الجامعة المستنصرية

كلية العلوم

قسم علوم الحياة

المرحلة الثالثة

فرع نبات

Plant secondary metabolism

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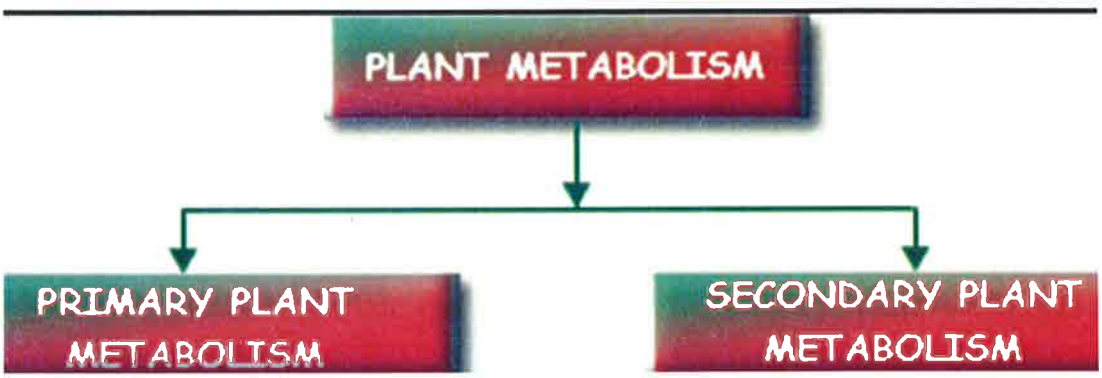
Introduction

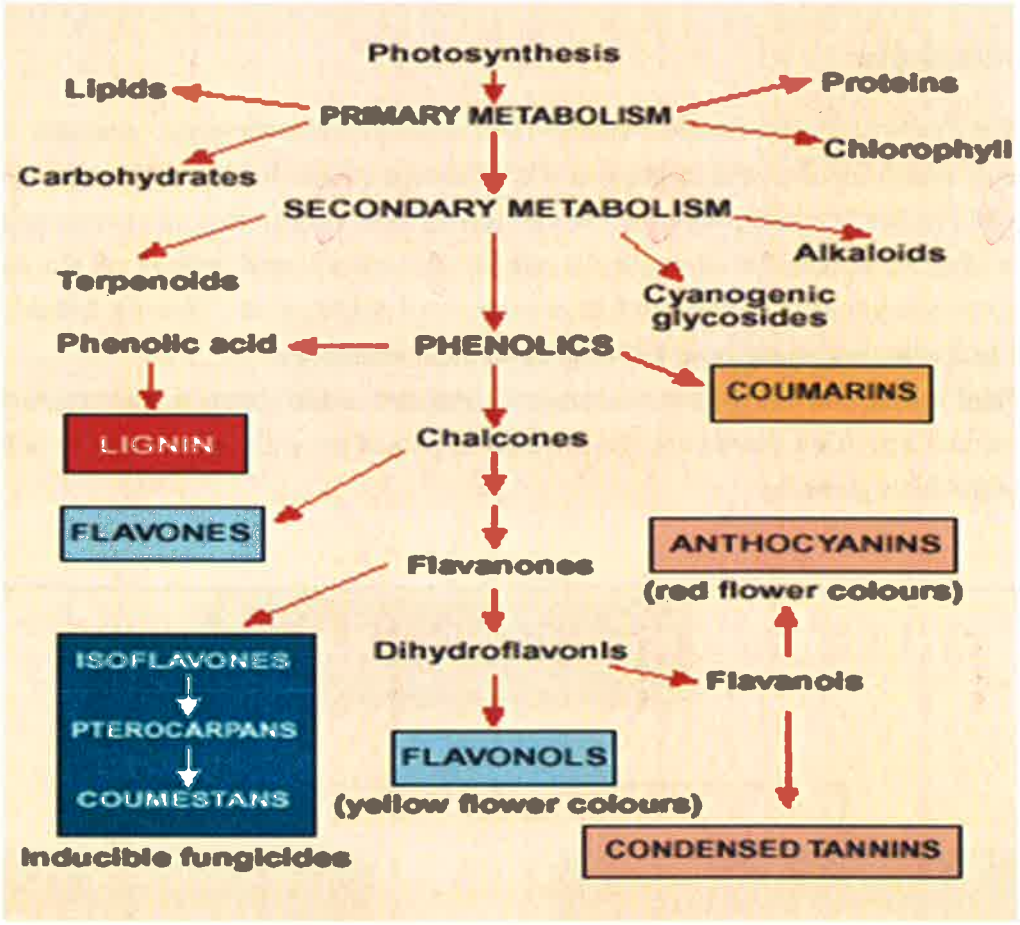
Metabolism: (Gr. Metabole = change) the totality of the chemical changes in living cells which involves the buildup and breakdown of chemical compounds. Metabolism is usually divided into two categories: catabolism, the *breaking down* of organic matter, for example, by cellular respiration, and anabolism, the *building up* of components of cells such as proteins and nucleic acids. Usually, breaking down releases energy and building up consumes energy.
Plant metabolism is the set of chemical reactions, which helps a plant to perform its own activities. Plants are the primary source of essential nutrients for billions of individuals globally.



- **Primary metabolites : are the compounds, which are commonly produced by all plants and are directly used by them for their growth , development and reproduction. It usually performs a physiological function in the organism using CO_2, H_2O, and NH_3 as starting material inall organisms .**
  Some common examples of primary metabolites include: lactic acid, amino acids, lipids, proteins, nucleic acids, and carbohydrates ect.

- **Secondary metabolism (also called specialized metabolism) is a term for pathways and small molecule products of metabolism that are not absolutely required for the survival of the organism are not directly involved in the normal growth, development, or reproduction. often play an important role in plant defense against herbivory and other interspecies, humans use secondary metabolites as medicines, flavorings, and recreational drugs. Examples terpenoids, , growth factors and alkaloids, Antibiotics such as streptomycin (Streptomycin, an important antibiotic drug produced by Streptomyces bacteria) and penicillin (Penicillin antibiotics were among the first medications to be effective against many bacterial infections caused by staphylococci and streptococci.) , Pigments such as delphinidin (also delphinidine) is an anthocyanidin , a primary plant**

pigment, and also an antioxidant Delphinidin gives blue hues to flowers in the genera *Viola* and *Delphinium*) .



*** Functions of secondary metabolic compounds.

- The product of secondary metabolism plays a vital role in interactions between plants and other organisms.
- They also play an ecological role in governing interactions between plants and other organisms.
- The product of secondary metabolism also helps in attracting pollinators, fruit and seed dispersers. These are because of their bright coloured pigments of flowers.
- Few toxic compounds, which are produced from secondary metabolism like nicotine, which helps the plant in protecting them from plant eating animals (herbivores) and also from the microbes.

- ALKALOIDS

Alkaloids are secondary metabolites a group of naturally occurring chemical compounds that mostly contain basic nitrogen ,alkaloids may also contain oxygen, carbon, hydrogen, sulfur. The name "alkaloids" (German: *Alkaloide*)

was introduced in 1819 by the German chemist Carl Friedrich and widely used in medicine, They can also be highly toxic, Alkaloids are produced by a large variety of organisms including bacteria, fungi, plants, and animals , have a wide range of pharmacological activities including antimalarial (e.g. quinine), antiasthma (e.g. ephedrine), anticancer (e.g. homoharringtonine).

Morphine : was the first alkaloid to be found. Morphine comes from the plant *Papaver sonniferum*, or the opium poppy, It is used as a pain reliever in patients with severe pain levels and cough suppressant.

Another example of an alkaloid is cocaine It can be highly dangerous and addictive. However, it has also been used as an anesthetic.

Perhaps the most loved and known alkaloid is caffeine. While we use it to stay alert, it has protective properties for the plants it comes from: cocoa, coffee and tea. Seedlings of the coffee plant have a high concentration of caffeine. The high concentration is toxic and protects the seedlings from insects that want to snack on it. Toxic caffeine levels also have another interesting defense mechanism. It prevents the germination of any other plants in the area. This is referred to as allelopathy. In humans, caffeine has also been thought to reduce the risk of diabetes and heart disease.

• Naming Of alkaloid

1- Many individual names are formed by adding the suffix "ine" to the species or genus name For example, atropine is isolated from the plant *Atropa belladonna.*
2- **If several alkaloids are extracted from one plant then their names often contain suffixes "idine", "anine", "aline", "inine" etc.**
3- **Naming alkaloids as the second Latin name the plant extract from him like Belladonine from belladonna.**
4- **Naming alkaloids according to the physiological effect (therapeutic) ex. Narcotic (Narcotine) , emetic (emetine).**
5- **Naming alkaloids according to the Discoverer ex. Pelletierine from pelletier.**

- ## Classifications Of alkaloid.

Alkaloids are often divided into the following major groups :

1- **"True alkaloids", which contain nitrogen in the heterocycle and originate from amino acids. Their characteristic examples are atropine, nicotine, and morphine. This group also includes some alkaloids that besides nitrogen heterocycle contain terpene (e.g., evonine) or peptide fragments (e.g. ergotamine[l]). This group also includes piperidine alkaloids coniine and coniceine although they do not originate from amino acids.**

2- **Protoalkaloids", which contain nitrogen and also originate from amino acids. Examples include mescaline, adrenaline and ephedrine.**

3- **Polyamine alkaloids – derivatives of putrescine, spermidine, and spermine.**

4- **Peptide and cyclopeptide alkaloids.**

5- **Pseudoalkaloids – alkaloid-like compounds that do not originate from amino acids. This group includes terpene-like and steroid-like alkaloids, as well as purine-like alkaloids such as caffeine, theobromine, theacrine and theophylline. Some authors classify as pseudoalkaloids such compounds such as ephedrine and cathinone. Those originate from the amino acid phenylalanine, but acquire their nitrogen atom not from the amino acid but through transamination.**

- ## Properties Of alkaloid

1- **Most alkaloids contain oxygen in their molecular structure.**

2- **Those compounds are usually colorless , crystals at ambient conditions.**

3- **Oxygen-free alkaloids, such as nicotine or coniine.**

4- **Some alkaloids are colored, like berberine (yellow) and sanguinarine (orange)**

5- **Most alkaloids are weak bases, but some, such as theobromine and theophylline, are amphoteric.**

6- **Many alkaloids dissolve poorly in water but readily dissolve in organic solvents, such as diethyl ether, chloroform.**

7- **Most alkaloids have a bitter taste or are poisonous when ingested.**