UNIT-II

Part- (A)

GENERAL INTRODUCTION, COMPOSITION, CHEMISTRY AND CHEMICAL CLASS , BIOSOURCES, THERAPEUTIC USES AND COMMERCIAL APPLICATION OF VARIOUS SECONDARY METABOLITES

Points to be covered in this topic

- **Alkaloid : Vinca, Rauwolfia, Belladonna, Opium**

ALKALOIDS

- Alkaloids are **basic nitrogen containing** compound obtained from plant, animal and microorganisms **having** marked physiological action.
- Alkaloids are important class of plant **secondary metabolite**
- Term alkaloids was coined by **Meissner in 1819**

Fig. W. Meissner

❖ Properties

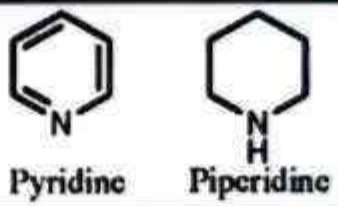
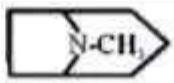
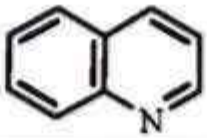
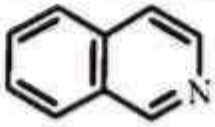
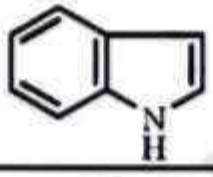
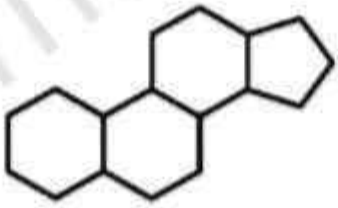
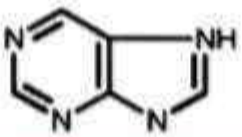
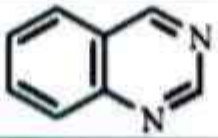
- Most of alkaloids are **basic in nature** due to the **availability of lone pair of electron on nitrogen**
- The alkaloid contain one or more number of nitrogen and it may exist in the form as :
  - ✓ Primary amine – Mescaline
  - ✓ Secondary amine – Ephedrine
  - ✓ Tertiary amine – Atropine
  - ✓ Quarternary amine – Tubocurarine Chloride
- Alkaloids are colorless, crystalline, non-volatile, solid and bitter in taste
- Leavo isomers are more active

Colour alkaloids	Red	**Betanidine**
	Copper Red	**Sanguinarine**
	Yellow	**Berberine, Tylophorine**
Liquid alkaloids	**Sparteine, Conine and Nicotine**	
Optically inactive alkaloid	**Papaverine, Atropine**	

Fig. Sanguinarine

Fig. Mescaline

❖ Classification of alkaloids

S.NO.	Type of Alkaloids	Structure	Source
1.	Pyridine and Piperidine	 Pyridine Piperidine	Tobacco, Areca, Lobelia
2.	Tropane [G-10, 17]		Belladonna, Datura, Stramonium, Hyoscyamus, Dubosia, Coca
3.	Quinoline		Cinchona, Camptotheca
4.	Isoquinoline		Opium, Ipecac, Curare
5.	Indole		Ergot, Nux-vomica, Rauwolfia, Vinca, Physostigma
6.	Imidazole		Pilocarpus
7.	Steroidal		Veratrum, Kurchi, Ashwagandha
8.	Alkaloidal amine	$CHCH_2CH_2NH_2$	Ephedra, Colchicum
9.	Purine Alkaloid		Tea, Coffee, Kola, Cocoa.
10.	Glycoalkaloid	-	Solanum
11.	Quinazoline		Vasaka
12.	Terpenoid	-	Aconite
13.	Pyrazoline		Pepper

❖ Type of alkaloids

S.NO.	TYPES	DESCRIPTION
1	True Alkaloid	• Derive from amino acid and contain nitrogen in heterocyclic ring • All true alkaloids have a bitter taste • Appear as a white solid, with the exception of nicotine which has a brown liquid appearance • True alkaloids form water-soluble salts Ex- Atropine, Morphine, Nicotine
2	Proto alkaloids	**Proto alkaloids** are compounds, in which the N atom derived from an amino acid is not a part of the heterocyclic ring Ex-Hordenine, Mescaline and Yohimbine
3	Pseudoalkaloids	Compounds of which basic carbon skeleton are not derived from amino acids. Ex- **Coniine, Capsaicin, Ephedrine, Solanidine, Caffeine And Theobromine**
4	Polyamine alkaloids	Derived from spermidine and spermine
5	Peptide and cyclopeptide alkaloids	Sativanine-N and Sativanine-O

❖ Chemical test

REAGENT	OBSERVATION
Dragendorff's Test Drug solution + Dragendroff's reagent (Potassium bismuth iodide)	Orangish red colour
Mayer's Test Drug solution + few drops of Mayer's reagent (Potassium mercuric iodide)	Creamy-white precipitate

Hager's Test Drug solution + few drops of Hager's reagent (Saturated aq. Solution of Picric acid)	**Crystalline yellow precipitate**
Wagner's Test Drug solution + few drops of Wagner's reagent (Dilute iodine solution)	**Reddish-brown precipitate**
Tannic Acid Test Drug solution + few drops of tannic acid solution	**Buff coloured precipitate**
Ammonia Reineckate Test Drug solution + slightly acidified (HCl) saturated solution of ammonia reineckate	**Pink flocculent precipitate**

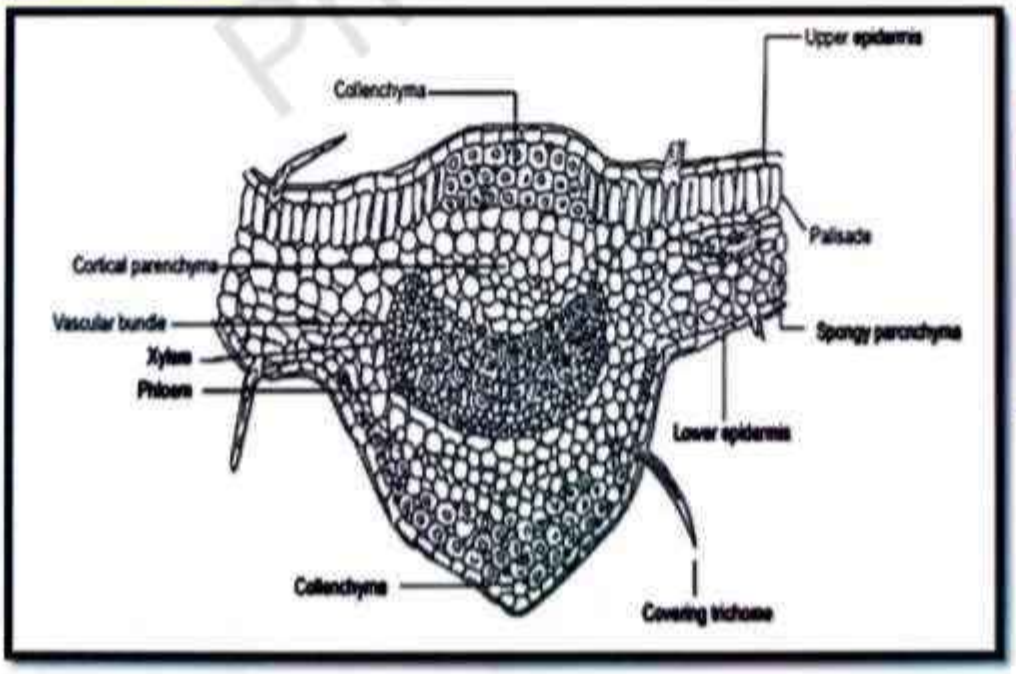
VINCA

Synonyms : Vinca rosea, Catharanthus, Madagascar periwinkle

Biological Source : Vinca is the dried entire plant of *Catharanthus roseus* belonging to family Apocynaceae

Geographical Source : India, Australia, South Africa and North and South America

Microscopy :



- Upper surface shows presence of single layer of rectangular celled epidermis with unicellular covering trichomes
- Spongy parenchyma
- Cruciferous stomata / Anisocytic stomata present
- Calcium oxalate crystals are absent

Chemical Constituent: Vinca contains mainly Indole alkaloids such as Vinblastine and Vincristine posses anticancer activity , Ajmalicine, Serpentine

Therapeutic use:

- Vinblastin is an antitumor alkaloid used in the treatment of Hodgkin's disease
- Vincristine is a cytotoxic compound and used to treat leukaemia in children
- Vinca is used in herbal practice for its astringent and tonic properties in menorrhagia and in haemorrhages generally
- In cases of scurvy and for relaxed sore throat, it may also be used as a gargle
- For bleeding piles
- It is also used in the treatment of diabetes

RAUWOLFIA

Synonyms: Sarpagandha, Chandrika, Chotachand, Indian snake root

Biological source: Rauwolfia consists of dried roots of *Rauwolfia serpentina* Benth., belonging to family Apocynaceae

Geographical Source: In India it occurs in the sub-Himalayan tracts from Sirhind eastwards to Assam, especially in Dehradun, Siwalik range, Gorakhpur ascending to 1,300 m, east and west ghats of Tamil Nadu, in Bihar (Patna and Bhagalpur), Karnataka and Bengal, Thailand, Philippines, Vietnam, Indonesia, Malaysia, Pakistan and Java

Macroscopic Characters :

- ✓ Colour - Outer surface is greyish yellow to brownish
- ✓ Odour - Odourless
- ✓ Taste - Very bitter
- ✓ Shape – root are cylindrical or slightly tapering, tortuous
- ✓ Fracture - Short and irregular

In external appearance pieces of rhizome and root resembles to each other and the only reliable method of distinction is to find out the small central pith of rhizome having a diameter of only 1 to 2mm as seen in smoothed transversely cut surface

Fig. Rauwolfia root

Chemical Constituent :

- Weakly basic tertiary indole alkaloid like reserpine, Deserpidine, yohimbine
- Medium basic tertiary indole alkaloid like ajamaline
- Strongly basic quaternary bases like serpentine tetrahydroserpentine

Microscopy :

- T.S section of root shows externally by stratified cork with 2-7 layers of small cells that is followed by phelloderm
- Both bark and wood contains abundant starch
- Xylem is entirely lignified
- Sclerenchyma is absent
- Tetrastichious arrangement present

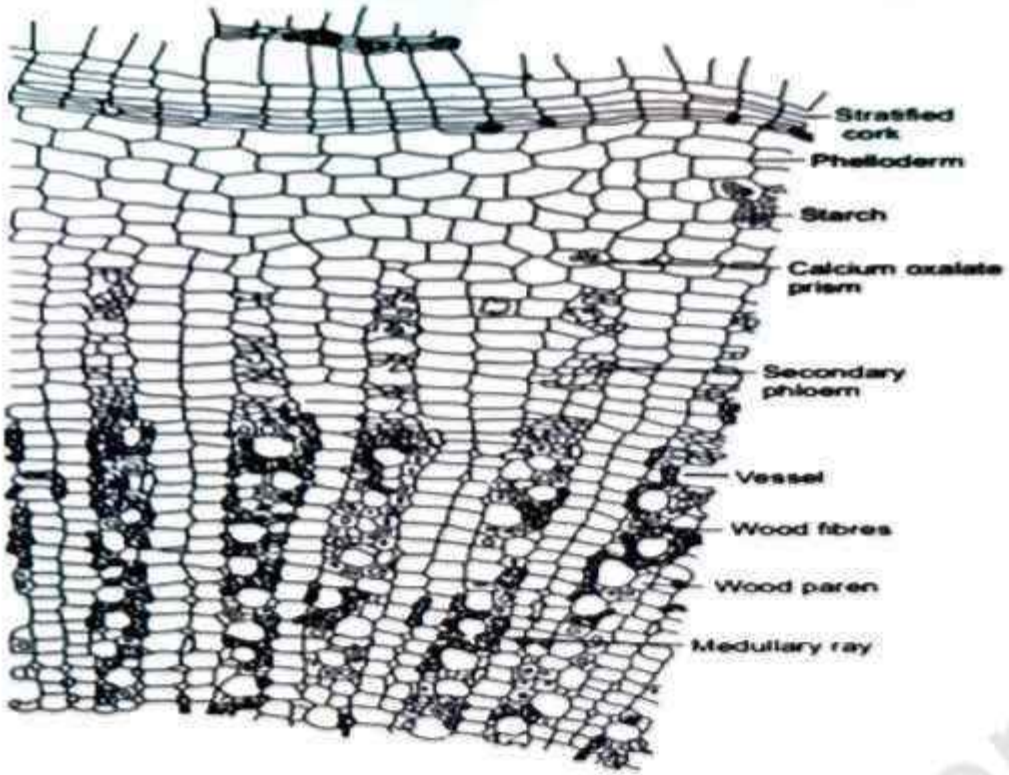


Fig. T.S. of Rauwolfia root

Therapeutic use :

- Rauwolfia is used as hypnotic, sedative and antihypertensive
- It is given in labours to increase uterine contractions and in certain neuropsychiatric disorders

Chemical test

- Powdered rauwolfia + H_2SO_4 + p-dimethylaminobenzaldehyde → Violet to red colour
- Freshly fractured root + conc. Nitric acid → red colour
- Reserpine shows violet colour when treated with solution of vanillin in acetic acid

OPIUM

Synonym : **Afim**

Biological source : Opium is obtained from dried latex by incision of the unripe capsule of ***Papaver somniferum***

Variety : *Papaver somnifarum* album (Indian) ***Papaver somnifarum glabrum*** (Turkey) ***Papaver somnifarum nigrum*** (European)

Family : Papaveraceae

Geographical Source : It is mainly found in **Turkey, Russia, Tasmania, India, Pakistan, Iran, Afghanistan, China, Thailand** . In India, **Opium is cultivated in M.P. (Neemuch) and U.P.** for alkaloidal extraction and seed production

Microscopy : Microscope shows agglomerated latex granules in irregular mass, **Stomata** – **Anomocytic, Pointed trichomes, few starch granules present**

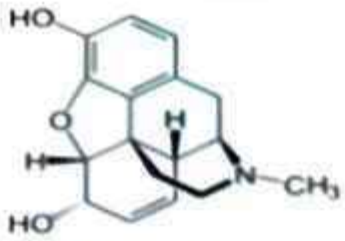
Chemical constituents :

- The present alkaloids has combined with organic acid i.e. **Meconic acid**

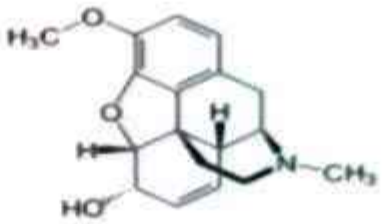
OPIUM ALKALOIDS

Benzylisoquinoline	**Phenantherene ring**
Noscapine	Morphine
Narceine	Codeine
Narcotine	Thebaine
Papaverine (optically inactive)	

- Morphine is **monoacidic, phenolic alkaloids**
- Morphine is **levorotator in nature**
- Opium alkaloids are present as salt of **meconic acid**
- Opium also contains **sugar, wax, mucilage and salt of calcium, potassium and magnesium**



Morphine



Codeine

Therapeutic uses :

- Morphine is used as **Analgesic**
- **Sedatives and hypnotics**
- Morphine also produces respiratory depression and constipation.
- **Codeine – Cough syrup preparation**
- **Papaverine – smooth muscle relaxants**
- **Apomorphine – Emetic (for treating poisoning cases)**

Chemical test :

1) MARQUIS TEST

Morphine + Conc. H_2SO_4 + HCHO → Dark violet color

2) MECONIC ACID TEST

Drug + FeCl3 → Deep reddish purple color

Morphine + SiO_2 - Blue color

Papaverine solution + HCl + potassium ferricyanide → Lemon yellow color

Morphine + HNO_3 → orange red color, this is not allowed by codeine

BELLADONNA

Synonyms : Belladonna leaf, Deadly night shade leaves; Death's herb, Poison black cherry

Biological Source : Belladonna consists of **dried leaves and flowering tops of *Atropa belladonna*** (European Belladonna), belonging to **family : Solanaceae**

- It contains about **0.35% of total alkaloids** calculated as **hyoscyamine**

Geographical Source :

Belladonna is cultivated in **United States, Canada, UK, Germany and India**

Microscopy :

- The leaf is **dorsiventral**, the epidermis consists of tabular cells having distinctly **striated cuticle** and more or **less sinuous anticlinal walls**
- **Anisocytic Stomata** are present on both surfaces
- Hairs are few usually present near the veins, on the lower surface more numerous on young leaves
- The **glandular hairs** are either short with 1 to 3 celled stalk and a rounded or club-shaped multicellular head, or long with 4 to 6 celled stalk and 1-celled ovoid head
- **Non-glandular** hairs are uniseriate, 2 to 6-celled, smooth, thin-walled
- The **mesophyll shows a single layer of palisade and occasional idioblasts filled with microsphenoidal crystals of calcium oxalate**
- The meristele is surrounded by an **endodermis, starch sheath**
- The palisade ratio is **5 to 7**

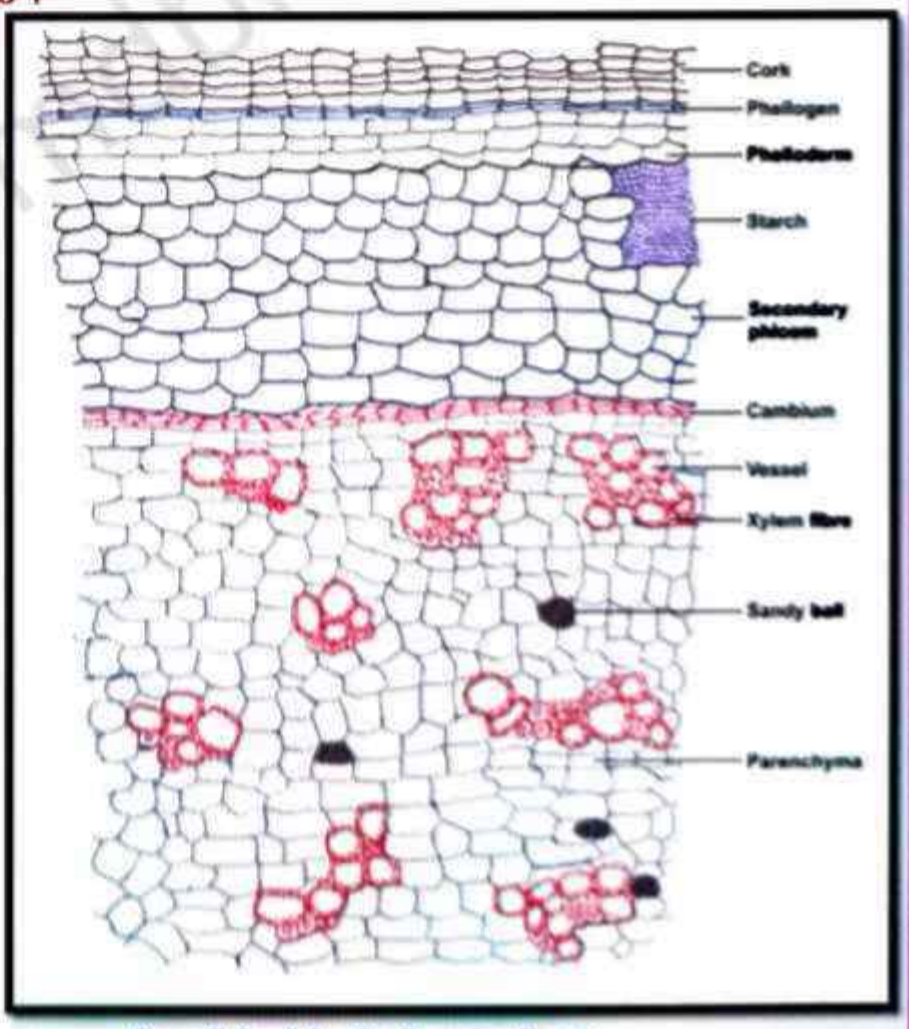
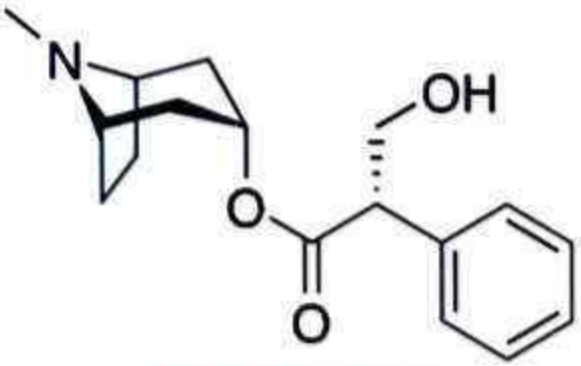


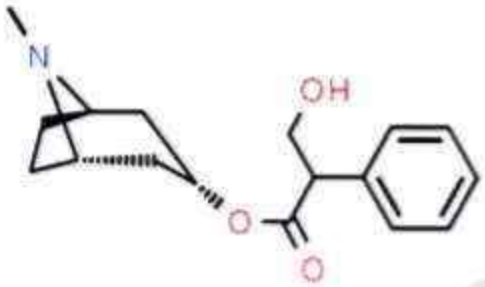
Fig. T.S of Belladonna leaf

Chemical constituents :

- It contain about **0.3-1.0% of alkaloids**
- Main alkaloids are **l-hyoscyamine** and its **racemic form is atropine**
- The leaves also contain a **fluorescent substance Scopoletin**
- ***l*- hyoscyamine** (ester of **tropic acid and tropine**)



hyoscyamine



Atropine

Adultrants and substitute :

- ✓ ***Phytolacca Americana*- Idioblast present** and **anommocytic stomata**
- ✓ ***Solanum nigrum* - Pallisade ratio**
- ✓ ***Alianthus glandulosa* - Lignified trichome present**

Uses:

- It is a **Parasymphathetic drug** with **anticholinergic property**
- In treatment of **peptic ulcer, digestive disorder and pancreatitis**
- **Relive from spasm of urinary tract**
- Belladonna is **narcotic, sedative, diuretic, mydriatic**

UNIT-II

Part- (B)

GENERAL INTRODUCTION, COMPOSITION, CHEMISTRY AND CHEMICAL CLASS, BIOSOURCES, THERAPEUTIC USES AND COMMERCIAL APPLICATION OF VARIOUS SECONDARY METABOLITES

Points to be covered in this topic

- Phenylpropanoids and flavonoids : Lignans, Tea, Ruta
- Steroidal, cardiac and triterpenoid glycoside : Liquorice, Dioscorea, Digitalis
- Glycosides : Senna, Aloe , Bitter almond

PHENYLPROPANOIDS AND FLAVONOIDS

Flavonoids **are polyphenolic compounds** which found in fruits, flower, seed and vegetables

LIGNANS

Biological source : These are obtained from wide variety of **plant based food including seed** whole grains fruits and vegetable. **Family : berberidaceae**

Chemical Constituents :

The lignans are the large group of polyphenols found in plants lignans are macromolecules, polymers of basic units of **C6-C3 n-propylbenzenes** which are linked by the **β carbon** by their **side chains**

Chemical test :

0.5 ml of aqueous solution of extract + **2 ml** of **2% furfuraldehyde**

Red colour indicate presence of lignan

Uses :

- Lignans have been found to exhibit **antiviral, antibacterial, antifungal, antimitotic and antitumor properties**
- Lignans have been used as **preservatives in the food, agriculture, rubber and pharmaceutical industries**
- These are used as **stabilizing agents for lubricants and polymers** such as **adhesives and plastics**

TEA

Synonym : Camelia thea

Biological source : Tea is obtained from the prepared leaves and leaf buds of ***Thea sinensis.*** **Family : Theaceae**

Chemical Constituents : Contains caffeine, theobromine, theophylline. **Color** of leaves is due to **gallotannic acid** . Also contain an **enzymatic mixture called thease**

Types of tea

Green tea: skips the oxidizing step It is simply withered and then dried more delicate taste and is pale green / It a golden in color

Black tea withered ,is fully oxidized and dried. Black tea yields a hearty, amber colored brew. Some of the popular black teas include English Break fast and Darjeeling

White tea: is the least processed. originated from China, White tea is not oxidized or rolled, but simply withered and dried by steaming

Oolong tea: popular in China, withered, partially oxidized, and dried. Oolong is a cross between black and green tea in color and taste

Fig. Green tea

Fig. Oolong tea

Fig. Black tea

Fig. White tea

Chemical test :

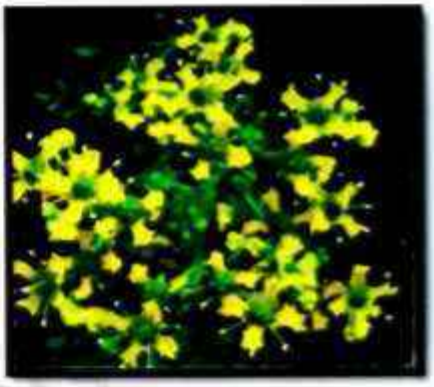
Murexide Test -

Caffeine + HCl + $KClO_3$ → Purple colour —(Alkali)→ Colourless

Uses :

Stimulant effect on nervous system

RUTA



Synonym : Garden Rue

Biological source : Obtained from dried leaves and roots of ***Ruta graveolens*** Family : Rutaceae

Chemical constituents :

Active principle of plant are rutin (flavonoid glycoside) , alkaloid such as skimmianine and graveoline and essential oil containing compound such as methyl – amyl - ketone

Chemical test :

Drug + Lead acetate → Yellow ppt

Drug + ferric chloride → Greenish blue colour

Uses :

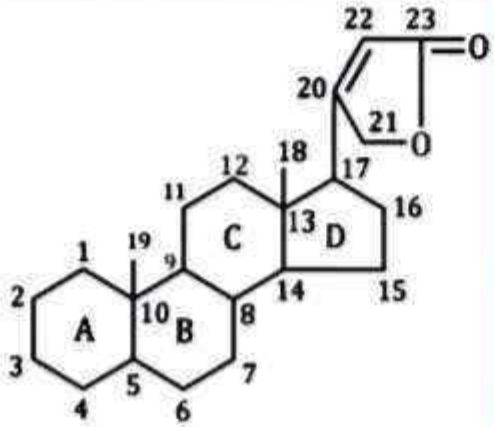
- Extracts from rue have been used to treat eyestrain, sore eyes and as insect repellent
- Antioxidant , anticancer
- Rue has been used internally as an antispasmodic, as a treatment for menstrual problem, as an abortifacient and as sedative

STEROIDAL, CARDIAC AND TRITERPENOID GLYCOSIDE

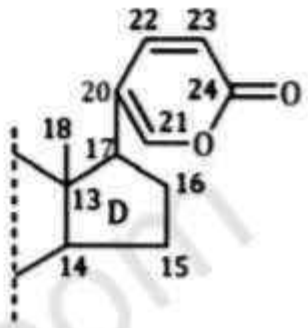
❖ Introduction

- The aglycone part of cardiac glycoside is a **steroidal moiety**
- Basic structure present in cardiac glycosides is **Cyclopentano perhydro phenanthrene**

These are two types :



Cardenolide

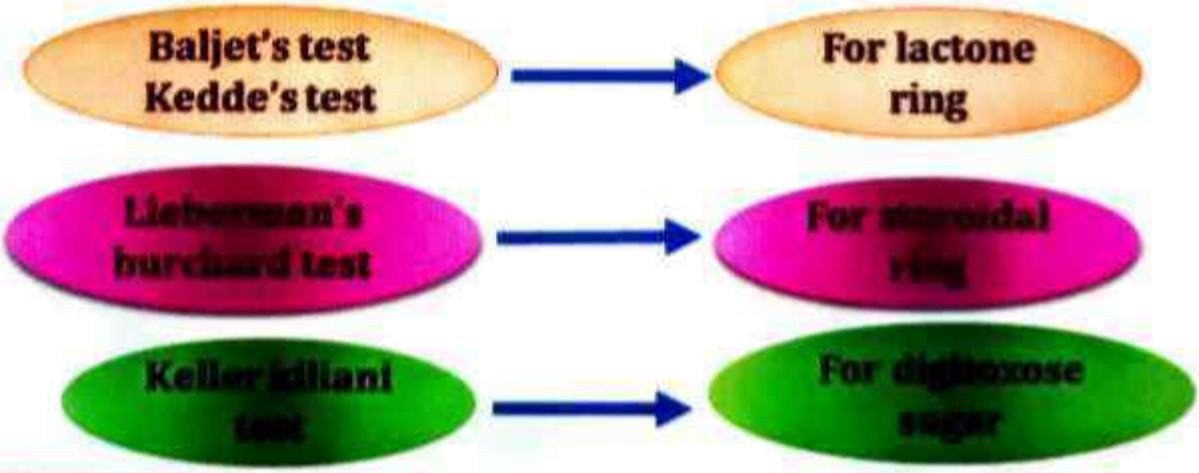


Bufadienolide

For maximum cardiac activity-

The presence and attachment through a specific position to steroidal nucleus of the **lactone is essential for proper cardiac activity**

- **Lactone ring** is attached to steroidal nucleus through **17β position** **Sugar part** is attached to **3β position**
- A/B, C/D ring should have **cis** configuration. Sugar part help in its absorption and distribution in body
- **Increase in the number of OH group on aglycone leads to quicker onset of action and enhanced metabolism**



LIQUORICE

Synonym : Mulethi

Biological source : Liquorice is obtained from dried peeled or unpeeled root an stolon of

Glycyrrhiza glabra var. typica **(Spanish liquorice)**

Glycyrrhiza glabra var. glandulifera **(Russian liquorice)**

Family : Leguminaceae

Macroscopy

- ✓ **Colour** - Peeled liquorice is pale yellow in colour Unpeeled liquorice is **yellowish brown** externally and internally it is yellowish in colour
- ✓ **Odour** - Faint and Characteristic
- ✓ **Taste** – Sweet
- ✓ **Shape** - Peeled pieces are angular Unpeeled pieces are straight or cylindrical

Size - About 20cm in length and 1 to 2cm in diameter

Fracture - It is fibrous in bark and splintery in wood

Microscopy

✓ **T.S of stolon**

- Cork consist of several rows of radially arranged thin walled polygonal tabular cells beneath which there may be a few rows of parenchyma which forms the cortex
- Contain **starch grains and calcium oxalate prism**
- **Pericycle is present with small groups of pericycle fibres** at intervals
- Phloem consists of fibres **slightly lignified alternating** with sieve tissue
- Xylem consists of fibres similar to phloem, xylem vessels

✓ **T.S of root**

- Four small primary xylem bundles arranged at right angles to each other, **protoxylem directing outward**
- Phelloderm is in the outer part, below the cork. Rest of the structure is similar to that of stolon

Chemical constituents

- Chief constituents is pentacyclic triterpenoid saponin known as glycyrrhizin (glycyrrizic acid) which is a potassium and calcium salts of glycyrrhizinic acid

Glycyrrhizinic acid —Hydrolysis→ Glycyrrhetinic acid (glycyrrhetic acid) + 2 glucouronic

- Presence of flavonoid (liquiritin & isoliqiritin) cause antigastric effect and it is useful in peptic ulcers
- Carbenoxolone (used as anti ulcer drug) is an oleandane derivative prepared from glycyrrhiza
- Sweet taste of Glycyrrhiza is due to potassium and calcium salts of glycyrrhizinic acid
- Bitter principle glycyramarin resins
- The flavonoids, yellow in colour, are liquiritin and isoliquiritin

Chemical test of liquorice

Section of drug + 80% H_2SO_4 ⟶ Deep yellow Colour

DIOSCOREA

Synonym : Yam plant

Biological source : Dioscorea is obtained from **dried** tubers of plant ***Dioscorea deltoidae***. Family : Dioscoraceae

Macroscopic Characters

- ✓ Colour - Light brown
- ✓ Odour – Odourless
- ✓ Taste - Bitter
- ✓ Shape - Cylindrical or globose tubers
- ✓ Size - Variable

Chemical constituents

Dioscin —(Acid hydrolysis)→ **Diosgenin + L-Rhamnose(2 mol.) + D Glucose**

- Dioscorea rhizomes contain **75 % of starch**
- The chief active constituent of dioscorea is **diosgenin**, a **steroidal sapogenin (4 to 6 per cent), and its glycosides, smilagenin and epismilagenin and β-isomer yammogenin**
- Rhizomes are also found to contain an **enzyme sapogenase**
- Tubers are also rich in **glycosides, and phenolic compounds**
- **Diosgenin is the hydrolytic product of saponin-dioscin**

Uses

- As a precursor for the synthesis of **corticosteroids, sex hormones and oral contraceptives**
- Used in the treatment of **rheumatic arthritis**

DIGITALIS

Synonym : Foxglove leaves

Biological source : Digitalis is obtained from dried leaves of plant *Digitalis purpurea and Digitalis lanata*. Family : Scrophulariaceae

Description

- Contains not less than **0.3% of total cardinolides** calculated as digitoxin
- Dried at temperature **below 60°C**, immediately after collecting the leaves
- In leaves should **contain not more than 5% of moisture**

Macroscopy

- ✓ **Colour** - Upper surface is **deep green and greyish. Lower surface is greyish green**
- ✓ **Odour** - **Characteristic**
- ✓ **Taste – Bitter**
- ✓ **Shape** - **Ovate-lanceolate to broadly ovate**
- ✓ **Size** -10 to 30cm in length. Tram le 4 to 10cm in width