Name Of Unit	General introduction, composition, chemistry & chemical classes, bio -sources, therapeutic uses and commercial applications of certain secondary metabolites.
Subject /Course	**Pharmacognosy and Photochemistry-II**
Subject/Course ID	BP 504T
Unit	2nd
Class: B.Pharm.	Semester 5th
Course Coordinator	Mr. Anubhav Gupta

Learning Outcome

To outline the pharmacognosy of secondary metabolites given in syllabus.

Module Content Topic

General introduction, composition, chemistry & chemical classes, bio - sources, therapeutic uses and commercial applications of following secondary metabolites:

Alkaloids: Vinca, Rauwolfia, Belladonna, Opium.

Phenylpropanoids and Flavonoids: Lignans, Tea, Ruta.

Steroids, Cardiac Glycosides & Triterpenoids: Liquorice, Dioscorea, Digitalis.

Volatile oils: Mentha, Clove, Cinnamon, Fennel, Coriander.

Tannins: Catechu, Pterocarpus.

Resins: Benzoin, Guggul, Ginger, Asafoetida, Myrrh, Colophony.

Glycosides: Senna, Aloes, Bitter Almond.

Iridoids, Other terpenoids & Naphthaquinones: Gentian, Artemisia, Taxus, carotenoids.

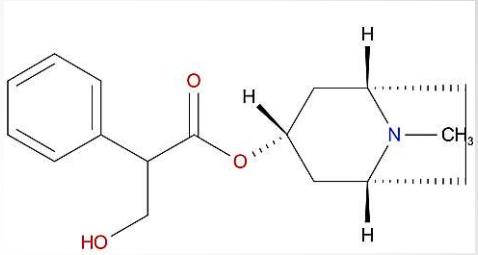
ALKALOIDS

- There are more than 10,000 compounds categorized as Alkaloids.
- The term 'Alkaloid' was coined by **Meisener**, a German pharmacist in 1819.
- **Nicotine** was discovered by Dersone in 1803 and **Morphine** by Sertuner in 1803.
- Alkaloids can be defined as alkali like compounds which are basic nitrogenous compounds of plant or animal origin and can have physiological action in human or animals when used in small quantities.
- They can be found in varieties of plant like Ephedra (**Ephedrine**), Vinca (**Vinblastin**), Tea (**Caffeine**), Rauwolfia (**Reserpine**), Cinchona (**Quinine**), Black Pepper (**Piperine**), Opium (**Morphine**).
- On the basis of origin, they are classified into **three**:
    - **True Alkaloids**
    - **Proto Alkaloids**
    - **Pseudo Alkaloids**

i. TRUE ALKALOIDS

- They contain one or more nitrogen atom within the ring.
- They are obtained directly from Amino acids.
- They are basic in nature and form water soluble salts.

e.g:- Quinine, Atropine, Morphine.

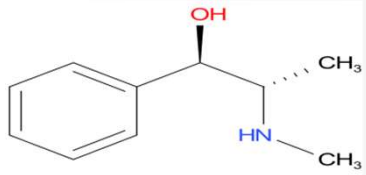


ATROPINE

ii. PROTO / AMINO ALKALOIDS

- They are simple amines, nitrogen is outside the heterocyclic ring.
- Basic in nature, prepared in plants from amino acids.

e.g:- Colchicine, Ephedrine.

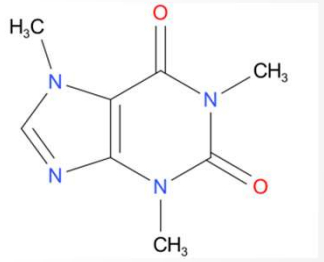


EPHEDRINE

iii. PSEUDO ALKALOIDS

- Not derived from amino acids.
- It includes steroidal, terpenoidal and purine alkaloids.
- Don't show typical characters of Alkaloids, but give test for alkaloids.

e.g., Conine, Caffeine.



CAFFEINE

PROPERTIES:

- Nicotine is liquid, berberine is yellow.
- Alkaloids are colorless, crystalline, non-volatile, solids.
- Bitter in taste.
- Salts are insoluble in water.

CHEMICAL TEST FOR ALKALOIDS

S.No.	Chemical Test / Name	Observation
1	**Mayer's Reagent** (Potassium Mercuric Iodide solution)	Creamy precipitate
2	**Wagner's reagent** (Potassium Tri-iodide solution)	Reddish brown precipitate
3	**Dragendroff's reagent** (Potassium Bismuth Iodide solution)	Reddish brown precipitate
4	**Hager's reagent** (Picric acid)	Yellow precipitate
6	**Sonnenschein's reagent** (Phospomolybdic acid)	Precipitate
7	**Scheibler's reagent** (Phospotungstic acid)	Precipitate
8	**Tannic acid test**	Precipitate
9	**Murexide test** (Caffeine + Hcl +Kcl3)	Purple color to colorless after addition of alkali

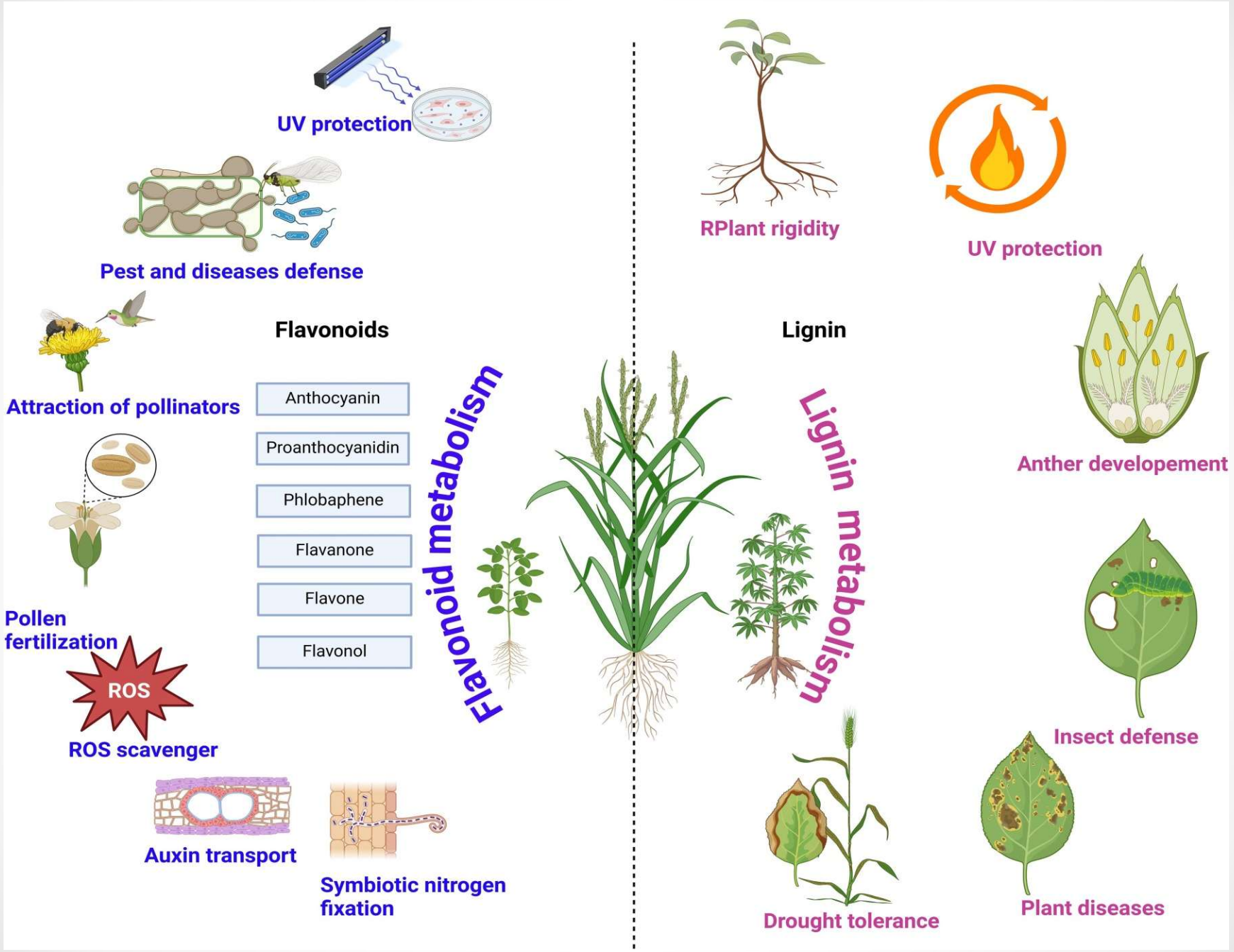
S.No.	B. Name	Family	Morphology	Chemical Constituents	Therapeutic Uses
01	**VINCA** (Sadabahar) ***Catharanthus roseus*** or ***Vinca rosea***	Apocynaceae	**C:** Leaves are green, Flowers are Pink-Violet or Crimson Red **O:** Characteristic **T:** Bitter	**Vincristine, Vinblastin,** Ajmalicine and Serpentine	Anti-tumor, Anti-cancer, Anti-hypertensive, Analgesic
02	**RAUWOLFIA** (Sarpagandha) **Rauwolfia *serpentina***	Apocynaceae	**C:** Greyish yellow/brown **O:** Odourless **T:** Bitter	**Reserpine,** Ajmaline, Ajmalacine, Rescinnamine	Anti-Hypertensive, Anti-Spasmodic, Anti-Rheumatic
03	**BELLADONNA** (Deadly Nightshade) **Atropa *belladonna***	Solanaceae	**C:** Leaves are Brownish-green, Flowers are Purple **O:** Slight and characteristic **T:** Bitter and acrid	**Hyoscyamine,** Scopoletin, Pyridine	Anticholinergic , anti-epileptic, Mydriatic, Antidote in opium poisoning.
04	**OPIUM** (Afeem, Opium Poppy) **Papaver *somniferum***	Papaveraceae	**C:** Latex is brown to dark brown **O:** Strong Characterisitic **T:** Bitter	**Morphine**, codeine, thebaine, Noscapine, Papaverine	Opioid Analgesic, Sedative, Emetic, Smooth Muscle Relaxant

PHENYLPROPANOIDS

- Phenylpropanoids are diverse mixture of naturally occurring phenolic compounds obtained from phenylalanine and tyrosine (aromatic amino acids) or sometimes from the intermediates of shikimic acid biosynthetic pathway.
- Phenylpropanoids phenolic in nature due to the presence of hydroxyl group.

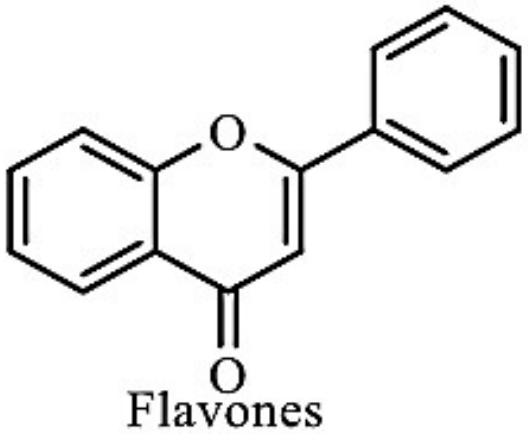
- Phenylpropanoids can be found as derivatives of:
  - **Hydroxycinnamic Acids:** *p*-Coumaric acid, Caffeic acid and Ferulic acid
  - **Phenylpropenes:** Eugenol, Anethole, and Cinnamaldehyde.
  - **Coumarins:** Coumarins, Hydroxycoumarins, and Furanocoumarins.
  - **Biphenylpropenoid:** Lignans and Flavonoids.
  - **High Molecular Weight Phenylpropanoids:** Lignins and Tannins.

PHENYLPROPANOIDS

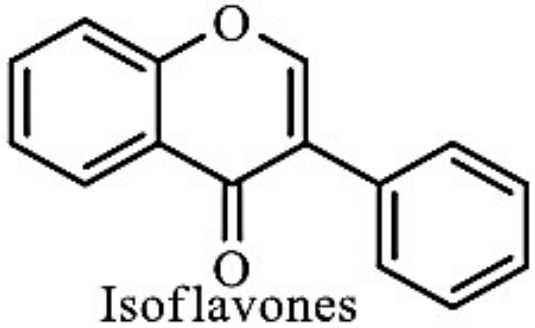


FLAVONOIDS

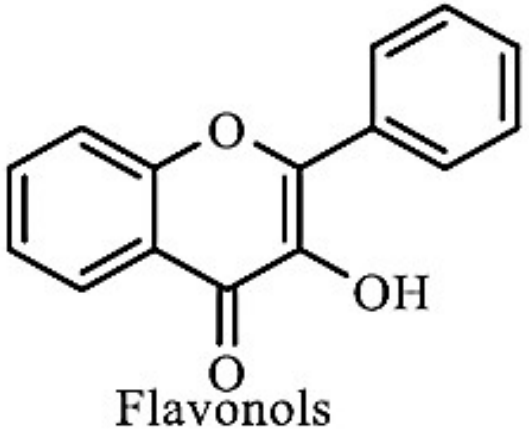
- Flavonoids are a diverse group of phytonutrients found in almost all fruits and vegetables.
- Along with carotenoids, they are responsible for the vivid colours in fruits and vegetables.
- Flavonoids are chemically polyphenolic compounds of 15 carbon atoms.
- The chemical structure of flavonoids is based on a C-15 skeleton with a chromane ring bearing a second aromatic ring at position 2, 3, or 4.
- Flavonoids are essential for the pigmentation of flowers.
- They also guard the petals and other parts of flower from UV radiation and oxidative stress.



Flavones



Isoflavones



Flavonols

FLAVONOIDS

S.No.	B. Name	Family	Morphology	Chemical Constituents	Therapeutic Uses
01	**TEA** **Thea *sinensis***	Theaceae	**C:** Leaves are Shiny green. **O:** Fragrant **T:** Aromatic	**Caffeine,** Xanthine, Adenine, Theophylline	CNS stimulant, diuretic, antioxidant
02	**RUTA** **Ruta *graveolens***	Rutaceae	**C:** Leaves are greyish green **O:** Pleasant **T:** Characteristic	**Rutin** and **quercetin** **Psoralen,** Coumarins	Emmenagogue, antispasmodic, aphrodisiac , abortifacient

STEROIDS

- A steroid is **an organic compound with four fused rings** (designated A, B, C, and D) arranged in a specific molecular configuration.
- Plant steroids are a diver se group of natural products. They are biosynthetically derived from S -squalene-2,3-epoxide through acetate mevalonate pathway.
- Steroidal alkaloids found in the plants of Solanaceae and Melanthiaceae family.
- Steroids are used in treating the following conditions:

  1) Asthma and Chronic Obstructive Pulmonary Disease (COPD),
  2) Hay fever,
  3) Hives and eczema,
  4) Painful joints or muscles, such as arthritis, and frozen shoulder,
  5) Pain caused by an irritated or trapped nerve, such as sciatica,
  6) Inflammatory bowel disease, such as Crohn‟s disease, and
  7) Multiple Sclerosis (MS).

STEROIDS

Steroids are chemically classified into the following:

1. **Anabolic Steroids:** They interact with androgen receptor, increase muscle Mass **e.g.** Testosterone, Oxandrolone
2. **Glucocorticoids:** They regulate metabolism and immune function. **e.g.** Cortisol, Prednisone
3. **Mineralocorticoids:** They maintain blood volume and renal excretion. **e.g.** Aldosterone, fludrocortisone
4. **Progestins:** They are involved in the development of female sex organs and characteristics. **e.g.** Progesterone, Levonorgesterol
5. **Phytosteroids:** They are plant steroids. **e.g.** Beta-sitosterol, stigmasterol
6. **Ergosteroids:** They are the steroids of fungi, and are vitamin D related.

STEROIDS

S.No.	B. Name	Family	Description	Chemical Constituents	Therapeutic Uses
01	**(Mulethi)** **LIQUORICE** **Glycyrhizza *glabra***	Leguminaceae	**C:** Yellowish Brown **O:** Characteristic **T:** Sweetish	Glycyrhizzin Glycyrrhizinic Acid Liquiritin	Expectorant Demulcent Mineralocorticoid Flavoring Agent
02	**(Yam Plant)** **DIOSCOREA** **Dioscorea *deltoidae***	Dioscoreaceae	**C:** Brownish White **O:** Faint **T:** Bitter & Acrid	Starch 75% Diosgenin Dioscin Yammogenin	Anti-Rheumatic Precursor in synthesis of Corticosteroids, Contraceptives
03	**(Fox Gloves)** **DIGITALIS** **Digitalis *lanata*** **Digitalis *purpurea***	Scrophulariaceae	**C:** Greyish Green **O:** Slight **T:** Bitter &Acrid	Digoxin, Digitoxin Gitoxin Purpurea Glycoside A & B	Cardiac Stimulant Cardiotonic

TERPENOIDS & VOLATILE OILS

- Terpenoids are hydrocarbons of plant origin with general formula **(C5H8)n** as well as their oxygenated, hydrogenated and dehydrogenated derivatives.
- Terpenoids are abundantly available in volatile oils.
- They consist of a complex mixture of terpenes or sesquiterpenes, alcohols, aldehyde, ketones, acids and esters. **e.g.** Menthol, Citral, Eugenol, Citronellol, Geraniol, Limonene, etc.
- The odorous, volatile principle of plant and animal source having high evaporation rate are known as volatile oil.
- Volatile oils are also called essential oil because they produce essence. **e.g.** Peppermint oil, Lemon grass oil, Clove oil, Citronella oil, Caraway oil, etc.
- These are commonly found in the species of Labiateae, Rutaceae, Piperaceae, Zingiberaceae, Umbelliferae, etc.

TERPENOIDS & VOLATILE OILS

PHYSICAL PROPERTIES:

- Terpenoids are colourless liquid.
- Soluble in organic solvents and insoluble in water.
- Most of the terpenoids are optically active.
- Volatile in nature.
- Boiling point 150 – 180C.

CHEMICAL PROPERTIES:

- They are unsaturated compounds.
- They undergo addition reaction with hydrogen, halogen, halogen acids to form addition products like NOCl, NOBr and hydrates.
- They undergo polymerization and dehydrogenation in the ring.
- On thermal decomposition, terpenoids gives isoprene as one of the product.

TERPENOIDS & VOLATILE OILS

Classification

Sr. No.	Name of the class of terpenoids	No. of Isoprene units	Molecular formula	Example
1	Monoterpenes Or Terpenes	2	C10H16	Peppermint, Camphor, Eucalyptus, Lemon grass, Turpentine.
2	Sesquiterpenes	3	C15H24	Artemisia, Clove, Sandalwood.
3	Diterpenes	4	C20H32	Taxus
4	Triterpenes	6	C30H48	Ambergris
5	Tetraterpenes or Carotenoids	8	C40H64	Annatto, Crocus, Chlorophyll
6	Polyterpenes	n	(C5H8)n	Rubber

VOLATILE OILS

S.No.	B. Name	Family	Description	Chemical Constituents	Therapeutic Uses
01	**(Peppermint Oil)** **MENTHA OIL** **Mentha *piperita***	Labiatae	**C:** Yellowish **O:** Characteristic **T:** Sweetish & Cooling Sensation	Menthol Limonene Pinene Camphene	Carminative Stimulant Flavoring Agent
02	**CLOVE OIL** **Eugenia *caryophyllus*** or **Syzgium *aroamaticum***	Myrtaceae	**C:** Yellowish **O:** Strong Aromatic **T:** Pungent	Eugenol Eugenol Acetate Caryophyllene Eugenin	Antiseptic Aromatic & Stimulant Dental Analgesic Flavoring Agent
03	**CINNAMON OIL** **Cinnamomum *Zeylanicum***	Lauraceae	**C:** Clear Yellowish **O:** Aromatic **T:** Sweetish	Cinnamaldehyde Linalool Cinnamic Acid Eugenol Phlobatannins	Carminative Stomachic Astringent Aromatic Flavoring Agent

VOLATILE OILS

S.No.	B. Name	Family	Description	Chemical Constituents	Therapeutic Uses
03	**FENNEL** **Foeniculum *vulgare***	Umbellifareae	**C:** Yellowish Green **O:** Aromatic **T:** Sweetish & Strongly Aromatic	Fenchone Anethol Anisicaldehyde Cimonene	Carminative Stimulant Expectorant Flavoring Agent
04	**CORIANDER** **Coriandrum *sativum***	Umbellifareae	**C:** Yellowish Brown **O:** Aromatic **T:** Spicy	D-Linalol Coriandryl Acetate L-Borneol Geraniol, Pinene	Aromatic & Stimulant Carminative Flavoring Agent

TANNINS

- The name ‘tannin’ is derived from the French word ‘tanin’ (tanning substance) and is used for a range of **natural polyphenols**.
- Tannins are complex organic, non nitrogenous plant products, which generally have astringent
- properties.
- The term ‘tannin’ was first used by Seguin in 1796 to denote substances which have the ability to combine with animal hides to convert them into leather which is known as tanning of the hide.
- According to this, tannins are substances which are detected by a tanning test due to its absorption on standard hide powder.
- The test is known as Goldbeater’s skin test.

TANNINS

- Tannins are colloidal solutions with water.
- Non crystalline substance.
- Soluble in water (exception of some high molecular weight structures), alcohol, dilute alkali, and glycerin.
- Sparingly soluble in ethyl acetate.
- Insoluble in organic solvents, except acetone.
- Molecular weight ranging from 500 to >20,000.
- Oligomeric compounds with multiple structure units with free phenolic groups.
- Can bind with proteins and form insoluble or soluble tannin—protein complexes.

CATECHU

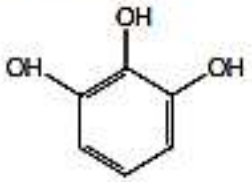
PTEROCARPUS

TANNINS

CLASSIFICATIONS OF TANNINS

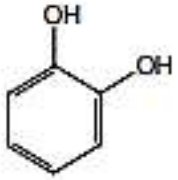
According to the products of thermic destruction (Prokter`s)

Pyrogallol derivatives



Pyrogallol

Pyrocatechin derivatives



Pyrocatechin

According to the chemical structure and their properties (Freodenberg`s)

- **HYDROLISABLE**
  - **Gallotannins**
  - **Ellagotannins**
  - **Nonsugar esters of phenolcarbon acids**
- **CONDENSED / NON-HYDROLISABLE**
  - **Catechin derivatives**
  - **Leucoanthocyanidins derivatives**
  - **Stillbens derivatives**

CHEMICAL TESTS FOR TANNINS

***Goldbeater's skin test*:**

Goldbeater's skin is a membrane produced from the intestine of Ox.

A piece of **goldbeaters skin** + 2% hydrochloric acid + wash with distilled water + tannin solution → Wait for 5 minutes.

Washed with distilled water → 1% ferrous sulphate solution → **Brown** or **Black** Colour.

Phenazone Test:

Aq. sol. of Tannin 5 ml + Drug → 0.5 g Sodium Acid Phosphate → Warm + Cool → Filter.

Add 2% Phenazone Sol to the filtrate →**Tannins Precipitates**.

Gelatin Test:

1% Gelatin Sol + 10% NaCl + 1% Solution of Sample → **Precipitation**

Vanillin - HCl test:

Vanillin **:** Alcohol **:** $HCl_{(dil.)}$ (1:10:10) + Drug Sample → **Pink** or **Red** colour

TANNINS

S.No.	B. Name	Family	Description	Chemical Constituents	Therapeutic Uses
01	**(Gambir, Khair, Khattha)** **CATECHU** **Uncaria *gambier***	Rubiaceae	**C:** Reddish Brown **O:** Odorless **T:** Astringent, Bitter	Catechin Catechutannic Acid Querecetin	Astringent, Anti-Diarrhoeal
02	**(Malbar Kino)** **PTEROCARPUS** **Pterocarpus *marsupium***	Leguminaceae	**C:** Ruby Red **O:** Odorless **T:** Astringent	Kinnotannic acid, Kino-red Gallic acid, Kinnoin	Astringent, Anti-Diarrhoeal, In passive haemmorrhage Dental Analgesic