CLASSIFICATION OF ALKALOIDS:-

The alkaloids can be classified according to

Biosynthetic Classification In this particular instance the significance solely lies to the precursor from which the alkaloids are produced in the plant biosynthetically.

Examples

1. Ornithine Derived Alkaloids
2. Lysine Derived Alkaloids
3. Nicotinic Acid Derived Alkaloids
4. Tyrosine Derived Alkaloids
5. Tryptophan Derived Alkaloids
6. Anthranilic Acid Derived Alkaloids
7. Histidine Derived Alkaloids
8. Amination Reaction Derived Alkaloids
9. Purine Alkaloids

Ornithine-Derived Alkaloids

1. Pyrrolidine and Tropane Alkaloids (Hyoscyamine, Hyoscine, Atropine)
2. Pyrrolizidine Alkaloids

A non-protein amino acid, L-ornithine, usually constitutes an integral part of the ‘urea-cycle’ in animals, wherein it is eventually produced from L-arginine in a reaction sequence catalyzed by the enzyme arginase as given below:

Structures of L-ornithine and tropane
Pharmacognosy

Tropane alkaloid

Tropane is a bicyclic amine that has a pyrrolidine and a piperidine ring sharing a common nitrogen atom and 2 carbon atoms.

The nucleus always carries an oxygen in position 3.

Tropane does not occur naturally in free form rather it is found as part of esters in plant species. Esters of tropane are generally secondary metabolites of these plants.

Tropane alkaloids are esters of hydroxytropanes and various acids (tropic, tiglic).

-Tropane moiety is formed from ornithine

-Acid moiety from Phenylalanine.

Approximately 200 alkaloids are known in this group, and they are distributed in a small number of Angiosperm families especially Solanaceae (they are found in about twenty genera like atropa and Scopolia contains hyoscyamine, Datura Stronium contain hyoscine and atropine mainly is found in Atropa Belladona), Erythroxylaceae (Cocaine is found Erythroxylum Coca)
STRUCTURE OF TROPANE ALKALOIDS

tropane alkaloids are esters of tropane alcohols and of acids of various structures, either aliphatic or aromatic.

Tropane Alkaloids are classified into:

1- Solanaceous Tropane Alkaloids.
2- Erythroxylon (Coca) Alkaloids

1.A. Solanaceous alkaloids:-

Solanaceous alkaloids come from the solanaceae .Some of the alkaloids they produce are: Atropine ,Hyoscyamine ,Hyoscine

Hyoscyamine is the pure optical isomer; (+)Hyoscyamine, (-)Hyoscyamine. Atropine is the racemic of hyoscyamine (Atropine = (±)Hyoscyamine). The 3-hydroxy derivative of tropane is known as TROPINE.

Hyoscyamine is the major natural alkaloid with negative optical rotation (l- form). During extraction hyoscyamine racemizes to the optically inactive dl Atropine.

Both alkaloids composed of tropine base and tropic acid.
While Hyoscine is an ester of l-tropic acid with scopoline base.

Hyoscine is a syrupy liquid

**Separation of the Alkaloidal mixtures:**

1. Alkalize by NaHCO₃ pH 7.5
2. Extract with Ether

Ether
- Hyoscine free base
  - (pKa = 6.2)
- Aqueous layer
  - Atropine & Hyoscyamine HCl
    - (pKa = 9.3)

  Convert to oxalate salts, Fractional Crystallization (Acetone/Ether)

  - Atropine Oxalate Crystals
  - Hyoscine Oxalate Solution
Pharmacognosy

Chemical tests:-
Vitali-Morin’s test:
Solid alkaloid + fuming HNO3 → Evaporate to dryness, dissolve residue in acetone, add methanolic solution of KOH → Violet colour.

P-dimethylaminobenzaldehyde:
Alkaloid + reagent in porcelain dish and heat on boiling water path → Intense Red Colour → Cherry Red after cooling.

Gerrard’s test:
Alkaloid + 2% HgCl2 in 50% Ethanol →
Red colour Atropine
Red after warming Hyoscyamine
White ppt Hyoscine

OFFICIAL SOLANACEAE CONTAINING TROPANE ALKALOIDS
Deadly nightshade Atropa belladonna Belladonae folium
Thorn apple Datura stramonium Stramonii folium
Henbane Hyoscyamus niger Hyoscyami herba

Belladonna
The deadly nightshade Atropa belladonna (Solanaceae) has a long history as a highly poisonous plant. The generic name is derived from Atropos, in Greek mythology the Fate who cut the thread of life.

The berries are particularly dangerous, but all parts of the plant contain toxic alkaloids, and even handling of the plant can lead to toxic effects since the alkaloids are readily absorbed through the skin. Although humans are sensitive to the toxins, some animals, including sheep, pigs, goats, and rabbits, are less susceptible. Cases are known where the consumption of rabbits or birds that have ingested belladonna has led to human poisoning.

Belladonna herb typically contains 0.3–0.6% of alkaloids, mainly (−)-hyoscyamine. While Belladonna root has only slightly higher alkaloid content at 0.4–0.8%, again mainly (−)-hyoscyamine. Minor alkaloids including (−)-hyoscine and cuscohygrine are also found in
Pharmacognosy

the root, though these are not usually significant in the leaf. The mixed alkaloid extract from belladonna herb is still used as a gastrointestinal sedative, usually in combination with antacids. Root preparations can be used for external pain relief, e.g. in belladonna plasters.

Datura stramonium

is commonly referred to as thorn apple on account of its spikey fruit. It is a tall bushy annual plant widely distributed in Europe and North America, and because of its alkaloid content is potentially very toxic.

Indeed, a further common name, Jimson or Jamestown weed, originates from the poisoning of early settlers near Jamestown, Virginia. At subtoxic levels, the alkaloids can provide mild sedative action and a feeling of well-being.

The concentration of the total alkaloids is between 0.2 and 0.5%, and at the time of the harvest, hyoscyamine and scopolamine represent two-third and one-third of the total alkaloids respectively.

Hyoscyamus niger Hyoscyami herba

Hyoscyamus niger (Solanaceae), or henbane, is a European native with a long history as a medicinal plant. Its power to induce hallucinations with visions of flight may well have contributed to our imaginary view of witches on broomsticks.

The plant has both annual and biennial forms, and is cultivated in Europe and North America for drug use, the tops being collected when the plant is in flower, and then dried rapidly.

The alkaloid content of hyoscyamus is relatively low at 0.045–0.14%, but this can be composed of similar proportions of (−)-hyoscine and (−)-hyosycamine.

Egyptian henbane, Hyosycamus muticus, has a much higher alkaloid content than H. niger, and although it has mainly been collected from the wild, especially from Egypt. The alkaloid content of the leaf is from 0.35% to 1.4%, of which about 90% is (−)-hyoscyamine.

Pharmacological Activity

Atropine and hyoscyamine have the same activity: they are parasympatholytics; hyoscyamine has a stronger activity than rasemic atropine, but it is the latter that is commonly prepared and used.

atropine compete with acetylcholine for the muscarinic site of the parasympathetic nervous system thus preventing the passage of nerve impulses, and are classified as anticholinergics
In the heart and after temporary bradycardia, atropine increases the heart rate by supressing vagal inhibition.

In the blood vessels, the effects on blood pressure are not marked (but with toxic doses, a vasodilatation of cutaneous capillaries is observed, especially on the face).

- In the smooth fibers, atropine induces relaxation and motor inhibition: it decreases intestinal tone as well as the amplitude and frequency of peristaltic contractions, paralyzes the ureters and blocks the bronchoconstricting effect of acetylcholine.

Secretions are effected: saliva, sweat, gastric, pancreatic, bronchial, and lachrymal secretions are all decreased (toxic doses inhibit sweat production and cause high fever).

- In the eyes, the alkaloid induces a passive mydriasis, by paralyzis of the sphincter pupillae.

In addition to the effects on the autonomic nervous system, atropine has effects resulting from its interaction with central muscarinic receptors. Toxic doses cause substantial excitation: agitation, disorientation, hallucinations, delirium, mental confusion and insomnia; at low doses, the action is less clear, and tends to be depressant and sedative.

**Scopolamine:**

The parasympatholytic activity of scopolamine is identical to that of atropine, but much less marked, especially on the myocardium. Its effects on the CNS are clear different: sedative, depressant, hypnotic, with amnesia. It potentiates neuroleptics and improves parkinsonism. Scopolamine also can be used against motion sickness. Also it has antispasmodic action on the gastrointestinal tract.