Alkaloids

Definition:-

- Alkaloids are natural compounds display an exceptionally wide array of biological activities and have a wide distribution, being present in plants, fungi, bacteria, insects, marine, animal and man.
- Many drugs and poisons are alkaloids and many are well-known, such as:-

  Morphine, codeine, strychnine, nicotine, and cocaine.

Distribution of alkaloids

- In the plants kingdom, the alkaloids appear to have a restricted distribution in certain families and genera.
- Among the angiosperms, the Apocyanaceae, Papaveraceae, Ranunculaceae, Rubiaceae, Solanaceae, and beberidaceae are outstanding for alkaloids-yielding plants.
- Although it has been claimed that monocotyledons do not produce alkaloids, investigation indicate that the Amarylidaceae and Liliaceae are two of the most promising families in which to search for alkaloids- yielding plants.

- Specific alkaloids are ordinarily confined to specific plant families (hyoscyamine in Solanaceae, colchicine in Liliaceae).
- There are an exception to this rule such as:-

1. Nicotine, which is found in a number of widely scattered plant families.
2. Ergot alkaloids in the fungus Claviceps pupurea

- Alkaloids may occur in various parts of the plants

1) In seeds (physostigma, areca).
2) In underground stems (sanguinaria).
3) In roots (belladonna root).
4) In rhizome and root (ipecac, hydrastic).
5) In barks (cinchona).
6) They also found in fungi (ergot).

Names of alkaloiods:-

1. From the generic name of the plant yielding them as atropine (Atropa belladona).
2. From the specific name of the plant yielding them as belladonine (Atropa belladona).

3. From the common name of the drug yielding them as ergotamine (Ergot).
4. From their physiologic activity as emetine (Ipecac causes emesis).
5. From the discoverer as pelletrine.

- A suffix is added sometimes to designate the alkaloids which are similar in structure but differ in their stereochemistry. For example quinine and quinidine.
- A prefix is added to designate alkaloids found in the same plant example hydroquinine.
- Alkaloids name should end with ine.

Classification of alkaloids

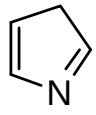
1. True alkaloids (characterized by a heterocyclic ring with a nitrogen atom and are derived from amino acid).
2. Proto alkaloids (characterized by absence of the heterocyclic ring but derived from amino acid).
3. Pseudo alkaloids (characterized by a heterocyclic ring with a nitrogen atom, but are not derived from amino acids) (steroidal alkaloids).

- In general the alkaloids are classified according to the chemical structure into two broad division:-

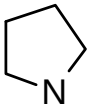
A. Non-hetrocyclic or a typical alkaloids or biological amines.

B. Hetrocyclic or typical alkaloids divided into 14 group according to their structure:-

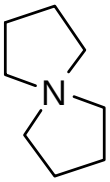
1. Pyrrol and pyrrolidine.
2. Pyrrolizidine.
3. Pyridine and piperidine.
4. Tropane.
5. Quinoline.
6. isoquinoline.
7. Aprophine.
8. norlupinane.
9. indole.
10. indolizidine.
11. imidazole.
12. purine.
13. Steroid.
14. Terpenoid.



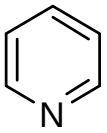
pyrrole



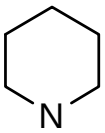
pyrrolidine



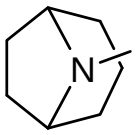
pyrrolizidine



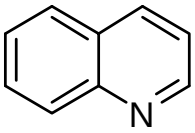
pyridine



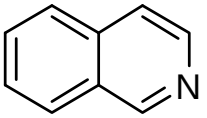
piperidine



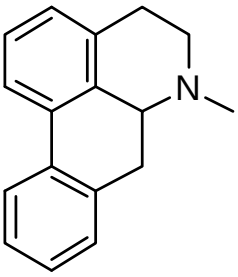
tropane



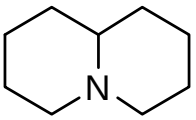
quinoline



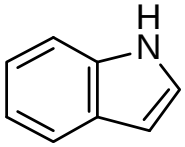
isoquinoline



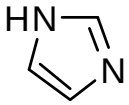
aporphine



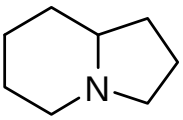
nor-lupinane



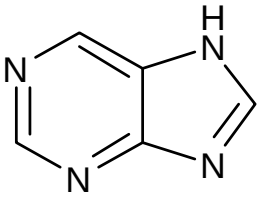
indole



imidazole



indolicidine



purine

You should know the skeletal type but not the individual structure

Alkaloids

Chemistry of alkaloids

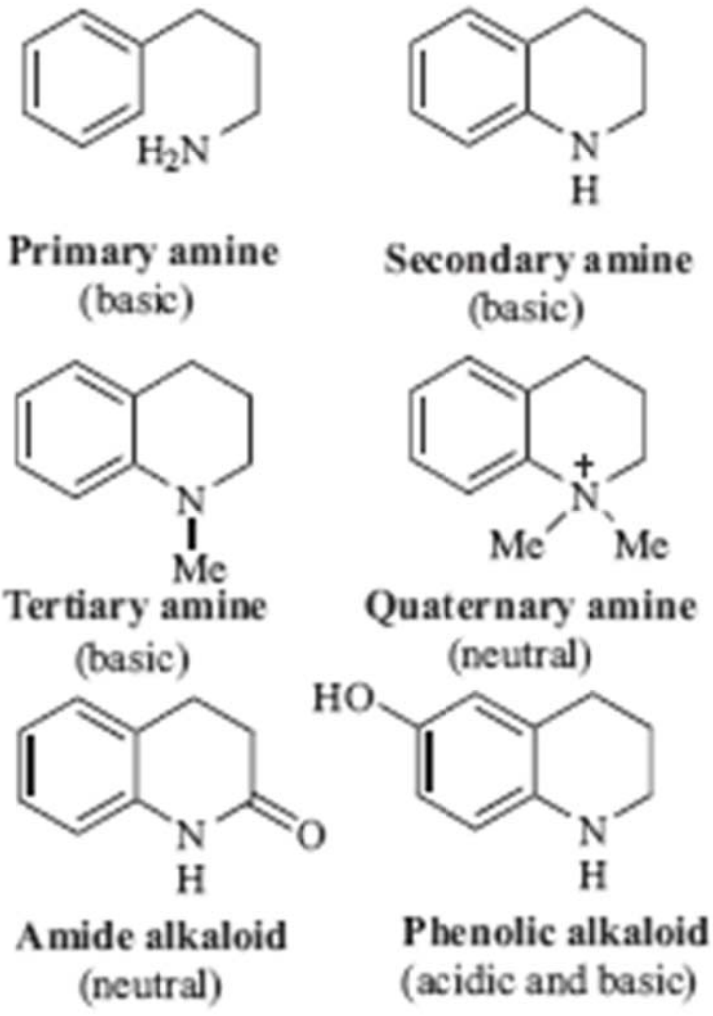
- Alkaloids are difficult to define because they are represented a non homogenous group of compounds.
- The term alkaloid is used to describe substances that had alkaline properities.
- Many alkaloids are indeed alkaline in nature as they possess either a primary, secondary or tertiary amine functional groups.
- The degree of basicity varies greatly depending on the structure of the molecule and the presence and location of other functional groups.
- the alkaloid are converted into their salts by aqueous mineral acids and when the salt of an alkaloids is treated with hydroxide ion nitrogen gives up hydrogen ion and the free amine is liberated.
- Alkaloid base + acid → alkaloid salt $+H_2O$
- Alkaloid salt + OH^- → Alkaloid base $+H_2O$

This property is useful in the extraction from plants.

- However, some alkaloids exist as quaternary amine salts in which a lone pair of electrons from the nitrogen atom is used to form a bond with another

group (e.g methyl), and therefore, a positive charge resides on the nitrogen making this group essentially neutral (neither basic nor acidic)

- Care must, therefore, be taken with the alkali or base definition of alkaloids as some are neutral, especially the amides, and some alkaloids possess phenolic groups which actually contribute to the acidity of the molecule.



- The quaternary ammonium compound have no proton to give up thus is not effected by hydroxide ion.
- For the most parts the alkaloids are insoluble or sparingly so in water, but the salts formed on reaction with acids are usually freely soluble.
- The free alkaloids are usually soluble in ether, chloroform, immiscible solvents, in which, however, the alkaloid salts are insoluble.
- This is important in the isolation, purification and quantitative estimation.
- Most of the alkaloids are crystalline solids, although a few are amorphous.
- An additional few, coniine, nicotine, and sparteine, which lack oxygen in their molecules, are liquids.
- Alkaloidal salts are crystalline, and their crystals are a useful means of rapid microscopic identification.
- **Here is some of the possibility of the function of alkaloids in plans and the reasons why they occur there:-**

1. Poisonous agents protecting the plants against insects and herbivores.
2. End products of detoxification reactions.
3. Regulatory growth factor.

4. Reserve substances capable of supplying nitrogen or other elements necessary to the plant's economy.

Identification of alkaloids

The alkaloids may precipitate from neutral or acidic solutions by a reagent.

These reagents include:-

1. Wagner's reagent (iodine in potassium iodide).
2. Mayer's reagent (potassium mercuric iodide).

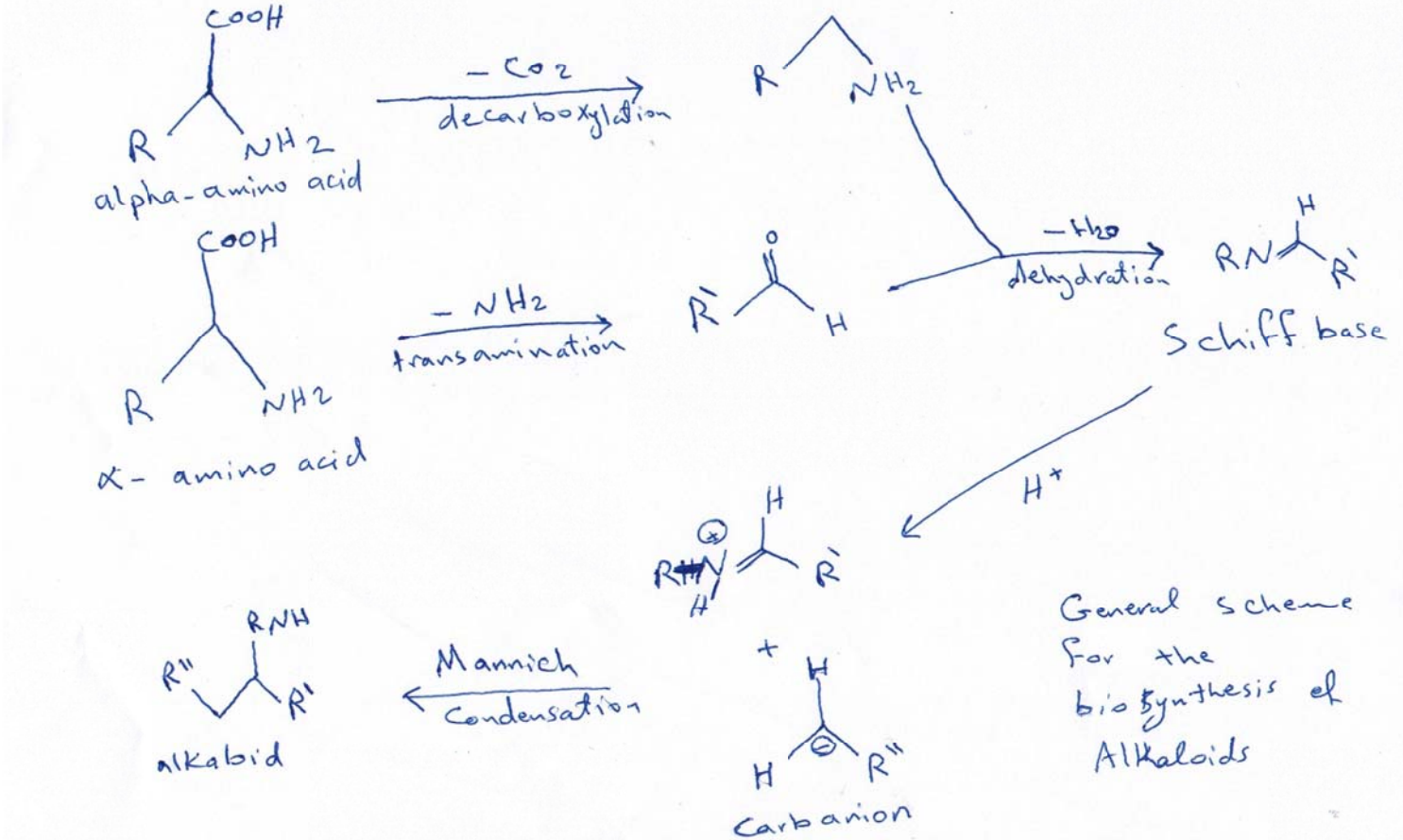
3- dragendroff's reagent (potassium bismuth iodide).

4- Some of the alkaloids did not give precipitate with these reagents like caffiene so we use a specific test (muroxide test).

Modern phytochemistry used TLC with a marker from standered alkaloids to detect the presence of alkaloids in plants.

Biosynthesis of alkaloids

- ❖ Shikimate and acetate pathways are the sources of amino acids which are the sources of alkaloids.
- ❖ In general alkaloids from by a Mannich like condensation between Schiff base (imine) and carbanion.


COOH
R
NH2
alpha-amino acid
− CO2
decarboxylation
R
NH2
− NH2
transamination
R'
H
O
−H2O
dehydration
RN
H
R'
Schiff base
COOH
R
NH2
α- amino acid
H+
H
R'
RNH
R''
R'
alkalid
Mannich
condensation
H
H
R''
Carbanion
General scheme for the biosynthesis of Alkaloids