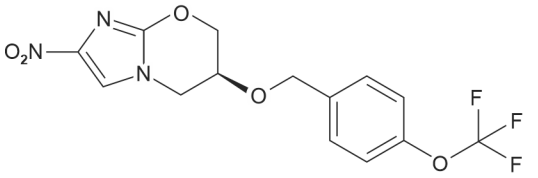
3 Give the structure, chemical name, properties, stability and storage, uses, pharmaceutical formulations, brand names of pretomanid.

☞ **Pretomanid**

- Pretomanid is an antimycobacterial agent that is administered with bedaquiline and linezolid to treat resistant forms of pulmonary tuberculosis.

- It was the first antitubercular drug developed by a non-profit organization, known as TB Alliance and was granted FDA approval on 14th August 2019.

Structure



Chemical Name

(6S)-2-nitro-6-[[4-(trifluoro methoxy) phenyl]methoxy]-6, 7-dihydro-5H-imidazo[2, 1-b] [1, 3] oxazine.

Properties

1. It is white to yellow coloured crystalline powder.
2. It is practically insoluble in water.

Stability and Storage

It should be stored at room temperature below 30°C.

Uses

It is used to treat following disease conditions:

(a) Non-responsive pulmonary multi-drug resistant tuberculosis.
(b) Pulmonary extensively drug-resistant tuberculosis.
(c) Treatment intolerant pulmonary tuberculosis.

Pharmaceutical Formulations

Pretomanid tablet.

Brand Name: Dovprela.

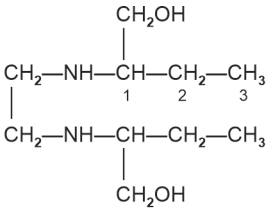
Dose: 100–200 mg daily.

4 Give the properties, storage, uses, pharmaceutical formulations, brand names of the following antitubercular drugs.

(a) Ethambutol, (b) Para-amino salicylic (PAS) acid, (c) Pyrazinamide, (d) Rifampicin, (e) Bedaquiline, (f) Delamanid.

☞ (a) Ethambutol (Ethylenediamine derivative)

Structure



Bis (1-hydroxy methyl, propyl) ethylene diamine

Properties

- It occurs as a white crystalline powder.
- It is odourless, bitter in taste and hygroscopic in nature.
- It is soluble in water and alcohol and insoluble in chloroform and ether.
- A solution of ethambutol in water is dextrorotatory.

Stability and Storage

It should be stored in a well tightly closed container and protected from light.

Uses

- It is a tuberculostatic agent.
- It is used in the treatment of pulmonary tuberculosis.

Pharmaceutical Formulations

1. Ethambutol HCl tablet BP, IP.
2. Ethambutol powder.

Brand Names

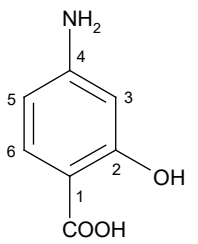
E-tibi, Mycobutol, Combutol, Zytham, Albutol, Myambutol.

Dose

15 mg/kg per day.

(b) Para-amino Salicylic (PAS) Acid

Structure



Chemical Name

4-amino, 2-hydroxy benzoic acid.

Properties

- It occurs as a white or yellowish white crystal.
- It is odourless and has slightly acidic taste.
- It is slightly soluble in water.
- Its sodium salt is very soluble in water.

Stability and Storage

It darkens on exposure to air and light. Hence, it is stored in tightly closed light-resistant containers.

Uses

- It is a bacteriostatic.
- It is used in the treatment of tuberculosis.

Brand Names

Benzapar, Idipas, Parasal, Monopas, Paser, Isopar, Benzapas.

Pharmaceutical Formulations

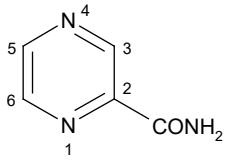
- Calcium aminosalicylate tablet IP.
- Sodium aminosalicylate tablet IP.
- Sodium aminosalicylate granules IP.
- Amino salicylic acid tablets.
- Amino salicylate potassium tablets.
- Benzoyl PAS calcium tablets.

Dose

10–12 g per day in divided doses.

(c) Pyrazinamide

Structure



Chemical Name

Pyrazine-2-carboxamide or 2-carbamoyl pyrazine

Properties

- It occurs as a white crystalline powder.
- It is odourless and has slightly bitter taste.
- It is sparingly soluble in water but soluble in ether and chloroform.

Stability and Storage

It is stored in a tightly closed light-resistant container.

Uses

It is used as a tuberculostatic.

Pharmaceutical Formulations

Pyrazinamide tablet IP, BP.

Brand Names

Zinamide, Pyrina, PZA ciba, Pyride, Pyrina-500.

(d) Rifampicin

Properties

- It occurs as a brick red crystalline powder.
- It is odourless.
- It is very slightly soluble in water.
- It is soluble in chloroform.
- It is unstable in the presence of moisture.

Stability and Storage

Rifampicin is unstable in the presence of moisture. It is affected by light, air and oxygen. Hence it is stored in tightly closed light resistant containers in an atmosphere of nitrogen and a temperature not exceeding 15°C.

Uses

It is used to treat:

- Tuberculosis.
- Bacillary dysentery.
- Meningitis.

Pharmaceutical Formulations

- Rifampicin capsules
- Rifampicin oral suspension BP.

Brand Names

Rimpin, Rimpacin, R-cin, Monocin

(e) Bedaquiline

Bedaquiline is a diarylquinoline antimycobacterial used in combination with other antibacterials to treat pulmonary multidrug resistant tuberculosis (MDR-TB).

Properties

1. It is a white powder.
2. It is insoluble in water.

Stability and Storage

It is stored in tightly closed containers protected from light and moisture.

Uses

It is used as a part of combination therapy in adults with pulmonary multidrug resistant tuberculosis (MDR-TB).

Pharmaceutical Formulation

Bedaquiline tablet.

Brand Names

Sirturo.

Dose

400–600 mg per day.

(f) Delamanid

Delamanid is an antitubercular agent derived from the nitro-dihydro-imidazo-oxazole class of compound.

Properties

1. It is a white to pale yellow crystals or crystalline powder.
2. It is practically insoluble in water.
3. It is slightly soluble in methanol.

Stability and Storage

It is stored at room temperature below 25°C.

Uses

1. Delamanid is used along with other antitubercular medications for active multidrug resistant tuberculosis.
2. It is given in combination with linezolid, levofloxacin, and pyrazinamide.

Pharmaceutical Formulation

Delamanid tablet.

Brand Name

Deltyba

Dose

100 mg per day

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Streptomycin** was the first aminoglycoside antibiotic introduced in chemotherapy in 1944 by Waskmann.
2. **Isoniazid, Rifampicin, Ethambutol** is first-line drugs for Chemotherapy of TB.
3. Rifampicin is used in treatment of **Tuberculosis, Leprosy, and Brucellosis**.
4. In *Mycobacterium avium*-complex (MVA) infection, **Ethambutol** is given.
5. **Isoniazid** is a first-line drug used in the treatment of tuberculosis.
6. PAS means **Para Amino Salicylic acid**.
7. Pretomanid is an **antimycobacterial agent**.
8. The dose of isoniazid is **300 mg once daily**.
9. The causative organism of tuberculosis is ***Mycobacterium tuberculosis***.
10. 4-amino, 2-hydroxy benzoic acid is a chemical name of **PAS**.

Chapter
15

Antiviral Agents

1 Define and classify antiviral drugs with examples.

☞ **Antiviral Agents:**

The drugs which are used in the treatment of viral infections are called antiviral agents.

Classification of antiviral drugs:

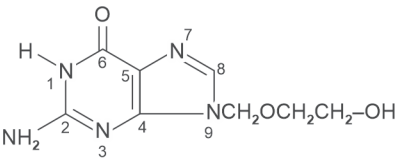
1. **Drugs acting as anti-herpes virus**
   For example, Idoxuridine, acyclovir, favipiravir, foscarnet.
2. **Drugs acting as anti-influenza virus**
   For example, Amantidine
3. **Drugs acting as anti-hepatitis virus**
   For example, Ribavirin
4. **Drugs acting as anti-retrovirus**
   For example, Zidovudine (AZT)

2 Give the details of "Acyclovir" as antiviral agent.

☞ **Acyclovir**

Acyclovir is a synthetic analogue of the purine nucleoside, guanosine with potent antiviral activity against herpes simplex viruses type 1 and 2, varicella-zoster virus and other viruses of the herpes virus family.

Structure



Chemical Name

2-amino-9-(2-hydroxyethoxymethyl) purine-6-olate, or 2-amino-9-[(hydroxyethoxy) methyl]-1, 9, dihydro-6H-purin-6-one.

Properties

1. It is a white or almost white crystalline powder.
2. It is slightly soluble in water.
3. It is soluble in dimethyl sulphoxide and dilute mineral acids.
4. It is very slightly soluble in ethanol.

Stability and Storage

It should be stored at room temperature and protected from light and moisture.

Uses

1. It is used as antiviral agent against herpes viruses.
2. It has been approved for short-term treatment of chickenpox.
3. Oral acyclovir is used in the initial treatment of genital herpes and to control mild recurrent episodes.
4. It shows antiviral activity against varicella-zoster virus.

Pharmaceutical Formulations

1. Acyclovir tablet IP
2. Acyclovir oral suspension IP
3. Acyclovir intravenous infusion IP
4. Acyclovir sodium intravenous infusion.
5. Acyclovir cream IP
6. Acyclovir eye ointment IP

Brand Names

Acivir, Ocuvir, Herpex-200, Cyclovir, Zovirax, Aciv, Aciherpin.

Dose

200–800 mg, 4–5 times daily.

3 Give properties, stability and storage, uses, pharmaceutical formulations. Brand names of the following antiviral drugs:

(a) Amantidine, (b) Idoxuridine, (c) Foscarnet, (d) Zidovudine, (e) Ribavirin, (f) Remdesivir, (g) Favipiravir

☞ (a) Amantidine

It is a synthetic tricyclic amine which prevents replication of influenza virus.

Properties

1. It is a white crystalline powder.
2. It sublimes when heated.
3. It is soluble in water and in alcohol.
4. Chemically it is adamantan-1-amine.

Stability and Storage

It undergoes decomposition at 360°C. It is stable in light, heat and air. It should be stored in a tightly closed containers at room temperature (15–30°C)

Uses

1. It is used as an antiviral drug.
2. It is used in the treatment of various strains of influenza A virus.
3. Amantidine is used in the treatment of Parkinson's disease.
4. It is also used as a dapamine receptor agonist.
5. Amantidine is used for the treatment of many prototypes of influenza A virus (H_1N_1, H_2N_2, Asian type, H_3N_2)
6. Amantidine is used for the treatment of cerebral arteriosclerosis.
7. It is used to relieve fatigue.

Pharmaceutical Formulations

1. Amantidine tablet.
2. Amantidine capsule.
3. Amantidine syrup.
4. Amantidine solution.

Brand Names

Amantrel, Camantral, Neaman, Osmolex.

Dose

100–200 g daily in two divided doses.

(b) Idoxuridine

- It was the first pyrimidine antimetabolite to be used of antiviral drug.
- It is a nucleoside analogue of deoxyuridine and containing a halogenated pyrimidine.

Properties

1. It is white or almost white crystalline powder.
2. It is odourless.
3. It is slightly soluble in water and ethanol.
4. It is practically insoluble in ether.
5. It dissolves in dilute solutions of alkali hydroxides.

Stability and Storage

It should be stored in a tightly and light resistant container and stored between 2°C and 8°C.

Uses

1. It is an antiviral agent against herpes virus.
2. It is used for topical treatment of herpes keratitis.
3. It is used for the treatment of herpes labialis, gentalis and zoster.
4. It is used for the topical treatment of herpes simplex virus (HSV) keratitis.
5. It is used in ophthalmic for the treatment of HSV kerato-conjunctivitis.

Pharmaceutical Formulations

1. Iodoxuridine ophthalmic solution.
2. Iodoxuridine ophthalmic ointment.
3. Iodoxuridine eye drops IP.

Brand Names

Idrin, Xurin, Herplex, Dendrid, Toxil.

(c) Foscarnet

- Foscarnet is a selective inhibitor of viral DNA polymerase that inhibits replication in herpes viruses.
- Foscarnet can act synergistically with nucleoside triphosphate antimetabolite in the inhibition of viral DNA synthesis.
- The chemical name of foscarnet sodium is phosphonoformic acid, trisodium salt.

Properties

1. It is a white crystalline powder.
2. It is soluble in water.
3. It is practically soluble in ethanol.
4. Its molecular weight is 300.1.

Stability and Storage

It is stored in tightly closed containers protected from light and moisture. It should be stored between 20°C and 25°C.

Uses

1. Foscarnet is used to treat cytomegalovirus (CMV) in retinitis in people with AIDS.
2. Foscarnet is also used to treat herpes simplex virus (HSV) in people with a weak immune system.
3. Foscarnet is used to control opportunistic infections in patients with AIDS.

Pharmaceutical Formulations

Foscarnet sodium intravenous infusion BP.

Brand Name

Foscavir.

(d) Zidovudine (Azidothymidine)

- It is a deoxythymidine analogue and is reverse transcriptase inhibitor.

Properties

1. It is an odourless, off-white powdered solid.
2. It is soluble in ethanol and in methanol.
3. It is sparingly soluble in water.

Stability and Storage

It is a heat and light sensitive, hence it should be protected from light and stored at room temperature.

Uses

1. It is an effective antiviral drug.
2. Zidovudine is effective against HIV-1, HIV-2, HTLV-1 and many other retroviruses.
3. Zidovudine is useful in treatment of symptomatic HIV infections.
4. Zidovudine is also used in anaemia in AIDS patients.
5. Zidovudine is a drug choice for post-exposure prophylaxis of HIV, as well as for mother off-spring transmission.

Pharmaceutical Formulations

1. Zidovudine tablets IP.
2. Zidovudine capsules IP.
3. Zidovudine syrup.
4. Zidovudine oral solution IP.
5. Zidovudine injection IP.
6. Zidovudine, lamivudine and nevirapine tablets IP.

Brand Names

Retrovir, Zidovir, Viro-Z, Zydowin, Zidomax.

Dose

300 mg twice daily.

(e) Ribavirin

- Ribavirin is a broad spectrum direct antiviral agents.
- Ribavirin is efficient both *in vitro* and *in vivo* against several RNA or DNA viruses.
- Ribavirin inhibits the replication of a very wide variety of RNA and DNA viruses.

Properties

1. It is a white crystalline powder.
2. It is soluble in water.
3. It is slightly soluble in ethanol and in methylene blue.
4. It is very slightly soluble in dichloromethane.

Stability and Storage

It should be stored in a tightly closed container protected from light.

Uses

1. Ribavirin is used in the treatment of influenza type-A and type-B, hepatitis, genital herpes and Lassa fever.
2. It is used for treatment of severe lower respiratory infections caused by RSV.
3. Oral ribavirin is used in chronic hepatitis C.
4. Nebulized ribavirin is used for respiratory syncytial virus, bronchitis in infants and children, particularly those with congenital heart disease.

Pharmaceutical Formulations

1. Ribavirin syrup.
2. Ribavirin capsule.
3. Ribavirin inhalation solution IP.
4. Ribavirin powder to be reconstituted in an aqueous aerosol.

Brand Names

Ribavin virazole, virazide, Rebetol, Ibavyr.

(f) Remdesivir

- Remdesivir is a prodrug of an adenosine triphosphate (ATP) analogue.
- Remdesivir has potential antiviral activity against a variety of RNA viruses.
- Remdesivir is first described in the literature in 2016 as a potential treatment of Ebola.
- Remdesivir being a prodrug, is metabolized into its active form GS-441524.

Properties

1. It is a white or off-white crystalline powder.
2. It is soluble in DMSO, ethanol.
3. It is insoluble in water.

Stability and Storage

It is stored in tightly-closed containers protected from light and moisture.

Uses

1. Remdesivir is used for the treatment of coronavirus disease 2019 (COVID-19) infection requiring hospitalization.
2. It is useful for the treatment of SARS-COV-2 virus in hospitalized adult and children 12 years of age.
3. Remdesivir is an antiviral drug.
4. Remdesivir helps to stop the spread of the virus throughout the body.
5. Remdesivir is used as a potential treatment of Ebola.
6. Remdesivir activity against the coronaviridae family was first demonstrated in 2017, for the treatment of COVID-19.

Pharmaceutical Formulations

1. Remdesivir injection.
2. Remdesivir lyophilized powder for reconstitution.

Brand Names

Covifor, Veklury, Redyx, Cipremi, Remdac.

Dose

By I.V., 200 mg as a single dose on day 1, followed by 100 mg once daily. Duration is generally 5 days.

(g) Favipiravir

- Favipiravir is a pyrazine carboxamide derivative with activity against RNA viruses.
- It is an antiviral drug used to manage influenza that has the potential to target other viral infections.
- Favipiravir is known to be teratogenic, therefore, should be avoided in pregnancy conditions.
- Favipiravir is extensively metabolized with metabolities exerted mainly in the urine.

Properties

1. It occurs as a white crystalline powder.
2. It is slightly soluble in water.
3. It has melting point 187–193°C.

Stability and Storage

It is stored in a tightly closed container protected from light and air.

Uses

1. Favipiravir is an antiviral drug used to manage influenza.
2. Used in the treatment of avian influenza.
3. Recently favipiravir is used in COVID-19 infection and has the potential to target other viral infections.

Pharmaceutical Formulations

1. Favipiravir tablet.

Brand Names

Avifavir, Areplivir, Avigan, Favimed, BAL Flu

Dose

1800 mg orally twice daily for COVID-19.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Idoxuridine is an **antiviral drug**.
2. **Ribavirin** is a drug used as anti-hepatitis virus.
3. Acyclovir is an antiviral drug used against **herpes viruses**.
4. Zidovudine is effective against **HIV**.
5. Remedesivir is used for the treatment of **COVID-19 infections**.

Chapter
16

Antimalarials

1 What is malaria? Give the causative agents of malaria.

☞ **Malaria:**

- Malaria is a mosquito-born disease caused by the malarial parasite (*Plasmodium*) which belongs to class protozoa.
- Malaria is transmitted through a bite of female anopheles vector and the host is human being.
- Malaria is caused by four *Plasmodium* species, namely:
  i. *Plasmodium vivax*.
  ii. *Plasmodium falciparum.*
  iii. *Plasmodium malariae.*
  iv. *Plasmodium ovale.*
- The symptoms of malarial infections are:
  - Chills followed by fever, anaemia.
  - Enlargement of liver.
  - Body pains and sweating.
- *Plasmodium falciparum* causes severe and fatal form of malaria. It destroys a large number of blood cells causing anaemia. It also penetrates the tissue of organs like brain, spleen, kidney, etc. penetration in brain tissue may be fatal.
- The main important protozoal diseases of man are: Amoebiasis, malaria, trypanosomiasis, Chagas disease, trichomoniasis, leishmaniasis, giardiasis.

2 Define and classify antimalarial drugs with suitable examples. (S.23, W.23)

☞ **Antimalarials:**

The drugs which are used for prevention and treatment of malaria are called antimalarials.

Classification of antimalarials:

(I) On the Basis of Site of Action:

(a) **Sporonticide (Sporozoitocides):** These are effective sporozoites, e.g. pyrimethamine.

(b) **Tissue schizonticides:** These are effective at pre-erythrocytic stage, e.g. primaquine, proguanil, pyrimethamine.

(c) **Blood schizonticides:** These are effective at erythrocytic stage.

(i) **Fast-acting schizonticides,** e.g. quinine, chloroquine, amodiaquine.

(ii) **Slow-acting schizonticides,** e.g. proguanil, pyrimethamine.

(d) **Gametocides:** These drugs are effective gametes, e.g. primaquine, quinine.

(II) On Chemical Basis:

- Cinchona alkaloids, e.g. quinine.
- 4-aminoquinoline derivatives, e.g. chloroquine, amodiaquine, mefloquine.
- 8-aminoquinoline derivaties, e.g. primaquine.
- 9-amino acridine derivatives, e.g. mepacrine.
- Biguanide derivative, e.g. proguanil.
- 2,4-diaminopyrimidine derivatives, e.g. pyrimethamine, trimethoprim.
- Miscellaneous:

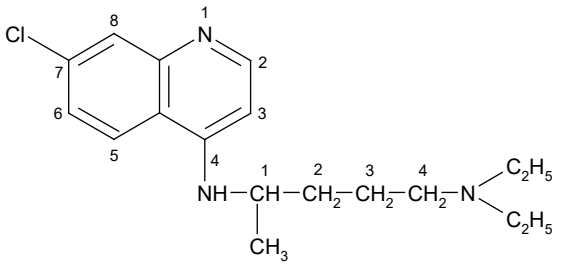
i. Sulphonamides, e.g. protonsil.

ii. Sulphones, e.g. dapsone.

3 Give the structure, chemical name, properties, stability and storage uses, pharmaceutical formulations, Brand names of the following antimalarials: (a) Chloroquine, (b) Mefloquine.

☞ (a) Chloroquine (4-aminoquinoline derivative) (S.23, W.22, 23)

Structure



Chemical Name

7-chloro 4 (4-diethyl amino-1-methyl butylamino) quinoline

Properties

- It is a white crystalline powder.
- It is odourless and has a bitter taste.
- It is freely soluble in water but slightly soluble in chloroform.

Storage

It is discoloured in the presence of sunlight and hence it is stored in well-closed, light-resistant container.

Uses

- It is used in the treatment of malaria.
- It is also used to treat hepatic amoebiasis.
- It is used to treat giardiasis.
- It is used to treat rheumatoid arthritis.

Pharmaceutical Formulations

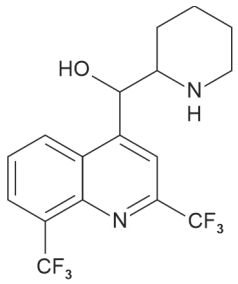
- Chloroquine phosphate tablet.
- Chloroquine phosphate injection.
- Chloroquine sulphate tablet.
- Chloroquine sulphate injection.
- Hydroxychloroquine sulphate tablet.

Brand Names

Ciplaquin, Nivaquin, M-quin, Resochin.

(b) Mefloquine

It is the newer 4-amino quinoline derivative.



Chemical Name

(R S) - [2,8-bis 13 (trifluoro methyl) quinolone-4-yl] [(2SR) piperdin 2-yl] methanol hydrochloride.

Properties

1. It is a white or slightly yellow crystalline powder.
2. It is soluble in ethanol, and in ethylacetate.
3. It is slightly soluble in water.

Stability and storage

It is stored in tightly-closed container protected from light.

Uses

1. Mefloquine is an antimalarial effective against *P. falciparum*.
2. Mefloquine may inhibit merozoite invasion.
3. Mefloquine is used for prophylaxis of malaria among travellers to areas with multidrug resistance.
4. Mefloquine is effective against chloroquine-resistant forms of *Plasmodium falciparum*.

Pharmaceutical Formulations

Mefloquine Tablets IP.

Brand Names

Mefque, Facital, Lariam, Confal

Dose

5 mg/kg per week.

4 Give the details of the following antimalarial drugs: (a) Quinine sulphate, (b) Primaquine phosphate, (c) Cycloguanil, (d) Pyrimethamine, (e) Artemisinin

☞ (a) Quinine Sulphate

- Quinine is the chief alkaloid of cinchona bark (fever bark).
- Quinine was the first drug having significant antimalarial activity.

Properties

- It occurs as a white, microcrystalline powder.
- It is odourless and intensely bitter in taste.
- It is slightly soluble in ether and chloroform.
- Quinine sulphate is slightly soluble in water.

Storage and Stability

It should be stored in a tightly closed container, protected from light.

Uses

1. It is a highly active blood schizonticide and is also gametocide.
2. It is used as antimalarial agent.
3. It is used to treat severe and complicated malaria caused by *P. falciparum*.
4. It is used to treat cerebral malaria.
5. It is used to relieve muscle cramps in myotonia congenita.
6. It is used as a sclerosing agent with urethane.

Pharmaceutical formulations

1. Quinine sulphate tablets IP.
2. Quinine hydrochloride tablets.
3. Quinine dihydrochloride injection IP.

Brand Names

Vigotab, flue-foe, Qualaquin, Quinarsol-300, Cinkona.

(b) Primaquine Phosphate

It is 8-amino-quinoline derivative.

Properties

1. It is an orange-red-crystalline powder.
2. It is odourless and has a bitter taste.
3. It is soluble in water.
4. It is practically insoluble in alcohol.

Stability and Storage

It is affected by light and moisture, hence it is stored in well-closed light-resistant containers protected from moisture.

Uses

1. It is mainly used for a radical cure of *P. vivax* infection in conjunction with chloroquine.
2. It is an antimalarial having tissue schizonticide and gametocide activity.

Pharmaceutical Formulations

Primaquine tablets.

Brand Names

Aralon, Primalex, Leoprime, Malirid.

(c) Cycloguanil

- Cycloguanil is the active metabolite of proguanil.
- Cycloguanil is a dihydrofolate reductase inhibitor.
- Cycloguanil (proguanil) intereferes with deoxythymidylate synthesis by inhibiting dihydrofolate reductase.

Stability and Storage

It is stored in tightly-closed container protected from light.

Uses

1. It is used for malarial prophylaxis alone or in combination with chloroquine.
2. Its combination with atovaquone as a fast-acting erythrocyte schizonticide for the treatment of multidrug-resistant falciparum malaria.
3. It is used as a clinical curative for vivax malaria.

Pharmaceutical Formulation

Proguanil tablet.

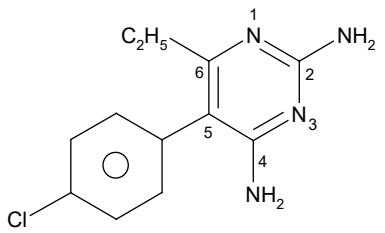
Brand Names

Progumal, Paluride, Micromedex, Malarone.

(d) Pyrimethamine

It is a 2,4-diaminopyrimidine derivative.

Structure



Chemical Name

2,4-diamino, 5 (p-chlorophenyl) 6-ethyl pyrimidine

Properties

- It is a white crystalline powder.
- It is odourless and tasteless.
- It is practically insoluble in water.
- It is soluble in warm dilute mineral acids.

Storage

It should be stored in a tightly closed, light-resistant containers.

Uses

- It is used in the treatment of malaria.
- It is used to treat toxoplasmosis.

Preparations

- Pyrimethamine tablet IP, BP.
- Pyrimethamine and sulphadoxine injection.
- Pyrimethamine and sulphadoxine tablet.

Brand Names

Daraprim, Pyralfin, Onli-2.

Dose

25–50 mg per day.

(e) Artemisinin

- Artemisinin is derived from the leaves and flowers of the annual mugwort (*Artemisia annua*).
- Artemisinin is used in traditional Chinese medicine for centuries.
- Artemisinin, its semisynthetic derivatives are collectively known as Artesunate and Artemether.
- Artemisinin is a sesquiterpene lactone obtained from sweet worm wood, *Artemisia annua*.

Properties

- It is soluble in organic solvents such as ethanol, DMSO and DMR.
- Artemisinin is sparingly soluble in aqueous buffers.

Stability and Storage

It is stored in well-closed container.

Uses

1. Used as antimalarial agent.
2. In treatment of schizophrenia.

3. Useful to treat parasitic worms (Helminths)
4. Artemisinin has a clinical impact potential in treatment of COVID-19.

Pharmaceutical Formulations

1. Artemisinin tablets.
2. Artemisinin capsule.
3. Artemisinin extract powder.

Brand Names

Antoxipan, Vinilex Ivermectin.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Malaria is a **mosquito-born** disease.
2. **Quinine** is blood schizonticide.
3. Chloroquine is a **4-aminoquinoline derivative**.
4. M-quin and Resochin are the popular brand names of **Chloroquine**.
5. **Quinine** is chief alkaloid of Cinchona bark.
6. Mefloquine is an antimalarial effective against ***P. falciparum***.
7. Primaquine is an **8-amino quinoline derivative**.
8. Vigotab is a popular brand name of **Quinine**.
9. Artimisinin is used as an **antimalarial**.
10. Malaria is caused by ***Plasmodium*** species.

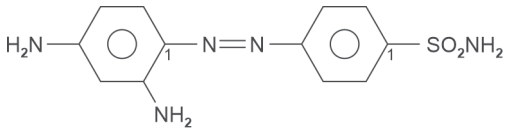
Chapter
17

Sulphonamides

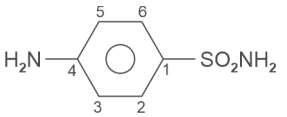
1 What are sulphonamides? Explain the structures of sulphanilamide and para-aminobenzoic acid (PABA).

☞ **Sulphonamides:**

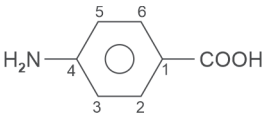
- Sulphonamides are the antibacterial agents containing sulphonamido group ($-SO_2\ NH_2$) and are the derivatives of sulphanilamide.
- They are also called sulpha drugs.
- The first sulphonamide was trade named protonsil, which is first commercially available antibacterial drug.
- **Structure of protonsil:**



- **Structure of sulphanilamide and PABA:**



(P-amino benzene sulphonamide)
A. Sulphanilamide



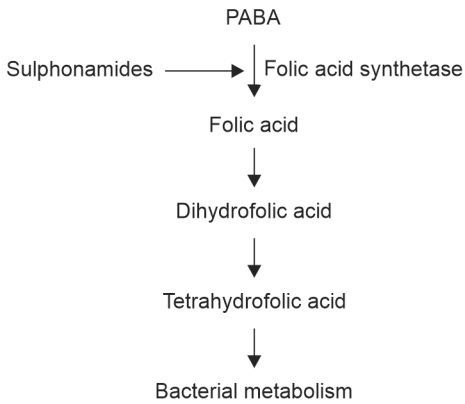
(Para-aminobenzoic acid)
B. PABA

- Paul Ehrlich is known as Father of Chemotherapy.

Mechanism of Action of Sulphonamides

- Sulphonamide has structural similarity to para-amino benzoic acid (PABA).
- Hence it competes with PABA in bacterial metabolism.
- Folic acid derived from PABA is important in bacterial metabolism.
- Sulphonamide inhibits the bacterial enzyme folic acid synthetase which is useful for conversion of PABA into folic acid.

- This causes folic acid deficiency resulting in injury to the bacterial cell.
- Such injured cells can be phagocytosed easily.



2 Define and classify sulphonamides giving suitable examples. (W.22)

☞ **Sulphonamides:**

"Sulphonamides are the antimicrobial compounds containing a sulphonamide group ($-SO_2NH_2$) and are the derivatives of sulphanilamide."

Classification of Sulphonamides

a. Sulphonamides are classified on chemical basis:

- N^1 substituted sulphonamides, e.g. sulphacetamide, sulphadiazine, sulphaguanidine, sulphamethoxazole.
- N^4 substituted sulphonamides, e.g. sulphasalazine.
- Both N^1 and N^4 substituted sulphonamides, e.g. phthalyl-sulphathiazole, succinylsulphathiazole.

b. As per therapeutic use sulphonamides are classified as:

- Used in eye infection, e.g. sulphacetamide.
- Used in intestinal infection, e.g. sulphaguanidine, succinylsulphathiazole, phthalylsulphathiazole.
- Used in urinary tract infection, e.g. sulphamethoxazole, trimethoprim, sulphadiazine.
- Used in respiratory tract infection, e.g. co-trimoxazole, sulphadiazine.
- Used in burn therapy, e.g. silver sulphadiazine, mefenide.

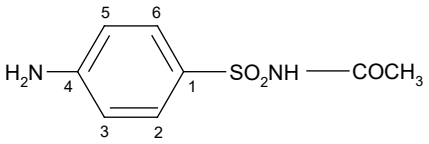
c. On the basis of duration of action:

1. **Short acting (4–8 hours) sulphonamides:**
   e.g. sulphadiazine, sulphathiazole, sulfisoxazole, sulphamethiazine, sulphasomidine, sulphamethizole.
2. **Intermediate acting (8–16 hours) sulphonamides:**
   e.g. sulphaphenazole, sulphamethoxazole.
3. **Long acting (1–7 days) sulphonamides:**
   e.g. sulphadimethoxine, sulphamethoxypyridazine.

3 Write the structures, chemical names, properties, uses, formulations and brand names of the following sulphonamides: (a) Sulphacetamide (b) Dapsone.

☞ (a) Sulphacetamide (Sulphonamide used in eye infection)

Structure



Chemical Name

N-acetyl sulphanilamide
OR
P-aminobenzene sulphonyl acetamide.

Properties

- It occurs as a white crystalline powder.
- It is soluble in water and alcohol.
- Aqueous solutions are acidic to litmus.
- It has a saline taste.

Storage

It should be stored in well-closed light-resistant containers.

Uses

- As antibacterial.
- It is used to treat eye infections.
- It is used to treat urinary tract infections.

Pharmaceutical formulations

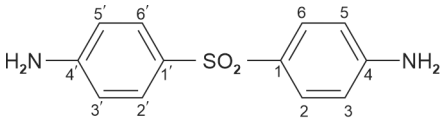
- Sulphacetamide eye drops.
- Sulphacetamide eye ointment.
- Sulphacetamide tablet.

Brand Names

Albucid, Nebasulf, Eycula.

(b) Dapsone Diaminodiphenylsulphone (DDS) (S.23)

Dapsone is a sulphone. The term sulphone is used for all the derivatives containing 4,4-diaminodiphenylsulphone. In this class the amino group of sulphamoyl group of sulphanilamide is replaced by p-aminophenyl group.



4,4' diaminodiphenylsulphone OR Bis (4-aminophenyl) sulphone

Properties

- It occurs as a white or creamy white crystalline powder.
- It is odourless and has slightly bitter taste.
- It is very slightly soluble in water and soluble in acetone and in dilute mineral acids.

Stability and Storage

It is stored in a well-closed light-resistant container.

Uses

- In the treatment of leprosy.
- It has suppressive action on malarial parasite.
- It is also used in the treatment of dermatitis.
- Combination of dapsone with pyrimethamine is used to treat pneumonia.

Pharmaceutical Formulations

- Dapsone tablet IP.
- Dapsone tablet BP.
- Dapsone tablet USP.

Brand Names

Dubronax, Novaphone, Aczone.

Dose

100 mg per day

4 What is co-trimoxazole? Give the properties, uses, mechanism of actions, formulations, brand names of co-trimoxazole, OR Write a note on co-trimoxazole. (S.22)

☞ Co-trimoxazole

Co-trimoxazole is a mixture of 5 parts of sulphamethoxazole and 1 part of trimethoprim.

The two components of co-trimoxazole interfere with the bacterial synthesis of tetrahydrofolic acid which is an essential stage in the production of nucleic acids.

Sulphamethoxazole inhibits the synthesis of dihydrofolic acid from PABA and trimethoprim inhibits the action of dihydrofolate reductase and prevents the synthesis of tetrahydrofolic acid from dihydrofolic acid.

Sulphamethoxazole (SMX)

- It is a sulphanilamide derivative.
- It is a white crystalline powder.
- It is odourless and has bitter taste.
- It is very slightly soluble in water.

Trimethoprim (TMP)

- It is a pyrimidine derivative.
- It is a white to yellowish powder.
- It is odourless and has bitter taste.
- It is very slightly soluble in water.

When sulphamethoxazole is given alone, a resistance develops to susceptible bacteria and needs higher doses.

Trimethoprim also develops resistance when given alone. When combination of these two drugs is used, the spectrum of antibacterial activity is increased.

This is due to synergistic effect.

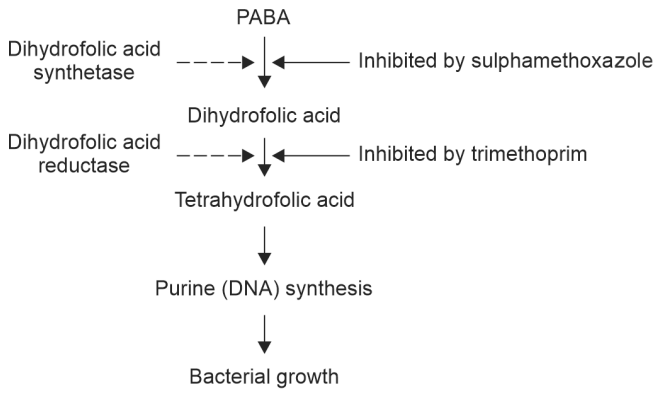
Uses of Co-trimoxazole

It is used in:

- Urinary tract infections.
- Respiratory tract infections like bronchitis, pneumonia.
- Meningitis.
- Enteric infections like typhoid and paratyphoid.
- Ear infections such as otitis media.

Mechanism of Action of Co-trimoxazole:

- PABA is essential for bacterial growth.
- Sulphamethoxazole and trimethoprim act synergistically by blocking the formation of folic acid and its utilisation. This combination is called co-trimoxazole (5 : 1).
- Sulphamethoxazole inhibits the conversion of PABA into dihydrofolic acid by inhibiting the enzyme dihydrofolic acid synthetase.
- Trimethoprim inhibits conversion of dihydrofolic acid into tetrahydrofolic acid by inhibiting the enzyme dihydrofolic acid reductase.
- Tetrahydrofolic acid (THF) is necessary in purine and DNA synthesis.
- So, co-trimoxazole inhibits both steps in bacterial metabolism and acts as antibacterial.



Stability and Storage

It is stored in tightly-closed containers protected from light and moisture.

Pharmaceutical Formulations

- Co-trimoxazole tablet
- Co-trimoxazole injection
- Dispersible co-trimoxazole tablet
- Paediatric co-trimoxazole tablet
- Paediatric co-trimoxazole mixture.

Brand Names

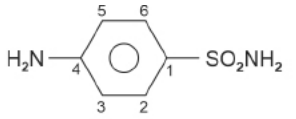
Ciplin-DS, Septran, Bactrim-DS (double strength), Bactrin-DS, Uritrim.

5 Write a note on sulphanilamide.

☞ **Sulphanilamide**

- Sulphanilamide was synthesized for the first time in 1908 by Austrian chemist Paul Josef Jakob Gelmo.

Structure



P-amino benzene sulphonamide

Sulphonamide group is attached to aniline known as sulphanilamide.

Properties

1. Sulphanilamide is a white powder.
2. It is soluble in water, glycerol.
3. It is insoluble in chloroform, ether, benzene, etc.

Stability and Storage

It is stored in a tightly-closed containers protected from light.

Uses

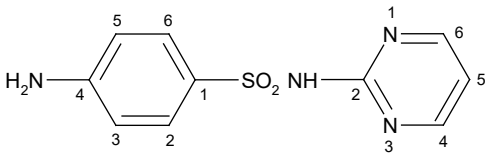
1. It is used as anti-infective/antibacterial.
2. It is used to treat vulvovaginal candidiasis caused by *Candida albicans, Trichomonas vaginalis,* and *Gardnerella vaginalis*.

Pharmaceutical Formulations

1. Sulphanilamide cream.
2. Sulphanilamide suppositories.

6 Describe the following sulphonamides in detail: (a) Sulphadiazine (b) Mafenide acetate.

☞ **(a) Sulphadiazine**



Chemical Names

2 (P-amino benzene sulphonamido) pyrimidine
OR
N^1-(Pyrimidin-2-yl) sulphanilamide

Properties

- It is a white crystalline powder.
- It is practically insoluble in water.
- It is soluble in solutions of alkali hydroxides and carbonates.
- It is slightly alkaline in taste.

Stability and Storage

It should be stored in a well tightly closed container and protected from light.

Uses

Sulphadiazine is used in the treatment of:

- Meningitis
- Burns
- Urinary tract infection
- Toxoplasmosis.

Pharmaceutical Formulations

Sulphadiazine tablet IP, BP.
Sulphadiazine sodium injection BP.

Brand Names

Pyrimol, Adiazine, Cotrizine, Trimozin, Atrina.

(b) Mafenide acetate

- Mafenide is a synthetic sulphonamide analogue of PABA with topical anti-infective activity.
- It is only used topically to inhibit a variety of gram-positive and gram-negative bacteria.

Properties

1. It is a white crystalline powder.
2. It is slightly soluble in water.
3. It is soluble in DMSO.

Stability and Storage

It is stored in a well-closed container.

Uses

1. Mafenide acetate is used in the treatment of slow-healing, infected wounds.
2. To treat burns.
3. It is used as topical antimicrobial agent to control bacterial infection when used under moist dressings.

Pharmaceutical Formulations

1. Mafenide acetate cream.
2. Mafenide acetate powder or solution.

Brand Name

Sulfamylon.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. Sulphonamide has structural similarity to **PABA**.
2. Sulphonamide used in eye infection is **Sulphacetamide**.
3. Sulphaguanidine is used to treat **GIT infections**.
4. Dapsone is a drug of choice in treatment of **Leprosy**.
5. **Co-trimoxazole** is a mixture of 5 parts of sulphamethoxazole and 1 part of trimethoprim.

Chapter
18

Antibiotics

1 Define and classify antibiotics giving examples. (S.22, 24, W.22, 23)

☞ **Antibiotics**

Antibiotics are chemical substances produced by living organisms, which are capable of inhibiting the growth of other microorganisms, in small concentration.

☞ **Classification of Antibiotics**

(A) On the basis of Spectrum of Antimicrobial Activity:

a. Narrow Spectrum Antibiotics

The antibiotics which are selectively effective on gram +ve or gram –ve bacteria or fungi or yeast are called narrow spectrum antibiotics. For example, bacitracin, nystatin, benzyl penicillin.

b. Broad Spectrum Antibiotics

The antibiotics which are effective on a large number of pathogens, not only gram +ve and gram –ve bacteria but also affect the intracellular organisms like viruses and rickettsiae are called broad spectrum antibiotics. For example, tetracyclines, chloramphenicol, streptomycin, penicillins.

(B) On the basis of Chemical Structure/Lactam Ring:

a. β-lactam Antibiotics

For example, benzyl penicillin, benzathin penicillin, ampicillin, phenoxymethyl penicillin, cloxacillin, cephalexin, carbencillin, cephaloridine.

b. Nonlactam Antibiotics

i. Antibiotics containing hydronaphthacene ring, e.g. tetracyclines.

ii. Aminoglycoside antibiotics, e.g. streptomycin, neomycin, gentamycin, kanamycin.

iii. Macrolide antibiotics, e.g. erythromycin.
iv. Anthracycline antibiotics, e.g. actinomycin, daunorubicin.
v. Polyene macrolide antibiotics, e.g. nystatin, amphotericin B.
vi. Peptide antibiotics, e.g. bacitracin.
vii. Non-classifiable antibiotics, e.g. griseofulvin, chloramphenicol.
viii. Miscellaneous antibiotics, e.g. novobiocin, rifamycin.

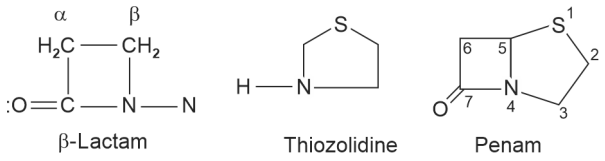
2 What are penicillins? Explain the basic structure of penicillin and 6-amino penicillanic acid (6-APA). What are β-lactam antibiotics?

☞ Penicillins

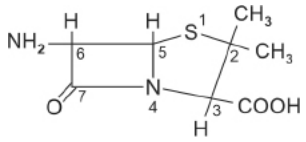
Penicillin is the first antibiotic discovered by Alexander Fleming. They are obtained from mould *Penicillium chrysogenum* and *Penicillium notatum.*

Penicillins contain β-lactam ring, a 4-membered cycle amide, fused with thiazolidine ring.

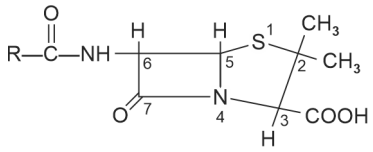
This gives bicyclic heterocyclic system called **penam.**



a. 6-Amino Penicillanic Acid (6-APA)

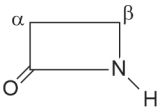


b. Basic Structure of Penicillins



☞ β-Lactam Antibiotics

- β-Lactam antibiotics are the antibiotics which contain a beta-lactam ring in their molecular structure, e.g. Penicillins, cephalosporins, cephamycins, carbapenems, carbacephems.
- β-lactam antibiotics are used in the management and treatment of bacterial infections.



β-lactam ring

- β-lactam is a cyclic amide with four atoms in its ring system.
- It is named as such because the nitrogen atom is attached to the beta-carbon atom relative to the carbonyl group in the four- membered ring.

3 Who is the founder of penicillin? Classify penicillins giving examples.

☞ Penicillin:

- Penicillin was discovered in 1929 by Alexander Fleming in England.
- It is extracted from the mould *Penicillium notatum* and *Penicillium chrysogenum*.

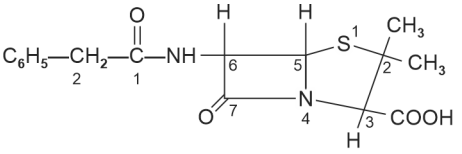
☞ Classification of Penicillins:

1. Natural penicillins, e.g. benzyl penicillin, phenoxymethylpenicillin.
2. Acid-resistant penicillins, e.g. ampicillin, cloxacillin, phenoxymethylpenicillin.
3. Penicillinase-resistant penicillins, e.g. oxacillin, cloxacillin, methicillin.
4. Broad spectrum penicillins, e.g. ampicillin, carbenicillin.
5. Penicilling effective against pseudomondas e.g. carbenicillin.

4 Give the structure chemical names, properties, uses and formulations of the following drugs: (a) Penicillin-G and (b) Amoxicillin.

☞ (a) Benzyl Penicillin (Penicillin-G) (S.23)

Structure:



Chemical Name:

6-(2-phenoxyacetamido) penicillanic acid

Properties

- It is a white, finely crystalline powder.
- It has faint characteristic odour.
- It is hygroscopic.
- It is very soluble in water.
- It is dextrorotatory.

Stability and Storage

If the moisture content of benzyl penicillin is less than 0.5%, then at room temperature it is stable for 2–3 years.

Hence, it is stored in tightly closed containers protected from moisture.

Uses

It is used to treat:

- Abscesses.
- Syphilis.
- Gonorrhoea.
- Pharyngitis, pneumonia, meningitis, endocarditis due to staphylococci.
- Pneumonia, endocarditis due to streptococci.
- Pneumococcal infection.
- Tetanus, diphtheria, anthrax.
- Otitis media.

Pharmaceutical Formulations

- Benzyl penicillin injection.
- Benzyl penicillin eye drops.
- Benzyl penicillin eye ointment.
- Procaine penicillin injection.
- Fortified procaine penicillin injection.

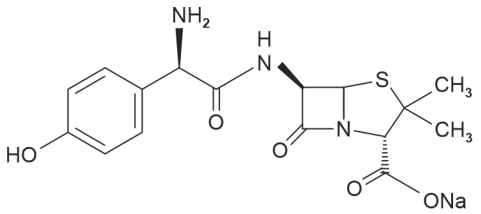
Brand Names

Novapen, Crystapen-G, Pentids, Benpen, Bicillin CR, Pfizerpen

(b) Amoxicillin (S.22, W.22, 23)

- It is a β-lactam antibiotic of penicillin group.
- It is a semisynthetic derivative of penicillin.

Structure:



Chemical Name:

Sodium (6R) 6-(α-4-hydroxy phenyl D-glycylamino) penicillanate.

Properties

1. It is a white crystalline powder.
2. It is very soluble in water.
3. It is sparingly soluble in anhydrous ethanol.
4. It is very slightly soluble in acetone.

Stability and Storage

It is stored at room temperature betwen 20 and 25°C and is kept away from excess heat and moisture.

Uses

1. It is used to treat bacterial infections like bronchitis, middle ear infection, throat infection, pneumonia, skin infections and urinary tract infections.
2. It is effective against gram-negative bacteria.

Pharmaceutical Formulations

1. Amoxicillin capsule IP.
2. Amoxicillin injection IP.
3. Amoxicillin oral suspension IP.
4. Amoxicillin dispersible tablets IP.
5. Amoxicillin and potassium clavulanate tablets IP.
6. Amoxicillin and potassium clavulanate injection IP.
7. Amoxicillin tablet.

Brand Names

Amoxil, Amoxylin, Novamox, Mox, Polymox, Purimox, Larotid, Synamax, Trimox.

5 Write notes on: (a) Cloxacillin and (b) Streptomycin.

☞ (a) Cloxacillin

It is a semisynthetic penicillin.

Properties

1. It is white crystalline powder.
2. It is soluble in water, methanol, ethanol.
3. It is slightly hygroscopic.

Stability and Storage

It is stored at room temperature between 15 and 30°C and is kept away from light and moisture.

Uses

Cloxacillin is used to treat the following infections:

1. Respiratory tract infection.
2. Urinary tract infection.
3. Otitis media.
4. Endocarditis.
5. Bone and joint infections.
6. Septicaemia.
7. Meningitis.

Pharmaceutical Formulations

1. Cloxacillin capsules I.P.
2. Cloxacillin syrup I.P.
3. Cloxacillin injection I.P.

Brand Names

Ampiclox, Cloxin, Cloxa-A, Bioclox, Klox, Amclo.

(b) Streptomycin (Aminoglycoside antibiotic)

- Streptomycin was the first aminoglycoside antibiotics introduced in chemotherapy in 1944 by Waskman.
- Streptomycin was obtained/derived from *Streptomyces griseus*.
- Streptomycin is called aminoglycoside because its structure consists of amino sugar linked by glycosidic linkage.

- Streptomycin contains two strongly polar and basic guanidino groups and one weakly basic methyl amino group. Hence, it acts as triacidic base.
- Streptomycin is the first antibiotic active against tuberculi bacilli for the treatment of Tuberculosis in 1952.
- Streptomycin acts by binding the bacterial 30S ribosomal subunit.

Properties

1. It is white to off-white powder.
2. It is odourless.
3. It has slightly bitter taste.
4. It is very soluble in water but sparingly soluble in alcohol.
5. It is strongly basic in nature.

Stability and Storage

It is affected by moisture, light and heat and hence it is stored in well-closed containers protected from moisture and at a temperature not exceeding 30°C.

Uses

1. It is a broad spectrum aminoglycoside antibiotic and is antibacterial.
2. It is used to bacterial infections such as:
   - Tuberculosis
   - Pneumonia
   - Influenza
   - Plague
   - *Mycobacterium avium*-complex
   - Endocarditis
   - Brucellosis
   - Tubercular meningitis
   - Cholecystitis and peritonitis.

Pharmaceutical Formulations

1. Streptomycin tablets IP.
2. Streptomycin injection IP.

Brand Names

Streptomac, Ambistryn-S, Chlorostrep, Enterostrop, Lykastrep, Cipstryn.

6 What are tetracyclines? Give its source. Give the basic structure of tetracyclines. Classify tetracyclines giving examples.

☞ Tetracyclines

- Tetracyclines are broad spectrum antibiotics and are effective against gram +ve and gram –ve bacteria.
- Tetracyclines are octahydronaphthacene derivatives.
- The tetracyclines contain octahydrotetracene-2-carboxamide skeleton as structural unit.
- Tetracyclines are derived directly from bacterium known as *Streptomyces coelicolor*.
- In 1945, chlortetracycline (prototype) of tetracycline was discovered by Dr. Benjamin.
- 7-chlortetracycline (aureomycin) was the first member among tetracyclines. It was introduced in 1947, obtained from *Streptomyces aureofaciens*.
- Oxytetracycline (tetramycin) was produced by *Streptomyces rimosus*.

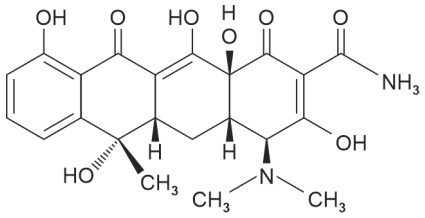
☞ Classification of Tetracyclines:

(a) Naturally occurring, e.g. chlortetracycline, oxytetracycline, demeclocycline.

(b) Semisynthetic, e.g. doxycycline, minocycline, rolitetracycline.

☞ Tetracycline

Structure:



Chemical Name:

4-(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,6,10,12,12a-Pentahydroxy-6-methyl-1,11-dioxonaphthacene-2-carboxamide.

Properties

- It is a yellow crystalline powder.
- It is odourless and has bitter taste.

- It is very slightly soluble in water and dilute acids.
- It is levorotatory.

Stability and Storage

- It darkens in strong sunlight and in presence of moisture. Hence, it is stored in tightly-closed, light-resistant containers.
- If it is used for parenteral preparation, the container should be sterile and sealed, so as to exclude the microorganism.

Uses

It is a broad spectrum antibiotic and is used to treat:

- Plague.
- Cholera.
- Syphilis, gonorrhoea.
- Chronic bronchitis.
- Amoebic dysentery.
- Chlamydial infection of eye.
- Urinary tract infection.
- Balantidiasis.
- Gram +ve, gram –ve and rickettsial infections.

Pharmaceutical formulations:

- Tetracycline tablet.
- Tetracycline capsule.
- Tetracycline injection.
- Tetracycline eye ointment.
- Tetracycline and procaine injection.
- Tetracycline intravenous injection.

Brand Names

Resticlin, Terramycin, Enterocycline, Achromycin.

7 Give the details of the following tetracyclines: (a) Doxycycline, (b) Minocycline.

☞ (a) Doxycycline

Doxycycline is a tetracycline antibiotics that is effective against bacterial infection.

Properties

1. It is yellow, crystalline powder.
2. It has a slightly ethanolic odour.
3. It is hygroscopic.

4. It is soluble in water.
5. It is practically insoluble in chloroform and in ether.
6. It is soluble in solution of alkali hydroxides and carbonates.

Stability and Storage

It is stored at room temperature in a tightly closed light-resistant container.

Uses

It is used to treat infections such as:

1. Acne.
2. Urinary tract infections.
3. Intestinal infections.
4. Respiratory infections.
5. Eye infections.
6. Periodontitis (gum disease).
7. Gonococcal urethritis.
8. In malaria.

Pharmaceutical Formulations

1. Doxycycline hydrochloride capsules IP.
2. Doxycycline dispersible tablets IP.
3. Doxycycline syrup.

Brand Names

Novadox, Tetradox, Monodox, Adoxa, Doxypal, Doxicip, Doxt, Peristat.

(b) Minocycline

Minocycline is a second generation tetracycline antibiotic effective against gram +ve and gram –ve bacteria.

Properties

1. It is yellow crystalline powder with slight bitter taste.
2. It is odourless.
3. It is sparingly soluble in water.
4. It is slightly soluble in ethanol.
5. It dissolves in solutions of alkali hydroxides and carbonates.

Stability and Storage

It is slightly hygroscopic and sensitive to light. Hence, it is stored in a tightly-closed airtight container and kept in a dry place.

Uses

1. It is used to treat a number of bacterial infections such as acne vulgaris, pneumonia and rheumatoid arthritis.
2. It is used to treat infections caused by rickettsiae, *Mycoplasma pneumoniae, Chlamydia trachomatis.*

Pharmaceutical Formulations

1. Minocycline tablets BP.
2. Minocycline capsules BP.
3. Minocycline prolonged-release capsules BP.

Brand Names

Arestin, Minocin, Dynacin, Amzeeq, Solodyn, Ximino.

Dose

100 mg per day.

8 What are macrolide antibiotics? Classify them with examples.

☞ Macrolide Antibiotics

- Macrolides are the class of natural products that consist of a large macrocyclic lactone ring to which one or more deoxy sugars are attached.
- Macrolide belongs to polyketide class of natural products.
- Macrolides are derived from *Saccharopolyspora erythraea*.
- Macrolide produces the action by binding to the 50s ribosomal subunit, thereby inhibiting the protein synthesis.

☞ Classification of Macrolide Antibiotics

(a) 1st generation macrolides, e.g. picromycin, erythromycin.
(b) 2nd generation macrolides:
  (i) 14-Membered ring, e.g. clarithromycin, roxithromycin, flurithromycin, dirithromycin.
  (ii) 15-Membered ring, e.g. azithromycin.
(c) 3rd generation macrolides, e.g. spiramycin, tylosin, carbomycin.

9 Write notes on: (a) Erythromycin, (b) Azithromycin.

☞ (a) Erythromycin

- It belongs to a group of drugs called macrolide antibiotics.
- It is obtained from *Streptomyces erythreus*.

Properties

1. It is a white or slightly yellow crystalline powder.
2. It is slightly soluble in water.
3. It is soluble in organic solvents such as ethanol, DMSO.
4. It is odourless and has a bitter taste.
5. It is hygroscopic in nature.

Stability and Storage

It should be stored in a tightly closed light-resistant container at 15–30°C.

Uses

- It is a drug of choice to treat pneumonia, urethritis, pelvic inflammation.
- It is used to treat amoebic dysentery.
- It is used to treat wounds and burn infection.
- It is also used in the treatment of intestinal amoebiasis.
- Used to treat gonorrhoea and syphilis.

Pharmaceutical Formulations

- Erythromycin tablet.
- Erythromycin injection.
- Erythromycin soluble powder.
- Erythromycin estolate capsule BP.
- Erythromycin stearate tablet BP, IP.

Brand Names

Erythrocin, Althrocin, Erycin, Erysert, Acnederm, Acnelak.

(b) Azithromycin

- It is a broad spectrum antibiotics belongs to macrolide class.
- It is a semisynthetic derivative of erythromycin.

Properties

1. It is white or almost white powder.
2. It is freely soluble in anhydrous ethanol and in dichloromethane.
3. It is practically insoluble in water.

Stability and Storage

It is stored in a well-closed container protected from excess heat and moisture.

Uses

1. It is used for the treatment of pharyngitis and tonsillitis.

2. It is more effective against gram-negative bacteria.
3. It is used to treat respiratory tract infection.
4. It is used to treat urinogential and sexually transmitted infections.
5. Used to treat pneumonia.

Pharmaceutical Formulations

1. Azithromycin tablet IP.
2. Azithromycin capsule IP.
3. Azithromycin oral suspension.
4. Azithromycin dry syrup.
5. Azithromycin injection.

Brand Names

Azithral, Zithromax, Aziwok, Aziwin, Azro, Glenazee.

Dose

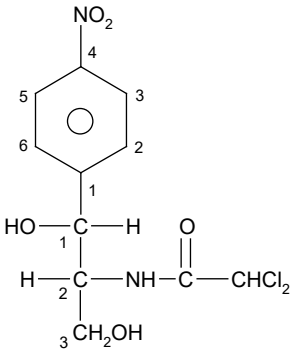
500 mg per day.

10 Give the structure, chemical name, stability and storage, uses and preparations of chloramphenicol. (S.22, W.23).

☞ Chloramphenicol

It is a broad spectrum antibiotic.
It is a propane 1,3-diol derivative.

Structure



Chemical Name

2-dichloroacetamido, 1 (p-nitrophenyl) propane 1, 3-diol

Properties

- It occurs as a white or greyish white crystalline powder.

- It is odourless and has very bitter taste.
- It is slightly soluble in water.

Stability and Storage

It is stable in solid form but is affected by light and hence it is stored in well-closed light-resistant containers. If the material is used for parenteral preparation the container should be sterile and sealed so as to exclude microorganism.

Uses

Chloramphenicol is a broad spectrum antibiotic and is used to treat:

- Typhoid and paratyphoid fever.
- Meningitis.
- Urinary tract infection.
- Rickettsial infection.
- Infection of eye and ear.
- Superficial infection of the skin.
- Septicaemia (brain abscess).

Pharmaceutical Formulations

- Chloramphenicol capsules.
- Chloramphenicol ear drops.
- Chloramphenicol eye ointment.
- Chloramphenicol injection.
- Chloramphenicol palmitate suspension.

Brand Names

Chloromycetin, Chlorostrep, Enteromycin, Fenicol, O-mycin.

11 Give the properties, storage, uses, formulations, and brand names of clindamycin.

☞ Clindamycin

- Clindamycin is a semisynthetic chloro derivative of lincomycin.
- Lincomycin is a natural antibiotics produced by the actinobacterium *Streptomyces lincolnensis*.

Properties

1. It is a white crystalline powder.
2. It is very soluble in water.
3. It is slightly soluble in ethanol.
4. It is odourless.

Stability and Storage

It is hygroscopic, hence it is stored in a tightly closed container protected from moisture.

Uses

1. Clindamycin is used most commonly to treat gram-positive cocci infections.
2. It is used for the treatment of bacterial infections such as:
   - Acne.
   - Joint infections.
   - Pelvic inflammatory disease.
   - Strep throat.
   - Pneumonia.
   - Upper respiratory tract infection.
   - Middle ear infections.
   - Endocarditis.

Pharmaceutical Formulations

1. Clindamycin capsules IP.
2. Clindamycin injection IP.
3. Clindamycin cream,
4. Clindamycin suppository.
5. Clindamycin palmitate oral suspension IP.

Brand Names

Clindac, Clinzee, Clincia, Dalcinex, Acnesol, Clindests.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Streptomycin** is an aminoglycoside antibiotic
2. Penicillin is the first antibiotic discovered by **Alexander Fleming**.
3. 6-(2-phenoxy acetamido) penicillanic acid is a chemical name of **Penicillin G**.
4. **Streptomycin** was the first aminoglycoside antibiotic introduced in chemotherapy in 1944 by Waskmann.
5. **Tetracyclines** contains octahydrotetracene-2- carboxamide skeleton as Structural unit.
6. Erythromycin and Azithromycin are **Macrolide antibiotics**.
7. The drug effective in pharyngitis and tonsilitis is **Azithromycin**.
8. **Chloramphenicol** is a drug of choice in typhoid and parathyroid.
9. Benzyl penicillin is also known as **Penicillin G**.
10. The most common side effect observed in beta-lactam antibiotics is **Allergic reactions**.

Chapter
19

Antineoplastics/Anticancer Agents

1 What is cancer (neoplasm/tumour)? Mention the types of cancer.

☞ **Cancer**

- Cancer means a relatively autonomous growth of tissues.
- Cancer is a disease in which some of the body's cell grow uncontrollably and spreads to other parts of the body through blood and lymph systems.
- Cancer is a group of diseases characterized by abnormal and uncontrolled growth of the cells with ability of invade and destory adjacent tissues and even distant organs.
- **Types of cancer:**
  - (a) **Carcinomas:** These are developed from ectodermal or endodermal cells, e.g. skin cancer, brain cancer.
  - (b) **Sarcomas:** These cancers develop in connective tissues and mesoderm, e.g. bone cancer.
  - (c) **Lymphomas:** These are developed from lymph glands. In this type glands are enlarged lymphocytes are more in numbers.
  - (d) **Leukemias:** It is developed from blood tissue. It is called blood cancer. WBCs are increased and RBCs are decreased.
  - Benign tumour is growing slowly while malignant tumour is growing fastly.
  - Some common features of cancer are excessive cell proliferation, tumour may develop, invades surrounding cells, may produce new cancerous growth.
  - Cancer chemotherapy began in 1940 when stilbestrol phosphate was introduced for treating cancer of prostate gland.

2 Define and classify anticancer/antineoplastic drugs with suitable examples. (S.22, 23, W.22, 23)

☞ Anticancer drugs

The drugs which are used in the treatment of cancer/neoplasm are called anticancer/antineoplastic/antitumour agents.

Classification of antineoplastic/anticancer drugs

1. **Alkylating agents,** e.g. chlorombucil, melphalan, busulfan, cyclophosphamide, thiotepa, carmstine, lomustine, dicarbazine, semustine.
2. **Antimetabolite:**
   (a) Purine antagonist, e.g. 6-mercaptopurine, azathioprine.
   (b) Pyrimidine antagonist, e.g. 5-fluorouracil (5-FU) cytarabine.
   (c) Folate antagonist, e.g. methotrexate, trimetrexate.
3. **Vinca alkaloids,** e.g. vinblastine, vincristine.
4. **Antibiotics,** e.g. actinomycin D, mitomycin, daunorubicin, bleomycins.
5. **Radioisotopes,** e.g. radioiodine, radiogold.
6. **Hormones,** e.g. androgens, estrogens, progestins, corticosteroids.
7. **Enzymes,** e.g. L-asparaginase.
8. **Taxanes,** e.g. paclitaxel, docetaxel.
9. **Epipodophyllotoxin,** e.g. etoposide.
10. **Camptothecin analogues,** e.g. irinotecan, topotecan.
11. **Miscellaneous,** e.g. cisplatin, hydroxyurea, procarbazine, carboplatin, imatinib.

3 What are alkylating agents? Explain in detail about cyclophosphamide.

☞ Alkylating agents

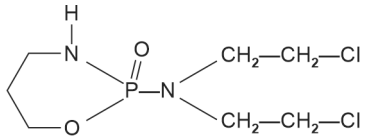
- Alkylating agents are highly reactive drugs that bind to certain chemical groups (phosphate, amino, sulfhydril, hydroxyl, and imidazole groups) commonly found in nucleic acids and other macromolecules, bringing about charges in the DNA and RNA of cells.
- Alkylating agent used in cancer treatment that attaches an alkyl group to DNA.

- Alkylating agents interfere with DNA replication by cross-linking DNA strands, DNA strand breaking and abnormal pairing of base pairs.
- The following are alkylating agents used in the treatment of cancer:
  (a) Chlorambucil is an aromatic nitrogen mustard effective against chronic lymphocytic leukemia, malignant lymphomas, and carcinoma of breast and ovary.
  (b) Busulphan is mainly used to treat gastrointestinal and breast cancer.
  (c) Cyclophosphamide is effective against malignant lymphomas, lymphoblastic leukaemia, and various carcinomas.
  (d) Cisplatin is used to treat testicular cancer, ovarian cancer, bladder cancer, etc.

Cyclophosphamide

Cyclophosphamide is an alkylating agent used as anticancer drug.

Structure



Chemical Name

(RS) 2-Bis(2-chloroethyl)aminoperhydro-1, 3, 2-oxazaphosphorine-2-oxide monohydrate

Properties

1. It occurs as a fine, white crystalline powder.
2. It is odourless and has slight bitter taste.
3. It is soluble in water.
4. It is very soluble in alcohol but very slightly soluble in ether.
5. Its melting point is between 41° and 45°C.

Stability and Storage

It is sensitive to light, heat and moisture, hence stored in tightly closed containers and away from light.

Uses

It is an anticancer drug used to treat:

- Breast cancer.
- Lung cancer.
- Cancer of ovary.

- Malignant lymphomas.
- Multiple myeloma.
- Chronic leukaemias.
- Hodgkin's disease.
- Neuroblastoma.
- Ewing's sarcoma.
- It is used as an immunosuppressive agent.

Pharmaceutical formulations

1. Cyclophosphamide tablet IP.
2. Cyclophosphamide injection IP.

Brand Names

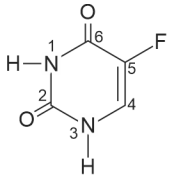
Cycloxan, Endoxan-Asta, Ledoxan.

4 Write a note on the following antineoplastic agents: (a) Fluorouracil, (b) Cisplatin

☞ **(a) Fluorouracil (S.23, 24)**

- It is an antimetabolite antineoplastic agent.
- It is a nucleobase analogue.

Structure



Chemical Name

5-fluorouracil.

Properties

1. It is a white crystalline powder.
2. It is odourless.
3. It is soluble in water.
4. It is very slightly soluble in alcohol.

Stability and Storage

It is affected by air and light, hence it is stored in tightly closed, light-resistant containers.

Uses

1. It is a cytotoxic (antineoplastic agent).
2. It is the most active drug against colorectal cancer.

3. It is used to treat solar keratoses and other malignant conditions of skin.
4. It is used in the treatment of cancers of breast, colon, stomach, head, neck, bladder, etc.
5. Used in the palliative treatment of neoplasm of gastrointestinal tract, breast and pancrease and respiratory tract.

Pharmaceutical formulations

Fluorouracil injection IP.

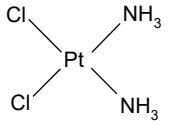
Brand Names

Fluracil, Fivocil, Oncpurcil, Flocil, Florac, Fivoflu.

(b) Cisplatin (W.23)

- It is platinum containing drug with alkylating properties.
- It causes cross-linking of DNA and RNA chains.
- It is only used intravenously.

Structure



Properties

- It is a white crystalline solid.
- It is insoluble in water and soluble in dimethyl formamide.

Stability and Storage

It should be stored in a well tightly closed container and protected from light and stored at a temperature between 2° and 8°C.

Uses

- It is used as an immunosuppressive agent.
- In metastatic tumours of testis.
- In metastatic tumours of ovary.
- In solid tumours including those of the bladder, prostate and head and neck.

Brand Names

Neoplastin, Plastinex, Platinol, Aquaplat.

Pharmaceutical formulations

Cisplatin injection IP.

5 Explain following anticancer/antineoplastic drugs: (a) Busulphan, (b) Mercaptopurine, (c) Methotrexate, (d) Dactinomycin, (e) Doxorubicin hydrochloride, (f) Vinblastine sulphate, (g) Dromostanolone propionate

☞ (a) Busulphan

It is an alkylating agent.

Properties

- It is a white crystalline powder.
- It is odourless.
- It is slightly soluble in water and soluble in acetone.

Storage

It is stored in tightly closed light-resistant container.

Pharmaceutical Formulations

Busulphan tablet BP, IP.

Brand Names

Myleran, Misulban.

Uses

- It is a cytotoxic agent.
- It is used to treat:
  i. Chronic granulocytic leukaemia.
  ii. Chronic myeloid leukaemia.
- Myelosclerosis.
- Polycythemia vera.
- Essential thrombocythemia.

(b) Mercaptopurine (6-Mercaptopurine) (6-MP)

It is a purine antagonist type of antimetabolite used as antineoplastic drug.

Properties

1. It is a yellow crystalline powder.
2. It is odourless.
3. It is very slightly soluble in water.
4. It is soluble in solutions of alkali hydroxides.

Stability and Storage

It is affected by air and light and hence it is stored in tightly closed, light-resistant containers protected from moisture.

Uses

1. It is used in the treatment of acute monocytic leukaemia, lymphoblastomas, myeloblastoma leucosis and to treat neuroleukemia.
2. It is used to treat:
   - Acute lymphatic leukaemia.
   - Acute myelogenous leukaemia.
   - Chronic granulocytic leukaemia.
3. It is also an immunosuppressive agent used to treat nephrotic syndrome, autoimmune disease like haemolytic anemia, severe rheumatoid arthritis.
4. In conjunction with folic acid antagonists, it is used to treat choriocarcinoma.

Pharmaceutical Formulations

Mercaptopurine tablet IP.

Brand Names

Mercapthol, Purinethol, Empurine, Purixan, Empurine.

Dose

250 mg/kg per day.

(c) Methotrexate

It is a folate antagonist from antimetabolite class used as antineoplastic.

Properties

1. It is yellow to orange brown crystalline powder.
2. It is odourless.
3. It is insoluble in water, alcohol, chloroform, ether.
4. It is slightly soluble in dilute hydrochloric acid.

Stability and Storage

It is affected by air and light and hence it is stored in a tightly closed light-resistant container.

Uses

It is an antineoplastic drug used to treat:

- Acute lymphoblastic leukaemia.
- Acute lymphocytic leukaemia.
- Lung cancer.
- Neck cancer.
- Epidermoid cancer of the head and breast.

- Ovarian and testicular cancer.
- Medulloblastoma.
- Severe psoriasis.

Pharmaceutical Formulations

1. Methotrexate tablets IP.
2. Methotrexate injection IP.

Brand Names

Neotrexate, Biotrexate.

(d) Dactinomycin (Actinomycin-D)

It is a chromopeptide antineoplastic antibiotic isolated from the bacterium streptomyces parvulus.

Properties

1. It is a bright red crystalline powder.
2. It occurs as lyophylised powder.
3. It is soluble in alcohol and alcohol–water mixture.
4. It is very slightly soluble in water.

Stability and Storage

It is affected by light, excessive heat and moisture, hence it is stored in light-resistant containers.

Uses

It is an antineoplastic agent used to treat:

- Pelvic or limb tumours.
- Rhabdomyosarcoma.
- Testicular and ovarian malignant teratomas.
- Wilms' tumour in children.

Pharmaceutical Formulations

Dactinomycin injection.

Brand Names

Cosmagen, Lyovac

Dose

15 mg/kg IV per day.

(e) Doxorubicin Hydrochloride

- Doxorubicin is an anthracycline antibiotic with antineoplastic activity.
- **Doxorubicin** is isolated from the bacterium *Streptomyces peucetius*.

- It intercalates between base pairs in the DNA helix, thereby **preventing** DNA replication and ultimately inhibiting protein synthesis.

Properties

1. It is a red, crystalline solid.
2. It is odourless.
3. It is hygroscopic.
4. It is soluble in water, soluble in aqueous alcohol.
5. It is insoluble in non-polar organic solvents.

Stability and Storage

It is kept in tightly closed container under an inert atmosphere and stored under ambient temperature.

Uses

1. It is an antineoplastic/anticancer agent.
2. It is used in the treatment of acute lymphocytic leukaemia.
3. With other drugs, it is used to treat solid tumours.
4. It is used for the treatment of:
   - Leukemias.
   - Wilms' tumour.
   - Neuroblastoma.
   - Small cell lung cancer.
   - Ovarian and testicular cancer.
   - Acute myeloid as well as lymphoblastic leukemia.
   - Breast, thyroid, bladder cancer.

Pharmaceutical Formulations

1. Doxorubicin HCl tablet IP.
2. Doxorubicin HCl injection IP.
3. Doxorubicin HCl injection BP.

Brand Names

Adriamycin, Dounocin, Daunomycin, Oncodria, ADM, Adria.

Dose

66–75 mg/m^2 BSA by slow IV injection every 3 weeks.

(f) Vinblastine sulphate

- Vinblastine is a natural alkaloid isolated from the plant *Catharanthus roseus* with antineoplastic properties.
- Vinblastine disrupts microtubule formation and function during mitosis and intereferes with glutamic acid metabolism.

- Vinblastine is a part of ABVD (adriamycin, bleomycin, vinblastine and dacarbazine) regimen used in the treatment of Hodgkin's lymphoma.

Properties

1. It is a white or yellowish amorphous or crystalline powder.
2. It is freely soluble in water.
3. It is soluble in methanol.
4. It is practically insoluble in ethanol and in ether.

Stability and Storage

It is kept in tightly closed container under inert atmosphere and stored under ambient temperatures.

Uses

It is an antineoplastic drug used in the treatment of:

- Severe lymphoblastic leukemia.
- Hodgkin's disease.
- Neuroblastoma.
- Sarcoma.
- Lymphocytic lymphoma.
- Histiocytic lymphoma.
- Advanced testicular carcinoma.
- In choriocarcinoma and breast cancer.

Pharmaceutical Formulations

Vinblastine injection

Brand Names

Biocristin, Velban, Velsar, VLB, Uniblastin, Cytoblastin.

(g) Dromostanolone propionate

- It is a synthetic androgen or male hormone similar to testosterone.
- It is an anabolic steroid related to dihydrotestosterone that has antiestrogenic effect.

Properties

1. It is a white to creamy white crystalline powder.
2. It has melting point of 128°C.

Stability and Storage

It is kept in tightly closed container under an inert atmosphere and stored under ambient temperatures.

Uses

It is an antineoplastic/anticancer agent used to treat:

- Breast cancer in women.
- Ovarian cancer.
- Gestational trophoblastic neoplasm.
- Metastatic testicular tumours.
- Local recurrent solid tumours.

Pharmaceutical Formulations

Dromostanolone propionate injection.

Brand Names

Masteril, Masteron, Drolban, Mastisol, Permastril, Prometholone.

OBJECTIVE QUESTIONS WITH ANSWERS IN BOLD LETTERS

1. **Methotrexate** is folate antagonist used as antineoplastic agent.
2. Vinblastin and vincristin are alkaloid drugs used in the treatment of **cancer**.
3. **Cisplatin** is a platinum containing drug with alkylating properties used as antineoplastic agents.
4. If cancer cells originate from the skin epithelial cells then it is described as **carcinomas**.
5. **Busulphan** is an alkyl sulfonate derivative used as anticancer.
6. **Leukaemia** is also a known blood cancer.
7. Chlorambucil is an example of **Nitrogen Mustard**.
8. The most important target of action of chlorambucil is **lymphoid tissue**.
9. **Vinblastine** is used to treat Hodgkin's disease.
10. Cyclophosphamide is particularly used to treat **malignant lymphomas**.

Board Examination Papers

Summer Examination 2022 (Question Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Attempt any SIX of the following. **30 Marks**

a. What is Parasympatholytic agent? Classify it with suitable examples. Give the chemical structure, chemical name, and uses of Dicyclomine hydrochloride.
b. Define Gravimetric analysis. State its principle and describe various steps involved in it.
c. Draw the chemical structure of antipsychotics having piperidine nucleus. Give its chemical name, uses, formulations and popular brand name.
d. Draw the structure from the IUPAC name and write name of drugs:
   i. 2-(2, 4-difluorophenyl)-1, 3-di (1H-1, 2, 4,-triazol-1-yl) propan-2-ol
   ii. 2-amino-1, 9-dihydro-9-[(2-hydoxyethoxy) methyl]-3H-purin-6-one
e. Define and classify antimicrobial agents and explain their mechanism of action. Give pharmaceutical formulations, marketed preparations, storage conditions and uses of Boric acid.
f. Classify antibiotics according to chemical structure with examples. Draw and explain the structure of the basic nucleus of Penicillin. Also give structure of Amoxicillin with its chemical name.
g. Explain reaction and principle involved in limit test of arsenic and draw a neat, labelled sketch of Gutzeit apparatus.

Q.2 Attempt any TEN of the following. **30 Marks**

a. Give any two brand names of:
   i. Diazepam ii. Amitryptyline iii. Carbamazepine
b. Draw the chemical structure of Chloramphenicol. Give its uses and brand name.
c. State what is meant by 'Volumetric analysis. Enlist its types and explain one precipitation type of titration.
d. What are diuretics? Draw the chemical structure of diuretics having furan nucleus. Give its chemical names and uses.
e. Define 'Neoplasm' and classify antineoplastic agents with example.

f. Enlist different "sources of impurities" and describe any two sources.
g. What is co-trimoxazole? Explain its mechanism of action and give two brand names of Co-trimoxazole.
h. Define and classify antihypertensive agents. Draw the chemical structure of captopril.
i. Give structure, properties, uses and brand names of Ibuprofen.
j. Classify Adrenergic drugs. Draw the structure and give the chemical name of Naphazoline.
k. Explain Diabetes mellitus. Classify hypoglycemic agents with examples.

Q.3 Attempt ALL questions of the following. 20 Marks

a. Select the drug from the following which act as alkylating agents.
(a) 5-Fluorouracil (b) Doxorubicin
(c) Cyclophosphamide (d) Vincristine

b. In what dosage form Azithromycin is given?

c. The basic heterocyclic ring present in phenytoin is _____.
(a) Pyrazole (b) Imidazole
(c) Imidazolidine (d) Pyrazolidine

d. To prepare a solution of accurately known volume, use a_____.
(a) Beaker (b) Conical flask
(c) Volumetric flask (d) Measuring cylinder

e. Cathartics are the drugs used to_____
(a) Relieve acidity
(b) Relieve constipation
(c) Reduce gastrointestinal irritation
(d) All of the above

f. In limit test for sulphate, to prevent the super saturation of $BaSO_4$, a small amount of _____ has been added in the reagent.
(a) Alcohol (b) Dilute HCl
(c) Potassium sulphate (d) Barium chloride

g. To prevent the dental caries, toothpaste should contain_____
(a) Strontium chloride (b) Zinc chloride
(c) Sodium metaphosphate (d) Sodium fluoride

h. The antifungal drug, ketoconazole contains _____ heterocyclic ring
(a) Imidazole (b) Pyridine
(c) Acridine (d) Pyrimidines

i. Lasix is a popular brand name of:

(a) Hydrochlorothiazide (b) Furosemide
(c) Amiloride (d) Acetazolamide

j. Name the antidepressant agent, which is a dibenzazepine derivative.

(a) Citalopram (b) Fluoxetine
(c) Imipramine (d) Paroxetine

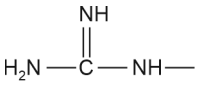
k. Match the following:

1. Class I	(a) Calcium channel blockers
2. Class II	(b) Beta-blockers
3. Class III	(c) Sodium channel blockers
4. Class IV	(d) Potassium channel blocker

Options:

(a) 1-a, 2-b, 3-c, 4-d (b) 1-d, 2-b, 3-a, 4-c
(c) 1-b, 2-c, 3-a, 4-d (d) 1-c, 2-b, 3-d, 4-a

l. The name of the following group is_____



(a) Anilino- (b) Amidino-
(c) Guanidino- (d) Amino-

m. In what dosage form Isosorbide Dinitrate is given?

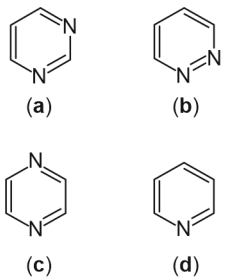
n. Which of the following NSAID's is phenyl acetic acid derivative?

(a) Diflusinal (b) Aspirin
(c) Mefenamic acid (d) Diclofenac

o. Give structure and method of numbering for Acridine.

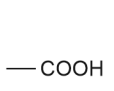
p. Write name and uses of drug containing imidazoline heterocycle.

q. The structure of pyridine ring is:

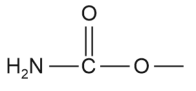


r. 2-acetoxybenzoic acid is IUPAC name of_____

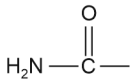
s. The structure of carbamoyl group is_____



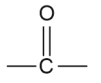
(**a**)



(**b**)



(**c**)



(**d**)

t. Which of the following drug is a direct acting cholinomimetic agent?

(a) Parathion (b) Physostigmine

(c) Carbachol (d) Pyridostigmine

Summer Examination 2022
(Specimen Answer Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Attempt any SIX of the following. **30 Marks**

a. What is parasympatholytic agent? Classify it with suitable examples. Give the chemical structure, chemical name, and uses of Dicyclomine hydrochloride.

Ans: Parasympatholytic agents: The compounds which block the action of acetylcholine (a neurohormone released in the parasympathetic system) is called as parasympatholytic agent.

Classification of parasympatholytic agents

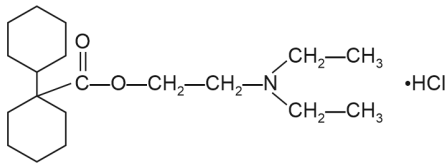
Chemical/structural classification (method 1)

a. Amino alcohol esters: e.g. Atropine, Hyoscine, Homatropine, Propantheline
b. Amino Alkyl ethers: e.g. Benztropine, Chlorphenoxamine
c. Amino alcohols: e.g. Biperiden,Benzhexol, Procyclidine
d. Amino amides: e.g. Aminopentamide, Isopropamide, Tropicamide

Classification method (2)

a. Natural: Solanaceous alkaloids and related compounds, e.g. Atropine, Hyoscine
b. Semisynthetic agents, e.g. Homatropine, Ipratropium bromide
c. Synthetic drugs:
    i. Anti-secretory drugs, e.g. Clidinium, Diphenanil, Isopropamide
    ii. Antispasmodic drugs, e.g. Dicyclomine, Glycopyrrolate, Propantheline
    iii. Mydriatic and cycloplegic drugs, e.g. Cyclopentolate, Tropicamide
    iv. Antiparkinsonism drugs, e.g. Benztropine, Benzhexol, Procyclidine

Chemical Structure of Dicyclomine Hydrochloride



Chemical Name

2-(diethylamino) ethyl [1, 1'-bi(cyclohexane)]-1-carboxylate hydrochloride

Uses of Dicyclomine HCl:

i. Dicyclomine is used to treat a certain type of intestinal problem called irritable bowel syndrome.
ii. Used as anticholinergics.
iii. It helps to reduce the symptoms of stomach and intestinal cramping.
iv. It is used in the treatment of abdominal pain.

b. Define gravimetric analysis. State its principle and describe various steps involved in it.

Ans: Gravimetric analysis: Gravimetric analysis is a method of quantitative chemical analysis in which the analyte is converted into a substance (of known composition) that can be separated from the sample and weighed.

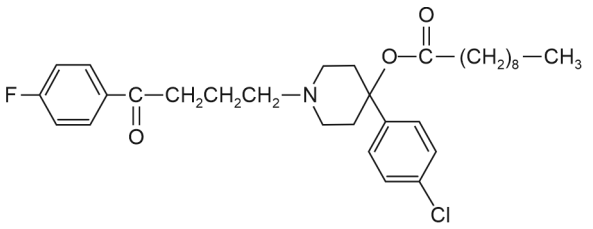
Principle: The principle of gravimetric analysis is based on the estimation of the mass percent of anion in an impure compound of known quantity by determining the mass of the same ion in a pure compound. In order to determine the mass, the ion of interest needs to be completely isolated. This isolation of ions is done with the help of precipitation the ion being analyzed is completely precipitated.

The steps commonly followed in gravimetric analysis are:

1. Preparation of a solution by using a known weight of the sample analyte.
2. Separation of the desired ion/element/radical in pure forms by various separation methods
3. After the ion has been separated, weighing the amount of the pure insoluble compound formed.
4. Calculating the value of the individual component of interest, based on the weight of the compound observed.

c. Draw the chemical structure of antipsychotics having piperidine nucleus. Give its chemical name, uses, formulations and popular brand name.

Ans: Antipsychotics having piperidine nucleus is Haloperidol.



Chemical Name of Haloperidol:

4-(4-(4-chlorophenyl)-4-hydroxypiperidin-1-yl)-1-(4-fluorophenyl) butan-1-one

Uses of Haloperidol

a. Haloperidol is an antipsychotic agent used to treat schizophrenia and other psychoses, as well as symptoms of agitation, irritability, and delirium.
b. It is used to treat uncontrolled movements and outbursts of words/ sounds related to Tourette's syndrome.
c. Haloperidol is also used for severe behavior problems in hyperactive children when other treatments or medications have not worked.
d. It is also used as antiemetic.

Formulations of Haloperidol

Tablets, Oral Solutions, Injections

Popular brand names of haloperidol-

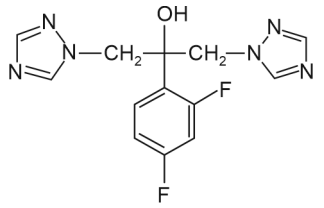
Haldol, Halidace, Halobid, Hexidol, Dolteus, Serenace, Senorm LA Injection

d. Draw the structure from the IUPAC name and write name of drug:

(i) 2-(2, 4-difluorophenyl)-1, 3-di (1H-1,2,4,-triazol-1-yl) propan-2-ol

Ans: Name of drug is **Fluconazole**.

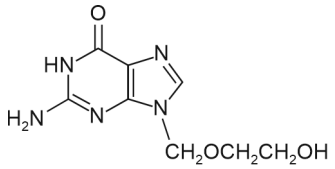
Structure of Fluconazole



(ii) 2-amino-1, 9-dihydro-9-[(2-hydoxyethoxy) methyl]-3H-purin-6-one

Name of Drug is Acyclovir

Structure of Acyclovir



e. Define and classify antimicrobial agents and explain their mechanism of action. Give pharmaceutical formulations, marketed preparations, storage conditions and uses of Boric acid.

Ans: Antimicrobial agents: An antimicrobial agent is defined as a natural or synthetic substance that kills or inhibits the growth of microorganisms such as bacteria, fungi and algae.

Classification and Mechanism of Action:

Inorganic antimicrobial agents act by following mechanisms

a. Oxidation—Hydrogen peroxide, Potassium permanganate
b. Halogenation—Iodine, Bleaching powder
c. Protein precipitation—Silver nitrate

Oxidation Mechanism:

a. The compounds act on protein containing sulphahydryl group (–SH).
b. The sulfhydryl group present in microbial protein oxidised to a disulphide bridge. (–S—S–)
c. Thus, alter the molecular shape of the protein, ultimately leading to the deactivation of the protein.
d. Sulfhydryl group, –SH form a disulphide bridge (–S—S–) and inactivate its function.

Halogenation Mechanism:

a. Halogenation – Addition of halogens (–Cl, –Br, –I, –F)
b. Amide groups present in protein at peptide linkage undergo chlorination with change in molecular shape and ultimate destruction of the protein.
c. Hence kills the microbes.

Protein Precipitation

a. A good number of polar groups as well as groups having lone pair of electrons always present in protein structure and they act as ligands
b. It will form "Complexes" with transition metal cations.
c. Thus, resulting in the precipitation of the protein.

Pharmaceutical Formulations

Products containing boric acid can be liquids, granules, pellets, vaginal tablets, wettable powders.

Marketed Preparations

Azo vaginal tablets, Borosprit ear drops, Cebran DPS eye/ear drops, Moisol powder

Storage Conditions

Stored in a well-closed container, in a cool, dry place.

Uses:

- Boric acid is widely used as an antiseptic for the treatment of minor cuts and burns.
- This compound is also used in medical dressings and salves (an ointment used to promote healing of the skin or as protection).
- Very dilute solutions of boric acid can be used as an eye wash.
- Owing to its antibacterial properties, boric acid can also be used for the treatment of acne in humans.
- In its powdered form, it can also be sprinkled into socks and shoes to prevent athlete's foot (tinea pedis).

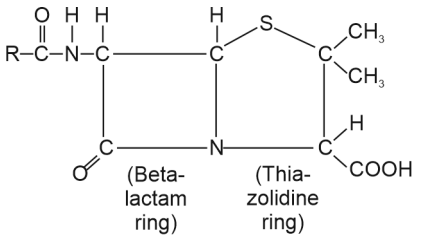
f. Classify antibiotics according to chemical structure with examples. Draw and explain the structure of the basic nucleus of penicillin. Also give structure of Amoxicillin with its chemical name.

Ans: Chemical Classification of Antibiotics

a. Beta—lactam antibiotics
   i. Penicillins—example: phenoxymethyl penicillin, flucloxacillin and amoxicillin.
   ii. Cephalosporins—example: cefaclor, cefadroxil and cephalexin.

b. Tetracyclines—example: doxycycline and minocycline.
c. Aminoglycosides—example: streptomycin
d. Macrolides—example: erythromycin, azithromycin
e. Polypeptides—example: bacitracin,
f. Polyenes antifungal antibiotics—example: amphotericin, nystatin and candicidin
g. Ansamycins—example: rifamycins (Rifampin, Rifampicin, Rifabutin)
h. Lincomycins example: clindamycin.
i. Antibiotics derived from single amino acid—examples: cycloserine and chloramphenicol
j. Miscellaneous—examples: fusidic acid, griseofulvin, novobiocin etc.

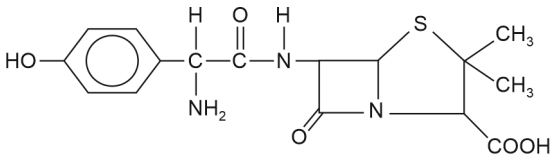
Basic Structure of Penicillin



Explanation of Basic Structure

- The basic chemical structure of all penicillins consists of a beta-lactam ring, a thiazolidine ring, and a side chain (6-aminopenicillanic acid). The antibacterial activity of the penicillins lies within the beta-lactam ring.
- Penicillin core structure, where "R" is the variable group

Structure of Amoxicillin



Amoxicillin

Chemical Name of Amoxicillin

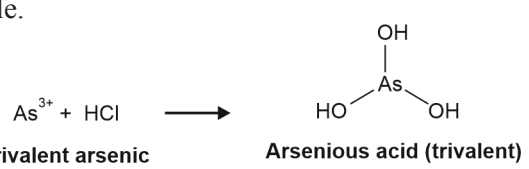
α-(p-hydroxy phenyl) - α- amino methyl penicillin OR α-amino-p-hydroxy benzyl penicillin

g. Explain reaction and principle involved in limit test of arsenic and draw a neat, labelled sketch of Gutzeit apparatus.

Ans: Limit Test for Arsenic

Reaction and Principle:

- It is also called as Gutzeit test and requires special apparatus called Gutzeit apparatus.
- Limit test of Arsenic is based on the reaction of arsenic gas with hydrogen ion to form yellow stain on mercuric chloride paper in presence of reducing agents like stannous acid, potassium iodide.
- The sample dissolved in stannated acid, which converts the arsenic impurities to arsenious acid to arsenic acid depending upon valency state of arsenic impurity present in the test sample.

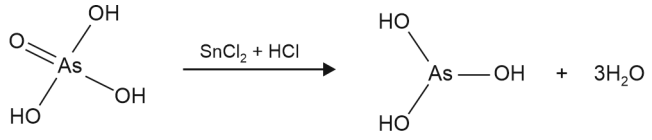


Trivalent arsenic — **Arsenious acid (trivalent)**



Pentavalent arsenic — **Arsenic acid (pentavalent)**

- When acidic solution of sample treated with reducing agent (stannous chloride) converts pentavalent arsenic acid into trivalent arsenious acid



Arsenic acid (pentavalent) — **Arsenic acid (trivalent)**

- The arsenious acid is then converted into gaseous hydride (arsine gas) with help of nascenthydrogen (which is produced by zinc and HCl)



Arsenious acid (trivalent) + **Nascent hydrogen** → **Arsine gas**

- Arsine gas is carried through the tube by steam of hydrogen and out through the mercuric chloride paper. A reaction occurs between arsine and mercuric chloride which produces yellow colour stain.

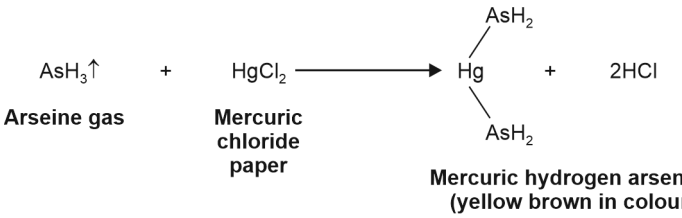
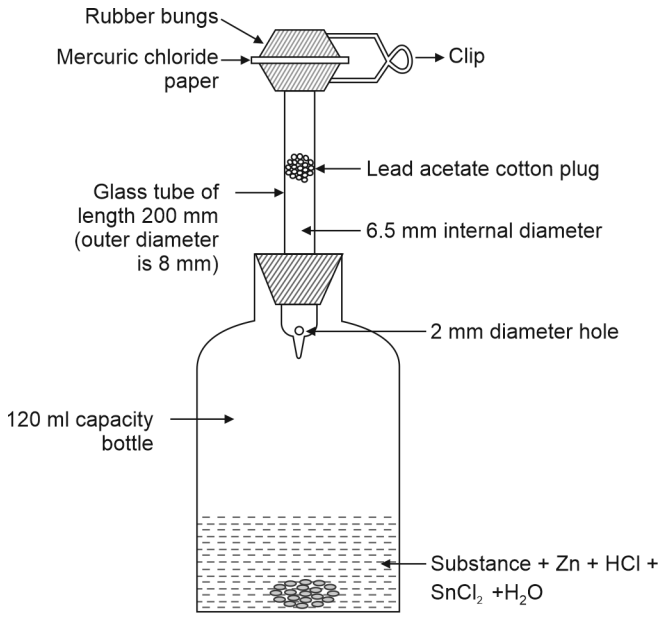


Diagram of Gutzeit Apparatus



Q.2 Attempt any TEN of the following. 30 Marks

a. Give any two brand names of:

(i) Diazepam (ii) Amitryptyline (iii) Carbamazepine

Ans:

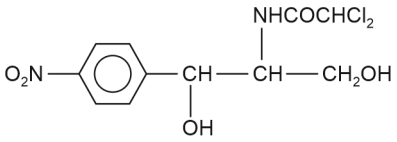
i. Diazepam: Valium, Calmpose, Sedanite

ii. Amitryptyline: Eliwel, Amitone, Relidep, Amitrip, Tryptanol Amline, Tryptomer, Sarotena

iii. Carbamazepine: Tegrital, Versitol Retard, Mazetol, Carbatol.

b. Draw the chemical structure of chloramphenicol. Give its uses and brand name.

Ans: Chloramphenicol



Uses of chloramphenicol:

i. It is used in the treatment of bacterial infections.
ii. It is used to treat bacterial eye infections.
iii. Chloramphenicol has wide range of activity that includes gram-positive and gram-negative aerobic and anaerobic bacteria.
iv. It is useful in treatment of typhoid fever, bacterial meningitis, Rickettsial diseases, etc.

Brand name of chloramphenicol:

Chlorostrep, O-mycin, Enterostrep, Enteromycin, Chloromycetin

c. State what is meant by 'Volumetric analysis. Enlist its types and explain one precipitation type of titration.

Ans: Volumetric Analysis:

Volumetric (also known as titrimetric) analysis involves the gradual addition of a solution of accurately known concentration to the solution whose concentration is to be determined.

Types of volumetric Analysis:

1. Acid-base or neutralization titration
2. Redox or oxidation-reduction titration
3. Precipitation titration
4. Complexometric titration
5. Non-aqueous titration

Precipitation Titration:

- In precipitation titration, reaction occurs in which two ions bond together to form insoluble salt in the aqueous solution. The insoluble salt is referred to as precipitate.
- The titrant reacts with the analyte and forms an insoluble substance.
- The titration is continued till the last drop of analyte is consumed.
- When the titrant is in excess it reacts with the indicator and signals termination of reaction by forming coloured precipitate.

Argentometric Titrations:

The titration in which silver nitrate ($AgNO_3$) is used as a precipitating agent is named as argentometric titration.

The titration is used to determine halides like Cl^-, Br^-, and I^-

$$AgNO_3 + X \rightarrow AgX + NO_3$$

(Silver nitrate) (Halides) (Silver halides white coloured precipitate)

$AgNO_3$ + indicator → indicator complex (coloured) at the end point

Types of Argentometric Titrations:

1. Mohr's method
2. Volhard's method
3. Fajan's method
4. Gay-lussac method

Mohr's Method:

- The method was proposed by Mohr in 1856.
- The method is employed for the estimation of halides with standard solution of silver nitrate using potassium chromate as an indicator.
- The estimation is carried out in a neutral medium.

Theory:

- In this method, the given chloride solution (NaCl) is titrated with a standard silver nitrate solution. When Cl^- ions are precipitated as silver chloride (AgCl)

  $AgNO_3$ (aq) + NaCl (aq) → AgCl (s) + $NaNO_3$ (aq)
- A small amount of $K_2Cr_2O_4$ (potassium chromate) is added to the chloride solution which acts as an indicator.
- When $AgNO_3$ is gradually added, the end point is confirmed by the permanent appearance of brick red coloured precipitate of $Ag_2Cr_2O_4$

Volhard's Method:

- The method was first proposed by Volhard in 1874.
- Initially the method was developed for the estimation of silver ions, later halide estimation is also determined.
- The method is carried out in acidic medium

Theory:

- The method involves the addition of an excess amount of silver nitrate ($AgNO_3$) solution to the halides for the back titration.

  $AgNO_3$ (aq) + KCl (aq) → AgCl (s) + KNO_3 (aq)

- The excess of silver ions is titrated against potassium thiocyanate (KSCN) or ammonium thiocyanate (NH_4SCN) using iron (III) salt as an indicator in acidic medium.
- The end point is detected by the formation of blood red colour (reddish brown colour).

Fajan's Method:

- It was introduced in the year 1923 by K Fajan.
- Adsorption indicators are used in this method, e.g. fluoroscien, dichloro-fluorosciene, eosine, etc.

Theory:

- It involves titration of $AgNO_3$ with any halide solution in presence of adsorption indicators.
- Adsorption indicators adsorb on the precipitate formed and give pink colour.

Gay-Lussac's Method:

- It is also known as turbidity method.
- It involves titration of $AgNO_3$ with standard halide solution in presence of nitric acid and barium nitrate.
- At the end point coagulation process is accelerated and disappearance of turbidity occurs.

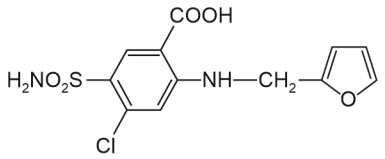
d. What are diuretics? Draw the chemical structure of diuretics having furan nucleus. Give its chemical name and uses.

Ans: Diuretics: Diuretics are drugs which increase the rate of urine excretion by kidneys.

It acts by inhibiting reabsorption of sodium and its osmotic equivalent amount of water.

A diuretic is any substance that promotes diuresis, the increased production of urine.

Frusemide/Furosemide has Furan Nucleus in its Structure.



Chemical Name:

4-chloro-2-((furan-2-ylmethyl amino)-5-sulfamoylbenzoic acid

Uses of Furosemide

i. It is used as a diuretic.

ii. It is useful for treatment of oedema associated with CHF, liver cirrhosis and renal diseases.
iii. It is used to treat high blood pressure (hypertension).

e. Define 'Neoplasm' and classify antineoplastic agents with example.

Ans: Neoplasm

- Neoplasm is the medical term for Cancer or tumor which means a relatively autonomous growth of tissues.
- The term neoplasm refers to an abnormal growth of tissue caused by the rapid division of cells that have undergone some form of mutation.
- A neoplasm is a type of abnormal and excessive growth of tissue. This abnormal growth usually forms a mass, when it may be called a tumor.
- Antineoplastic drugs are medications used to treat cancer.

Classification of Antineoplastic Agents

1. Alkylating Agents.
   a. Nitrogen mustard drugs: Mustine, Chormabucil, cyclo phosphamide
   b. Aziridines: Thiotepa
   c. Alkyl sulphonate: Busulphan
   d. Nitrosourea group compound: Lomustine
2. Antimetabolites: Methotrexate, Mercaptopurine, Azathioprine, Fluorouracil
3. Antibiotics: Actinomycin, Daunorubicin, Doxorubicin
4. Plant Products: Sulphates of vinblastine and vincristine.
5. Hormones and related drugs: Glucocorticoids, Tamoxifen
6. Miscellaneous agents: Hydroxyurea, Cisplatin

f. Enlist different "sources of impurities" and describe any two sources.

Ans: Sources of impurities

1. Raw materials used in manufacture
2. Processes used in manufacture
3. Material of the plant
4. During storage
5. Accidental substitution or deliberate adulteration
6. Manufacturing hazards

1. **Raw materials used in manufacture**
   - Traces of impurities in raw materials may be carried to contaminate the final product
   - For example, common salt (NaCl) prepared from rock salt will almost certainly contain traces of calcium (Ca) and magnesium (Mg) compounds
   - Metallic zinc may be present as an impurity in zinc oxide (ZnO) sample as it is prepared by heating metallic zinc
2. **Processes used in manufacture**
   - Some impurities are incorporated during the manufacturing process. This may occur due to reagents used in process.
   - Reagents added to remove other impurities.
   - Solvents—water is the cheapest solvent widely available. Tap water contains many ion impurities in small amounts like Cl^-, Ca^{++}, Mg^{++}, Na^+, etc.
   - The intermediate products may come along the process in the final product as impurity
3. **Material of the plant**
   - The vessels used in the manufacturing process are generally made up of metals like iron, copper, zinc, nickel, aluminium and stainless steel. Due to the solvent action on the plant material the traces of metals i.e. impurities come in the product.
   - Similarly, glass of an unsatisfactory standard and plastic containers used for handling liquid and semisolid products may yield traces of alkalies and antioxidants, respectively.
4. **During storage:**
   - Filth—stored product may become contaminated with dust, insect, or insect excreta.
   - Decomposition of the product during storage—many chemical substances undergo changes or decomposition due to careless storage, e.g. ferrous sulphate is slowly converted into insoluble ferric oxide by air and moisture
   - Ether and chloroform decompose in the presence of light and air. Chloroform on decomposition gives carbonyl chloride (phosgene gas) so it should be stored in well filled, well-closed amber coloured bottle.
5. **Accidental substitution or deliberate adulteration**
   - Accidental substitution can take place if toxic substances are stocked with other substances or compounds. Some pharma-

ceutical products may be adulterated with cheaper substitutes, e.g. Honey may be adulterated with inverted sugar, potassium bromide with sodium bromide.

6. **Manufacturing hazards:**
   - Particulate contamination—accidental inclusion of dirt, glass, porcelain, metallic or plastic fragments from sieves, granulating, tableting, and filling machines or even from product containers is possible.
   - Process error—gross errors arising from incomplete solution of solute in a liquid preparation must be detected by normal analytical procedures.
   - Special care is required for highly potent medicaments of low dose (5 mg or less)
   - Cross contamination—the handling of powders, granules and tablets in large quantities creates considerable amount of airborne dust and may lead to cross-contamination.
   - Microbial contamination—liquid preparations and creams for topical application are prone to bacterial and fungal contamination.
   - Special care should be taken in parenteral and ophthalmic preparations to avoid microbial contamination
   - Packing errors—products of similar appearance as tablets of same size, colour and shape packed in similar containers may lead to mislabeling.

g. What is co-trimoxazole? Explain its mechanism of action and give two brand names of Co-trimoxazole.

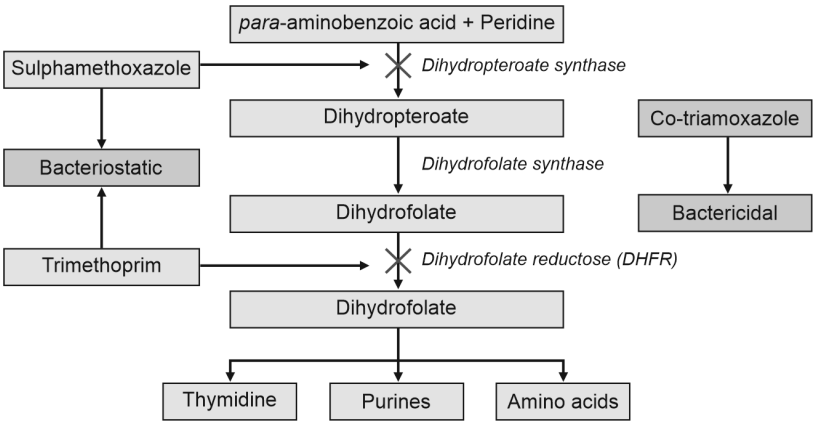
Ans: Co-trimoxazole:

Cotrimoxazole is the combination of two drugs i.e. Sulfamethoxazole and Trimethoprim in a proportion of 5:1.

Mechanism of Action

- Co-trimoxazole inhibits successive steps in the folate synthesis pathway.
- Sulphamethoxazole—sulfonamide derivatives-dihydro teroate synthase inhibitor
- Therapeutic effects induced by competing with p-aminobenzoic acid (PABA) in the biosynthesis of dihydrofolate.
- Trimethoprim a competitive inhibitor of dihydrofolate reductase (DHFR) and blocks the conversion of folic acid to tetrahydofolic acid (THF).

- Tetrahydrofolate is crucial in the synthesis of purines, thymidine, and methionine which are needed to produce DNA and proteins.
- Combination of Sulphamethoxazole and Trimethoprim by synergism produces a bactericidal effect.



Brand Names of Co-trimoxazole

Septran, Spectra DS, Bactrim, Sulfatrim, Ciplin, Uritrim, Eeptabid, Sepmax

h. Define and classify antihypertensive agents. Draw the chemical structure of captopril.

Ans: Antihypertensives agents

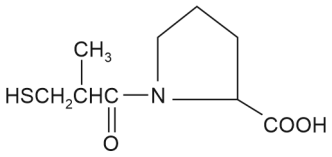
An agent that reduces elevated blood pressure is called as an antihypertensive agent. The drugs which are useful for treatment of hypertension are called as antihypertensive agents.

Classification of antihypertensive agents

1. ACE inhibitors: Captopril, Enalapril, Ramipril
2. Angiotensin antagonist: Losartan, Candesartan
3. Calcium channel blockers: Verapamil, Nifedipine,
4. Diuretics:
   a. Thiazides: Hydrochlorothiazide
   b. High ceiling: Furosemide
   c. Potassium sparing: Spironolactone
5. Beta-adrenergic blockers: Propranolol, Metoprolol, Atenolol
6. Alpha-adrenergic blockers: Prazosin, Terazosin
7. Alpha + beta adrenergic blockers: Labetalol, Carvedilol

8. Central sympatholytic: Clonidine, Methyldopa
9. Vasodilators: Hydralazine, Minoxidil sodium

Chemical structure of captopril

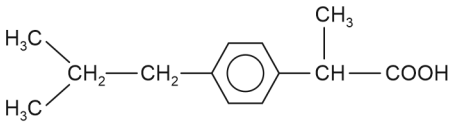


Captopril

1-(3-Mercaplo-2-methyl-1-Oxopropyl)-L-Proline

i. Give structure, properties, uses and brand names of Ibuprofen.

Ans: Ibuprofen



Ibuprofen

Properties:

i. It occurs as white crystals or white crystalline powder having characteristic odour.
ii. It is very slightly soluble in water but freely soluble in alcohol.
iii. It is soluble in aqueous solution of alkali.

Uses:

- Ibuprofen is painkiller for a range of aches and pains including back pain, toothache or menstrual pain. (Used as analgesics and anti-inflammatory)
- It also treats inflammation such as strains and sprains and pain from arthritis.

Brand names: Brufen, Ibugesic, Acifen

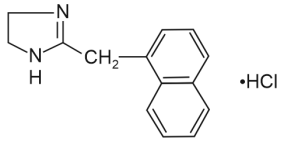
j. Classify adrenergic drugs. Draw the structure and give the chemical name of Naphazoline.

Ans: Classification of Adrenergic drugs

The adrenergic drugs can be classified based on their chemical structure.

1. Catecholamines—Adrenaline, Nor-adrenaline, Isoprenaline
2. Non-catecholamines—Phenylephrine, Salbutamol, Terbutaline, Ephedrine, Pseudoephedrine.
3. Imidazoline derivatives—Naphazoline, Tetrahydrozolium.

Structure of Naphazoline



Chemical Name

2-(naphthalen-yl-methyl)-4, 5-dihydro-1H-imidazole

k. Explain Diabetes mellitus. Classify hypoglycemic agents with examples.

Ans: Diabetes mellitus

- It is a Metabolic disorders in which there are high blood sugar levels over a prolonged period.
- Diabetes mellitus is characterized by persistent hyperglycemia usually with glucosuria. The different factors involved in its origin are hereditary, immunological, age and stress.
- Symptoms: Hyperglycemia, glucosuria, ketonemia, ketonuria, hyperlipidemia, polyuria, polydipsia, polyphagia, etc.

Diabetes mellitus is divided into following types:

Type 1: Insulin dependent or juvenile onset

Type 2: Noninsulin dependent or maturity onset

Gestational diabetes—onset of glucose intolerance in women during pregnancy. Excludes women who were diabetic before pregnancy.

Classification of Hypoglycemic Agents

1. **Parenteral hypoglycemic agents**

   Insulin Preparations:

   - Fast acting Insulin
   - Intermediate acting Insulin
   - Long acting Insulin

2. **Oral hypoglycemic agents**

   a. Sulfonylureas: Tolbutamide, Chlorpropamide, Tolazamide, Acetohexamide, Glipizide, Glyburide, Glimepiride, Glicazide

   b. Thiazolindiones: Rosiglitazone, Pioglitazone

   c. Biguanidines: Metformin, Phenformin

   d. Nonsulfonylureas: Metaglinides, Repaglinides, Nateglinides

   e. α-glucosidase inhibitor: Acarbose, Miglitol.

   f. DPP-4 inhibitors, e.g. sitagliptin, saxagliptin, vildagliptin, linagliptin, alogliptin

g. SGLT2 inhibitors: dapagliflozin and canagliflozin
h. Cycloset: e.g.bromocriptine

Q.3 Attempt ALL questions of the following. 20 Marks

a. Select the drug from the following which act as alkylating agents.

(a) 5-Fluorouracil (b) Doxorubicin
(c) Cyclophosphamide (d) Vincristine

Ans: (c) Cyclophosphamide

b. In what dosage form Azithromycin is given?

Ans: Azithromycin is given in following dosage forms:

- Azithromycin oral suspension
- Azithromycin capsule IP
- Azithromycin tablets IP
- Azithromycin dry syrup
- Azithromycin injection

c. The basic heterocyclic ring present in phenytoin is _____.

(a) Pyrazole (b) Imidazole
(c) Imidazolidine (d) Pyrazolidine

Ans: (c) Imidazolidine

d. To prepare a solution of accurately known volume, use a_____.

(a) Beaker
(b) Conical flask
(c) Volumetric flask
(d) Measuring cylinder

Ans: (c) Volumetric flask

e. Cathartics are the drugs used to_____

(a) Relieve acidity
(b) Relieve constipation
(c) Reduce gastrointestinal irritation
(d) All of the above

Ans: (b) Relieve constipation

f. In limit test for sulphate, to prevent the super saturation of $BaSO_4$, a small amount of _____ has been added in the reagent.

(a) Alcohol (b) Dilute HCl
(c) Potassium sulphate (d) Barium chloride

Ans: (a) Alcohol

g. To prevent the dental caries, toothpaste should contain_____

(a) Strontium chloride (b) Zinc chloride

(c) Sodium metaphosphate (d) Sodium fluoride

Ans: (d) Sodium fluoride

h. The antifungal drug, ketoconazole contains _____ heterocyclic ring

(a) Imidazole (b) Pyridine

(c) Acridine (d) Pyrimidines

Ans: (a) Imidazole

i. Lasix is a popular brand name of_____

(a) Hydrochlorothiazide (b) Furosemide

(c) Amiloride (d) Acetazolamide

Ans: (b) Furosemide

j. Name the antidepressant agent, which is a dibenzazepine derivative.

(a) Citalopram (b) Fluoxetine

(c) Imipramine (d) Paroxetine

Ans: (c) Imipramine

k. Match the following:

1. Class I	(a) Calcium channel blockers
2. Class II	(b) Beta-blockers
3. Class III	(c) Sodium channel blockers
4. Class IV	(d) Potassium channel blocker

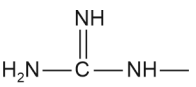
Options:

(a) 1-a, 2-b, 3-c, 4-d (b) 1-d, 2-b, 3-a, 4-c

(c) 1-b, 2-c, 3-a, 4-d (d) 1-c, 2-b, 3-d, 4-a

Ans: (d) 1-c, 2-b, 3-d, 4-a

l. The Name of the following group is_____



(a) Anilino- (b) Amidino-

(c) Guanidino- (d) Amino-

Ans: (c) Guanidino-

m. In what dosage form isosorbide dinitrate is given?

Ans: Isosorbide dinitrate is given in following dosage forms:

1. Dilute isosorbide dinitrate IP
2. Isosorbide dinitrate capsule
3. Isosorbide dinitrate tablet

n. Which of the following NSAIDs is phenylacetic acid derivative?

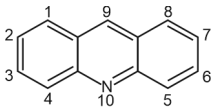
(a) Diflusinal (b) Aspirin

(c) Mefenamic acid (d) Diclofenac

Ans: (d) Diclofenac

o. Give structure and method of numbering for acridine.

Ans:



p. Write name and uses of drug containing imidazoline heterocycle.

Ans: The drug containing imidazoline heterocycle is clonidine.

Uses of clonidine: It is useful for treatment of:

1. Hypertension,
2. Attention deficit hyperactivity disorder
3. Drug withdrawal (Opioid, Alcohol, or Nicotine)
4. Menopausal flushing
5. Diarrhoea
6. Spasticity
7. Certain pain conditions.

q. The structure of pyridine ring is:



(**a**)

(**b**)



(**c**)



(**d**)

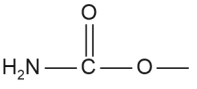
Ans: (d) 

r. 2-acetoxybenzoic acid is IUPAC name of_____

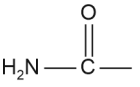
Ans: Aspirin

s. The structure of carbamoyl group is:

(**a**)



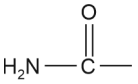
(**b**)



(**c**)



(**d**)

Ans: (c) 

t. Which of the following drug is a direct acting cholinomimetic agent?

(a) Parathion (b) Physostigmine

(c) Carbachol (d) Pyridostigmine

Ans: (c) Carbachol

Winter Examination 2022
(Question Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Answer any SIX of the following. **30 Marks**

a. Explain the principle and procedure involved in the limit test for arsenic.
b. Define and classify antibiotics giving suitable example of compounds under each class.
c. Give a brief account of: (i) Precipitation titration (ii) Acid-base titration.
d. Draw the structure of Phenytoin and give its chemical name, Therapeutic uses, Formulations, Stability-storage conditions and Popular Brand names.
e. Write storage condition and uses of: (i) Carbon dioxide (ii) Hydrogen peroxide
f. Define and classify adrenergic drugs giving suitable example of compounds under each class.
g. Give the structure, Chemical name, Therapeutic uses, Stability-storage conditions and Popular Brand names of Chloroquine phosphate.

Q.2 Answer any TEN of the following. **30 Marks**

a. What is meant by 'Impurity'? Enlist different sources of impurities. Explain any two.
b. Classify different types of titrimetric analysis and explain redox type of titration.
c. Give the structure and chemical name and uses of diazepam.
d. Give the structure, uses and storage condition of atenolol.
e. Define and classify antihypertensive agents with suitable examples.
f. Give the structure and chemistry of frusemide.
g. Define and classify hypoglycaemic agents giving suitable example of compounds under each class.

h. Write the uses and popular brand names of piroxicam or diclofenac sodium
i. Define and classify sulphonamides giving suitable examples.
j. Give the structure, storage condition and official preparations of any one beta-lactam antibiotics.
k. Define and classify antineoplastic agents with suitable examples.

Q.3 Solve ALL questions of the following. 20 Marks

1. **Organic chemistry is the chemistry of _____**
   (a) Halogen (b) Nitrogen
   (c) Carbon (d) Hydrogen
2. **The substance being titrated is called as _____**
   (a) Titrant (b) Indicator
   (c) Titrate (d) End point
3. **Name of the group –CH=CH_2**
   (a) Methyl- (b) Vinyl-
   (c) Allyl- (d) n-butyl
4. **Following is *not* a topical agent.**
   (a) Talc (b) Calamine
   (c) Oxygen (d) Zinc oxide
5. **Calcium carbonate is used as_____**
   (a) Astringent (b) Protective
   (c) Dental product (d) Cathartic
6. **The order of preference in numbering the heteroatom's follows:**
   (a) N-O-S (b) S-O-N
   (c) O-N-S (d) O-S-N
7. **The name of five membered heterocyclic ring containing two double bonds ends with_____**
   (a) –lidine (b) –toin
   (c) –ole (d) –dine
8. **Example of piperidine heterocyclic ring is _____**
   (a) Pethidine (b) Phenobarbitone
   (c) Dibenzazepine (d) Indole
9. **Chlorpromazine contains following heterocycle.**
10. **Nicotinic action of acetylcholine is _____**
    (a) Stimulation of smooth muscle
    (b) Peripheral Vasodialation
    (c) Cardiac inhibition
    (d) Stimulation of skeletal muscles

11. **Following is the example of adrenergic antagonists_____**
    (a) Propantheline (b) Tolazoline
    (c) Atropine (d) Biperidine
12. **Six membered heterocyclic ring containing three double bond and 1 and 3 position nitrogen atom is called _____**
    (a) Pyridine (b) Imidazole
    (c) Pyrazolidine (d) Pyrimidine
13. **Cardiac arrhythmia means disturbance in _____**
    (a) Respiration (b) Heart
    (c) Urine output (d) Heart valves
14. **Example of calcium channel blocker is _____**
    (a) Nifedipine (b) Guanethidine
    (c) Propranolol (d) Atropine
15. **Brand name of urea**:
    (a) Lasix (b) Burinex
    (c) Cotaryl-H (d) Diamox
16. **NSAIDs stands for _____**
    (a) Nor-steroidal Anti-inflammatory Drugs
    (b) Non-steroidal Anti-inflammatory Drugs
    (c) Non-steroidal Anti-immunity Drugs
    (d) New-steroidal Anti-inflammatory Drugs
17. **Brand name of acetyl salicylic acid is _____**
    (a) Anacin (b) Paramol
    (c) Calpol (d) Enderal
18. **Name of drug used in treatment of dental caries**.
    (a) Sodium Sulphate (b) Sodium Fluoride
    (c) Sodium Bicarbonate (d) Sodium Salicylate
19. **Synonym of ferrous sulphate.**
    (a) Green Vitriol (b) French Chalk
    (c) China Clay (d) Spirit of Salt
20. **Cotrimoxazole is a combination of _____**
    (a) Sulphadimidine + Trimethoprim
    (b) Sulphamethoxazole + Trimethoprim
    (c) Sulphaguanidine + Trimethoprim
    (d) Sulphacetamide + Trimethoprim

Winter Examination 2022
(Specimen Answer Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

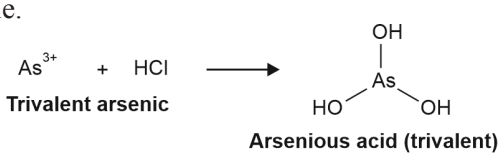
Q.1 Answer any SIX of the following. **30 Marks**

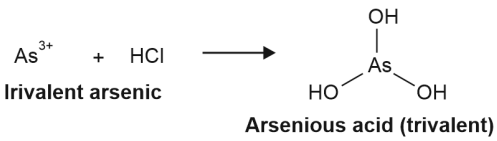
a. Explain the principle and procedure involved in the limit test for arsenic.

Ans: Limit Test for Arsenic

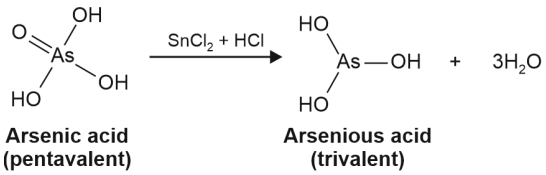
Principle:

1. It is also called as Gutzeit test and requires special apparatus called Gutzeit apparatus.
2. Limit test of Arsenic is based on the reaction of arsenic gas with hydrogen ion to form yellow stain on mercuric chloride paper in presence of reducing agents like stannous acid, potassium iodide.
3. The sample dissolved in stannated acid, which converts the arsenic impurities to arsenious acid to arsenic acid depending upon valency state of arsenic impurity present in the test sample.

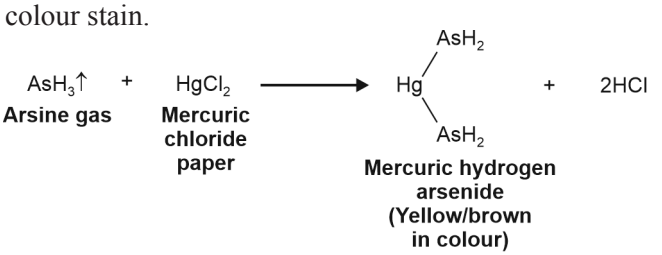




4. When acidic solution of sample treated with reducing agent (stannous chloride) converts pentavalent arsenic acid into trivalent arsenious acid



5. The arsenious acid is them converted into gaseous hydride (arsine gas) with help of nascent hydrogen (which is produced by zinc and HCl)
6. Arsine gas carried through the tube by steam of hydrogen and out through the mercuric chloride paper. A reaction occurs between arsine and mercuric chloride which produces yellow colour stain.



7. The depth of yellow stain on mercuric chloride paper will depend upon the quality of arsenic present in the sample.
8. Stannous chloride is used for complete evolution of arsine.
9. Zinc, potassium iodide and stannous chloride is used as a reducing agent.
10. Hydrochloric acid is used to make the solution acidic
11. Lead acetate cotton plug or papers are used to trap any hydrogen sulphide which may be evolved along with arsine.

Procedure:

Take two 50 ml of Arsenic LT apparatus bottles. Label one "Test" and the other as "Standard".

Standard solution	***Test solution***
1. A known amount of dilute arsenic Solution is kept in the wide-mouthed bottle of the apparatus.	1. Dissolving a specific amount of sample in water and stannate HCl (as free) and kept in the wide-mouthed bottle of the apparatus.
2. To this solution, 1 g of KI, 5 ml of stannous chloride, and 10 gm of zinc are added (all these reagents should be arsenic-free).	2. To this solution, 1 g of KI, 5 ml of stannous chloride, and 10 g of zinc are added (all these reagents should be arsenic-free).
3. Keep the solution aside for 40 minutes.	3. Keep the solution aside for 40 minutes.
4. Compare the stain obtained on the mercuric chloride paper with that in the apparatus containing the test solution.	4. Compare the stain obtained on the mercuric chloride paper with that in the apparatus containing standard solution.

Observation: The colour produce in sample solution should not be greater than standard solution. If colour produces in sample solution is less than the standard solution, the sample will pass the limit test of heavy metals and *vice versa*.

b. Define and classify antibiotics giving suitable example of compounds under each class.

Ans: Antibiotics: Antibiotics are chemical substances produced by certain species of microorganisms and their synthetic analogues having the property of inhibiting the growth of or destroying other microorganisms in high dilutions or low concentration.

Classification of Antibiotics

A. Chemical classification of antibiotics

1. **Beta-lactam antibiotics:**
   a. Penicillin—phenoxymethylpenicillin, flucloxacillin, amoxicillin.
   b. Cephalosporins—cefaclor, cefadroxil and cephalexin.
2. **Tetracyclines:** Doxycycline and minocycline.
3. **Aminoglycosides:** Streptomycin
4. Macrolides: Erythromycin, azithromycin
5. **Polypeptides:** Bacitracin,
6. **Polyenes antifungal antibiotics:** Amphotericin, nystatin and candicidin
7. **Ansamycins:** Rifamycins (Rifampin, Rifampicin, Rifabutin)
8. **Lincomycins:** Clindamycin.
9. **Quinolones:** Ciprofloxacin, levofloxacin and norfloxacin
10. **Antibiotics derived from single aminoacid:** s-Cycloserine and Chloramphenicol
11. **Miscellaneous:** s-fusidic acid, griseofulvin, novobiocin, etc.

B. Classification of antibiotics according to Mode of Action

1. ***Inhibitors of bacterial cell wall synthesis:*** Penicillin, Cephelosporins
2. ***Inhibitors of protein synthesis:*** Tetracyclines, Chloramphenicol, Macrolide, Aminoglycoside
3. ***Inhibitors of nucleic acids metabolism (DNA/RNA):*** Griseofulvin, Actinomycin

C. Classification of antibiotics depending on spectrum of activity

1. ***Narrow spectrum:*** Bacitracin
2. ***Broad spectrum:*** Cephalosporin

c. Give a brief account of: (i) Precipitation titration (ii) Acid- base titration

Ans:

i. **Precipitation titration:**

- Precipitation titration is a type of titration which involves the formation of precipitate during the titration technique.
- In precipitation titration, the titrant reacts with analyte and forms an insoluble substance called precipitate.
- It continues till the last amount of analyte is consumed.
- In this titration, a substance that precipitates from solution in a clearly visible form at the end point is used as an indicator, e.g. Potassium chromate in Mohr's method, Ferric ammonium sulphate in Volhard's method, etc.

ii. **Acid–base titration:**

- An acid–base titration is a method of quantitative analysis for determining the concentration of an acid or base by exactly neutralizing it with a standard solution of base or acid having known concentration.
- Thus, these are neutralization reactions with formation of salt and water as the end products.
- A pH indicator is used to indicate the end point of acid-base neutralization reaction.

Four Basic Types of Acid-base Titrations

- The below table shows the four types of titrations, and you note that the titrant (compound in the burette that is added to the analyte) is always strong, while the analyte can be strong or weak.)

Type	***Analyte***	***Titrant***
SA/SB	Strong acid	Strong base
WA/SB	Weak acid	Strong base
SB/SA	Strong base	Strong acid
WB/SA	Weak base	Strong acid

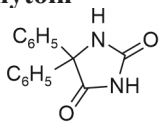
- In acid- base titration, a solution of known concentration (the titrant) is added to a solution of the substance being studied (the analyte).
- In an acid-base titration, the titrant is a strong base or a strong acid, and the analyte is an acid or a base, respectively.

- For example, hydrochloric acid and sodium hydroxide form sodium chloride and water:

  $HCl(aq) + NaOH(aq) \rightarrow H_2O + NaCl(aq)$
- Neutralization is the basis of titration.
- A pH indicator shows the equivalence point—the point at which the equivalent number of moles of a base has been added to an acid and a sharp colour change is observed.
- Examples of acid-base titration are Assay of Sodium bicarbonate, Assay of Ibuprofen, Assay of Boric acid, etc.

d. Draw the structure of Phenytoin and give its chemical name, Therapeutic uses, Formulations, Stability-storage conditions and Popular Brand Names.

Ans: Structure of Phenytoin



Chemical name of phenytoin

5, 5-diphenylimidazolindine-2, 4-dione or 5, 5-diphenyl-2, 4-imidazolindinedione

Therapeutic uses of phenytoin:

1. Phenytoin, formerly known as diphenyl hydantoin, is a potent anticonvulsant used to treat and prevent generalized grand mal seizures, complex partial seizures and status epilepticus.
2. Used as anticonvulsant and hypnotics
3. Used in cardiac arrhythmias

Stability-storage of phenytoin

Store at room temperature between 68°–77°F (20°–25°C) away from light and moisture.

Do not freeze.

Brand names of phenytoin: Dilantin, Spentoin, Eptoin

Formulations of phenytoin: Injection, Capsule

e. Write storage condition and uses of: (i) Carbon Dioxide (ii) Hydrogen Peroxide

Ans:

i. Storage condition of carbon dioxide:

- Carbon dioxide is supplied in metal cylinders at a temperature not exceeding 31ºC.

- The shoulder of the cylinder is painted grey and has the name and symbol of CO_2 stencilled on it.

Uses of carbon dioxide:

1. Carbon dioxide is important for regulating the acid-base balance of the blood and tissues.
2. Carbon dioxide has been used as a respiratory stimulant.
3. Carbon dioxide 5–7% in oxygen has been used in the treatment of carbon monoxide poisoning.
4. Carbon dioxide, when given by mouth in solution form or as carbonates orbicarbonates, promotes the absorption of liquids by the mucous membrane.

   Therefore, aerated waters rapidly relieve thirst, hasten the action of alcohol and soon cause diuresis.
5. The frozen form of carbon dioxide, dry ice, has been used in the treatment of skin disorders like acne, angiomas, corns, eczema, moles, warts, etc.

ii. Storage condition of hydrogen peroxide:

- It is stored in containers protected from light, in bottles closed with glass stoppers or plastic caps provided with a vent for the escape of oxygen. It is kept in a cool place.
- The label of the container should indicate whether it contains a stabilizing agent or not.

Uses of Hydrogen peroxide:

- Hydrogen peroxide solution is primarily used for its antiseptic action.
- The antiseptic action is associated with mechanical cleansing provided by rapid foaming release of oxygen. This helps in removal of dirt, bacteria from cuts and wounds and acts as cleaning-antiseptic.
- Hydrogen peroxide is effective against many pathogenic bacteria including anaerobic bacteria.
- The diluted solution (1:1 with water) is used for gargle, mouthwash or for treatment of infections of the throat.
- It is also used for treatment as ear wash and vaginal douche.
- Hydrogen peroxide solution is an effective antidote for phosphorus and cyanide poisoning.

f. Define and classify adrenergic drugs giving suitable example of compounds under each class.

Ans: Adrenergic agents:

An adrenergic agent is a drug, or other substance, which has effects like, or the same as, epinephrine (adrenaline). Thus, it is a kind of sympathomimetic agent. Alternatively, it may refer to something which is susceptible to epinephrine, or similar substances, such as a biological receptor (specifically, the adrenergic receptors).

Classification of Adrenergic Drugs:

The adrenergic drugs can be classified based on their chemical structure.

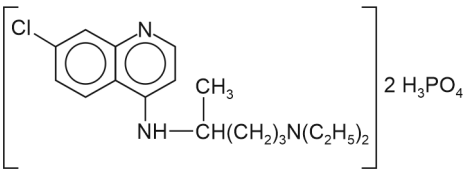
1. **Catecholamines:** Adrenaline, Nor-adrenaline, Isoprenaline
2. **Non-catecholamines:** Phenylephrine, Salbutamol, Terbutaline, Ephedrine, Pseudoephedrine.
3. **Imidazoline derivatives:** Naphazoline, Tetrahydrozolium

Alternatively, these agents classified as:

1. **Directly acting (act directly on α or β receptors):** Direct stimulation of the α- and β-adrenergic receptors can produces sympathomimetic effects. e.g. Epinephrine, Norepinephrine, Dopamine, Salbutamol, Phenylephrine, Terbutaline, Naphazoline, Tetrahydrozoline.
2. **Indirectly acting (act by providing more norepinephrine to act on α or β receptors):** work by causing the release of dopamine and norepinephrine, along with (in some cases) blocking the reuptake of these neurotransmitters, e.g. amphetamine, hydroxyamphetamine, and propylhexedrine, pseudoephedrine
3. **Mixed acting (act by both mechanisms):** Ephedrine, metaraminol many sympathomimetics alternatively, also classified as:
   i. Alpha-adrenoceptor agonists (α-agonists): Phenylephrine
   ii. Beta-adrenoceptor agonists (β-agonists): Terbutaline, Salbutamol
   iii. Both alpha and beta agonist: Adrenaline, Noradrenaline

g. Give the structure, Chemical name, Therapeutic uses, Stability-storage conditions and Popular Brand names of Chloroquine Phosphate.

Ans: Structure of chloroquine phosphate



Chemical name of chloroquine phosphate: 7-chloro-4-(4'-diethylamino-1'-methyl, butyl amino)-quinoline phosphate

Therapeutic uses of chloroquine phosphate:

- Chloroquine is used to prevent and treat malaria.
- It is also used to treat liver infection caused by protozoa (extraintestinal amoebiasis).
- Chloroquine may also be used to treat coronavirus (COVID-19) in certain hospitalized patients.
- To treat giardiasis, rheumatoid arthritis, systemic erythematosus.

Stability-storage of chloroquine phosphate: Store in a cool, dry place, protected from light and heat.

Brand names of chloroquine phosphate: Ciplaquin, Nivaquine P, Lariago, Aralen,

Q.2 Answer any TEN of the following. 30 Marks

a. What is meant by 'Impurity'? Enlist different sources of impurities. Explain any two.

Ans: Impurity: Undesirable matter which may or may not be toxic but present in the pharmaceutical products.

Sources of Impurities

1. Raw materials used in manufacture
2. Processes used in manufacture
3. Material of the plant
4. During storage
5. Accidental substitution or deliberate adulteration
6. Manufacturing hazards

1. **Raw materials used in manufacture:** Traces of impurities in raw materials may be carried to contaminate the final product.
   - For example, common salt (NaCl) prepared from rock salt will almost certainly contain traces of calcium (Ca) and magnesium (Mg) compounds.
   - Metallic zinc may be present as an impurity in zinc oxide (ZnO) sample as it is prepared by heating metallic zinc.

2. **Processes used in manufacture:** Some impurities are incorporated during the manufacturing process. This may occur due to:
   - Reagents used in process
   - Reagents added to remove other impurities
   - Solvents—water is the cheapest solvent widely available. Tap water contains many ion impurities in small amounts like Cl^-, Ca^{++}, Mg^{++}, and Na^+, etc.
   - The intermediate products may come along the process in the final product as impurity.
3. **Material of the plant:** The vessels used in the manufacturing process are generally made up of metals like iron, copper, zinc, nickel, aluminium, and stainless steel. Due to the solvent action on the plant material the traces of metals, i.e. impurities come in the product. Similarly, glass of an unsatisfactory standard and plastic containers used for handling liquid and semisolid products may yield traces of alkalies and antioxidants respectively.
4. **During storage:**
   - Filth—stored product may become contaminated with dust, insect, or insect excreta.
   - Decomposition of the product during storage—many chemical substances undergoes changes or decomposition due to careless storage, e.g. ferrous sulphate is slowly converted into insoluble ferric oxide by air and moisture
   - Ether and chloroform decompose in the presence of light and air. Chloroform on decomposition gives carbonyl chloride (phosgene gas) so it should be stored in well filled, well-closed amber coloured bottle.
5. **Accidental substitution or deliberate adulteration:** Accidental substitution can take place if toxic substances are stocked with other substances or compounds. Some pharmaceutical products may be adulterated with cheaper substitutes.
   - For example, honey may be adulterated with inverted sugar, potassium bromide with sodium bromide.
6. **Manufacturing hazards:**
   - **Particulate contamination:** Accidental inclusion of dirt, glass, porcelain, metallic or plastic fragments from sieves, granulating, tableting, and filling machines or even from product containers is possible.

- **Process error:** Gross errors arising from incomplete solution of solute in a liquid preparation must be detected by normal analytical procedures. Special care is required for highly potent medicaments of low dose (5 mg or less)
- **Cross contamination:** The handling of powders, granules and tablets in large quantities creates considerable amount of air-borne dust and may lead to cross-contamination
- **Microbial contamination:** Liquid preparations and creams for topical application are prone to bacterial and fungal contamination. Special care should be taken in parenteral and ophthalmic preparations to avoid microbial contamination
- **Packing errors:** Products of similar appearance as tablets of same size, colour and shape packed in similar containers may lead to mislabeling.

b. Classify different types of titrimetric analysis and explain redox type of titration.

Ans: Classification/ types of titrimetric analysis

1. Acid-base titrations
2. Non-aqueous titrations
3. Precipitation titrations
4. Complexometric titrations
5. Redox titrations

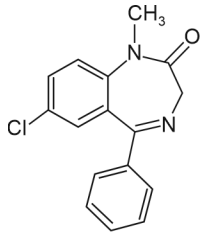
Redox Titrations

In redox reaction, oxidation and reduction usually occur simultaneously. Oxidation reaction is the reaction where addition of oxygen or removal of hydrogen takes place, while in reduction, there will be addition of hydrogen or removal of oxygen.

Various oxidising agents are employed in the reactions, and depending upon the agents used, they are classified into-

1. **Permanganate titrations:** Potassium permanganate is used as an oxidant it is also self-indicator.
2. **Dichromate titrations:** Potassium dichromate is used as an oxidant.
3. **Iodine titrations:** Iodine is used as an oxidising agent.
4. **Cerimetry:** Ceric salts are used as oxidants.

c. Give the structure and chemical name and uses of diazepam.
Ans: Diazepam

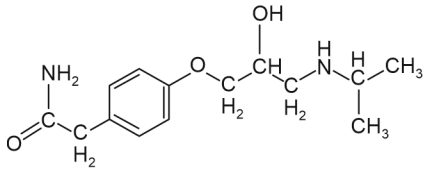


Chemical name: 7-Chloro-1, 3-dihydro-1-methyl-5-phenyl-3H-1,4-benzodiazepin-2-one

Uses:

- Diazepam is used to treat anxiety disorders, alcohol withdrawal symptoms, or muscle spasms.
- Diazepam is sometimes used with other medications to treat seizures.
- Sedatives and hypnotics
- Used in treatment of insomnia.

d. Give the Structure, Uses and Storage condition of Atenolol.
Ans: Atenolol



Uses: It is β-blocker used for:

1. Management of hypertension,
2. Management of angina pectoris,
3. Management of acute myocardial infarction,
4. Management of heart failure,
5. Management of atrial fibrillation,
6. Management of supraventricular tachycardia,
7. Management of ventricular arrhythmias,
8. Management of symptomatic thyrotoxicosis,
9. Prophylaxis of migraine headaches,
10. Management of alcohol withdrawal.

Storage: Store at a room temperature 20–25ºC, in a dry place.

e. Define and Classify Antihypertensive agents with suitable examples.

Ans: Antihypertensive agents

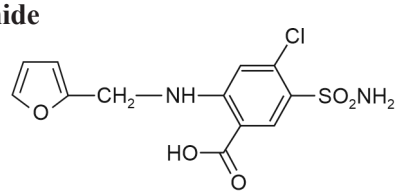
An agent that reduces elevated blood pressure is called as an antihypertensive agent.

Classification

1. ACE inhibitors: Captopril, Enalapril, Ramipril
2. Angiotensin antagonist: Losartan, Candesartan
3. Calcium channel blockers: Verapamil, Nifedipine,
4. Diuretics:
   a. Thiazides: hydrochlorothiazide
   b. High ceiling: furosemide
   c. Potassium sparing: spironolactone
5. Beta-adrenergic blockers: Propranolol, Metoprolol, Atenolol
6. Alpha-adrenergic blockers: Prazosin, Terazosin
7. Alpha + beta adrenergic blockers: Labetalol, Carvedilol
8. Central sympatholytic: Clonidine, Methyldopa
9. Vasodilators: Hydralazine, Minoxidil sodium.

f. Give the Structure and Chemistry of Frusemide.

Ans: Frusemide



Chemical name: 4-chloro-2-((furan-2-yl methyl) amino)-5-sulfamoyl benzoic acid.

- **Formula:** C12H11ClN2O5S
- **Mol weight:** 330.74 g/mol
- It is anthranilic acid derivative containing furan as heterocyclic ring and sulphonamide as functional group.

g. Define and classify hypoglycaemic agents giving suitable example of compounds under each class.

Ans: Hypoglycemic Agents

Drugs used in diabetes treat diabetes mellitus by altering the glucose level in the blood. Antidiabetic drugs administered orally are also called as Oral Hypoglycemic Agents.

Classification:

1. **Hormones:** Insulin and its preparations
2. **Oral hypoglycemic agents**
   a. Sulfonylureas: Tolbutamide, Chlorpropamide, Tolazamide, Acetohexamide, Glipizide, Glyburide, Glimepiride, Glicazide
   b. Thiazolindiones: Rosiglitazone, Pioglitazone
   c. Biguanidines: Metformin, Phenformin
   d. Nonsulfonylureas: Metaglinides, Repaglinides, Nateglinides
   e. α-glucosidase inhibitor: Acarbose, Miglitol.
3. **Plant based products** e.g. Guar gum

h. Write the uses and popular brand names of piroxicam or diclofenac sodium.

Ans: i. **Piroxicam**

Uses: Anti-inflammatory drug used in the treatment of Osteoarthritis, Rheumatoid arthritis, Ankylosing spondylitis.

Brand Names: Dolonex, Ugesic, Suganril, Doloforce, Doloxicam, Feldex, Dupox, Medicam, Prixicam, Rexicam, Pirox.

ii. **Diclofenac sodium**

Uses: Anti-inflammatory drug used in the treatment of Osteoarthritis, Rheumatoid arthritis, Ankylosing spondylitis, Ocular Pain, Toothache, Dysmenorrhoea, renal colic.

Brand names: Voltaren, Voltaflam, cataflam, Diclonac.

i. Define and classify sulphonamides giving suitable examples.

Ans: Sulphonamides

Sulphonamides are the group of synthetic antimicrobial agents that are structural analogues of para-amino benzoic acid (PABA).

Classification of Sulphonamides

A. Chemical classification

1. **N^1- substituted sulphonamides**
   a. With acyclic substituents: Sulphacetamide, sulphaguanidine
   b. With heterocyclic substituents: Sulphadiazine, sulphamethoxazole, sulphadimethoxine, sulphamethoxypyridazine.
2. **N^4 - substituted sulphonamides** e.g. Sulphasalazine.
3. **Sulphonamides with both N^1 and N^4 substituents,** e.g. Phthalylsulphathiazole, succinylsulphathiazole.

B. On the basis of duration of action

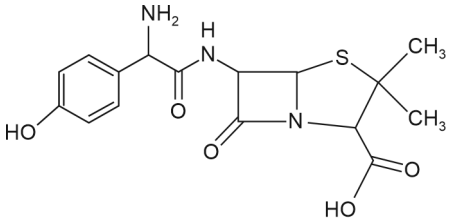
1. **Short-acting sulphonamide** (plasma half-life less than 10 hours)
   a. Poorly absorbed and locally acting—succinyl sulphathiazole, Sulphaguanidine, phthalylsulphathiazole.
   b. Absorbed and excreted rapidly—sulphacetamide.
2. **Medium-acting sulphonamides** (plasma half-life is between 10–24 hours): Sulphamethoxazole, sulphadiazine.
3. **Long-acting sulphonamides** (plasma half-life is more than 24 hours): Sulphadimethoxine, sulphamethoxypyridazine.
4. **Ultra-long-acting sulphonamides**—sulphamethoxine, sulphamethoxypyrazine

C. Depending upon their therapeutic uses

1. **Sulphonamides are used for systemic infections:**
   a. Urinary tract infections: Sulphamethoxazole, sulphacetamide.
   b. Respiratory tract infections: Cotrimoxazole, sulphadiazine.
   c. Meningeal infections: Sulphadiazine.
2. **Sulphonamides are used for local infections:**
   a. Intestinal infections: Sulphaguanidine, phthalylsulphathiazole, Succinyl sulphathiazole.
   b. Ophthalmic infections: Sulphacetamide.
   c. Burn therapy: Mefenide, Silver sulphadiazine.

j. Give the structure, storage condition and official preparations of any one beta-lactam antibiotics

Ans: Beta-lactam antibiotics, e.g. Amoxicillin



Storage conditions:

- Capsules and tablets are stored at room temperature (20–25ºC) away from heat, light and moisture.
- Syrups and injections are stored in air tight containers in refrigerator (2–8ºC) but do not freeze.

Official preparations:

- Oral tablet /capsules 125, 250, 500 mg per tablet or capsule
- Syrup: 125 mg/5 mL, 30 ml bottle
- Injection: 125, 250, 500 mg per vial for IM/IV use

Brand names: Mox, Novamox, Synomox, Amoxil, etc.

k. Define and classify Antineoplastic agents with suitable examples

Ans: Antineoplastic agents: Antineoplastic agents are medications used to treat cancer. Drugs that are effective in the treatment of malignant or cancerous disease.

Classification:

1. **Alkylating agents:**
   a. Nitrogen mustard drugs: Mustine, Chormabucil, cyclophosphamide
   b. Aziridines: Thiotepa
   c. Alkyl sulphonate: Busulphan
   d. Nitrosourea group compound: Lomustine
2. **Antimetabolites:** Methotrexate, Mercaptopurine, Azathioprine, Fluorouracil
3. **Antibiotics:** Actinomycin, Daunorubicin, Doxorubicin
4. **Plant Products:** Sulphates of vinblastine and vincristine.
5. **Hormones and related drugs:** Glucocorticoids, Tamoxifen
6. **Miscellaneous agents:** Hydroxyurea, Cisplatin

Q.3 Solve ALL questions of the following. 20 Marks

1. **Organic chemistry is the chemistry of _____**
   (a) Halogen (b) Nitrogen
   (c) Carbon (d) Hydrogen
   Ans: (c) Carbon
2. **The substance being titrated is called as _____**
   (a) Titrant (b) Indicator
   (c) Titrate (d) End point
   Ans: (c) Titrate
3. **Name of the group $-CH=CH_2$**
   (a) Methyl- (b) Vinyl-
   (c) Allyl- (d) n-butyl
   Ans: (b) Vinyl-
4. **Following is not a topical agent.**
   (a) Talc (b) Calamine
   (c) Oxygen (d) Zinc Oxide
   Ans: (c) Oxygen

5. **Calcium carbonate is used as _____**
   (a) Astringent (b) Protective
   (c) Dental product (d) Cathartic
   Ans: (c) Dental Product
6. **The order of preference in numbering the heteroatom's follows:**
   (a) N-O-S (b) S-O-N
   (c) O-N-S (d) O-S-N
   Ans: (d) O-S-N
7. **The name of five membered heterocyclic ring containing two double bonds ends with _____**
   (a) –lidine (b) –toin
   (c) –ole (d) –dine
   Ans: (c) –ole
8. **Example of piperidine heterocyclic ring is _____**
   (a) Pethidine (b) Phenobarbitone
   (c) Dibenzazepine (d) Indole
   Ans: (a) Pethidine
9. **Chlorpromazine contains following heterocycle _____**
   (a) Acridine (b) Phenothiazine
   (c) Dibenzazepine (d) Indole
   Ans: (b) Phenothiazine
10. **Nicotinic action of acetylcholine is _____**
    (a) Stimulation of smooth muscle
    (b) Peripheral vasodialation
    (c) Cardiac inhibition
    (d) Stimulation of skeletal muscles
    Ans: (d) Stimulation of skeletal muscles
11. **Following is the example of adrenergic antagonists _____**
    (a) Propantheline (b) Tolazoline
    (c) Atropine (d) Biperidine
    Ans: (b) Tolazoline
12. **Six membered heterocyclic ring containing three double bond and 1 and 3 position nitrogen atom is called _____**
    (a) Pyridine (b) Imidazole
    (c) Pyrazolidine (d) Pyrimidine
    Ans: (d) Pyrimidine

13. **Cardiac arrhythmia means disturbance in _____**
    (a) Respiration (b) Heart beats
    (c) Urine output (d) Heart valves
    Ans: (b) Heart beats
14. **Example of calcium channel blocker is _____**
    (a) Nifedipine (b) Guanethidine
    (c) Propranolol (d) Atropine
    Ans: (a) Nifedipine
15. **Brand name of urea is:**
    (a) Lasix (b) Burinex
    (c) Cotaryl-H (d) Diamox
    Ans: (c) Cotaryl-H
16. **NSAIDs stands for _____**
    (a) Nor-steroidal Anti-inflammatory Drugs
    (b) Non-steroidal Anti-inflammatory Drugs
    (c) Non-steroidal Anti-immunity Drugs
    (d) New-steroidal Anti-inflammatory Drugs
    Ans: (b) Non-steroidal Anti-inflammatory Drugs
17. **Brand name of acetyl salicylic acid is _____**
    (a) Anacin (b) Paramol
    (c) Calpol (d) Enderal
    Ans: (a) Anacin
18. **Name of drug used in treatment of dental caries.**
    (a) Sodium sulphate (b) Sodium fluoride
    (c) Sodium bicarbonate (d) Sodium salicylate
    Ans: (b) Sodium fluoride
19. **Synonym of ferrous sulphate is _____**
    (a) Green vitriol (b) French chalk
    (c) China clay (d) Spirit of salt
    Ans: (a) Green vitriol
20. **Cotrimoxazole is a combination of _____**
    (a) Sulphadimidine + Trimethoprim
    (b) Sulphamethoxazole + Trimethoprim
    (c) Sulphaguanidine + Trimethoprim
    (d) Sulphacetamide + Trimethoprim
    Ans: (b) Sulphamethoxazole + Trimethoprim

Summer Examination 2023 (Question Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Answer any SIX of the following. **30 Marks**

a. Name any 2 examples of the following:
i. Haematinics ii. Antacids iii. Dental Products iv. Cathartic
v. Antiseptics/Disinfectants
b. Define—"Volumetric analysis". List the apparatus needed in volumetric analysis. Mention the types of volumetric analysis.
c. Define the term "epilepsy". Classify Anti-epileptic agents with suitable examples.
d. Draw chemical structure of Dapsone. Give it chemical name, uses, formulations and storage conditions.
e. Explain reaction and principle involved in Limit Test of Arsenic and draw neat and labelled sketch of Gutzeit's apparatus.
f. What are adrenergic drugs? Classify with examples. Draw the structure of Norepinephrine.
g. Define and classify anti-neoplastic agents. Draw structure of 5 Fluorouracil.

Q.2 Answer any TEN of the following. **30 Marks**

a. Discuss any three different sources of impurities in pharmaceuticals.
b. Classify Antimalarials. Draw structure of chloroquine phosphate.
c. Give storage-stability, uses and brand name of drug Penicillin G.
d. What are parasympathomimetic agents? Draw structure of drug Acetylcholine. Give its storage and stability conditions.
e. Define and classify sedatives and Hypnotics with examples. Draw the structure of Phenobarbitone.
f. Give the structure, chemical name and uses of Frusemide.
g. Define diabetes mellitus. Draw structure of metformin and give its popular brand names.
h. What are narcotic analgesics? Give its classification with examples.
i. Give uses for:
(i) Chlorpromazine (ii) Chloramphenicol (iii) Propranolol
j. Classify Antihypertensive agents with suitable examples.
k. Draw structure for: (i) Beta-Lactum antibiotic (ii) Sulfa Drug

Q.3 Attempt ALL questions of the following. 20 Marks

a. Define antibiotics.
b. Write any 2 uses of Azithromycin.
c. Draw structure of acetyl group and chloro group.
d. Draw structure of Pyridine and give its method of numbering.
e. Chemical formula for bleaching powder is _____
(i) $Ca(ClO)_2$ (ii) $Ca(ClO)_4$ (iii) $CaCO_3$ (iv) Ca_2CO_3
f. Prazosin drug is used for _____
(i) Hypertension (ii) Brain tumor (iii) Diarrhoea (iv) Cancer
g. Name any 2 indicators used in Acid-base titration.
h. The synonym of Calcium Carbonate is_____
i. The precipitating agent used in Limit Test for chloride is_____.
j. Define "Redox Titration".
k. Draw structure of Atropine sulphate.
l. Doxycycline belongs to the structural class of antibiotics _____
(i) Penicillins (ii) Macrolides (iii) Tetracyclines (iv) None of these
m. IUPAC name of Paracetamol is _____
(i) N-(2, 2-diethyl hydroxyl) acetamide
(ii) N-(4-hydroxy phenyl) anilide
(iii) 4-hydroxy-Acetanilide
(iv) None of the above
n. Full form of NSAID is _____
o. Structure of Indole ring is _____
p. State whether true or false for antacids are meant for constipation and hypoacidity.
q. Define "non-aqueous titration".
r. Gravimetry analysis is a semi-quantitative method. (True or False).
s. Give two uses of Atenolol.
t. Name any two anti-depressant drugs.

Summer Examination 2023
(Sepecimen Answer Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Answer any SIX of the following. **30 Marks**

a. Name any 2 examples of the following:

Ans:

i. **Haematinics:** Ferrous sulphate, Ferrous fumarate, Ferric ammonium citrate, Ferrous ascorbate, Carbonyl iron.

ii. **Antacids:** Aluminium hydroxide gel, Sodium bicarbonate, Calcium carbonate, Magnesium hydroxide, Magaldrate.

iii. **Dental products:** Sodium fluoride, Calcium carbonate, Stannous fluoride

iv. **Cathartics:** Magnesium sulphate, Sodium potassium tartrate, Magnesium hydroxide

v. **Antiseptics/disinfectants:** Ionic Silver, Chlorhexidine Gluconate, Hydrogenperoxide, Boric Acid, Bleaching powder, Potassium Permanganate

b. Define "Volumetric analysis". List the apparatus needed in volumetric analysis.

Ans: Volumetric analysis: Volumetric analysis is a quantitative analytical method which is used widely and involves measurement of the volume of a solution whose concentration is known and applied to determine the concentration of the analyte.

Apparatus needed in volumetric analysis are:

1. Burette
2. Pipette (Bulb, Graduated)
3. Volumetric flask
4. Conical flask/ Iodine flask/ Stoppered flask
5. Beaker
6. Funnel
7. Burette stands
8. White tile

Types of volumetric analysis

1. Acid-base titrations (aqueous and non-aqueous)

2. Redox titrations (permanganate, iodimetry, iodometry, cerimetry, bromometry)
3. Precipitation titrations (argentometry)
4. Complexometric titrations.

c. Define the term "epilepsy". Classify Anti-epileptic agents with suitable examples.

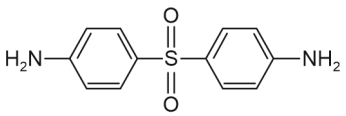
Ans: Definition: Epilepsy is also known as a seizure or convulsion disorder is a brain disorder neurological condition) that causes recurring seizures.

Classification of Antiepileptics agents

1. Aldehydes, e.g. Paraldehyde (1882). One of the earliest anticonvulsants. It is still used to treat status epilepticus, particularly where there are no resuscitation facilities.
2. Aromatic allylic alcohols, e.g. stiripentol
3. Barbiturates, e.g. Phenobarbital, Methylphenobarbital
4. Benzodiazepines, e.g. Diazepam, Clobazam, Clonazepam, Lorazepam
5. Carboxamides, e.g. Carbamazepine, Oxcarbazepine, Eslicarbazepine acetate
6. Fatty acids, e.g. valproates: valproic acid, sodium valproate, and divalproex sodium, Vigabatrin, Progabide,
7. Fructose derivatives, e.g. Topiramate
8. Hydantoins, e.g. Ethotoin, Phenytoin, Mephenytoin, Fosphenytoin
9. Oxazolidinones, e.g. Paramethadione, Trimethadione, Ethadione
10. Pyrrolidines, e.g. Brivaracetam, Etiracetam, Levetiracetam
11. Succinimides, e.g. Ethosuximide, Phensuximide, Methsuximide
12. Pyrimidinediones, e.g. Primidone
13. Triazines, e.g. Lamotrigine
14. Sulfonamides, e.g. Sultiame
15. Ureas, e.g. Phenacemide

d. Draw chemical structure of dapsone. Give its chemical name, uses, formulations and storage conditions.

Ans: Dapsone:



Chemical name: - 4, 4'-diaminodiphenyl sulfone OR
4-[(4-aminobenzene)sulfonyl]aniline OR

Uses:

1. Dapsone is bacteriostatic and is used only in the treatment of leprosy.
2. Dapsone is used in combination with pyrimethamine in the treatment of malaria.

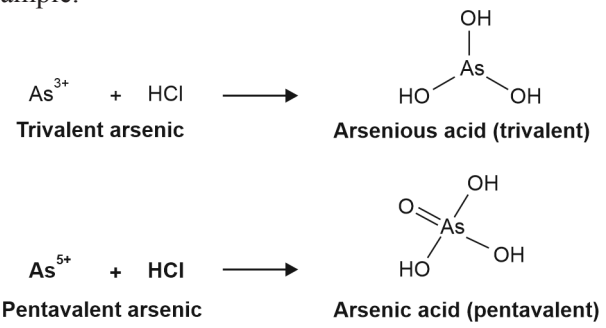
Formulations: Tablet, Cream, Gel

Storage conditions: Store in a cool, dry place, protected from light, heat and moisture.

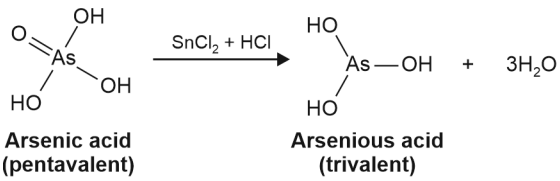
e. Explain reaction and principle involved in limit test of Arsenic and draw neat and labeled sketch of Gutzeit's apparatus.

Ans: Limit Test for Arsenic—Reaction and Principle:

- It is also called as Gutzeit test and requires special apparatus called Gutzeit apparatus.
- Limit test of Arsenic is based on the reaction of arsenic gas with hydrogen ion to form yellow stain on mercuric chloride paper in presence of reducing agents like stannous acid, potassium iodide.
- The sample dissolved in stannated acid, which converts the arsenic impurities to arsenious acid to arsenic acid depending upon valency state of arsenic impurity present in the test sample.



- When acidic solution of sample treated with reducing agent chloride) converts pentavalent arsenic acid into trivalent arsenious acid



- The arsenious acid is then converted into gaseous hydride arsine gas with help of nascent hydrogen (which is produced by zinc and HCl)

$$H_3AsO_3 + 6H \longrightarrow AsH_3\uparrow + 3H_2O$$

Arsenious acid (trivalent) — **Nascent hydrogen** — **Arsine gas**

- Arsine gas is carried through the tube by steam of hydrogen and out through the mercuric chloride paper. A reaction occurs between arsine and mercuric chloride which produces yellow colour stain

$$AsH_3\uparrow + HgCl_2 \longrightarrow Hg(AsH_2)_2 + 2HCl$$

Arseine gas — **Mercuric chloride paper** — **Mercuric hydrogen arsenide (yellow brown in colour)**

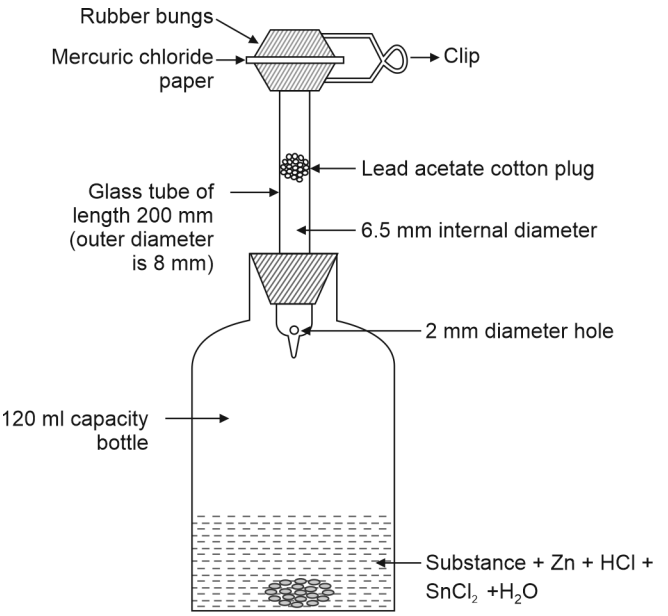


Diagram of Gutzeit Apparatus

f. What are adrenergic drugs? Classify with examples. Draw the structure of norepinephrine.

Ans: Adrenergic drugs: A drug or other substances which has effects like or the same as adrenaline (epinephrine)

Classification of Adrenergic Drugs

Method I

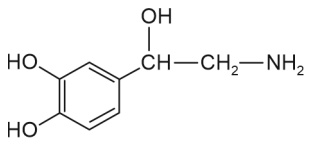
1. Catecholamines, e.g. Noradrenaline, adrenaline, isoprenaline, dopamine.
2. Noncatecholamines, e.g. Phenylephrine hydrochloride, mephentermine sulfate,
3. Imidazoline: Naphazoline

Method II

1. Directly acting (act directly on α or β receptors), e.g. Epinephrine, Norepinephrine,
2. Indirectly acting (act by providing more norepinephrine to act on α or β receptors), e.g. amphetamine, hydroxyamphetamine, and propylhexedrine, pseudoephedrine
3. Mixed acting (act by both mechanisms), e.g. ephedrine, Metaraminol

Method III

1. Alpha-adrenoceptor agonists (α-agonists), e.g. phenylephrine
2. Beta-adrenoceptor agonists (β-agonists), e.g. terbutaline, salbutamol
3. Both alpha and beta agonist—adrenaline, noradrenaline



g. Define and classify anti-neoplastic agents. Draw structure of 5-fluorouracil.

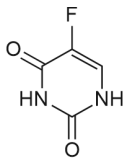
Ans: Antineoplastic agents: Antineoplastic drugs are medications used to treat cancer.

Other names for antineoplastic drugs are anticancer, chemotherapy, chemo, cytotoxic drugs.

Classification of Antineoplasic Drugs

1. Alkylating agents: e.g. Mustine, Cyclophosphamide, Busulfan, Chlorambucil, Thiotepa.

2. Antimetabolites:
   i. Folic acid analogues—methotrexate,
   ii. Pyrimidine analogues—fluorouracil,
   iii. Purine analogues—6-mercaptopurine, 6-thioguanine.
3. Antibiotics: (Anticancer antibiotics), e.g. Dactinomycin, Doxorubicin, Mitomycin-C, Daunorubicin.
4. Hormones and antagonists: Diethylstibesterol, tamoxifem
5. Plant products—vinca alkaloids: Vincristine, Vinblastine
6. Enzymes: Asparginase
7. Miscellaneous Agents: Cisplatin, Carboplatin, Procarbazine, Hydroxyurea.



(5-Fluorouracil)

Q.2 Answer any TEN of the following. 30 Marks

a. Discuss any three different sources of impurities in pharmaceuticals.

Ans: Sources of Impurities

1. Raw materials used in manufacture
2. Processes used in manufacture
3. Material of the plant
4. During storage
5. Accidental substitution or deliberate adulteration
6. Manufacturing hazards

1. **Raw materials used in manufacture:** Traces of impurities in raw materials may be carried to contaminate the final product
   - For example, common salt (NaCl) prepared from rock salt will almost certainly contain traces of calcium (Ca) and magnesium (Mg) compounds
   - Metallic zinc may be present as an impurity in zinc oxide (ZnO) sample as it is prepared by heating metallic zinc
2. **Processes used in manufacture:** Some impurities are incorporated during the manufacturing process. This may occur due to:
   - Reagents used in process
   - Reagents added to remove other impurities

- Solvents—water is the cheapest solvent widely available. Tap water contains many ion impurities in small amounts like Cl^-, Ca^{++}, Mg^{++}, Na^+, etc.
- The intermediate products may come along the process in the final product as impurity

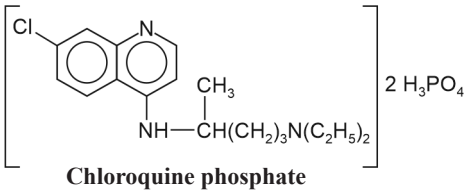
3. **Material of the plant:** The vessels used in the manufacturing process are generally made up of metals like iron, copper, zinc, nickel, aluminium and stainless steel. Due to the solvent action on the plant material the traces of metals, i.e. impurities come in the product.
   - Similarly, glass of an unsatisfactory standard and plastic containers used for handling liquid and semisolid products may yield traces of alkalies and antioxidants, respectively.
4. **During storage:** Filth—stored product may become contaminated with dust, insect, or insect excreta.
   - Decomposition of the product during storage—many chemical substances undergoes changes or decomposition due to careless storage
   - For example, ferrous sulphate is slowly converted into insoluble ferric oxide by air and moisture
   - Ether and chloroform decompose in the presence of light and air. Chloroform on decomposition gives carbonyl chloride (phosgene gas) so it should be stored in well filled, well-closed amber coloured bottle.
5. **Accidental substitution or deliberate adulteration:** Accidental substitution can take place if toxic substances are stocked with other substances or compounds.
   - Some pharmaceutical products may be adulterated with cheaper substitutes.
   - For example, honey may be adulterated with inverted sugar, potassium bromide with sodium bromide.
6. **Manufacturing hazards:** Particulate contamination- accidental inclusion of dirt, glass, porcelain, metallic or plastic fragments from sieves, granulating, tableting, and filling machines or even from product containers is possible.
   - Process error-gross errors arising from incomplete solution of solute in a liquid preparation must be detected by normal analytical procedures.

- Special care is required for highly potent medicaments of low dose (5 mg or less)
- Cross contamination—the handling of powders, granules and tablets in large quantities creates considerable amount of air-borne dust and may lead to cross-contamination
- Microbial contamination—liquid preparations and creams for topical application are prone to bacterial and fungal contamination.
- Special care should be taken in parenteral and ophthalmic preparations to avoid microbial contamination
- Packing errors—products of similar appearance as tablets of same size, colour and shape packed in similar containers may lead to mislabelling.

b. Classify Antimalerials. Draw structure of chloroquine phosphate.

Ans: Classification of Antimalarials

1. Quinolines:
   a. Cinchona alkaloids—Quinine, Cinchonine
   b. 4-aminoquinolines—Chloroquine, Amodiaquine
   c. 8-aminoquinolines—Primaquine, Pamaquine
2. Acridines dye—Quinacrine, Acriquine
3. 4-Quinoline carbinolamines—mefloquine
4. Diaminopyrimidines—Pyrimethamine
5. Biguanides—Proguanil, Chloroproguanil
6. Sulphones—Dapsone
7. Misc—Doxycycline.



Chloroquine phosphate

c. Give storage-stability, uses and brand name of drug penicillin G.

Ans: Penicillin G

Storage—stability: It should be stored in air-tight dry container and kept in a cool place

Uses:

1. It is used as antibiotics to treat wide range of bacterial infections.
2. It is active against wide range of gram-positive bacteria and *Neisseria* spp.

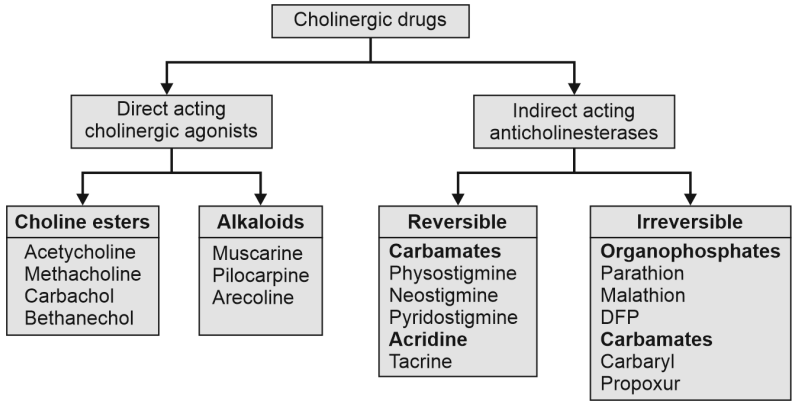
3. It is used to treat abscesses, syphilis, gonorrhoea, pneumonia, meningitis, anthrax, diphtheria, tetanus
4. It is used prophylactically, before dental and surgical procedures to prevent from developing endocarditis, re-occurance of rheumatic fever

Brand names: Novopen, Crystapen G, PAM, Pentids.

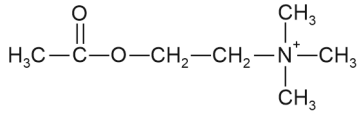
d. What are Parasympathomimetic agents? Draw structure of drug acetylcholine. Give its storage and stability conditions.

Ans: Parasympathomimetic agents: The agents that mimic the action of acetylcholine or produce the effect of parasympathetic nerve stimulation are called as cholinergic agents or parasympathomimetic agents

- Substance that stimulates the parasympathetic nervous system.
- Compounds which mimic the action of acetylcholine
- Chemicals that act at the same sites as the neurotransmitter acetylcholine (ACh).



Structure Acetylcholine



Storage-stability condition: It should be stored in air-tight dry container and keep it in a cool place as it is hygroscopic in nature.

e. Define and classify sedative and hypnotics with examples. Draw structure of Phenobarbitone.

Ans: Hypnotics: These are the drugs which depress C.N.S. and produce sleep resembling natural sleep in normal dose. They are used to overcome insomnia.

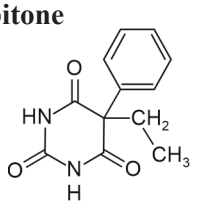
Sedatives: A drug that reduces excitement calms the patient without inducing sleep. They reduce excitement of nerves and hence are used in relief of tension, anxiety and restlessness.

Classification 1

1. **Barbiturates:** Depending upon duration of action
   a. Long-acting barbiturates (6 hours or more), e.g. Barbitone, Phenobarbitone.
   b. Intermediate-acting barbiturate (3–6 hours), e.g. Butobarbitone.
   c. Short-acting barbiturate (less than 3 hours), e.g. Cyclo-barbitone.
   d. Ultra-short acting (IV) barbiturates (1/2 to 1 hour), e.g. methohexitone sodium, thiopentone sodium.

2. **Non-barbiturates:**
   a. Benzodiazepine—Flurazepam, Triazolam
   b. Urea derivatives—Glutethimide
   c. Methylprylon
   d. Alcohols—Chloral hydrate, Ethchlorvynol
   e. Aldehydes—Paraldehyde
   f. Ureides—Carbromal
   g. Miscellaneous—Phenacemide, Carbamazepines

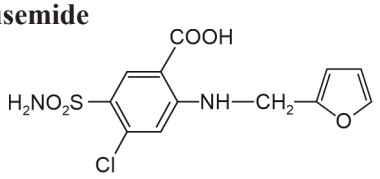
Structure Phenobarbitone



f. Give structure, chemical name and uses of Frusemide.

Ans:

Structure Frusemide



Chemical name: 4-chloro-2-((furan-2-ylmethyl) amino)-5-sulfamoylbenzoic acid

Uses of Furosemide

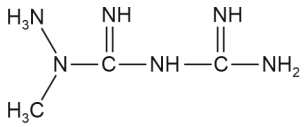
- It is used as a diuretic.

- It is useful for treatment of oedema associated with CHF, liver cirrhosis and renal diseases.
- It is used to treat high blood pressure (hypertension).

g. Define diabetes mellitus. Draw structure of metformin and give its popular brand names.

Ans: Diabetes mellitus: A group of diseases that result in too much sugar in the blood (high blood glucose—hyperglycaemia) due to insulin deficiency.

Metformin:



Popular brand names: Metformin, Glycomet, Glyciphage, Diabex, Diaformin, DMGG

h. What are narcotic analgesics? Give its classification with examples.

Ans: Narcotic analgesics: The drugs used to relief of moderate to severe pain by acting on central nervous system and produce the stupor.

Classification:

1. Morphine and related compounds: Morphine, codeine
2. Synthetic compounds
   a. Pethidine and related compounds: Pethidine
   b. Morphinan and benzomorphan derivatives: Pentazocine, lavorphanol
   c. Methadone and its analogue: Methadone, dextropropoxyphene

i. Give uses for: (i) Chlorpromazine (ii) Chloramphenicol (iii) Propranolol

Ans:

i. **Chlorpromazine**
   1. It is used as sedative and tranquilizer
   2. It is used to treat schizophrenia, mania, hypomania
   3. It is used to control nausea, vomiting
   4. It reduces salivary and gastric secretions
   5. It has local anesthetic properties
   6. It is used as analgesic and relaxes skeletal muscles
   7. It is used as antiemetic, antipruritic

ii. **Chloramphenicol**
   1. It was used in the treatment of typhoid.
   2. It may be used as a second-line agent in the treatment of tetracycline-resistant cholera.
   3. It is also useful in the treatment of brain abscesses.
   4. It is also applied locally for treatment of ear, eye and skin infection.
   5. It is used in treatment of rickettsia, chlamydia and mycoplasma.

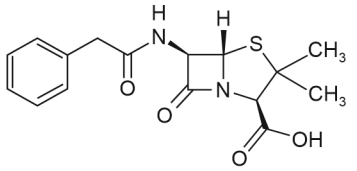
iii. **Propranolol**
   1. It is a typical beta adrenergic receptor blocker used in the treatment of cardiac diseases like:
      a. Angina pectoris
      b. Cardiac arrhythmia
      c. Hypertension
      d. Congestive heart failure
      e. Coronary atherosclerosis
      f. Arterial hypertension
   2. Treatment of pheochromocytoma
   3. Treatment of tachycardia.

j. Classify Antihypertensive agents with suitable examples.

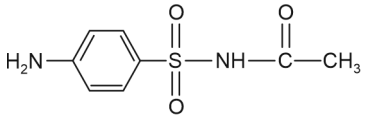
Ans: Classification of antihypertensive agents:

1. ACE inhibitors: Captopril, Enalapril, Ramipril
2. Angiotensin antagonist: Losartan, Candesartan
3. Calcium channel blockers: Verapamil, Nifedipine,
4. Diuretics:
   a. Thiazides: Hydrochlorothiazide
   b. High ceiling: Furosemide
   c. Potassium sparing: Spironolactone
5. Beta-adrenergic blockers: Propranolol, Metoprolol, Atenolol
6. Alpha-adrenergic blockers: Prazosin, Terazosin
7. Alpha + beta adrenergic blockers: Labetalol, Carvedilol
8. Central sympatholytic: Clonidine, Methyldopa
9. Vasodilators: Hydralazine, Minoxidil sodium

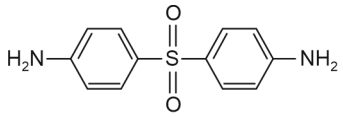
k. Draw structure for (i) beta lactum antibiotics (ii) Sulfa drugs
Ans:
Benzylpenicillin



Structure of Sulpha Drug
Sulphacetamide



Dapsone



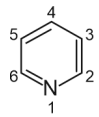
Q.3 Attempt ALL questions of the following. 20 Marks

a. Define antibiotics.
Ans: Antibiotics: Chemical compounds derived from living organism and capable to inhibit the growth of micro-oraganism or kill the micro-organism are called as antibiotics.

b. Write any 2 uses of Azithromycin.
Ans: It is used in the treatment of Acne vulgaris, bronchitis, COPD, Mycobacterial infection, Pneumonia, Sexually transmitted diseases (STD), CoVID-19 infection, ear nose and throat infection.

c. Draw structure of acetyl group and chloro group.
Ans: Acetyl Group: $-COCH_3$ Chloro Group: -Cl

d. Draw structure of Pyridine and give its method of numbering.
Ans: Pyridine



e. Chemical formula for bleaching powder is _____
(i) $Ca(ClO)_2$ (ii) $Ca(ClO)_4$ (iii) $CaCO_3$ (iv) Ca_2CO_3
Ans: (i) $Ca(ClO)_2$

f. Prazosin drug is used for _____

(i) Hypertension (ii) Brain tumor (iii) Diarrhoea (iv) Cancer

Ans: (i) Hypertension

g. Name any 2 indicators used in Acid-base titration.

Ans:

- Phenolphthalein
- Bromcresol green
- Methyl red
- Bromthymol blue
- Phenol red
- Neutral red
- Methyl yellow
- Methyl orange

h. The synonym of calcium carbonate is_____.

Ans: Limestone, calcite, aragonite, prepared chalk.

i. The precipitating agent used in limit test for chloride is

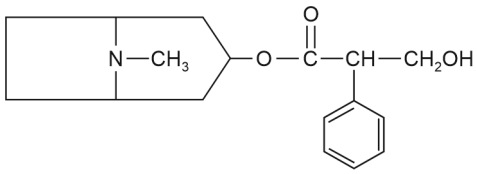
Ans: Silver Nitrate.

j. Define "Redox Titration".

Ans: It is titration in which oxidation and reduction reaction usually occurs simultaneously.

k. Draw structure of Atropine sulphate.

Ans:



l. Doxycycline belongs to the structural class of antibiotics_____

(i) Penicillins (ii) Macrolides (iii) Tetracyclines (iv) None of these

Ans: (iii) Tetracyclines.

m. IUPAC name of paracetamol is _____.

(i) N-(2, 2-diethyl hydroxyl) acetamide

(ii) N-(4-hydroxy phenyl) anilide

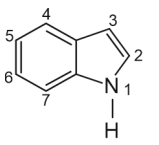
(iii) 4-hydroxy-Acetanilide

(iv) None of the above

Ans: (iii) 4 – hydroxyl-Acetanilide

n. Full form of NSAID is _____
Ans: Non-steroidal Anti-Inflammatory Drugs.

o. Structure of Indole ring is _____
Ans:



Indole

p. State whether true or false: Antacids are meant for constipation and hypoacidity:
Ans: False

q. Define "non-aqueous" titration.
Ans: A type of titration in which the analyte substance is dissolved in a solvent which does not contain water.

r. Gravimetry analysis is a semi-quantitative method. (True or False)
Ans: False.

s. Give two uses of Atenolol.
Ans: Atenolol is used to treat:
1. Angina pectoris
2. Hypertension
3. Atrial fibrillation
4. Supraventricular trachycardia
5. Cardiac arrythmia

t. Name any two anti-depressant drugs.
Ans: Imipramine, Trimipramine, Amitriptyline, Doxepin, Desipramine, Citalopram, Fluoxetine, Paroxetine, Venlafaxine, Phenelzine, Selegiline, Tranylcypromine, Trazodone.

Winter Examination 2023 (Question Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Answer any SIX of the following. **30 Marks**

a. Define the term impurity discuss any four sources of impurities in pharmaceuticals.
b. What do you mean by volumetric analysis? Give its classification depending on chemical reactions with one example each.
c. Define gastrointestinal agents classify with examples. Give uses of sodium bicarbonate and magnesium hydroxide.
d. Draw the structure of Haloperidol. Give its chemical name, uses, formulations and popular brand names.
e. State what are sympathomimetic drugs? Classify and give the structure and uses of norepinephrine.
f. Define and classify antimalarial drugs with example. Give structure and uses of chloroquine phosphate.
g. Define and classify antibiotics giving suitable examples. Give structure and uses of chloramphenicol.

Q.2 Answer any TEN of the following. **30 Marks**

a. Explain the principle and procedure involved in the limit test for Iron.
b. Describe Mohr's method for precipitation titrations with reaction.
c. Draw the structure from the given IUPAC name
   i. 5, 5-diphenylimidazolidine-2, 4-dione.
   ii. 3, (2-chloro-10H-phenothiazin-10-yl)-N, N-dimethylpropan-1-amine.
   iii. 7-chloro-1,3-dihydro-1-methyl-5-phenyl-1,4-benzodiazepine-2-one.
d. What are cholinergic antagonists? Give their examples. Name the drug used in Parkinsonism.
e. Draw the structure of propranolol. Give its uses and popular brand name.
f. Classify diuretics with examples. Write structure of frusemide.
g. What is Diabetes mellitus? Give structure and chemical name of metformin.

h. State what are NSAIDs 7 Give uses and popular brand names of Aspirin.
i. Define and classify antitubercular drugs. Draw the structure of Isoniazid (INH).
j. What are Beta-lactam antibiotics? Give the structure and uses of Amoxicillin.
k. Classify antineoplastic drugs with examples. Discuss uses of cisplatin.

Q.3 Attempt ALL questions of the following. 20 Marks

a. Guitzet's test apparatus is used to carry out limit test of_____
b. Name the indicator used in the assay of sodium chloride.
c. State the uses of hydrogen peroxide.
d. Use of ferrous sulphate is_____
e. Which one of the following five membered unsaturated heterocycle containing oxygen?
(i) Pyridine (ii) Oxazole (iii) Pyrrole (iv) Furan
f. The suffix "ole" is used for—
(i) Five membered unsaturated ring
(ii) Six membered unsaturated ring
(iii) Five membered saturated ring
(iv) Six membered saturated ring
g. Which of the following is not a five membered ring?
(i) Pyridine (ii) Furan (iii) Imidazole (iv) Oxazole
h. The prefix Thia / Thio is used for a heteroatom_____
i. Write brand name of phenytoin.
j. In what dosage form diazepam is given?
k. Acetyl choline is a_____
(i) Cholinergic blocker (ii) Adrenergic blocker
(iii) Adrenergic agent (iv) Cholinergic agent
l. _____ is an imidazoline derivative and a direct active sympathomimetic amine with vasoconstrictive activity.
m. Name the pharmacological category of quinidine sulphate.
n. Captopril is used in treatment of_____.
o. Which of the following diuretic is a derivative of anthranillic acid?
(i) Frusemide (ii) Urea (iii) Spironolactone (iv) Ethacrynic acid
p. Mefenamic acid is used in _____
q. Crocin is a popular brand name of_____.
r. Brand names of Remdesivir are _____.
s. In what dosage form Azithromycin is given?
t. Name antimetabolites used as antineoplastic agents.

Winter Examination 2023
(Specimen Answer Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Answer any SIX of the following. **30 Marks**

a. Define the term impurity. Discuss any four sources of impurities in pharmaceuticals.

Ans: Impurity: Undesirable matter which may or may not be toxic but present in the pharmaceutical substances.

Sources of Impurities

1. Raw materials used in manufacture
2. Processes used in manufacture
3. Material of the plant
4. During storage
5. Accidental substitution or deliberate adulteration
6. Manufacturing hazards

1. **Raw materials used in manufacture:**
   - Traces of impurities in raw materials may be carried to contaminate the final product.
   - For example, common salt (NaCl) prepared from rock salt will almost certainly contain traces of calcium (Ca) and magnesium (Mg) compounds.
   - Metallic zinc may be present as an impurity in zinc oxide (ZnO) sample as it is prepared by heating metallic zinc.
2. **Processes used in manufacture:**
   Some impurities are incorporated during the manufacturing process. This may occur due to
   - Reagents used in process.
   - Reagents added to remove other impurities.
   - Solvents-water is the cheapest solvent widely available. Tap water contains many ion impurities in small amounts like Cl-, Ca++, Mg++, Na+, etc.
   - The intermediate products may come along the process in the final product as impurity

3. **Material of the plant:**
   - The vessels used in the manufacturing process are generally made up of metals like iron, copper, zinc, nickel, aluminium, and stainless steel. Due to the solvent action on the plant material the traces of metals, i.e. impurities come in the product. Similarly, glass of an unsatisfactory standard and plastic containers used for handling liquid and semisolid products may yield traces of alkalies and antioxidants, respectively.
4. **During storage:**
   - Filth-stored product may become contaminated with dust, insect, or insect excreta.
   - Decomposition of the product during storage—many chemical substances undergo changes or decomposition due to careless storage e.g. ferrous sulphate is slowly converted into insoluble ferric oxide by air and moisture.
   - Ether and chloroform decompose in the presence of light and air. Chloroform on decomposition gives carbonyl chloride (phosgene gas), so it should be stored in well filled, well-closed amber coloured bottle.
5. **Accidental substitution or deliberate adulteration:**
   - Accidental substitution can take place if toxic substances are stocked with other substances or compounds. Some pharmaceutical products may be adulterated with cheaper substitutes.
   - For example, honey may be adulterated with inverted sugar, potassium bromide with sodium bromide.
6. **Manufacturing hazards:**
   - Particulate contamination-accidental inclusion of dirt, glass, porcelain, metallic or plastic fragments from sieves, granulating, tableting, and filling machines or even from product containers is possible.
   - Process error—process errors arising from incomplete solution of solute in a liquid preparation must be detected by normal analytical procedures. Special care is required for highly potent medicaments of low dose (5 mg or less)
   - Cross contamination—the handling of powders, granules and tablets in large quantities creates considerable amount of air-borne dust and may lead to cross-contamination.

- Microbial contamination—liquid preparations and creams for topical application are prone to bacterial and fungal contamination. Special care should be taken in parenteral and ophthalmic preparations to avoid microbial contamination.
- Packing errors—products of similar appearance as tablets of same size, colour and shape packed in similar containers may lead to mislabelling.

b. What do you mean by Volumetric analysis? Give it is classification depending on chemical reactions with one example of each.

Ans: Volumetric analysis: Volumetric (also known as titrimetric) analysis involves the gradual addition of a solution of accurately known concentration to the solution whose concentration is to be determined.

Types of Volumetric analysis

1. Acid-base or neutralization titration
2. Redox or oxidation-reduction titration
3. Precipitation titration
4. Complexometric titration
5. Non-aqueous titration

1. **Acid-base or neutralization titration:**
   i. An acid–base titration is a method of quantitative analysis for determining the concentration of an acid or base by exactly neutralizing it with a standard solution of base or acid having known concentration.
   ii. Thus, these are neutralization reactions with formation of salt and water as the end products.
   iii. A pH indicator is used to indicate the end point of acid-base neutralization reaction.
   For example, $NaOH + HCl \rightarrow NaCl + H_2O$.
2. **Redox or oxidation-reduction titration**
   i. In redox reaction, oxidation and reduction usually occur simultaneously. Oxidation reaction is the reaction where addition of oxygen or removal of hydrogen takes place, while in reduction, there will be addition of hydrogen or removal of oxygen.
   ii. Redox titration reaction involves the transfer of electron between the reactant (titrant) and titrate takes place.
   iii. A redox titration is the same as an acid-base titration except it involves a redox reaction and generally does not require an indicator.

iv. Various oxidising agents are employed in the reactions, and depending upon the agents used, they are classified into.
   1. *Permanganate titrations:* Potassium permanganate is used as an oxidant it is also self-indicator.
   2. *Dichromate titrations:* Potassium dichromate is used as an oxidant.
   3. *Iodine titrations:* Iodine is used as an oxidising agent.
   4. *Cerimetry:* Ceric salts are used as oxidants.

$$10FeSO_4 + 2KMnO_4 + 8H_2SO_4 \rightarrow 5Fe_2(SO_4)_3 + K_2SO_4 + 2MnSO_4 + 8H_2O$$

3. **Precipitation titration**
   i. Precipitation titration is a type of titration which involves the formation of precipitate during the titration technique.
   ii. In precipitation titration, the titrant reacts with analyte and forms an insoluble substance called precipitate.
   iii. It continues till the last amount of analyte is consumed.
   iv. In this titration, a substance that precipitates from solution in a clearly visible form at the end point is used as an indicator, e.g. Potassium chromate in Mohr's method, Ferric ammonium sulphate in Volhard's method, etc.

$$\underset{\text{(Silver nitrate)}}{AgNO_3} + \underset{\text{(halides)}}{X} \longrightarrow \underset{\text{(silver halides- white coloured precipitate)}}{AgX + NO_3}$$

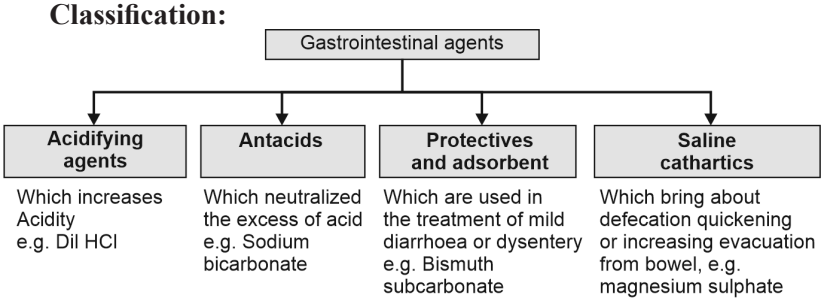
$$AgNO_3 + \text{indicator} \rightarrow \text{Indicator complex (coloured)}$$
at the end point

4. **Complexometric titration:** When the formation of stable complex is the reaction involved, certain organic reagents such as ethylene diamine tetraacetic acid (EDTA) from a stable complex with various metal ions and are thus used for analysis of these metal ions.
5. **Non-aqueous titration:**When reaction takes place in non-aqueous solvent, i.e. organic solvent. This type of titration is used for analysis of very weak acids and bases.

c. Define gastrointestinal agents. Classify with examples. Give uses of sodium bicarbonate and magnesium hydroxide.

Ans: Gastrointestinal agents used to treat gastrointestinal disturbance are known as gastrointestinal agents.

Classification:



Uses of sodium bicarbonate:

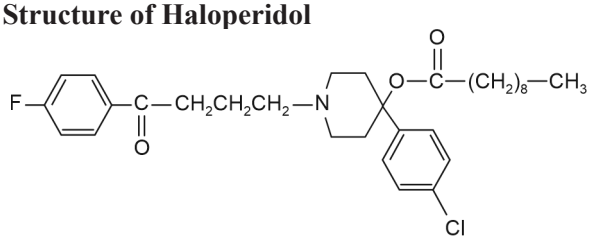
- Used as antacid
- Used as electrolyte replenishers
- Used in treatment of acidosis
- Used to produce systemic alkalosis

Uses of magnesium hydroxide:

- Used as non-systemic antacid
- Used as mild cathartic
- Used as a laxative to relieve occasional constipation.
- Used as an antacid to relieve indigestion, sour stomach, and heartburn.

d. Draw the structure of haloperidol. Give its chemical name, uses, formulations and popular brand names.

Ans: Structure of Haloperidol



Chemical name: 4-[4-(4-chlorophenyl)-4-hydroxypiperidin-1-yl]-1-(4-fluorophenyl) butan-1-one

Uses:

a. Haloperidol is an antipsychotic agent used to treat schizophrenia and other psychoses, as well as symptoms of agitation, irritability, and delirium.
b. It is used to treat uncontrolled movements and outbursts of words/sounds related to Tourette's syndrome.
c. Haloperidol is also used for severe behavior problems in hyperactive children when other treatments or medications have not worked.

d. Used in the control of agitated state of mania and schizophrenia. Formulations of Haloperidol: Tablet, Oral solution, Injection,

Brand names of haloperidol: Haldol, Serenace, Hexidol, Halidace, Dolsi, Halopel, Hpl, Halobid

e. State what are Sympathomimetic drugs? Classify and give the structure and uses of Norepinephrine.

Ans: Sympathomimetic drugs: A drug or other substances which has effects like or the same as adrenaline (epinephrine).

- An adrenergic agent is a drug, or other substance, which has effects similar to, or the same as, to those adrenergic nerve stimulation or injection of epinephrine (adrenaline or drug which stimulate adrenergic nerve.

Method I

- Catecholamines, e.g. Noradrenaline, adrenaline, isoprenaline, dopamine.
- Noncatecholamines, e.g. Phenylephrine hydrochloride, Mephentermine sulfate,
- Imidazoline, e.g. Naphazoline

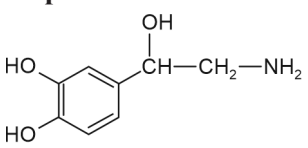
Method II

- Directly acting (act directly on α or β receptors), e.g. Epinephrine, Norepinephrine,
- Indirectly acting (act by providing more norepinephrine to act on α or β receptors), e.g. Amphetamine, hydroxyamphetamine, and propylhexedrine, pseudoephedrine
- Mixed acting (act by both mechanisms), e.g. ephedrine, Metaramino

Method III

- Alpha-adrenoceptor agonists (α-agonists), e.g. Phenylephrine
- Beta-adrenoceptor agonists (β-agonists), e.g. Terbutaline, Salbutamol
- Both alpha and beta agonist- Adrenaline, Noradrenaline

Structure of norepinephrine:



Uses of norepinephrine:

- Used in the treatment of low blood pressure.
- Used to relieve bronchial spasm in asthma.
- Used as vasoconstrictor in dental use.
- Used in treatment of heart block
- Used in the emergency treatment of allergic reactions, to treat low blood pressure during septic shock
- Used in eye surgery to maintain dilation of the pupil.

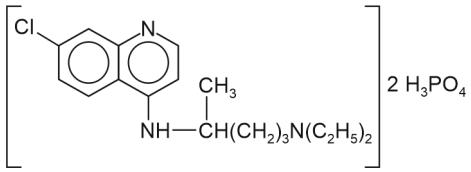
f. Define and classify antimalerial drugs with example. Give structure and uses of Chloroquine phosphate.

Ans: Antimalarial agents: The agents or drugs which prevent or cure the infectious disease malaria caused by protozoan plasmodium, characterized by successive chills fever, sweating and body pain.

Classification:

1. Quinolines:
   A. Cinchona alkaloids—Quinine, Cinchonine
   B. 4-aminoquinolines—Chloroquine, Amodiaquine
   C. 8-aminoquinolines—Primaquine, Pamaquine
2. Acridines dye—Quinacrine,
3. 4-quinoline carbinolamines—Mefloquine
4. Diaminopyrimidines—Pyrimethanamine
5. Biguanides—Proguanil, Chloroproguanil
6. Sulphones—Dapsone
7. Misc—Doxycycline.

Structure of Chloroquine Phosphate.



Uses:

- Chloroquine is used to prevent and treat malaria.
- It is also used to treat liver infection caused by protozoa (extraintestinal amoebiasis).
- Chloroquine may also be used to treat coronavirus (COVID-19) in certain hospitalized patients.
- To treat giardiasis, rheumatoid arthritis, systemic erythematosus.

g. Define and classify antibiotics giving suitable examples. Give structure and uses of Chloramphenicol.

Ans: Antibiotics: Chemical compounds derived from living organism and capable to inhibit the growth of micro-oraganism or kill the microorganism are called as antibiotics.

Classification:

A. Chemical classification of antibiotics

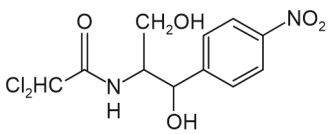
1. Beta-lactam antibiotics:
   a. Penicillin: Phenoxymethylpenicillin, flucloxacillin, amoxicillin.
   b. Cephalosporins: Cefaclor, cefadroxil and cephalexin.
2. Tetracyclines: Doxycycline and Minocycline.
3. Aminoglycosides: Streptomycin
4. Macrolides: Erythromycin, azithromycin
5. Polypeptides: Bacitracin,
6. Polyenes antifungal antibiotics: Amphotericin, Nystatin and Candicidin
7. Ansamycins: Rifamycins (Rifampin, Rifampicin, Rifabutin)
8. Lincomycins: Clindamycin.
9. Quinolones: Ciprofloxacin, levofloxacin and norfloxacin
10. Antibiotics derived from single aminoacid: s-Cycloserine and Chloramphenicol
11. Miscellaneous: s-fusidic acid, griseofulvin, novobiocin, etc.

B. Classification of antibiotics according to Mode of Action

1. Inhibitors of bacterial cell wall synthesis: Penicillin, Cephelosporins
2. Inhibitors of protein synthesis: Tetracyclines, Chloramphenicol, Macrolide, Aminoglycoside
3. Inhibitors of Nucleic acids metabolism (DNA/RNA): Griseofulvin, Actinomycin

C. Classification of antibiotics depending on spectrum of activity

1. Narrow Spectrum: Bacitracin
2. Broad Spectrum: Cephalosporin Structure of chloramphenicol



Uses of chloramphenicol:

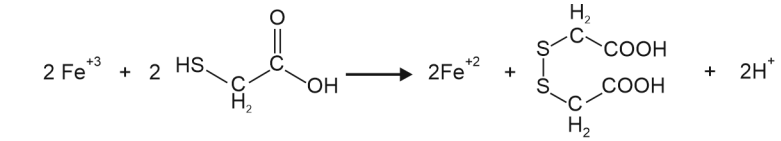
1. It was used in the treatment of typhoid.
2. It may be used as a second-line agent in the treatment of tetracycline-resistant cholera.
3. It is also useful in the treatment of brain abscesses.
4. It is also applied locally for treatment of ear, eye and skin infection.
5. It is used in treatment of rickettsia, *Chlamydia* and *Mycoplasma*.

Q.2 Answer any TEN of the following. 30 Marks

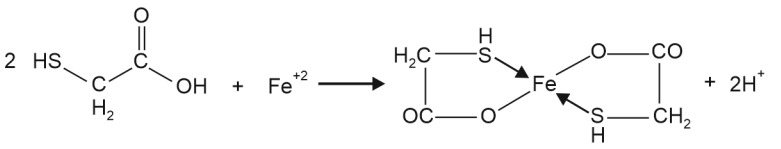
a. Explain principle and procedure involved in limit test for Iron.

Ans: Limit Test for Iron (Principle)

- The limit test for iron is based on the interaction of iron with thioglycolic acid in the presence of citric acid and ammonia solution.
- Iron forms a purple-coloured ferrous thioglycolate complex.
- The original state of iron is insignificant as thioglycolic acid reduces ferric (Fe^{3+}) to ferrous ion (Fe^{2+}). Subsequently, ferrous ions react with thioglycolic acid to form a coordination compound, namely the ferrous thioglycolate complex.
- This complex produces a purple colour only in an alkaline medium, which is why an ammonia solution is used
- Citric acid is employed to prevent the precipitation of iron with ammonia. It forms an ammonium citrate buffer that maintains iron in solution by creating soluble complexes with iron.



Ferric ions **Thioglycolic acid** **Ferrous ions** **Dithioglycolic acid**



Thioglycolic acid **Ferrous ions** **Ferrous thioglycolate complex**

Procedure: Prepare the standard solution (A) and the test solution (B) as mentioned in the following table and compare the purple colour against a white background

Standard solution (A)	Test solution (B)
In a Nessler's cylinder, Take 2.0 ml of iron standard solution (20 ppm Fe).	In a Nessler's cylinder, add specific amount of sample as per IP and dissolve in 20 ml of water.
Add 2 ml of a 20% w/v solution of iron free citric acid	Add 2 ml of a 20% w/v solution of iron free citric acid.
Then, add 0.1 ml of thioglycolic acid, mix well, make alkaline with iron free ammonia solution	Then, add 0.1 ml of thioglycolic acid, mix well, make alkaline with iron free ammonia solution.
Dilute to 50 ml with distilled water and allow to stand for 5 minutes	Dilute to 50 ml with distilled water and allow to stand for 5 minutes.
View the colour intensity produced against white background and compare with standard	

b. Describe Mohr's method for precipitation titrations with reaction.

Ans: Mohr's Method: Mohr's method is a type of precipitation titration used to determine the concentration of chloride ions in a solution.

- It is based on the reaction between silver nitrate ($AgNO_3$) and chloride ions (Cl^-) in an aqueous solution to form a silver chloride (AgCl) precipitate.
- The Mohr's method involves the addition of a known volume of silver nitrate solution of known concentration to the solution containing chloride ions.
- The silver nitrate is added until all the chloride ions have reacted, forming a white precipitate of silver chloride.
- The endpoint of the titration is determined by using an indicator such as potassium chromate which gives a brick red precipitate at the end point of the titration.
- The amount of silver nitrate solution added to the sample can be used to calculate the concentration of chloride ions present in the sample, using stoichiometry of the reaction.
- It is a simple, inexpensive, and reliable method for the determination of chloride ions in aqueous solutions.

- However, it may suffer from some limitations such as interference from other ions in the sample, and the need for careful handling of the silver nitrate solution due to its toxicity and light sensitivity.

Reaction:

$$\underset{\text{Silver Nitrate}}{AgNO_3} + \underset{\text{Sodium chloride}}{NaCl} \longrightarrow \underset{\text{(Silver chloride)}}{AgCl} + \underset{\text{(White coloured precipitate)}}{NaNO_3}$$

$2Ag^+ + CrO_4 \rightarrow Ag_2CrO_4$

$AgNO_3$ + indicator → indicator complex (Reddish brown) at the end point

c. Draw the structure from given IUPAC name.

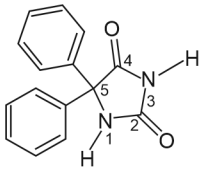
i. 5, 5-diphenylimidazolidine-2, 4-dione.

ii. 3 (2-chloro-10H-phenothiazin-10-yl)-N, N-dimethylpropan-1-amine

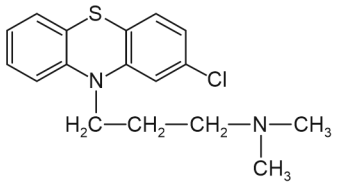
iii. 7-chloro-1,3-dihydro-1-methyl-5-phenyl-1,4-benzodiazepine-2-one

Ans:

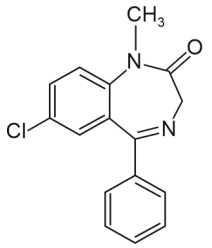
i. 5,5-diphenylimidazolidine-2, 4-dione



ii. 3(2-chloro-10H-phenothiazin-10yl)-N, N-dimethylpropan-1-amine



iii. 7-chloro-1, 3-dihydro-1-methyl-5-phenyl-1, 4-benzodiaze pine-2-one



d. What are cholinergic antagonists? Give their examples. Name the drugs used in Parkinsonism.

Ans: Cholinergic antagonists: These drugs do not prevent the release of acetylcholine at nerve endings, but they can act by competing with it, for the cholinergic receptor sites.

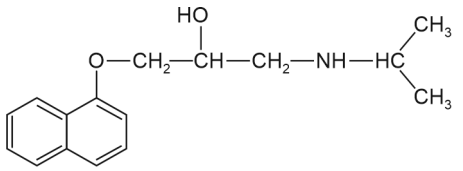
Examples of cholinergic antagonists: Atropine, Hyoscine, Homatropine, Ipratropium bromide, Cyclopentolate, Tropicamide, Clidinium bromide, Dicyclomine, Propantheline, Biperiden, Bentropine

Drugs used in parkinsonism: Benztropine, Benzhexol, Biperiden, Procyclidine

e. Draw the structure of propranolol. Give its uses and popular brand name.

Ans: Propranolol

Structure of Propranolol



Uses:

- It is used to treat—tremors, angina (chest pain), hypertension (high blood pressure), heart rhythm disorders and other heart or circulatory conditions.
- It is also used to treat or prevent heart attacks, and to reduce the severity and frequency of migraine headaches.

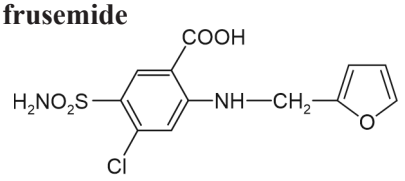
Brand names: Betacap, Ciplar, Ciplar-LA, Inderal, Provanol, Pranosol, Besprol, Arminol;

f. Classify diuretics with example. Write structure of frusemide

Ans: Classification of Diuretics:

1. Thiazide Diuretics Hydrochlorthiazide, Chlorothiazide, Benzothiazide
2. Loop/High–ceiling Diuretics Furosemide, Bumetanide, Ethacrynic acid, Torsemide
3. Carbonic anhydrase inhibitors Acetazolamide, Methazolamide.
4. Potassium-sparing diuretics Aldosterone antagonists: Spironolactone sodium channel blockers: Amiloride and triamterene.
5. Osmotic diuretics Mannitol, Urea, Glycerine
6. Methylxanthines Aminophylline, Caffeine

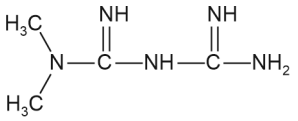
Structure of frusemide



g. What is Diabetes mellitus? Give structure and chemical name of metformin.

Ans: Diabetes mellitus: Diabetes mellitus is a condition in which the pancreas no longer produces enough insulin or cells stop responding to the insulin that is produced, so that glucose in the blood cannot be absorbed into the cells of the body.

Structure of Metformin



Chemical Name of Metformin:

1,1-dimethlybiguanide or 1,1-dimethyl biguanidine hydrochloride

h. State what are NSAID's? Give uses and popular brand names of Aspirin.

Ans: Non-steroidal anti-inflammatory drugs (NSAIDs):

The drugs which do not have the steroidal nucleus and are used to diminish or reduce inflammation and give relief from pain in arthritis and rheumatic diseases are called non-steroidal anti-inflammatory agents. NSAIDs work by inhibiting the activity of cyclooxygenase enzymes (COX-1 or COX-2).

Uses of Aspirin

- Used as an antipyretic to reduce fever.
- Used as an anti-inflammatory medication.
- Used long-term to help prevent further heart attacks and blood clots (an antiplatelet activity).
- Used for Angina (heart-related chest pain), heart attack and Stroke.
- Used as an analgesic to relieve minor aches and pains.

Popular brand names of Aspirin

Ecosprin, Dispirin, Asprin, CV sprin, ASA, Loprin, Alpyrin, Anacin, Apidin

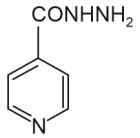
i. Define and classify antitubercular drugs. Draw the structure of Isoniazid (INH).

Ans: Antitubercular drugs: Antitubercular medications are a group of drugs used to treat tuberculosis, a disease caused by Mycobacterium tuberculosis (M-TB).

Classification of Antitubercular drugs:

a. p-amino salicylic acid derivative, e.g. PAS
b. Pyridine derivatives, e.g. Isoniazid, Ethionamide
c. Pyrazine derivatives, e.g. Pyrazinamide
d. Ethylene diamine derivatives, e.g. Ethambutol
e. Fluoroquinolones—Ofloxacin, Levofloxacin, Moxifloxacin
f. Antibiotics, e.g. Cycloserine, Streptomycin, Rifampicin

Structure of Isoniazid:

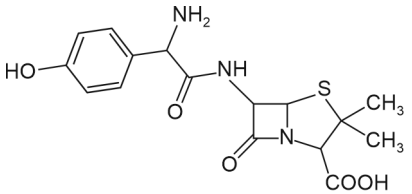


j. What are β-lactum antibiotics? Give the structure and uses of Amoxicillin.

Ans: β-lactum antibiotics: Beta-lactam antibiotics are a class of antibiotics that contain a beta-lactam ring (a four membered cyclic amide ring) in their chemical structure. They are bactericidal agents that prevent bacteria from forming cell walls.

Example: Penicillin, Cephalosporins

Structure of Amoxicillin:



Uses of Amoxicillin:

- Amoxicillin is a penicillin antibiotic.
- It is used to treat bacterial infections, such as chest infections (including pneumonia) and dental abscesses.
- It is also used with other medications to treat stomach/intestinal ulcers caused by the bacteria *H. pylori* and to prevent the ulcers from returning.

- Used to treat bacterial infection such as middle ear infection, strep throat, pneumonia, skin infections, and urinary tract infections among others.

k. Classify antineoplastic drugs with example. Discuss uses of cisplatin.

Ans: Classification of Anti-neoplastic Agents

1. Alkylating agents: Mustine, Cyclophosphamide, Busulfan, Chlorambucil, Thiotepa.
2. Antimetabolites:
   i. Folic Acid Analogues—Methotrexate,
   ii. Pyrimidine Analogues—Fluorouracil,
   iii. Purine Analogues-6-mercaptopurine, 6-thioguanine.
3. Antibiotics: (Anticancer Antibiotics)—Dactinomycin, Doxorubicin, Mitomycin-C, Daunorubicin.
4. Hormones and antagonists: Diethylstibesterol, tamoxifem.
5. Plant products—vinca alkaloids: Vincristine, Vinblastine
6. Enzymes: Asparginase
7. Miscellaneous Agents: Cisplatin, Carboplatin, procarbazine, Hydroxyurea.

Uses of Cisplatin:

- Cisplatin is particularly effective against testicular cancer
- Used to treat several cancers testicular cancer
- Ovarian cancer
- Cervical cancer
- Bladder cancer
- Head and neck cancer
- Esophageal cancer
- Lung cancer
- Brain tumors

Q.3 Attempt ALL questions of the following. 20 Marks

a. Guitzet's test apparatus is used to carry out limit test of _____

Ans: Arsenic.

b. Name the indicator used in the assay of sodium chloride.

Ans: Potassium chromate or Ferric ammonium Sulphate (Ferric alum)

c. State the uses of Hydrogen peroxide.

Ans: Antiseptic or Disinfectant or Oxidizing Agent or Bleaching Agent or Removal of wax from ears.

d. Use of ferrous sulphate is _____
Ans: Haematinics or used to treat and prevent iron deficiency anaemia.

e. Which one of the following five membered unsaturated heterocycle containing oxygen?
(i) Pyridine (ii) Oxazole (iii) Pyrrole (iv) Furan
Ans: (ii) Oxazole or (iv) Furan

f. The suffix "ole" is used for _____
(i) Five membered unsaturated ring
(ii) Six membered unsaturated ring
(iii) Five membered saturated ring
(iv) Six membered saturated ring
Ans: (i) Five membered unsaturated ring

g. Which of the following is not a five membered ring?
(i) Pyridine (ii) Furan (iii) Imidazole (iv) Oxazole
Ans: (i) Pyridine

h. The prefix Thia/Thio is used for a heteroatom _____
Ans: Sulphur.

i. Write brand name of phenytoin.
Ans: Dilantin, Eptoin, FenToin, Episol, Celetoin

j. In what dosage form diazepam is given?
Ans: Tablet or injection or Suppository or Syrup

k. Acetyl choline is a _____
Ans: Cholinergic agent.

l. _____ is an imidazoline derivative and a direct active sympathomimetic amine with vasoconstrictive activity.
Ans: Naphazoline

m. Name the pharmacological category of quinidine sulphate.
Ans: Antiarrhythmic or antimalarial

n. Captopril is used in treatment of _____
Ans: Hypertension or high blood pressure.

o. Which of the following diuretic is a derivative of anthranillic acid?
(i) Frusemide (ii) Urea (iii) Spironolactone (iv) Ethacrynic acid
Ans: (i) Frusemide

p. Mefenamic acid is used in _____

Ans: It is NSAID used to relieve mild-to-moderate pain, Pain associated with Dysmenorrhea (Menstrual pain), Treatment of Rheumatoid arthritis and Osteoarthritis.

q. Crocin is a popular brand name of _____

Ans: Paracetamol.

r. Brand names of Remdesivir are_____.

Ans: Cipami, Remdac, Desrem, Redyx, Remwin, Remdiz, Remizac, Covifor

s. In what dosage form azithromycin is given?

Ans: Tablet or Syrup or Injection or Suspension

t. Name antimetabolites used as antineoplastic agents.

Ans: Methotrexate, Mercaptopurine, Thioguanine, Fludarabine, Cladaribine, Fluorouracil, Cytarabine, Gemcitabin.

Summer Examination 2024 (Question Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Answer any SIX of the following. **30 Marks**

a. Draw the structure of chlorpromazine hydrochloride give its IUPAC name, therapeutic uses, formulations and brand names.
b. Draw the structure, IUPAC name, uses, formulations, and brand names of propranolol.
c. Enlist various sources of impurities in pharmaceuticals. Write any 4 effects of impurities.
d. Write uses of the following drugs:
   (a) Ketoconazole (b) Chloroquine (c) Norfloxacin
   (d) Remdesivir (e) Pretomanid
e. Enlist two examples and uses for each of the following:
   (a) Medicinal Gases
   (b) Dental Products
   (e) Define Antibiotics. Classify antibiotics based on chemical structure.
f. Explain complexometric titrations and Acid-base titrations.

Q.2 Answer any TEN of the following. **30 Marks**

a. Enlist any 3 α-adrenergic blockers and any 3 β-adrenergic blockers.
b. Classify anti-arrhythmic agents with examples.
c. Explain the principle and procedure involved in the limit test for sulphates.
d. Classify non-steroidal anti-inflammatory agents with suitable examples.
e. Explain principle and reactions in the assay of ferrous sulphate.
f. Draw the structure of Metformin, write its uses and enlist brand names.
g. Classify antidepressants with examples. Draw the structure of Imipramine
h. Draw the structure of Isoniazid, write its IUPAC name and enlist any 2 brand names.

i. Write uses of:
   (i) Chloramphenicol (ii) Streptomycin (iii) Azithromycin
j. Draw the structure of 5-Fluorouracil and enlist its uses and write its storage condition.
k. Draw the structure of Frusemide and give its storage condition and uses.

Q.3 Answer ALL questions of the following. 20 Marks

a. Write the use of lead acetate cotton plug in a limit test for arsenic.
b. Draw structure of Furan ring.
c. Pyrimidine ring contains two nitrogen atoms at _____ and _____ position.
   (i) 1 and 2 (ii) 1 and 4 (iii) 1 and 3 (iv) 2 and 3
d. Name any 2 anticonvulsant drugs.
e. Mordant Black is used in _____ type of titration.
   (i) Acid-base (ii) Redox (iii) Oxidation (iv) Complexometric
f. Draw the structure of Pyridine ring.
g. Which antacid produce carbon dioxide?
   (i) Aluminium hydroxide (ii) Calcium carbonate
   (iii) Magnesium hydroxide (iv) All of these
h. Choose INCORRECT statement (s):
   (a) Heterocyclic rings are not aromatic.
   (b) Thiazole has oxygen and nitrogen as hetero atoms.
   (c) Pyrrole is five-membered heterocyclic ring.
   Options: (i) a only (ii) b only (iii) a and b (iv) a, b and c
i. Enlist any two examples of cathartics.
j. Fill in the blank: Captopril contains _____ heterocyclic ring.
k. Choose INCORRECT statement(s):
   (a) Chlorpromazine is used in the treatment of Schizophrenia.
   (b) Risperidone is first generation typical anti-psychotic.
   (c) Phenobarbitone is used to induce epilepsy in rats.
   Options: (i) a only (ii) b only (iii) b and c (iv) a and b
l. Enlist the uses of Isosorbide dinitrate.
m. Enlist example of anti-cancer agent from anti metabolites.
n. The following analgesic lacks anti-inflammatory action.
   (i) Ibuprofen (ii) Paracetamol
   (iii) Diclofenac sodium (iv) Piroxicam

o. Name one high ceiling diuretic.

p. Which of the following is an inhibitor of cyclooxygenase?

(i) Aspirin (ii) Pethidine

(iii) Pentazocine (iv) All of these

q. Name any 2 tetracyclines.

r. The following is an anticholinergic agent:

(i) Prazosin (ii) Phentolamine

(iii) Yohimbine (iv) Atropine

s. Draw the structure of dapsone.

t. Which of the following drug is direct acting cholinomimetic agent?

(i) Pyridostigmine (ii) Physostigmine

(iii) Acetyl Choline (iv) Parathion

Summer Examination 2024
(Specimen Answer Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

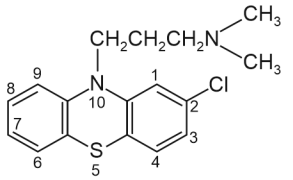
Time: 3 Hours **Max Marks: 80**

Q.1 Answer any SIX of the following. **30 Marks**

a. Draw the structure of Chlorpromazine hydrochloride give its IUPAC name, therapeutic uses, formulations and brand names.

Ans: Chlorpromazine

Structure of Chlorpromazine



IUPAC name: 2-Chloro, 10(3-dimethyl amino propyl) Phenothiazine.

Therapeutic uses of Chlorpromazine

i. It is an antipsychotic agent and used to treat schizophrenia, mania, etc.
ii. It is used to control nausea and vomiting.
iii. It is used to produce pre- and postoperative sedation.
iv. It is a vasodilator and reduces blood pressure.
v. It also reduces salivary and gastric secretions.
vi. It has a local anaesthetic property.
vii. It produces hypothermia condition.
viii. It produces tranquillizing effect.

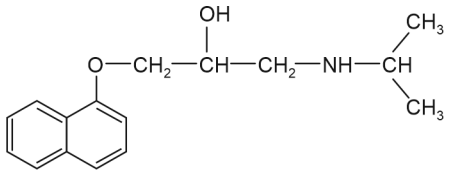
Pharmaceutical Formulations:

(a) Chlorpromazine tablet
(b) Chlorpromazine injection.
(c) Chlorpromazine elixir.
(d) Chlorpromazine suppositories.

Brand names: Largactil, Megatil, Sunprazin, Chlorozine, Clozine, Talentil-T, Talentil forte

b. Draw the structure, IUPAC name, uses, formulations, and brand names of propranolol.

Ans: Structure of Propranolol



IUPAC name: 1-(naphthalen-1-yloxy)-3-(propan-2-yl-amino) propan-2-01.

Therapeutic uses of Propranolol

i. Cardiac arrhythmia
ii. Angina pectoris
iii. Arterial hypertension.
iv. Hyperthyroidism in children.

Pharmaceutical Formulations:

- Propranolol tablet.
- Propranolol injection.

Brand name: Inderal, Ciplar, Innopran XL, Hemangeol

c. Enlist various sources of impurities in pharmaceuticals. Write any 4 effects of impurities.

Ans: Sources of impurities

1. Raw materials used in manufacture
2. Processes used in manufacture
3. Material of the plant
4. During storage
5. Accidental substitution or deliberate adulteration
6. Manufacturing hazards

1. **Raw materials used in manufacture**
   - Traces of impurities in raw materials may be carried to contaminate the final product
   - For example, common salt (NaCl) prepared from rock salt will almost certainly contain traces of calcium (Ca) and magnesium (Mg) compounds
   - Metallic zinc may be present as an impurity in zinc oxide (ZnO) sample as it is prepared by heating metallic zinc
2. **Processes used in manufacture**
   Some impurities are incorporated during the manufacturing process. This may occur due to

- Reagents used in process
- Reagents added to remove other impurities
- Solvents-water is the cheapest solvent widely available. Tap water contains many ion impurities in small amounts like Cl^-, Ca^{++}, Mg^{++}, Na^+, etc.
- The intermediate products may come along the process in the final product as impurity

3. **Material of the plant**
   - The vessels used in the manufacturing process are generally made up of metals like iron, copper, zinc, nickel, aluminium and stainless steel. Due to the solvent action on the plant material the traces of metals i.e. impurities come in the product.
   - Similarly, glass of an unsatisfactory standard and plastic containers used for handling liquid and semisolid products may yield traces of alkalies and antioxidants respectively.
4. **During storage:**
   - Filth- stored product may become contaminated with dust, insect, or insect excreta.
   - Decomposition of the product during storage-many chemical substances undergo changes or decomposition due to careless storage.
   - For example, ferrous sulphate is slowly converted into insoluble ferric oxide by air and moisture
   - Ether and chloroform decompose in the presence of light and air. Chloroform on decomposition gives carbonyl chloride (phosgene gas) so it should be stored in well filled, well-closed amber coloured bottle.
5. **Accidental substitution or deliberate adulteration**
   - Accidental substitution can take place if toxic substances are stocked with other Substances or compounds.
   - Some pharmaceutical products may be adulterated with cheaper substitutes.
   - For example, honey may be adulterated with inverted sugar, potassium bromide with sodium bromide.
6. **Manufacturing hazards:**
   - Particulate contamination—accidental inclusion of dirt, glass, porcelain, metallic of plastic fragments from sieves, granulating, tableting, and filling machines or even from product containers is possible.

- Process error—gross errors arising from incomplete solution of solute in a liquid preparation must be detected by normal analytical procedures.
- Cross contamination—the handling of powders, granules and tablets in large quantities creates considerable amount of air-borne dust and may lead to cross contamination.
- Microbial contamination—liquid preparations and creams for topical application are prone to bacterial and fungal contamination.
- Packing errors—products of similar appearance as tablets of same size, colour and shape packed in similar containers may lead to mislabeling

d. Write uses of the following drugs:

Ans:

i. Ketoconazole: Antifungal, candidiasis, blastomycosis, histoplasmosis
ii. Chloroquine: Antimalarial, giardiasis
iii. Norfloxacin: Urinary Track Anti-infective agent
iv. Remdesivir: Antiviral
v. Pretomanid: Antitubercular

e. Enlist two examples and uses for each of the following:

Ans:

i. **Medicinal gases:**

Example: Oxygen, Carbon dioxide, Nitrous oxide

Uses: Hypoxia, Anoxia, Asphyxia, respiratory stimulant

ii. **Dental products:**

Example: Sodium Fluride, Stannus Fluride, Zinc Chloride, Strontium Chloride

Uses: Anticaries agent, Cleansing agent, Polishing agent, Desensitizing agent

f. Define antibiotics. Classify antibiotics based on chemical structure.

Ans: Antibiotics:

Antibiotics are chemical substances produced by certain species of microorganisms and their synthetic analogues having the property of inhibiting the growth of or destroying other microorganisms in high dilutions or low concentration.

1. **Chemical classification of antibiotics**
   1. **Beta-lactam antibiotics:**
      a. Penicillin: Phenoxymethylpenicillin, flucloxacillin, amoxicillin.
      b. Cephalosporins: Cefaclor, cefadroxil and cephalexin.
   2. Tetracyclines: Doxycycline and Minocycline.
   3. Aminoglycosides: Streptomycin
   4. Macrolides: Erythromycin, azithromycin
   5. Polypeptides: Bacitracin,
   6. Polyenes Antifungal antibiotics: Amphotericin, Nystatin and Candicidin
   7. Ansamycins: Rifamycins (Rifampin, Rifampicin, Rifabutin)
   8. Lincomycins: Clindamycin.
   9. Quinolones: Ciprofloxacin, levofloxacin and norfloxacin
   10. Antibiotics derived from single aminoacid: s-Cycloserine and Chloramphenicol
   11. Miscellaneous: s-fusidic acid, griseofulvin, novobiocin etc.
2. **Classification of antibiotics according to mode of action**
   1. Inhibitors of bacterial cell wall synthesis: Penicillin, Cephelosporins
   2. Inhibitors of Protein synthesis: Tetracyclines, Chloramphenicol, Macrolide, Aminoglycoside
   3. Inhibitors of Nucleic acids metabolism (DNA/RNA): Griseofulvin, Actinomycin
3. **Classification of antibiotics depending on spectrum of activity**
   1. Narrow Spectrum: Bacitracin
   2. Broad Spectrum: Cephalosporin

g. Explain complexometric titrations and acid-base titrations.

Ans:

i. **Complexometric Titrations**

Complexometric fitration or chelatometry is a type of volumetric analysis wherein the coloured complex is used to determine the endpoint of the titration. It is a method used in quantitative chemical analysis. Complexometric Titration is used in the detection of mixtures of different metal ions present in the solution.

Principle: Metal ions, it turns wine-red, however, when it is free from metal ions, it remains blue in colour While ethylene

diamine tetraacetic acid (EDTA) is colourless regardless of whether it is coupled or not to a metal ion As Eriochrome black T binds to metal ions, adding an EBT indicator to the sample turns it wine-red in colour. Eriochrome Black T loosely binds with metal ions, whereas EDTA is strongly bounded with metal ions Therefore, when all the metal ions are bound to EDTA, the EBT indicator in the sample solution remains free and the solution appears blue.

Types of Complexometric Titrations:

1. **Direct titration:** In this case, the metal ion is titrated with standard solution of EDTA. The solution containing the metal ion is buffered to an appropriate pH at which the stability constant of the metal-EDTA complex is large. The free indicator has a different colour from that of the metal-indicator complex.
2. **Back titration:** In certain circumstances, a particular metal ion cannot be titrated directly. This includes situations where the metal ion precipitates in the absence of EDTA, the metal ion reacts too slowly with EDTA, and the metal ion forms an inert complex. In these cases, back titration is required. This involves the addition of a known excess of EDTA to the metal ion then, the excess EDTA is titrated with a standard solution of a different metal ion.
3. **Replacement titration:** It is used when direct titration or back titration don't give sharp endpoints. In this, analyte (containing metal) is added to the metal-EDTA complex. Metal present in the analyte displaces another metal from the metal-EDTA complex.
4. **Indirect titration:** Some anions form a precipitate with metal cations. These anions do not react with EDTA so, these can be analyzed by indirect titration with EDTA

Example:

MgIn + EDTA → MgEDTA + In (Red) (Colourless) (Colourless) (Blue)

Indicators used in a complexometric titration

Eriochrome Black T

Ethylene diamine tetraacetic acid (EDTA)

Acid–base titrations

ii. **Acid–base titration**

- An acid–base titration is a method of quantitative analysis for determining the concentration of an acid or base by exactly neutralizing it with a standard solution of base or acid having known concentration.
- Thus, these are neutralization reactions with formation of salt and water as the end products.
- A pH indicator is used to indicate the end point of acid-base neutralization reaction.

Four Basic Types of Acid-base Titrations

- The below Table shows the four types of titrations, and you note that the titrant (compound in the burette that is added to the analyte) is always strong, while the analyte can be strong or weak.

Type	Analyte	Titrant
SA/SB	Strong acid	Strong base
WA/SB	Weak acid	Strong base
SB/SA	Strong base	Strong acid
WB/SA	Weak base	Strong acid

- In acid–base titration, a solution of known concentration (the titrant) is added to a solution of the substance being studied (the analyte).
- In an acid–base titration, the titrant is a strong base or a strong acid, and the analyte is an acid or a base, respectively.
- For example, hydrochloric acid and sodium hydroxide form sodium chloride and water:

  $HCl(aq) + NaOH(aq) \rightarrow H_2O + NaCl(aq)$
- Neutralization is the basis of titration.
- A pH indicator shows the equivalence point—the point at which the equivalent number of moles of a base has been added to an acid and a sharp colour change is observed.
- Examples of acid–base titration are Assay of Sodium bicarbonate, Assay of Ibuprofen, Assay of Boric acid, etc.

Q.2 Answer any TEN of the following. 30 Marks

a. Enlist any 3 α-adrenergic blockers and any 3 β-adrenergic blockers.

Ans:

i. α-adrenergic blockers: Tolazoline, Phentolamine, Phenoxybenzamine, Prazosin

ii. β-Adrenergic blockers: Propranolol, Atenolol, Carvedilol.

b. Classify Anti-arrhythmic agents with examples.

Ans: Classification of Anti-arrhythmic agents:

I. Class I (Membrane Stabilizing Agents): Quinidine, Procainamide, Disopyramide, Lidocaine, Proprafenone, Flecainide, Lorcainide.

ii. ClassII (Anti-adrenergic Agents): Propanolol, Satolol, Esmolol.

iii. Class III (Agents Widening Action Potential): Amiodarone, Dronedarone, Dofetilide, Ibutilide.

iv. Class IV (Calcium Channel blocker): Verpamail, Diltiazem

c. Explain the principle and procedure involved in the limit test for sulphates.

Ans: Principle: Limit test of sulphate is based on the reaction of soluble sulphate impurity with barium chloride reagents in presence of dilute hydrochloric acid to form white precipitates of barium sulphate which appears as Opalescence/Turbidity in the solution.

$$SO_4^2 + BaCl_2 \xrightarrow{HCl} BaSO_4 + KCl$$

Procedure

Test sample	**Standard compound**
Specific weight of compound is dissolved in water or solution is prepared as directed in the pharmacopoeia and transferred in Nessler cylinder	Take 2.5 ml of 0.01 N solution of sulfuric acid (H_2SO_4) in Nessler cylinder
Add 1 ml of dilute hydrochloric acid	Add 1 ml of **dilute hydrochloric acid**
Dilute to 50 ml in Nessler cylinder	Dilute to 50 ml in Nessler cylinder
Add 1 ml of **barium sulphate reagent**	Add 1 ml of barium sulphate reagent
Keep aside for 5 min	Keep aside for 5 min
Observe the Turbidity	Observe the Turbidity

d. Classify non-steroidal anti-inflammatory agents with suitable examples.

Ans: Classification of Non-steroidal anti-inflammatory agents

A. Non-selective COX inhibitors (traditional NSAIDs)

1. Salicylates and analogs, e.g. Aspirin
2. Propionic acid derivatives, e.g. Ibuprofen, Naproxen, Ketoprofen, Flurbiprofen.
3. Anthranilic acid derivatives, e.g. Mefenamic acid.
4. Aryl-acetic acid derivatives, e.g. Diclofenac, Aceclofenac.
5. Oxicam derivatives, e.g. Piroxicam, Tenoxicam.
6. Pyrrolo-pyrrole derivative, e.g. Ketorolac.
7. Indole derivative, e.g. Indomethacin.
8. Pyrazolone derivatives, e.g. Phenylbutazone, oxyphenbutazone.

B. Preferential COX-2 inhibitors

For example: Nimesulide, Meloxicam, Nabumetone

C. Selective COX-2 inhibitors

For example: Celecoxib, Etoricoxib, Parecoxib

D. Analgesic-antipyretics with poor anti-inflammatory action

1. Para aminophenol derivative, e.g. Paracetamol
2. Pyrazolone derivatives, e.g. Propyphenazone.
3. Benzoxazocine derivative, e.g. Nefopam

e. Explain principle and reactions in the assay of ferrous sulphate.

Ans: Principle: The principle involved in the assay of ferrous sulphate is based on the fact that ferrous ions oxidize in the presence of potassium permanganate to form ferric ions, which can be titrated against a standardized basic solution (potassium hydroxide). The amount of ferric ions formed is proportional to the amount of ferrous ions present and is used to calculate the concentration of ferrous sulphate.

1. $2KMnO_4 + 3H_2SO_4$

II. Chemical reactions for assay:

1. $2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5(O)$

2. $2FeSO_4 + H_2SO_4 + (O) \rightarrow Fe_2(SO_4)_3 + H_2O$

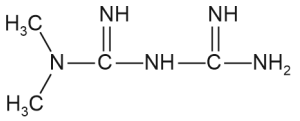
Net reaction:

3. $2KMnO_4 + 8H_2SO_4 + 10FeSO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 8H_2O$

4. $Fe^{+++} + \bar{e} \xrightarrow[\text{Oxidation}]{} Fe^{++}$

f. Draw the structure of Metformin, write its uses and enlist brand names.

Ans: Metformin



Chemical name of metformin: 1, 1-dimethlybiguanide or 1, 1-dimethyl biguanidine hydrochloride

Uses

i. As hypoglycemic agent.
ii. Used as first-line medication for the treatment of type
iii. To treat non-insulin dependent diabetes mellitus
iv. To treat insulin dependent diabetes mellitus.
v. To treat diabetes associated with hyperlipoproteinaemia

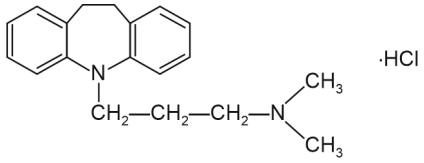
Brand names: Glucophage, Diabex, Fortamet, Glycomet, Diaformin, Glum, Riomet

g. Classify Antidepressants with examples. Draw the structure of Imipramine.

Ans: Classification of Antidepressants:

1. Tricyclic Antidepressants: Amitriptyl 1-triptylin
   For example: Imipramine, desipramine, Joxepin, anitripytilne for nontriptyline.
2. Mono-Amino-Oxidase Inhibitors (MAO)
   For example: Phenelzine, tranylcypromine, Hocarb moclobemide
3. Selective Serotonin Reuptake Inhibitors (SSRIs)
   For example: Fluoxetine, sertraline, citalopram, escitalopros
4. Dopamine and Norepinephrine Reuptake inhibit (DNRIs)
   For example: Bupropion
5. Mood Stabilizers
   For example: Lithium Carbonate
6. Miscellaneous:
   (a) (B-adrenorecepter agonist, e.g. salbutamol.
   (b) Thyrotropin releasing hormone (TRH)

Structure of Imipramine

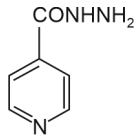


Chemical name: 3(10, 11-dihydro, 5-(3-dimethyl aminopropyl) 5H, dibenzo (b, f) azepine hydrochloride

h. Draw the structure of Isoniazid, write its IUPAC name and enlist any 2 brand names.

Ans: Isoniazid

- **IUPAC name of isoniazid:** Isonicotinic acid hydrazide
- **Brand names:** Isonex, Isokin, Tubizid, Isovit, Cardizide.



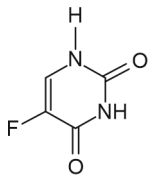
i. Write uses of:

Ans:

i. Chloramphenicol: Typhoid, Meningitis, UTI, eye ear infection, skin infection
ii. Streptomycin: Antibacterial, TB, Plague, Pneumonia
iii. Azithromycin: Pharyngitis, RTI, UTI, Pneumonia.

j. Draw the structure of 5-Fluorouracil and enlist its uses and write its storage condition.

Ans: 5-fluorouracil:



Uses of 5-Fluorouracil

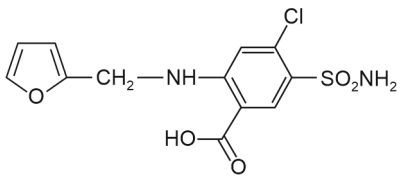
1. It is a cytotoxic (antineoplastic agent).
2. It is the most active drug against colorectal cancer.
3. It is used to treat solar keratoses and other malignant condi tions of skin.
4. It is used in the treatment of cancers of breast, colon, stomach, head, neck, bladder, etc.

5. Used in the palliative treatment of neoplasm of gastrointestinal tract, breast and pancrease and respiratory tract

Storage condition: It is affected by air and light; hence it is stored in tightly closed, light resistant containers.

k. Draw the structure of frusemide and give its storage condition and uses.

Ans: Structure of Frusemide



Storage condition: It should be stored in a well tightly closed container and protected from light

Uses of Frusemide

i. It is used as diuretic.
ii. It is used for management of hypertension.
iii. It is used to treat oedema associated with congestive heart failure, cirrhosis of liver.
iv. To treat renal disease

Q.3 Answer ALL questions of the following. 20 Marks

a. Write the use of lead acetate cotton plug in a limit test for arsenic.

Ans: Lead acetate cotton plug is used to trap any hydrogen sulphide which may be evolved along with arsine.

b. Draw structure of Furan ring.

Ans:



Furan

c. Pyrimidine ring contains two nitrogen atoms at _____ and _____ position.

(i) 1 and 2 (ii) 1 and 4 (iii) 1 and 3 (iv) 2 and 3

Ans: (iii) 1 and 3

d. Name any 2 anticonvulsant drugs.

Ans: Carbamazepine, gabapentin, pregabalin, Phenytoin, Valproic acid, Barbiturates, Benzodiazepines.

e. Mordant Black is used in _____ type of titration.
(i) Acid-Base (ii) Redox (iii) Oxidation (iv) Complexometric
Ans: (iv) Complexometric

f . Draw the structure of pyridine ring.
Ans:



g. Which antacid produce carbon dioxide?
(i) Aluminium hydroxide (ii) Calcium carbonate
(iii) Magnesium hydroxide (iv) All of these
Ans: (ii) Calcium carbonate

h. Choose INCORRECT statement (s):
(a) Heterocyclic rings are not aromatic.
(b) Thiazole have oxygen and nitrogen as hetero atoms.
(c) Pyrrole is five-membered heterocyclic ring.
(i) a only (ii) b only (iii) a and b (iv) a, b and c
Ans: (iii) a and b

i. Enlist any two examples of cathartics.
Ans: Magnesium Sulphate, Senna, Agar-agar, Isabgol, Methylcellulose, Cascara, Castor oil.

j. Fill in the blank: Captopril contains _____ heterocyclic ring.
Ans: Pyrrolidine.

k. Choose INCORRECT statement(s):
(a) Chlorpromazine is used in the treatment of Schizophrenia.
(b) Risperidone is first generation typical anti-psychotic.
(c) Phenobarbitone is used to induce epilepsy in rats.
(i) a only (ii) b only (iii) b and c (iv) a and b
Ans: (iii) b and c

l. Enlist the uses of Isosorbide dinitrate.
Ans: Isosorbide dinitrate is used to prevent angina (chest pain) caused by coronary artery disease and congestive heart failure.

m. Enlist example of anti-cancer agent from anti-metabolites.
Ans: Methotrexate, Mercaptopurine, Thioguanine, Cladribine, Fluorouracil, Cytarabin.

n. The following analgesic lacks anti-inflammatory action:
(i) Ibuprofen (ii) Paracetamol
(iii) Diclofenac sodium (iv) Piroxicam
Ans: (ii) Paracetamol

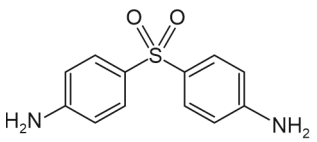
o. Name one high ceiling diuretic.
Ans: Ethacrynic acid and Bumetanide

p. Which of the following is an inhibitor of cyclooxygenase?
(i) Aspirin (ii) Pethidine (iii) Pentazocin (iv) All of these
Ans: Aspirin

q. Name any 2 tetracyclines.
Ans: Tetracycline, Chlortetracycline, Oxytetracycline, Doxycycline, Minocycline, Demeclocycline.

r. The following is a anticholinergic agent:
(i) Prazosin (ii) Phentolamine
(iii) Yohimbine (iv) Atropine
Ans: (iv) Atropine

s. Draw the structure of dapsone.
Ans:



t. Which of the following drug is direct acting cholinomimetic agent?
(i) Pyridostigmine (ii) Physostigmine
(iii) Acetyl Choline (iv) Parathion
Ans: (iii) Acetyl Choline

Winter Examination 2024 (Question Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Attempt any SIX of the following. **30 Marks**

a. Explain reaction and principle involved in limit test for arsenic and draw neat and labelled sketch of Gutzeit apparatus.

b. Give a brief account of:
   i. Acid-base titration
   ii. Complexometric titration

c. Define antibiotics. Classify with suitable example. Write uses of azithromycin.

d. State what are hypnotics and sedatives? Classify them giving suitable examples. Draw structure of chlorpromazine.

e. State what are sympathomimetic drugs? Classify and give the structure and uses of adrenaline.

f. Draw chemical structure of dapsone. Give its chemical name, uses, formulations and storage conditions.

g. Write uses for the following compounds:
   i. Ferrous sulfate
   ii. Aluminium hydroxide gel
   iii. Potassium permanganate
   iv. Calcium carbonate
   v. Oxygen.

Q.2 Attempt any TEN of the following. **30 Marks**

a. Explain principle and procedure involved in limit test for chloride.

b. Enlist different types of volumetric analysis. Explain at least one precipitation type of titration.

c. Define and classify general anaesthetics giving suitable examples of compounds under each class.

d. What are anticholinergic drugs? Give the therapeutic uses of anticholinergic drugs.

e. Draw the structure; uses and popular brand names (any two) of propranolol.
f. Give the structure, chemical name and uses of fursemide.
g. What is diabetes mellitus? Give pharmaceutical formulations of Insulin. Draw structure of metformin.
h. Define antipyretic analgesics. Give uses and popular brand names of paracetamol.
i. Write uses and brand names (any one) for the following drugs:
   i. Amoxycillin
   ii. Chloramphenicol.
j. Give structure and uses of following drugs:
   i. Isoniazid
   ii. Acyclovir.
k. Classify antineoplastic drugs with example. Draw structure of fluorouracil.

Q.3 Attempt ALL questions. 20 Marks

a. Gutzeit test apparatus is used to carry out limit test of_____.
b. Name the indicator used in acid-base titration:
   i. Methyl red
   ii. Phenolphthalein
   iii. Methyl orange
   iv. All of the above.
c. State the uses of boric acid.
d. The synonym of sodium bicarbonate is_____.
e. Organic chemistry is the chemistry of_____.
f. Which of the following is a six membered ring?
   i. Furan
   ii. Pyrimidine
   iii. Imidazole
   iv. Oxazole.
g. While numbering the heterocyclic ring, the order of preference in numbering the hetero atoms as follows:
   i. O-N-S
   ii. S-O-N
   iii. O-S-N
   iv. N-S-O
h. The prefix Aza/Azo is used for a hetero atom_____.
i. Write brand name of diazepam.

j. Which of the following is hydantoin derivative?
   i. Phenobarbitone
   ii. Trimethadione.
   iii. Phenytoin
   iv. Phenacemide.

k. Adrenaline is an_____.
   i. Cholinergic blocker
   ii. Adrenergic agent
   iii. Adrenergic blocker
   iv. Cholinergic agent.

l. Name any two drugs used for myasthenia gravis.

m. Name the pharmacological category of dopamine.

n. Isosorbide dinitrate is used in the treatment of_____.

o. Acetazolamide is used as_____.

p. Full form of NSAIDs_____.

q. The chemical name of aspirin is_____.

r. In what dosage form amoxycillin is given?

s. Write any two brand name of remdesivir.

t. Which plant products have anticancerous properties?

Winter Examination 2024
(Specimen Answer Paper)
First Year Diploma in Pharmacy
Subject: Pharmaceutical Chemistry (20112)

Time: 3 Hours **Max Marks: 80**

Q.1 Attempt any SIX of the following. **30 Marks**

Ans: [*Refer Specimen Answer Papers of Summer 2022,Winter 2023, Summer 2023,Winter 2023, Summer 2024 Examinations and Answers from this book for the Question 1 (a), (b), (c), (d), (e), (f), (g)]

Q.2 Attempt any TEN of the following. **30 Marks**

Ans: [*Refer Specimen Answer Papers of Summer 2022, Winter 2023, Summer 2023,Winter 2023, Summer 2024 Examinations and Answers from this book for the Question 2 (a), (b), (c), (d), (e), (f), (g), (h), (i), (j), (k)]

Q.3 Attempt ALL questions. **20 Marks**

a. Guitzet test apparatus is used to carry out limit test of _____
Ans: Arsenic.

b. Name the indicator used in acid-base titration:
i. Methyl red ii. Phenolphthalein
iii. Methyl orange iv. All of the above.
Ans: (iv) All of the above

c. State the uses of boric acid.
Ans:
- Used as antiseptics.
- Used as mild antifungal agent for skin infections.
- Act as a preservative in food and cosmetics
- Used as a buffer solution in chemical laboratories to maintain pH.

d. The synonym of sodium bicarbonate is _____.
Ans: Baking soda or sodium hydrogen carbonate

e. Organic chemistry is the chemistry of _____.
Ans: Compounds containing carbon

f. Which of the following is a six membered ring?
i. Furan ii. Pyrimidine
iii. Imidazole iv. Oxazole.
Ans: (ii) Pyrimidine

g. While numbering the heterocyclic ring, the order of preference in numbering the hetero atoms as follows:
i. O-N-S ii. S-O-N iii. O-S-N iv. N-S-O
Ans: (iii) O-S-N

h. The prefix Aza/Azo is used for a hetero atom_____.
Ans: Nitrogen (N).

i. Write brand name of diazepam.
Ans: Valium, Calmpose, Paxum, Diastat, Diazemuls

j. Which of the following is hydantoin derivative?
i. Phenobarbitone ii. Trimethadione.
iii. Phenytoin iv. Phenacemide.
Ans: (iii) Phenytoin

k. Adrenaline is an_____.
i. Cholinergic blocker ii. Adrenergic agent
iii. Adrenergic blocker iv. Cholinergic agent.
Ans: (ii) Adrenergic agent

l. Name any two drugs used for myasthenia gravis.
Ans: Pyridostigmine, Neostigmine, Edrophonium, Azathioprine, Cyclosporine, Rituximab

m. Name the pharmacological category of dopamine.
Ans: Adrenergic agonist/neurotransmitter/cardiotonic

n. Isosorbide dinitrate is used in the treatment of_____.
Ans: Angina pectoris/congestive heart failure/myocardial infarction

o. Acetazolamide is used as_____.
Ans: Diuretics/carbonic anhydrase inhibitor

p. Full form of NSAIDs_____.
Ans: Non-steroidal anti-inflammatory drugs

q. The chemical name of aspirin is_____.
Ans: Acetylsalicylic acid or 2-acetyloxybenzoic acid

r. In what dosage form amoxycillin is given?
Ans: Tablet/oral suspension/syrup/capsule/injection

s. Write any two brand name of remdesivir.
Ans: Veklury, Redyx, Covifor, Remdiz, Remizac, Remifav

t. Which plant products have anticancerous properties?
Ans: Vincristine, vinblastine, paclitaxel, docetaxel.

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