Glycosides

Anthracenes

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with grateful acknowledgement for inspirational teaching received at
The School of Pharmacy, University of London

Glycosides

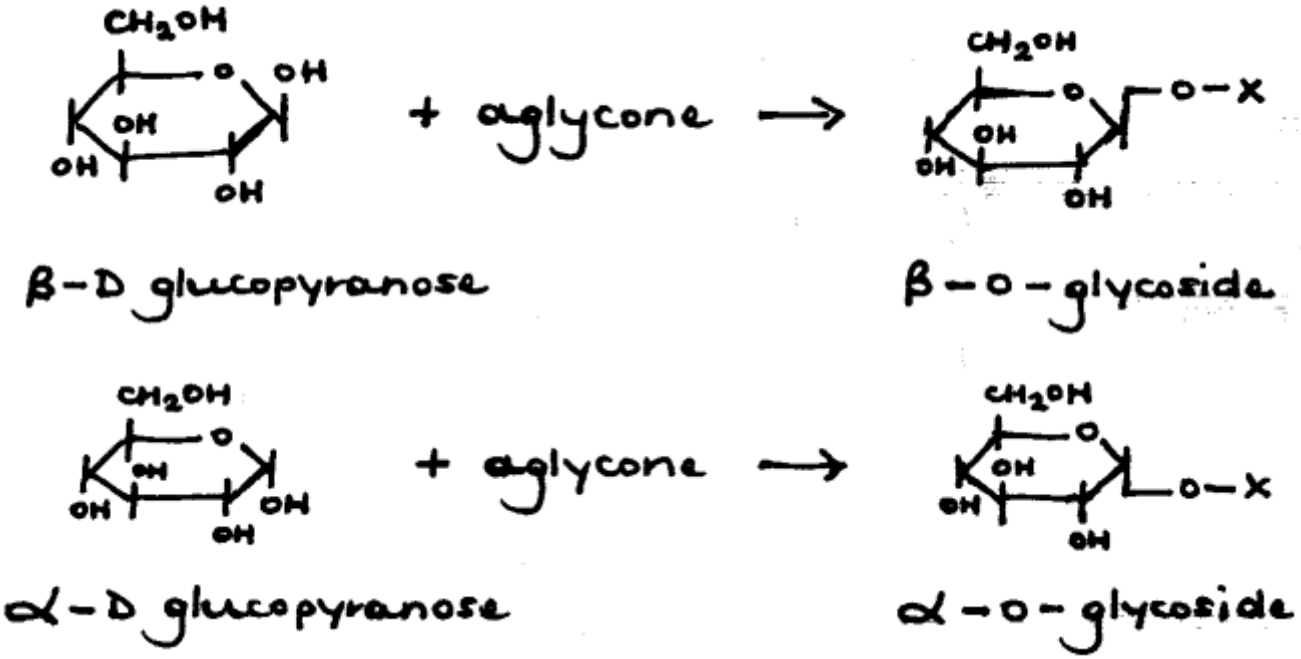
- more important in medicine than a lot of drugs
- occur in higher plant tissues in very small amounts
- also fungal and bacterial cells (exuded in medium) and animals
- formed by a biochemical reaction that makes a water insoluble compound more polar than a water soluble molecule
- hence can be removed from an organic system
- man forms them in the liver as part of the process of detoxification and they are excreted via urine
- mammalian glycosides are simple compounds whereas plant glycosides are much larger and chemically more complex

- higher plant glycosides used therapeutically
- have a bio-action
  - therapeutic in low doses, toxic in excess
  - ie have a narrow therapeutic index

- Glycosides =
  - aglycone / ‘genin’ - hydrocarbon part
  - + glycone - sugar part (water solubility)

- Ether linked:
  - X-OH + R-OH ↔ X-O-R + H_20 (glycosidic bond)
  - unstable
  - susceptible to hydrolysis (dilute acid, enzymes)

- important to determine which isomer has the activity
  - α or β glycosidal bond from an α or β pyranose sugar ring



  - natural glycosides tend to have β-linkage
  - acid hydrolysis to cleave α or β glycosides
  - identify component part of molecule
  - check stereochemistry with β-glucosidase

- Sugars vary
  - glucose, rhamnose, xylose, etc
  - simple mono- to 2-12 unit polysaccharides
  - can be branched

- (To determine non-linear linkages)
  - acetylate or methylate the sugar
  - above taken up by all free –OH groups
  - hydrolyse – determine by NMR technique

- Other possible linkages
  - direct C-C eg aloes of cascara
    - resistant to hydrolysis
    - oxidise C link with ferric chloride and split bond
  - S-linked eg in spices giving hotness, mustards
    - aglycones must have S-H in it to link up
    - v unstable – breakdown and liberate oil of mustard (pungent)
  - N-linked eg antitumour drugs (can straddle DNA strands)
    - sugar OH + NH aglycone -> R-N-X -> the nucleic acid
    - (ribose based link is N-glycosidal bond)

Classification

- On the basis of aglycone structure
- [1] Saponins (soaps)
  - aglycone = trans-linked steroid
- [2] Cardiac glycosides (poisons)
  - from squill, digitalis, lily of the valley
  - used as crow poisons through history
  - aglycone = cis-linked steroid
- [3] Anthracene derivatives (purgatives)
  - also poisons, cause inconvenience not death
- [4] Flavenoids and coumarins
  - yellow or orange coloured
  - phenolic compounds with aromatic rings

- (a) Flavenoids
  - mainly anti-inflammatory drugs, cyclooxygenase inhibitors
  - inhibit inflammatory mediators (prostaglandins)
- (b) Coumarins
  - eg from clover - basis of anticoagulants

- [5] Simple phenols
  - from willow and poplar bark
  - analgesics – aspirin
- [6] Mustard oils
  - S-linked compounds
- [7] Cyanogenic compounds
  - breakdown liberating CN
  - found in ‘cherry’ bark and kernel
  - also liberate benzaldehyde on breakdown (almond smell)

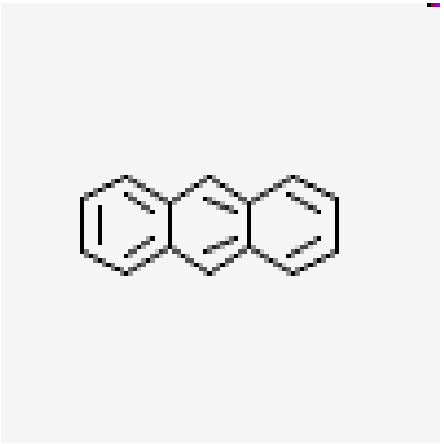
Preparation & extraction

- Polar substances – soluble in polar solvents
- Extraction:
  - starting material should be well dried and carefully stored
    - enzymes will decompose glycosides if >10% water content remaining
  - cold extraction procedure (room temp)
    - with percolation and maceration
  - water, water/alcohol mixture or alcohol
    - depending on mol wt

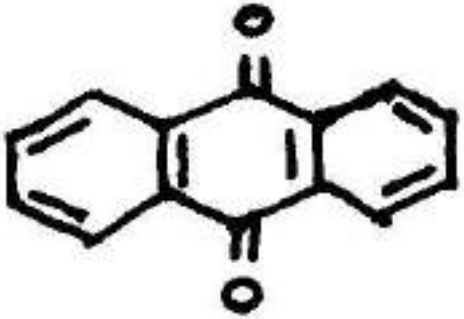
- Purification:
  - solvent/solvent partition
    - H_2O/hexane or CH_3Cl to remove pigments in the non-polar phase
  - or adsorption methods
    - make column and do chromatography
    - or mix with adsorbants (Celite, Fuller's Earth, graphite)
    - or use heavy metal to precipitate out impurities
  - should end up with clear (or coloured) alcoholic extract
  - crystallisation – final stage

Anthracene glycosides

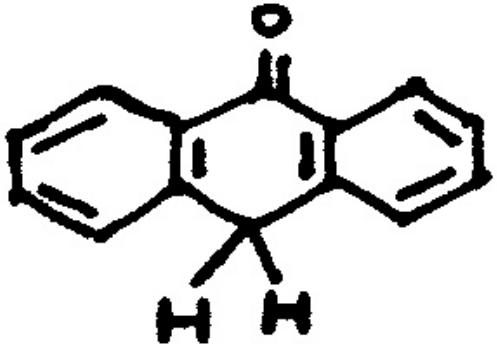
- purgative principles
- found in several plant drugs
- occur in glycoside form
  - and less commonly in aglycone form
  - free aglycones have to be removed in assay because inactive
- 2-3%w/w (both forms)
- based on anthracene molecule



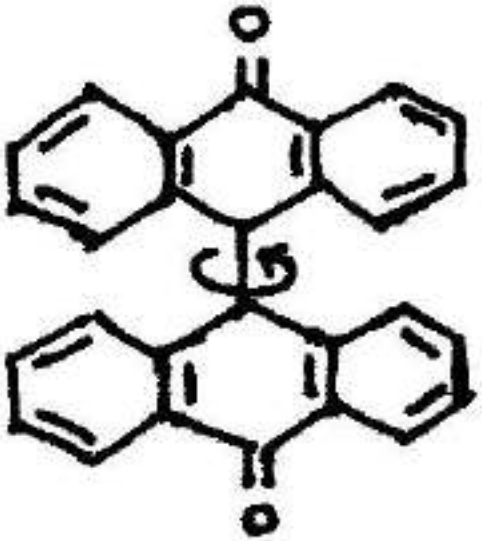
- 3 oxygenated or substituted forms of the anthracene molecule exist



Anthraquinone
(most common)



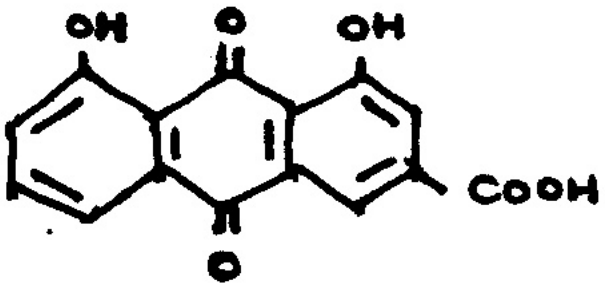
Anthrone (reduced
form occurring in plant)



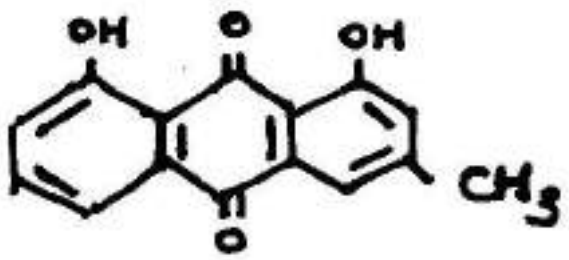
Dianthrone
(reduced dimer)

  - all flat, planar structures
    - has to be free rotation at dimer join for potency
    - flat molecule can get into gut mucosa and irritate eventually causing peristalsis

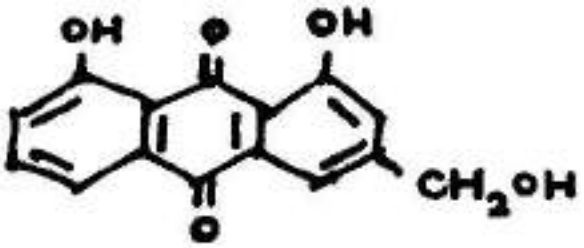
- 4 aglycone structures
  - all existing in any of the 3 forms
  - phenolic group is the irritant principle



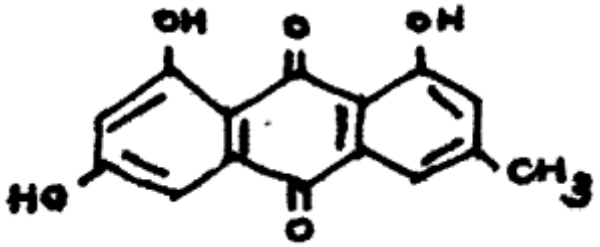
Rhein anthraquinone



Chrysophanol



Aloe-emodin

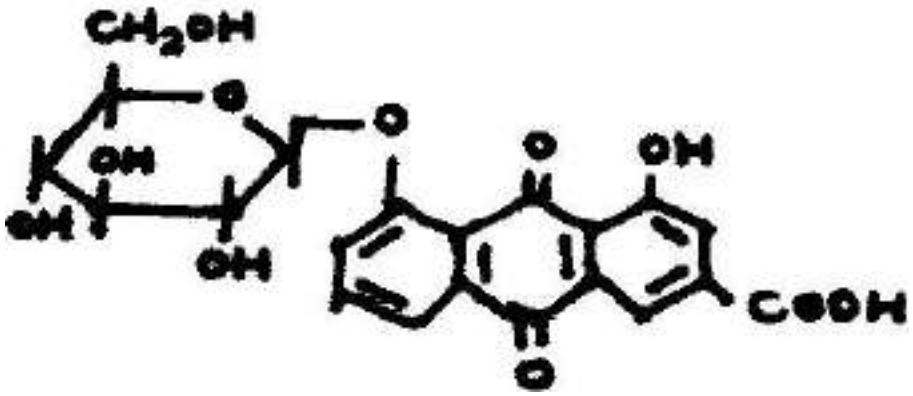


Emodin

- biologically active part is the glycoside
    - tend to have simple sugars attached

[1] monoglucoside at C8

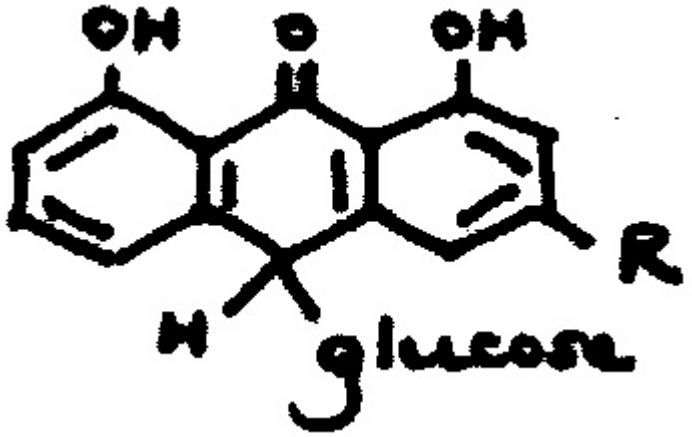
- O-linked



[2] diglucoside at C1 andC8

[3] ‘C’- glycosides

- have a direct C linkage – aloins



* resistant to hydrolysis (need to use ferric chloride)

[4] ‘CO’-glycosides

- O-linked at 1 and 8
- C linked as in aloins

- all types combined to give complex mixture in the plant
- assays different since each compound has different purgative potency

Extraction

- most quite polar
  - due to phenols and sugars
- water|alcohol or mixtures of them used

- dried plant material percolation in industrial columns with dilute alcohol
- tincture produced
- partitioned with chloroform|ether to clean up (remove green pigment, fats, lipids)
- clean yellow tincture subjected to column chromatography
- gradual elution of individual glycosides
- crystallised for purity

- pure glycoside makes expensive products
- cheaper to
  - use a clean tincture to make a dry extract
  - used for granules in tablets
  - standardise final tablet

- Identification:
  - easy – coloured orange-yellow
  - chemical test: Borntrager's test
  - in alkali (KOH, NH_3) phenolic groups -> phenate complex (bright red)
  - TLC using silica gel – plates do not have to be sprayed since yellow but can confirm with KOH (red spot)
  - mass spectrometry

Mechanism of action

- Molecules have to possess certain features for activity:
  - [1] glycosides
  - [2] carbonyl keto function on centre ring
  - [3] 1,-8- positions have to have –OH
- Potency:
  - anthrone > anthraquinone> dianthrone
- Aglycones not therapeutically active in animals – lipid soluble – absorbed in stomach and never reach colon to produce a local effect

- Highly active phenolic group irritant to mucosa
- Glycosides very water soluble – reach large intestine where they are hydrolysed by *E.coli* enzymes – become lipid soluble – absorbed into circulation – on way through gut wall disturb Aubach nerve plexus causing smooth muscle to contract – peristalsis
- 5-8 hours to act
  - take night before
  - in low doses – drug metabolised by liver and recirculated via bile to give more effect
  - people esp elderly can become reliant on them needing higher dose to produce an effect
  - carcinogenic – melanosis coli

Assay

- Isolating each active component too expensive
  - powdered plant material (tablets or capsules)
  - or aqueous (fluid) extracts used
- Difficult – each component in mixture has different potency
- Safest assay is:

[i] biological assay of dry material

  - wet faeces method – cage full of mice or rats on a grid with collecting tray below – feed eg senna in food – collect faeces and weigh – calculate ED_{50} – oral dose in food correlating to faeces produced

[ii] chemical assay

- spectroscopy – quick and cheap, more accurate but gives same emphasis to each compound

- To remove aglycones
  - make an extract, shake with ether
    - discard ether phase containing free aglycones
  - then acid hydrolyse aqueous phase containing glycosides
    - with ferric chloride for direct C- bonds
    - and with dilute HCl
  - extract in $CHCl_3$
    - gives aglycones from glycosides
  - colour with magnesium acetate
    - then measure on spectrophotometer peak 515nm
  - OR do colourimetric assay – red in alkali - 250nm

Senna

- *Cassia angustifolia*
  - Tinnevelly (India)
- *Cassia acutifolia*
  - Alexandria (Egypt)
- (Leguminosae)
- dry pods, leaves or mixture used
- tablet form
  - eg sennakot
  - (isolation of anthraquinone too expensive)
- kinder action - <u>use</u>
  - pregnant women
  - iron constipation
- activity & content same

Chemical constituents:

(i) 1 and 1,8 ‘O’ glucosides

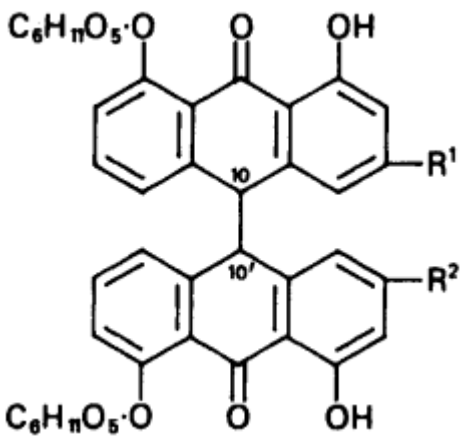
= 1st series glycosides

aglycones: rhein, aloe emodin

(ii) dimeric dianthrones

= 2nd series

reduced products



	R^1	R^2	10–10′
Sennoside A	COOH	COOH	*trans*
Sennoside B	COOH	COOH	*meso*
Sennoside C	CH_2OH	COOH	*trans*
Sennoside D	CH_2OH	COOH	*meso*
Aloe-emodin-dianthrone-diglucoside	CH_2OH	CH_2OH	*trans*
Aloe-emodin-dianthrone-diglucoside	CH_2OH	CH_2OH	*meso*

dimer can be split into two parts with $FeCl_3$ hydrolysis and monomer aglycones assayed for

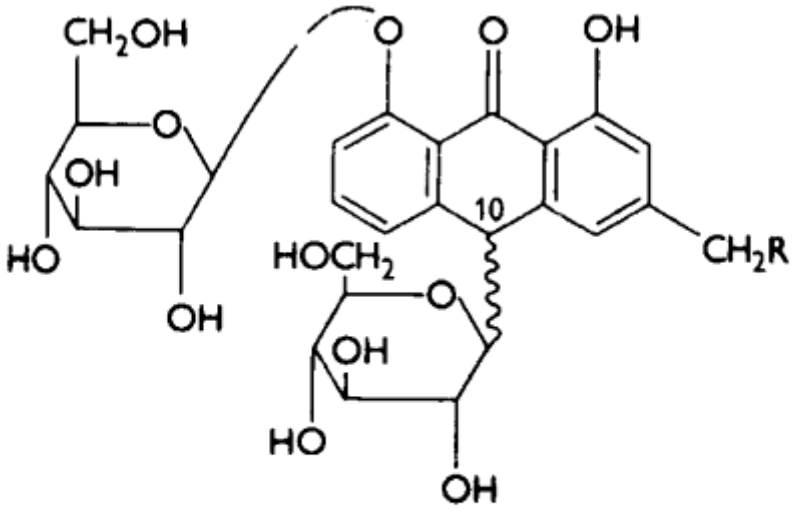
Cascara

- *Rhamnus pershiana* (Rhamnaceae)
- bark extract
  - collected, dried and stored for 12 months (↓ anthraquinone content -> less toxic)
- modern substance
  - discovered 100 years ago
  - Rocky Mtns, W.Coast, US
- more violent purgative
  - griping action
  - harder to eliminate
- Use: night before to clear bowels for x-rays and barium meal

Chemical constituents:

(i) 4 primary glycosides

- O- and C- linkages



Cascarosides of *Rhamnus purshianus*,
Configurations; Cascaroside A = 10β, R = OH; B = 10α, R = OH;
C = 10β, R = H; D = 10α, R = H.

To get aglycones $FeCl_3$

To get aloins oxidise with acid

(ii) C-glycosides - two aloins

- barbaloin – derived from aloe-emodin
- chrysaloin – derived from chrysophanol

(iii) a number of O-glycosides

- derived from emodin oxanthrone, aloe-emodin, chrysophanol

(iv) various dianthrones

- incl. emodin, aloe-emodin, chrysophanol, herterodianthrones palmidin A B C

(v) aloe-emodin, chrysophanol, emodin in free state

Rhubarb

Aloes

INTRODUCTION TO COSMECEUTICALS

The concept of beauty and cosmetics dates back to ancient mankind and civilization. Generally herbal cosmetics are also referred to as natural cosmetics. Plants are highly used for development of new drug products for cosmeceuticals and pharmaceutical applications. Herbal cosmetics are the products in which herbs are used in crude or extract form.

Herbal cosmetics are formulated, using different cosmetic ingredients to form the base in which one or more herbal ingredients are used to cure various skin ailments. The name itself suggests that herbal cosmetics are natural and free from all the harmful synthetic chemicals which otherwise may prove to be toxic to the skin. Compared to other beauty products, natural cosmetics are safe to use. Cosmeceuticals are cosmetic-pharmaceutical hybrid products intended to improve the health and beauty of the skin by providing a specific result, ranging from *acne-control* and *anti-wrinkle* effects, to sun protection.

Cosmeceuticals have medicinal benefits which affect the biological functioning of skin depending upon type of functional ingredients they contain. These are cosmetic products that are not just used for beautification but for different skin ailments. These products improve the functioning/texture of the skin by boosting collagen growth by eradicating harmful effects of free radicals, maintains keratin structure in good condition and making the skin healthier.

There are numerous herbs available naturally having different uses in cosmetic preparations for skincare, hair care and as antioxidants.

Advantages of Herbal Cosmetics over Synthetic:

Herbal cosmetics are the modern trend in the field of beauty and fashion. These agents are gaining popularity as nowadays, mostly women prefer natural products over chemicals for their personal care to enhance their beauty.

Following are some of the advantages of using natural cosmetics which make them a better choice over the synthetic ones:

- Safe to use
- Compatible with all skin types
- Available at low cost
- Not tested on animals
- No side effects

Herbs Used in Cosmetics/Cosmeceuticals: There are numerous herbs available, naturally having different uses in cosmetic preparations for skincare, hair care and as antioxidants, fragrant etc. Some of the important examples are as follows:

1. **SKIN CARE: & ANTIAGING:** Coconut oil, Sunflower oil, Jojoba oil, Olive oil, Carrot, Gingko, Green tea, Jasmine, Lavender, Ocimum, Badam, *Turmeric, Aloe*, *bitter orange peel, sandal wood.*

2. **HAIR CARE:** *Henna, Amla, Soap nut (Sapindus), Shikakai (Acacia sinuata), Calendula, Safflower, Centella, Fenugreek*

3. **ANTIOXIDANTS:** Tamarind, Vitamin C & E.

1. ALOE

Common name: Indian Aloe, Kumaari, Moosaambaram (dried juice).

Biological Source: Aloe is the dried juice collected by incision, from the bases of the leaves of various species of Aloe. *Aloe perryi* Baker, *Aloe vera* Linn or *Aloe barbadensis* Mil and *Aloe ferox* Miller.,belonging to family Liliaceae.

Active part: leaf gel

Chemistry:

The aloe gel composed of water (99%), mono and polysaccharides 25% of the dry weight of the gel. The prominent monosaccharide in the gel is mannose-6-phosphate and the most common polysaccharides are glucomannans. It also contains lignin, salicylic acid, saponins, sterols, tri terpenoids and vitamins like A, C, E, B_{12}, thiamine, niacin and folic acid as well as the minerals sodium, potassium, calcium, magnesium, manganese, copper, zinc, chromium, iron, sulphur and germanium. It also contains enzymes such as bradykinsae, glutathione peroxidise and superoxide dismutase. The amino acids present in aloe gel, alanine, arginine, aspartic acid, glutamic acid, glycine, cysteine, hydroxyl proline, leucine, isoleucine, histdine, lysine, phenyl alanine, methinine, serine, tyrosine, proline and valine.

Cosmeceutical uses:

Aloe plants have been used therapeutically, since 1750 B.C. and use of gel has been increased dramatically in the field of health care and cosmetics. Aloe vera is considered as a Cosmeceutical herb i.e. a blend of cosmetic and pharmaceutical product. The gel from its leaves finds a wide range of cosmetic and therapeutical applications which include anti-wrinkle creams, moisturizers, sunscreens, hair care products. Aloe gel has been added to shampoos, bubble baths, after-sun lotions, burn relief products, local antiseptic products, sun screen products, dry skin lotions, hydrocortisone preparations and antifungal liquids.

Therapeutically aloe gel used as wound healing agent, has the ability to cure thermal and radiation burns, anti inflammatory, it protects the skin form radiation, it can control the levels of glucose in blood circulation.

Aloe is a most ingenious mixture of an antibiotic, an astringent coagulating agent, a pain inhibitor and a growth stimulator (also called a "wound hormone"), whose function is to accelerate the healing of injured surfaces. It is used for pain relief and healing of 'hemorrhoids, applied externally and internally it’s also used for sunburn, scratch and a cleansing purge for the body or skin. It is an aid to growing new tissue and alleviating the advance of skin cancer caused by the sun.

2. RED SANDAL:

Common name: Red Sandalwood, Raktachandana.

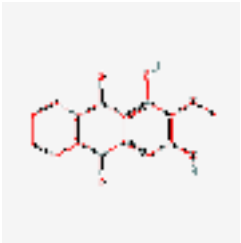
Active part: heart wood

Biological source: The heartwood of red sandalwood tree or Red Sanders (*Pterocarpus santalinus* Linn.family-leguminosae) also known as ruby wood, sanders red, saunder wood, santalwood, raktha chandana, is used as an ingredient in Ayurvedic medicines to support the management of inflammatory conditions and to improve skin health.

When included in traditional cosmetic formulations with turmeric, it imparts a healthy glow to the skin. It has also been used as talcum powder traditionally. The powdered heartwood has a pleasant aroma and an attractive red color. Ayurvedic literature also describes the "cooling" properties of raktha chandana.

Chemistry:

The principal red pigments in red sandal heartwood are santalin A and B, and these are soluble in organic solvents and alkalis, but not in water. Red sandalwood extract was found to be stable when tested for colour stability as 1% solution in Ethanol.



Santalin

Cosmeceutical and Nutricosmetic Applications:

Red sandal has been traditionally used with fish products in Europe and more recent applications include the colouring of seafood sauces, meat products, breadcrumbs and alcoholic drinks. In India, it has played a traditional role in medicine as an astringent, and for the treatment of gastric and skin disorders.

Red sandalwood was employed in the past for dyeing wool, cotton and leather and for wood staining. The extract can be used as a natural colour in various nutricosmetic and cosmetic preparations with the added benefit of antioxidant potential. In traditional "cosmeceutical" use, raktha chandana is ground to a paste with water or honey, and applied topically as a popular home remedy used in southern India, for lightening post-acne and other facial scars. Its antioxidant, anti-inflammatory and hepatoprotective effects are reported in literature. The extract was found to facilitate wound healing in a preliminary clinical study.

Natural Dye Red Sandalwood's natural dye, Santalin, is used as colorant in food, alcoholic beverages, wood polish, metal varnish, textiles, wool, silk, leather, jute, dye for Skin (Sun-tan), hair dye, medicines, tablet coating colorant, and as dye for dye sensitized solar cells. It is also an effective colour additive to body powders and scrubs.

It is an astringent and a cooling agent and is used in several skin care preparations. It is used in the treatment of pimples, acne, wrinkles etc. Red Sandalwood is used in soaps as an ingredient which can be added at first trace to produce a mottled light brown soap that is an excellent exfoliates.

Since this extract is stable in alkaline medium, it can be conveniently used in soaps for its gorgeous deep purplish rose colour. Similarly red sandalwood extract can be added to lipstick, and colour cosmetic compositions to impart colour and a healthy glow to the skin.

3. TURMERIC

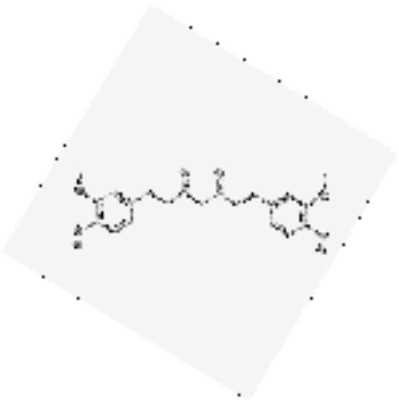
Common name: Saffron Indian; haldi (Hindi); Curcuma; Rhizoma curcumae

Biological Source: Turmeric is the dried rhizome of *Curcuma longa* Linn. (syn.*C. domestica* Valeton)., belonging to family Zingiberaceae.

Active part: Rhizome

Chemistry:

Turmeric contains yellow colouring matter called as curcuminoids (5%) and essential oil (6%). The chief constituent of the colouring matter is curcumin I (60%) in addition with small quantities of curcumin III, curcumin II and dihydrocurcumin.



Tetrahydro curcumin

The volatile oil contains mono- and sesquiterpenes like zingiberene (25%), α-phellandrene, sabinene, turmerone, arturmerone, borneol, and cineole. Choleretic action of the essential oil is attributed to b-tolylmethyl carbinol.

The volatile oil also contains α- and beta-pinene, camphene, limonene, terpinene, terpinolene, caryophyllene, linalool, isoborneol, camphor, eugenol, curdione, curzerenone, curlone, AR-curcumenes, beta-curcumene, g-curcumene.α- and beta-turmerones, and curzerenone.

Curcumin is the phytochemical that gives a yellow color to turmeric and is now recognized as being responsible for most of the therapeutic effects.

Cosmeceutical uses:

Uses of turmeric include antiseptic, analgesic, anti-inflammatory, antioxidant, antimalarial, insect-repellent, and other activities associated to turmeric. Turmeric is widely used as dietary pigment and spice, and has been traditionally used for the treatment of inflammation, skin wounds, and hepatic disorders in Ayurvedic, Unani, and Chinese medicine. The topical application of turmeric is used to improve skin trouble like chronic ultraviolet B irradiation. Curcumin's cholesterol-lowering actions include interfering with intestinal cholesterol uptake, increasing the conversion of cholesterol into bile acids and increasing the excretion of bile acids via its choleretic effects.

It has the potential against various cancer, diabetes, allergies, arthritis, Alzheimer's disease and other chronic and hard curable diseases. in the world, the biggest users of turmeric are India. India is also major producer of turmeric and used in cosmetic products for skin care and hair care.

The skin is the main portion of the body and provides a shielding barrier against harmful chemicals, microbes, and UV radiation. Natural plants like turmeric has been formulated heal and prevent dry skin, treat skin conditions such as eczema and retarded the aging process. Turmeric is used in many celebrations of Hindus; especially in Hindu wedding brides would rub with turmeric on their bodies for glowing look. New born babies also rubbed with turmeric on their forehead for good luck. Traditionally women rub turmeric on their cheeks to produce a natural golden glow, extract of turmeric has been added to creams for use as a colouring gent. Washing with turmeric powder improves skin complexion and also reduces hair growth on body.

Now a days there are lots of herbal products in the market in which main herb used is turmeric as natural ingredient. Natural cleansers like milk with turmeric powder are effective natural cosmetics in themselves; it brings a healthy glow to the skin and makes them beautiful. They also help to restore on maintain yongness by controlling wrinkles on the surface of the skin. A fresh juice from turmeric rhizome, a paste prepared and its decoction is often used as a local application as well as internally in the treatment of leprosy skin disease. In case of smallpox and chickenpox turmeric is applied as a powder or as a paste to facilitate the process of scabbing.

4. BITTER ORANGE PEEL

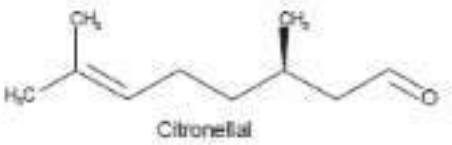
Common name: Sweet Orange, Narinja.

Kamala Pandu (Telugu), Kichili Pazham (Tamil), Kittale (Kannada),

Biological Sources: The orange peel is the fresh or dried outer part of the pericarp of *Citrus aurantium* Linn, belonging to family Rutaceae.

Chemistry:

Bitter orange peel contains of 1 to 2.5% volatile oil. The principle component of volatile oil is 90% limonene and small quantities of aldehydes citral, citronellal, bitter amorphous glycoside like aurantiamarin and its acid; hesperidin, isohesperidin, vitamin C, and Pectin.



Citronellal

Therapeutical uses: Bitter orange was found therapeutically effective in application of various diseases such as;

- It aid in digestion and relieves flatulence.
- Cardiovascular health.
- Anti-Cancer.
- Treatment of Stroke.
- An antianxiety and sedative

The essential oil of *C. aurantium* contains linalool and the fragrant substance limonene has antianxiety and sedative effects. Antidepressant Synephrine-rich *Citrus aurantium* extracts have antidepressant effects.

Cosmetic uses:

It has reported used in cosmetic related products such like sunless tanning, conditioner, bar soap, shampoo, makeup remover, exfoliate/scrub, blush, mask, facial cleanser. Bitter orange peel extract is classed as a biological product and is used as a miscellaneous skin-conditioning agent as well as a fragrance ingredient.

Delicious and juicy, oranges have always been a favourite among the fruits. They symbolize health and happiness. The color orange itself is vibrant and inspiring. Orange can be an important part of that diet. It's often said that "you are what you eat" and this is particularly true in the case of oranges. We can incorporate the goodness of oranges both in our diet as well as topical application on our skin.

Skin Benefits

Being an excellent source of vitamin C, orange can do wonders for your skin. Apart from the fruit itself, orange juice and even orange peels can provide a range of benefits to your skin. Thus, consumption as well as topical application of this fruit can be beneficial for your skin in the following ways.

- Treatment of dark spots and blemishes
- Treatment of acne
- Skin whitening qualities
- Great toner
- Rejuvenates dull skin

Hair benefits

Besides being great for skin, orange peel contains certain vital nutrients which strengthen your hair. This fruit can be beneficial for hair in the following ways.

- Excellent conditioner
- Stimulates hair Growth
- Treatment of dandruff

5. AMLA

Active part: fruit

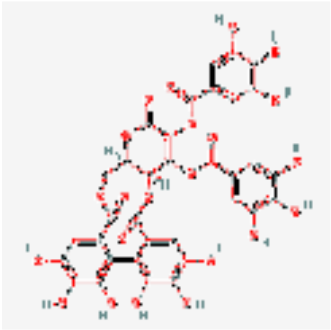
Common names: Emblica, Indian goose berry, amla, Nellikkaai, Nelli.

Biological source: This consists of dried, as well as fresh fruits of the plant *Emblica officinalis* Gaerth (*Phyllanthus emblica* Linn.), belonging to family Euphorbiaceae.

It grows throughout India and bears an edible fruit. This fruit is highly prized both for its high vitamin C content and for the precious oil, which is extracted from its seeds and pulp.

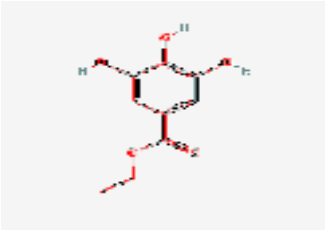
Chemistry:

Amla is one of the most extensively studied plant. Reports suggest that it contains tannins, alkaloids and phenols. Fruits have 28% of the total tannins distributed in the whole plant. The fruit contains two hydrolysable tannins Emblicanin A and B, which have antioxidant properties; one on hydrolysis gives gallic acid, ellagic acid and glucose wherein the other gives ellagic acid and glucose respectively.



Emblicanin A

The fruit also contains Phyllemblin. Activity directed fractionation revealed the presence of several phytochemicals like gallic acid, corilagin, furosin and geraniin. Flavonoids like quercetin, alkaloids like phyllantine and phyllantidine are found. Along with these, it primarily contains amino acids, carbohydrates and other compounds. Its fruit juice contains the highest concentration of vitamin-C (478.56mg/100mL). Vitamin C levels are more than those in oranges, tangerines and lemons.



Phyllemblin

Cosmeceutical uses:

Ayurveda, Siddha, Unani systems of India, Tibetan, Sri Lankan and Chinese systems of medicine utilizes amla for a variety of ailments. It is considered as rasayana (rejuvenator) and used in delaying the degenerative processes.

Hair tonic:

Enriches hair growth and pigmentation. Dried fruit boiled in coconut oil till solid matter becomes charres, prevents greying. The water in which dried amla pieces are soaked overnight is also nourishing to hair. This water should be used for the last rinse while washing the hair.

Ageing: Revitalizing effects. Prevent ageing and maintains strength in old age. Improves body resistance, strengthens heart, hair and glands of body. Rejuvenating effect on all organs. It is said that the great ancient sage Muni Chyawan rejuvenated himself in his late 70s and regained his virility by the use of amla.

Other home remedies:

- Anti-ageing-Fresh amla fruit has revitalizing effect on the body as it contains several nutrients and helps in preserving the stamina in aged people.
- Treats white spots on the nails- As a source of Vitamin C, serves as an effective remedy in vitamin deficit condition. Addition of Amla juice/powder in diet overcomes this condition.
- Promotes hair growth- Dried amla fruits are boiled in coconut oil and then ground to form amla oil. This is a very effective conditioner and prevents balding and greying of hair. For oily hair, mix half a cup of Amla juice, half a cup of lime juice and some water. Apply this to make an anti-grease hair wash.
- Natural eye tonic- Fresh Amla juice or dried Amla capsules are a good supplement to improve near-sightedness, cataract and glaucoma. It reduces intra ocular tension and corrects the vision.
- Treats hypertension High vitamin-C helps control blood pressure. Amla choorna (powder) or in the form of triphala tablets or decoction. Triphala, a combination of amla and two other herbs is an excellent medication for high blood pressure.
- Stabilizer of blood sugar - Amla seeds or dried amla powder in the form of capsules with bitter gourd juice daily.
- Natural cholesterol remedy It strengthens the heart muscles and causes a significant decrease in total cholesterol, LDL cholesterol, VLDL cholesterol and triglycerides. A 500 mg capsule of dried Amla powder can be added to your daily routine after consulting with doctor.

Therapeutically it has anti oxidant, as immunity booster, anti diabetic, anti hypertensive properties.

6. HENNA:

Common name: Mehndi.

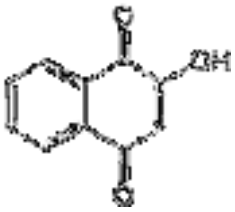
Active part: leaf

Biological source: it consists of dried leaves of *Lawsonia inermis* Linn.belonging to family *Lythraceae.*

It is a biennial dicotyledonous herbaceous shrub. A native of North Africa and South-West Asia, the plant is now widely cultivated throughout the tropics as an ornamental and dye plant.

Chemistry:

The principal colouring matter of henna is lawsone, 2- hydroxy-1:4 napthaquinone. Lawsone is a constituent of primary glycosides in henna leaves called hennosides A, B, and C and can be obtained from them after degradation and autoxidation. Lawsone, a quinone, dissolves rapidly in alkaline, aqueous solutions to produce an orange-red colour. Dried powdered leaves of henna contain approximately 0.5 to 1.5 percent lawsone.



Other constituents present are gallic acid, glucose, mannitol, fats, resin (2 %), mucilage and traces of an alkaloid. Leaves yield hennatannic acid and an olive oil green resin, soluble in ether and alcohol. Flowers yield an essential oil (0.01-0.02 %) with brown or dark brown colour, strong fragrance and consist mainly of α- and β- ionones; a nitrogenous compound and resin. Seeds contain proteins (5.0 %), carbohydrates (33.62 %), fibers (33.5 %), fatty oils (10- 11 %) composed of arachidic acid, stearic acid, palmitic acid, oleic acid and linoleic acid.

Cosmeceutical applications:

1. *Antifungal activity*: Lawsone was found to be an anti-fungal toward Alternaria, Aspergillius, Absidia, and Penicillium. The minimum dose effective again test organism is found to be 0.1%. It exhibits fungicidal activity, wide fungi toxic spectrum and non phytotoxicity.

2. *Antibacterial activity*: Antibacterial activities toward Brucella, Neisseria, Salmonella, and Streptococcus with a concentration of .005-.02% were observed. Additionally, lawsone extract from the leaves showed mild anti-bacterial activity against S. aureus and E. coli.

3. *Benefits in Alopecia*: In applications described in patent literature, henna extract was used with other hair growth promoting agents delivered transdermally. Lawsone may promote hair growth by acting on 5-alpha-reductase, an intracellular enzyme that converts the androgen testosterone into DHT (dihydrotestosterone). As DHT is implicated in the development of androgenic alopecia, Lawsone offers benefits by preventing its formation.

4. *Hair conditioning properties*: Natural henna is an excellent conditioning agent. Lawsone is widely used in shampoos, hair rinses, and conditioners.

5. *Hair Dye*: Henna has been used to dye hair for centuries. Lawsone by itself is colourless. However when exposed to sunlight or to air, it is converted to a new compound that has the characteristic red colour.

When lawsone is blended with *Indigofera tinctoria*, the hair dye can impart colour in various shades ranging from brown to black. The addition of herbs such as rhubarb, calendula, chamomile, and others to lawsone produces various shades of red. It can be used to cover gray hair without any adverse effects on hair structure. To obtain a long lasting colour, the pH of the composition must be in the acidic range (5.5) facilitated by using a weak acid such as adipic, citric or boric acid). Other applications of henna include its use in creating "temporary tattoos" to decorate the skin.

7. SOAP NUT

Common name: Indian soap nut, soap berry, kunkudu.

Ritha/Reetha/Aritha (Hindi), Kunkudukai (Telugu), Boondi Kottai (Tamil),

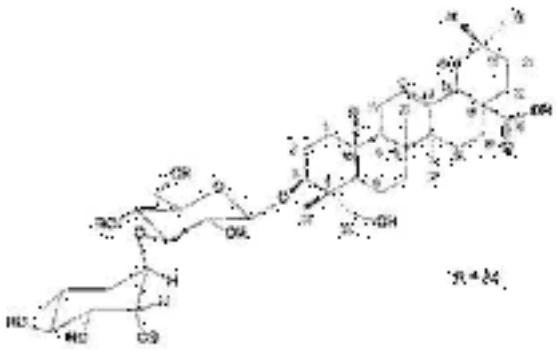
Biological source: it consists of dried leaves of dried fruits of *Sapindus saponaria L. Belonging to family* sapindaceae.

Chemistry:

Saponaria produces a complex mixture of glycosidic compounds with diverse biological effects. It is difficult to establish clear functionality and structure-activity relationships regarding the effects of saponins, because there are many saponins with similar chemical structures, and also because of the complexity of cellular physiological reactions.

The saponins are naturally occurring surface active glycosides. Saponin consists of a sugar moiety usually containing glucose, galactose, glucuronic acid, xylose, rhamnose or methylpentose, glycosidically linked to a hydrophobic aglycone (sapogenin), which may be a triterpenoids or steroid in nature. In water, saponins produce abundant and persistent suds that are stable to diluted mineral acids. The acyclic sesquiterpene oligoglycosides are glycosylated terpenoids. The terpernoids are derived from C5 isoprene units joined in a head-totail fashion. The sesquiterpenes are derived from three C5 isoprene units (C15) and contain 15 carbon atoms.

The new isolated saponin compound id 3-beta-*O*-[alpha-L-rhamnopyranosyl-(1-3)-beta-D-glycopyranosyl]-hederagenin.



Cosmetic uses:

Soapnut/reetha/soap berries/washing nuts is one of the most popular herbs in Ayurveda. It is all-natural, eco-friendly, cheap, and reusable. When it comes in contact with water, it creates mild suds that resemble soap. Hence, it is used for a variety of purposes, from washing clothes to making ornaments shine. Many of us are well aware of the benefits of Soapnuts for the hair. However, their benefits aren't restricted to just hair. These nuts are amazing for our health and skin as well and have multiple uses.

Soapnuts have been used to make natural hair care products since time immemorial. This plant is rich in saponin, which makes your hair healthy, shiny, and lustrous when used regularly.

Reetha is absolutely odourless, and doesn't cause any damage to fabrics. Hence, it is widely used as a cleaning agent. The sustainable nature and versatility of soapnuts make them an important part of one's home/pharmaceutical cosmeceutical and industries.

Skin Benefits of Soapnuts

Soapnuts are the best for hair growth. Hence, they are used in many natural hair tonics and solutions. Use powdered or liquid reetha to achieve thick and bouncy hair. The soapy texture of Soapnut makes it a wonderful ingredient in many hair care and skin care products all over the world. The Soapnuts shampoo, when used on a regular basis, cleanses hair.

Vitamins A, D, E, and K found in this fruit are known to impart shine to your hair and make it smooth. Since Soapnut is antimicrobial in nature, it is a good option to cure bacterial and other scalp infections. Soapnuts also exhibit insecticidal properties that help in killing lice on the scalp. Powdered reetha is known to fight various problems affecting the scalp, including dandruff.

Soapnuts tame dry and frizzy hair, condition it, and make it more manageable. Soapnuts also detangle your hair so that it can be easily styled. The regular usage of reetha hair wash can reduce split ends to a great extent.

Pharmacological/traditional uses:

Soapnuts also have natural anti-venom properties. They can be used to eject snake or scorpion venom from the affected people. This might come as a big surprise, but Soapnuts are very effective in helping to cure tobacco and drug addiction.

This is why reetha is provided to smokers to reduce their craving for tobacco. This natural product has also been found to relieve severe bouts of migraines. Powdered reetha can help cure excess salivation. Many studies have concluded that the saponin present in Soapnuts inhibits tumour cell growth. For relief from hysteria and epilepsy, consume a thick solution of reetha and warm water. Soapnuts are very good for asthma patients due to their tonic, emetic, astringent, and antihelmintic qualities.

Apart from the actual fruits, the bark, and roots of soapnuts are also very useful. They are used as a demulcent and as a mild expectorant. Soapnuts have anti-inflammatory properties that are effective in curing joint pains and edema.

These nuts also strengthen your immune system by inhibiting the growth of many pathogens like salmonella and *E.coli.*

It can maintain body heat with the help of Soapnuts as they act as a purgative. Drinking reetha juice can help control your cholesterol levels. The presence of antioxidants in Soapnuts can protect you from the threats of cancer to a certain extent. Soapnuts are anti diabetic in nature. Hence, they are helpful in controlling your blood sugar levels.

Having reetha can help getting instant relief from diarrhea, verminosis, and dyspepsia. Reetha water is known to be a good treatment for sore eyes.

Soapberries are anti-allergic and antibacterial in nature. Hence, they are used in hand washes. Soapnuts are also used as skin cleansers in spas and salons.

These berries possess contraceptive properties, which make them an integral part of some vaginal creams. They are also used for removing synthetic chemicals from fruits and vegetables due to their detoxifying effects.

Soapberries are mildly antiseptic in nature, and this property enables them to be widely used in the cosmetic industry. White powdered Soapnuts along with alum and water can be the perfect replacement for your regular toothpaste.

Nutraceuticals – Let food be your medicine & medicine be your food

The term nutraceutical was coined in 1989 by Stephen Defelice, founder and chairman of Foundation for Innovation in Medicine (FIM), an American organization which encourages medical health. According to him "a nutraceutical is any substance that is a food or a part of food and provides medical or health benefits, including the prevention and treatment of disease", such products may range from:

- isolated nutrients
- dietary supplements
- specific diets to genetically engineered designer foods
- herbal products

There is a slight difference between the functional foods and nutraceuticals. When food is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called "functional food". Thus, functional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates, etc. needed for its healthy survival.

When functional food aids in the prevention and/or treatment of disease(s) and/or disorder(s) it is called a nutraceutical. Examples of nutraceuticals include fortified dairy products (e.g. milk) and citrus fruits (e.g. orange juice).

Classification:

- Food source
- Mechanism of action
- Chemical nature
- Their higher contents in specific foods items

1. Nutraceuticals according to food source:

- Animals- conjugated linoleic acid, EPA, DHA, lecithene, ubiquinone
- Plants-ascorbic acid, quercetin, lycopene, beta-carotene, catechins, alpha-tocopherol, pectin, allicin, geraniol
- Microbes-yeast, lactobacillus acidophilus, streptococcus salvaricus

2. Nutraceuticals according to actions:

- Antioxidant-ascorbic acid, beta-carotene, polyphenols, tocopherols, lycopene, ellagic acid, catechins
- Anti-inflammatory-curcumin, quercetin, capsaicin, lenolenic acid, EPA, DHA
- Anti-cancer-genestein, limonene, glycyrrhizin, diallyl sulphide, tocopherol
- Bone protectives-soy-protein, genestein, calcium
- Antibacterial-garlic, curcumin.

3. Nutraceuticals according to chemical nature:

- Phenolic-tannins, anthocyanins, isoflavonols, coumarins, lignin
- Protein based-choline, isothio cyantes, capsaicinoids, amino acids, allyl thio compounds,
- Isoprenoids-carotenoids, saponines, tocopherols, tocotrienols
- Carbohydrate derivatives-oligosaccharides, non-starch products
- Fatty acids- n 3 PUFA, MUFA
- Minerals-Ca, Se, K, Zn, Fe
- Microbial-pro and pre biotic.

4. Nutraceuticals according to their higher contents in specific foods

- EPA & DHA-Fish Oils
- Lycopene-tomatoes
- Iso thiocyantes-vegetables of cruciferae family
- CLA-beef and dairy products
- Isoflavones-soyabean and legumes
- Beat-carotene- carrots, pumpkin
- Curcumin-turmeric
- Catechin-tea, berries
- Quercetins-citrus fruits, red grapes
- Allyl sulphur compounds-garlic, onion

The food products used as nutraceutical are categorized as:

• Probiotic • Prebiotic • Dietary fiber • Omega 3 fatty acid • Antioxidant

Probiotic: these are living organism, which when taken with or without food, improve the intestinal microbial balance and in turn functioning of the large intestine. It includes bifido bacteria, and lactobacilli species. These microorganisms exert their effects by producing substances and conditions which inhibit the harmful bacteria in the large intestine.

Prebiotic: promotes the growth of colonic probiotic bacteria.

Example-inulin. It is a polyfructose obtained mainly from raw polysaccharide inulin. It is a soluble dietary fibre and resistant to digestive enzyme, it reaches to large intestine or colon essential intact, where it is fermented by the resident bacteria. *Lactobacilli* and *Biffidobacteria* digest inulin and feed themselves on it. Hence, prebiotics acts as fertilisers for these symbiotic bacteria. Inulin also serves the role of dietary fibre. Safety of inulin has been evaluated and accepted by FDA & United states.

Dietary fiber: fibers are non-digestible polysaccharides found in plant cell walls. They are present in food including fruits, vegetables, grains, and legumes. Thus fibers which we eat are called dietary fibers.

Classification and sources:

Soluble: oat, nuts, seeds, legumes, apples, pears, straw berries, blue berries,

Insoluble: whole plant, wheat bran, carrots, cucumbers, tomatoes, brown rice, whole grains.

Both soluble and insoluble fibers are very important in the diet & provide several benefits to the digestive tract by helping to maintain regularity. Soluble fibres are more beneficial since they reduce blood cholesterol and risks of heart attack.

Recommended dose of fibers for adults per day-30gm, for children-5-14gm

Poly Unsaturated Fatty Acids (PUFA): they are present in various vegetables and marine animals. These sources include safflower oil, corn oil, mustard oil, soybean oil. They help to reduce cholesterol

formation/deposition. These vegetable oils mainly contain PUFA belonging to linoleic group (omega-6-type). Some marine fishes contain PUFA belonging to linolenic group.

Anti oxidants: anti oxidant nutraceuticals are those which contain vitamin E, C, A and beta-carotene. They are present in some fixed oils, fruits, vegetables, and fishes, such food compounds are which either prevent the formation of oxygen free radicals or trap them.

Nutraceuticals examples- spirulina, royal jelly, soya and garlic.

1. Spirulina – A Green Factory

Biological source: spirulina is a blue algae S*pirulina platensis* or *Spirulina maxima* family- Oscllatoriaceae. This group of algae is considered to be one of the remarkable groups of photosynthetic simple plant forms. It represents a link between green plants and bacteria. It has a soft cell wall made up of complex sugars and proteins and is different from most algae, that it is easily digested.

Habitat: it is a microscopic plant which grows in fresh water. Its thallus form is filamentous, unbranched and non-differentiated and looks like tiny green spiral coils. It possesses ability to thrive in conditions, which harsh for other algae. Spirulina is a rich source of food containing nutraceuticals and contain anti oxidants, probiotics, and phyto nutrients.

Geographical source: A current world production of spirulina for human consumption is more than 1000 metric tonnes. It is being cultivated in USA and leads world production which is followed by Thailand, Mexico, India and China.

Structure of Spirulina: Cell wall is multilayered and chemically it is made up of mucopolymer and pectic compounds. Generally there is no sheath, when sheath is present; it is made up of polysaccharides. There are no chloroplasts. The thylakoid lamellae are distributed randomly in the cell. Chlorophyll- a is present and Chlorophyll-b is absent. Other pigments are carotenoids, phycocyanin and phycoerthrin. Gas vacuoles help to regulate buoyancy. Nucleus is prokaryotic.

Spirulina is a blue green and nitrogen fixing alga. Some of current researches indicate that spirulina holds a great promise as a source of single cell protein (SCP). SCP is the protein obtained from unicellular organisms. Spirulina contains 60-65% proteins. It is cultured in a clean as well as in salty water.

Chemical composition: Spirulina contains proteins (50-70%), proteinous nitrogen (11.36%), and total organic nitrogen (13.35%), nitrogen from nucleic acids (1.9%). It has net protein utilization (NPU) upto 62%. It contains lipids (5-6%) having mostly essential fatty acids (Vit-F), composed of oleic, linoleic, gamma linoleic, palmitic, palmitoleic, heptadecanoic acids. About 40% of the fats include glycolipids including sulfolipids (2-5%) which have significant anti-HIV activity. Spirulina provides 8-14% of recommended daily allowance (RDA) of fats.

Spirulina contains the carbohydrates in the form of glycogen and rhamnose which are easily digestible and require less insulin. Among the vitamin content, it mainly possesses natural beta carotene with 9-cis-carotenoid isomer, which has more anti-oxidant capacity. The other vitamins present are B1, B2, B3, B6, B12 and E3. The mineral content (3-6%) mainly includes iron which is reported to be better absorbed than other natural iron, because of its soluble complexes with phycocyanin, (phycobiliprotein) which is an algal protein having the linear tetrapyrrole viz. Phycocyanobilin and resembles haemoglobin. Phycocyanin, which is a blue green pigment is believed to enhance general immunity and useful lymphocytic activity against cancer.

Spirulina has an enzyme content in the form of super oxide dismutase (SOD). This enzyme is known for its free radical scavenging effects and plays vital role pathophysiological conditions like atherosclerosis, arthritis, cataract, diabetes and also in emotional stress and aging process. Spirulina also contains crude fibres (0.8%) and ash (6%).

Biological role:

- Spirulina has been subjected to thorough screening for its biological role. Some of the findings are promising.
- It has immuno-stimulant activities. It stimulates the production and activity of bone marrow stem cells, macrophages and T-cells. Spleen and thymus gland shows enhanced function.
- In-vitro studies on spirulina indicate that it enhances cell nucleus enzyme activity and DNA repair and hence it has possible role in cancer treatment.
- Water extract of spirulina inhibits HIV-1 replication in human derived T cell lines and in human peripheral blood mononuclear cells. Calcium spirulan inhibits in-vitro replication of HIV-1, Herpes simplex, Human cytomegalovirus, Influenza virus, Mumps and Measle virus.
- Gamma linolenic acid of spirulina helps to reduce cholesterol levels. It has appetite suppressing activity.

Uses:

1. Spirulina is simple and is having fast growth rate since cultivation of spirulina can be undertaken even in waste water, this helps to solve the problems of water pollution.
2. Spirulina grows well in sewage water which is best material for bio-degradations.
3. Spirulina can fix atmospheric nitrogen during its growth; can be used as a source of nitrogenous fertilizer.

Substituents:

Spirulina resembles *chlorella* and *Apanizomemon flos-aquae*, which are also blue green alga. Chlorella is nutritious but lacks the anti viral and immune stimulant activities. Cell wall of chlorella is made up of indigestible cellulose. Aphanizomenon flos-aquae contains potent nerve toxins.

2. ROYAL JELLY:

Biological Source:

It's yellowish translucent highly viscous liquid produced by fermentation of the secretion of the salivary gland of worker bees namely *Apidae mellifera* family Apidae along with honey and pollen grains. Constitution of royal jelly (or queen bee jelly) reveals that it contains moisture 65-70%, proteins 15-20%, carbohydrates 10-15%, and lipids 1.5-6.0%.

Royal jelly and honey both originate from beehives, however bees produce these substances for very different reasons. Honey provides energy for the worker bees, while royal jelly serves as the principal food for the colony's queen. Royal jelly and honey have been harvested for centuries: the former as a nutritional supplement, the latter mainly as a natural sweetener. Both have valuable properties and both can be highly beneficial to your health depending on their application.

Chemistry: Royal jelly is a viscous jelly substance. It is partially soluble in water with a density of 1.1 g/mL. Its colour is whitish to yellow, the yellow colour increasing upon storage.

Royal jelly is rich source of

- The water content with 60-70 % is the main component of royal jelly,
- Proteins are 17 to 45 % of the RJ dry weight is the main substance after water,

- Free amino acids represent only 0.6-1.5% , the majority of which belong to the L series. The most representative are proline and lysine,
- Vitamins i.e., vitamin A, B1, B2, B6, B12, pantothenic acid, nicotinic acid, vit-C and vit E & only traces of vit C present,
- The lipids with 3 to 19 % of the RJ dry weight 30, 157, are second in importance after the proteins. 80 to 90 % of the lipid fraction consists of free fatty acids, the rest being neutral lipids, sterols, hydrocarbon,
- Carbohydrates are third in importance, composed of mainly fructose, glucose and sucrose with some traces of maltose, also being found,
- The major elements are K, P, S, Na, Ca, Al, Mg, Zn, Fe, Cu and Mn but there are trace amounts (0.01-1 mg/100 g) of Ni, Cr, Sn, W, Sb, Ti and Bi. The sodium content of RJ varies between 11 and 14 mg/ 100 g.
- 7-9 different sterols-sitosterol, cortisol, cholesterol,

Other bioactive components –

- Gamma Globulin- mostly immunoglobulins which powerfully strengthen the immune system
- 10-HyroxyDecanoic Acid (HAD) - 20-60mcg/gm, which has Immunomoduatory, powerful anti-bacterial and anti-fungal. It keeps RJ sterile.
- Gelatin- Precursor of collagen for skin, tendon, ligaments, etc
- Acetylcholine- up to 1mg/gram of RJ- the richest natural source. Important in nerve transmission and production and release of glandular secretions. “A tonic for the nervous system”. Provokes adrenaline secretion
- Nucleic acids- DNA and RNA the building blocks of genetic material available for repair projects.
- Adenosine monophosphate (AMP) N1 oxide, adenosine, acetylcholine, polyphenols, and hormones such as testosterone, progesterone, prolactin, and estradiol are other useful bioactive components reported to be present in royal jelly.
- Based on modern spectrometric analysis, approximately 185 organic compounds have been detected in royal jelly. Royalactin is the most important protein present in royal jelly. In addition, royal jelly is composed of a significant number of bioactive compounds, including 10-hydroxy-2-decenoic acid (HAD), which has some immunomodulatory properties.

Uses:

Royal jelly is used as general tonic and food supplement.

Health benefits:

- Wound management
- Paediatric care- beneficial effect on paediatric dermatitis caused by excessive use of napkins and diapers, eczema, and psoriasis.

- Diabetic Foot Ulcer (DFU). Consumption of RJ is a low-cost and effective therapy for the treatment of DFU. DFU is often complicated by microbial infections and slows the healing process.
- Gastrointestinal (GI) Disorder. Natural honey is composed of enzymes that facilitate the absorption of molecules,
- Oral Health -RJ is useful for the treatment of many oral diseases, including periodontal disease, stomatitis, and halitosis. In addition, it has also been applied for the prevention of dental plaque, gingivitis, mouth ulcers, and periodontitis. The antibacterial and anti-inflammatory properties of honey can stimulate the growth of granulation tissue, leading to the repair of damaged cells.
- Pharyngitis and Coughs. Pharyngitis, commonly known as sore throat, is an acute infection induced by Streptococcus spp. in the oropharynx and nasopharynx-RJ coats the inner lining of the throat and destroys the harmful microbes while simultaneously soothing the throat.
- Gastroesophageal Reflux Disease. Gastroesophageal reflux disease (GERD) is a mucosal infection caused by contents of abnormal gastric reflux into the esophagus-RJ can further stimulate the tissues on the sphincter to assist in their regrowth and finally reduce the chances of acid reflux.
- Dyspepsia, Gastritis, and Peptic Ulcer. Dyspepsia is a chronic disease in which the GI organs-RJ is taken as a dietary supplement for its antibacterial properties and protective effect.
- Neurodegenerative and Aging Diseases. Poor mental state and performance such as in the case of Alzheimer's disease (AD)- Royal jelly stimulates physical and mental functions for the elderly and increases their appetite and weight.
- Anti aging.
- Reproductive Health. A randomized clinical study has reported that royal jelly is effective in reducing premenstrual syndrome

3. SOYA BEANS

Biological source:
These are the fully natured dried seeds of the plant *Glycine-soja* and *Glycine max* family Leguminosae.

Chemical composition:
It is rich source of carbohydrates, fats, vita mins and minerals. Soya has high contents of high quality proteins. Along with calcium it also contains iron magnesium and potassium.

Biological role:
Traditionally soybean based-foods of have been consumed for centuries in most of the Asian countries. Soybean is gaining importance as a nutritionally important crop and also becoming popular for nutraceutical properties as it contains essential amino acid and secondary metabolites such as isoflavone, saponins**,** phytic acid**s,** phytosterols, trypsin inhibitors and peptides.

Soya contains low portion of saturated fat, but is a rare source amongst plants containing omega-3-fatty acids (EPA & DHA). It contains no cholesterol but helps to lower blood cholesterol levels. Soya additionally contains isoflavones i.e., Genestein and Diadzein. They are believed to have preventive roles towards breast and prostate as well as other carcinomas. These are also known to prevent osteoporosis.

It has been accepted by FDA of United States of America that soya bean is having a role in reducing the risk of coronary heart disease. The nutritional value of soya bean curd (Tofu) has been long realized by Chinese people.

Low incidence of cancers and cardio vascular diseases in Chinese and Japanese people has been linked to their traditional soya-rich diets.

4. **GARLIC:**

Garlic*, Allium sativum* (Family Lilliaceae) has been associated with humans and their food since ancient times. It is grown and used as food and medicine in all temperate climatic regions of the world. Garlic contains carbohydrates(31%), proteins (5-6%, fat(0.2%) and high amounts phosphorous, potassium and calcium. Garlic contains a sulphur basic compounds called Allin(present in cell vacoules). When the cells are broken it is converted to allicin and finally di allyl sulphide. Both of them are strong smelling and fiery tasting compounds.

Garlic reduces serum lipid levels because it causes,(i) reduction or inhibition of lipogenesis and (ii) enhancing breakdown and excretion of lipids. It increases HDL (High Density Lipoproteins) and reduces LDL(Low Density Lipoproteins).Overall, Garlic is used to reduce serum cholesterol and also in treatment of atherosclerosis. Garlic has also been found to reduce platelet aggregation.

Allicin from Garlic shows antibiotic activity against Mycobacterium tuberculosis, *Staphylococcus aureus* and *Staphylococcus faecalis*. Garlic is useful in treatment of amoebic dysentery and parasites like tapeworm and hookworm.

Garlic exerts strong antioxidant effect, prevents lipid peroxidation and hence protects liver cells from various toxins including mutagenic chemicals.

Anti-carcinogenic, Anti-inflammatory, Garlic and diabetes, Anti-thrombotic.

ALKALOIDS:

These are largest plant secondary metabolites produced as a biproducts, derived from aminoacids.

* Alkaloids are widely distributed in dicot families, over 300 families reported as containing 10,000 alkaloids.

*Generally these are recognised as "ALKALI-LIKE" phytochemical compounds.

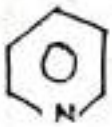
* Alkaloids can be broadly defined as — (negative oxidation state*)
'naturally occuring nitrogenous heterocyclic alkaline or base, organic compounds, having one or more nitrogen atoms inside the ring as a part of chemical structure with prominent or significant therapeutical actions in minimal doses) with limited distribution ~~among all~~ in living organisms".

CRITERIAS:

The word alkaloids must obey the following characters;

1) They must be originated from one or more amino acids like phenylalanine, ornithine, tyrosine, tryptophan etc.

2) They should have one or more nitrogenous atom inside the ring.



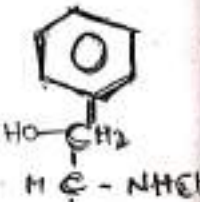
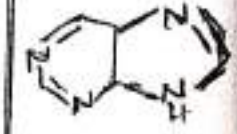
PYRIDINE

3) They must respond positively with general alkaloidal chemical tests.

* Dragendroff's Reagent
* Wagner's Reagent
* Mayer's Reagent
* Hager's Reagent

According to the above mentioned characters alkaloids can be divided into three groups. They are

1) True alkaloids
2) Proto alkaloids
3) Pseudo alkaloids

	AMINOACIDS	N-ATOM	CHEMICAL TEST	EXAMPLE
True alkaloids	✓	Inside the ring	✓	 Indole Reserpine
Proto alkaloids	✓	outside the ring	✓	 Ephedrine
Pseudo alkaloids	×	Inside the ring	×	coffee, Tea  Purine.

* Generally all purine alkaloids positively responded with "MUREXIDE TEST"

Properties of Alkaloids :-

* chemically they are medium polar compounds soluble in medium polar organic solvents like alcohols, where as insoluble in water.

* In nature alkaloids occured in free state and salt form.

Ex: QUININE	QUININE HCl / sulfate
• free base	• salt form of quinine
* soluble in organic solvents	* soluble in water
* Insoluble in water	* Insoluble in organic solvent
NOTE: Caffiene will soluble in water	NOTE : Morphine Codiene, soluble in organic solvents.

→ Generally, alkaloids are crystalline, solid, non-volatile, organic compounds.

NOTE :

Some of alkaloid compounds occured in amorphous (emetin), liquid (Nicotine) and volatile in nature (Nicotine).

* Generally all compounds are colourless in nature.

NOTE: Berberine (yellowish in colour)
Carotene — orange

* All alkaloids are optically active compou found in two isomers i.e, D and L and therapeu tically L - isomer is more active than D-isomer.

Ex: L - Ephidrene

L - Ergotamine

* chemically alkaloids are amine derivatives compounds and in ~~nature~~ they found in different amines like,

General Structures

1) Primary amine = RNH ; Mescaline
2) Secondary amine = R_2NH ; Epidrine
3) Teritary amine = R_3NH ; Atropine
4) Quaternary amine = R_4NH ; Tubocurarine

* The lone pair of electrons present on nitrog atom responsible for the alkaline nature of alkaloid

Stability of Amines:

$3° > 2° > 1° > 4°$

available in free,

salt - organic — oxalic, acetic
Inorganic — HCl, H_2SO_4
Special — Meconic

CLASSIFICATION OF ALKALOIDS

NON-HETEROCYCLIC [N-outside]

[proto alkaloids]

- phenyl amine
- Tropolone

HETEROCYCLIC [N-Inside]

[True alkaloids]

* Imidazole
* Pyridine
* Piperidine
* Quinoline
* Isoquinoline
* Quinazoline
* Indole
* Tropane
* Steroidal glyco alkaloids
* Purines (pseudo alkaloids)

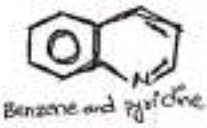
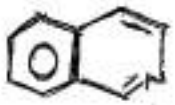
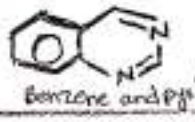
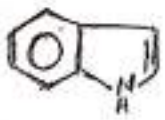
MONOCYCLIC 5-MEMBERED HETEROCYCLIC COMPOUNDS

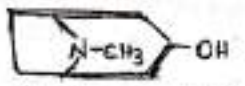
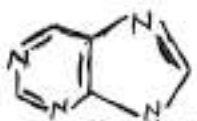
S.No	CHEMICAL COMPOUND	STRUCTURE	CRUDE DRUG	ACTIVE COMPOUND	AMINO ACID
1)	Imidazole		* Pilocarpus	• pilocarpine	→ Histidine

MONOCYCLIC 6-MEMBERED HETEROCYCLIC COMPOUNDS

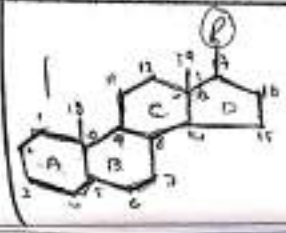
S.No	CHEMICAL COMPOUND	STRUCTURE	CRUDE DRUG	ACTIVE COMPOUND	AMINO ACID
	Pyridine		* Tobacco	• Nicotine	→ Lysine
	Piperidine		* Lobelia	• Lobeline	→ Lysine ornithine acid

Bicyclic - Heterocyclic Compounds

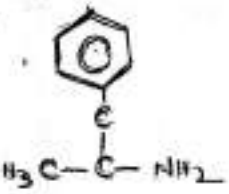
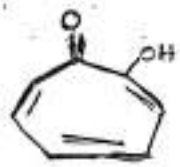
S.NO	Chemical Compound	Structure	Crude Drug	Active Compound	Amino Acid
1)	Quinoline	 Benzene and pyridine	* Cinchona	• Quinine • Quinidine • Quinic acid	→ Tryptophan
2)	Isoquinoline		* Opium	• Morphine • Codeine • Thebaine • Papavarin • Narcotin	→ Tyrosine
			* Ipecac	• Emetine • Sef Cephaelin	→ Dihydroxy phenylalanine + Dopamine
3)	Quinazoline	 Benzene and pyrimidine	* Vasaka	• Vascicine • Vascinone	→ Ornithine + Anthranilic acid
4)	Indole		* Rauwolfia * Ergot * Vinca * Nux Vomica	• Reserpine • Ergot alkaloid • Vinaystine & Vinblastin • Strychnine & brucine	→ Tryptophan

S.NO	CHEMICAL COMPOUND	OBSTRUCTURE	CRUDE DRUG	ACTIVE COMPOUND	AMINO ACID
5)	Tropane	 Piperidine + pyrimidine	* Atropa * Datura * Hyoscyamus * Coca	• Atropine • Hyoscyamine • Hyoscine • Cocaine	→ Ornithine
6)	Purine	 pyrimidine + Imidazole	* Coffee * Tea * Cocoa * Kola seeds	• Caffiene • Theophylline • Theobromine	→ Xanthone nucleitides

POLYCYCLIC - HETEROCYCLIC COMPOUNDS

S.NO	CHEMICAL COMPOUND	OBSTRUCTURE	CRUDE DRUG	ACTIVE COMPOUND	AMINO ACID
1)	Steroidal glyco alkaloids		* Solanum * Ashwagandha * Kurchi	• Solasidine • Anaferin & withanolides • Kurchine	→ Acetate mevalonate pathway with cholestrol

NON-HETEROCYCLIC COMPOUNDS

S.NO	CHEMICAL COMPOUND	STRUCTURE	CRUDE DRUG	ACTIVE COMPOUND	AMINOACID
1	phenyl ethyl amine		* Ephedra	• Ephedrine	→ phenyl alanine (PA)
2	Tropolone		* Colchicum * Tropophora	• colchicine • Mescaline	→ phenyl alanine (PA)

* steroidal glyco alkaloid → Steroidal glycosides Examples – Cardiac – Solanum – Solasidine
Lysine + Acetate melavonate pathway
↓
used for Biosynthesis steroidal glycosides

Steroidal alkaloids – Ashwagandha, Kurchi, veratrum – Acetate melavonate pathway + Lysine

DRUGS	PARTS USED
1) Pilocarpus	Rutaceae → Leaf — pilocarpine
2) Tobacco	Solanaceae → Leaf — nicotine
3) Lobelia	Lobeliaceae → Leaf — lobeline
4) Cinchona	Rubiaceae → Bark — Quinine
5) Opium	Papaveraceae → Latex of fruit — MCT
6) Ipecac	Rubiaceae → Root & Rhizome — E, C
7) Vasaka	Acanthaceae → Leaf — vasicine
8) Rauwolfia	Apocynaceae → Root & Rhizome — Reserpine
9) Ergot	clavicipitaceae / Gramineae → Sclerotium-fungus
10) Vinca	Apocynaceae → whole plant — Vcr, Vbl
11) Nux vomica	Loganiaceae → seed — S, B
12) Atropa	Solanaceae → Leaf — AHH
13) Datura	Solanaceae → Leaf —
14) Hyoscyamus	Solanaceae → Leaf —
15) Coca	Erythroxylaceae → Leaf — cocaine
16) Coffee	Rubiaceae → Berries — Caffeine, Theobromine
17) Tea	Theaceae → Leaf —
18) Kola	Sterculiaceae → seeds —
19) Solanum	Solanaceae → fruit — So
20) Ashwagandha	Solanaceae → Root & Rhizome —
21) Kurchi	Apocynaceae (Cyan) → Bark — K
22) Ephedra	Ephedraceae → Young stem — E
23) Colchicum	liliaceae → Corms — C
24) Veratrum	liliaceae → Root

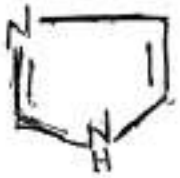
SNo	CRUDE DRUG	ACTIVE PART	BIOLOGICAL NAME	FAMILY	PHYTOCONSTITUENT	IDENTIFICATION TEST
1)	Pilocarpus	Leaf	Pilocarpus microphyllus Pilocarpus orneta Pilocarpus jaborandi	Rutaceae	Pilocarpine	dil. H_2SO_4 + chloroform + H_2O_2 + Hcl + $K_2Cr_2O_7$
2)	Tobacco	Leaf	Nicotiana tobaccum	Solanaceae	Nicotine	
3)	Lobelia	Leaf	Lobelia ~~terlecta~~ inflata	Lobeliaceae	Lobiline	Hcl + H_2SO_4 + NH_3
4)	Cinchona	Bark	Cinchona calisaya Cinchona ledgeriana Cinchona Succiruba Cinchona officinalis	Rubiaceae	Quinine & Quinidine	Thalleoquin reagent
5)	Opium	Dried latex of fruit	Papaver somniferum	Papaveraceae	Morphine, codiene, Thebaine, Papaverine	Meconic acid test
6)	Ipecac	Root and rhizome	Cephalis ipecacuanha	Rubiaceae	Emetic, cephaline	
7)	Vasaka	Leaf	Adathoda vasaka	Acanthaceae	Vasicine, Vasicinone	

S.No	CRUDE DRUG	ACTIVE PART	BIOLOGICAL NAME	FAMILY	PHYTO-CONSTITUENTS	IDENTIFICATION TEST
14)	Hyoscyamus	Leaf	Hyoscyamus niger	Solanaceae	Atropine, Hyoscine, Hyosciamine	Vitali morin's test
15)	Coca	Leaf	Erythroxylon coca	Erythroxylaceae	cocaine	Vitali morin's test
16)	coffee	Berries & seeds	Coffee arabica	Rubiaceae	caffine, Theophylline, Theobromine	Murexide test
17)	Tea	Leaf	Thea sinesis	Theaceae	caffine, Theophylline, Theobromine	Murexide test
18)	Kola	seeds	Colantida, Sterculia nitida	Sterculiaceae	caffine, Theophylline, Theobromine	Murexide test
19)	Solanum	Fruit	Solanum xanthocarpum	solanaceae	Solasidine	
20)	Ashwoganda	Root & Rhizome	Withania solanifera	solanaceae	Anaferin	
21)	Kurchi	Bark	Holarrhena floribunda	Apomanaceae	kurchine	
22)	Ephedra	young stem	Ephedra gevadiana	Ephedraceae	Ephedrine	HCl + NaOH + CuSO4
23)	Colchicum	seeds and corms	colchicum autumnale	Liliaceae	colchicine	70% H_2SO_4

(11)

(11)

1. IMIDAZOLE



Imidazole is a two nitrogen containing heterocyclic cyloperntane, aromatic organic compound and found in building blocks of "Histidine & Histamine" aminoacids.

Ex. Pilocarpus

PILOCARPUS (Histidine Aminoacid)

COMMON NAME: Jaborandi

BIOLOGICAL SOURCE:

Pilocarpus consists of dried leaflets of "Pilocarpus ornata"; "Pilocarpus jaborandi" belonging to the family of "Rutaceae".

GEOGRAPHICAL SOURCE: USA, Brazil, Caribbean islands

MORPHOLOGY: seed propogation

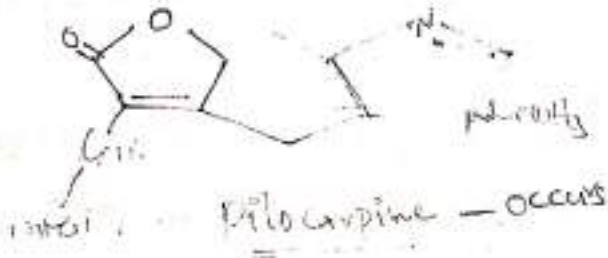
* Dorsiventral leaf, Imparipinnate Compound leaf with 7 leaflets.
* Ovate shape
* Entire margin
* Round apex
* Asymmetrical
* Green colour — greish
* Bitter taste
* characteristic odour: Aromatic

Only in Alkaloids also

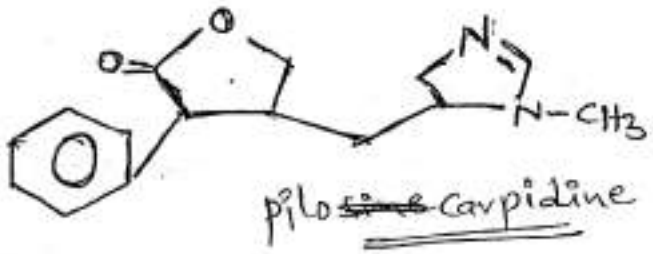
CHEMICAL CONSTITUENTS:

* Imidazole alkaloids (3)
* Alkaloids (1)
* True alkaloids (2)
* Pilocarpine and isomers (4)
* Pilosine (5)

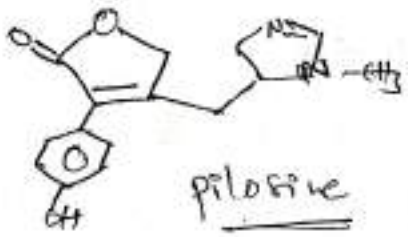
* Volatile oils - monoterpenes - limonene, α-pinene



Pilocarpine — occurs as - viscous oil / hygroscopic crystalline solid



pilo~~sine~~carpidine



pilosine

Uses:

* Pilocarpus is an example for cholinergic and antagonist to Atropine.
* Used in treatment of opthalmic disorders. Glucoma and sojgren's, characterised by dryness of mouth, causes from radiation therapy.
* It includes sweating ; act as diaphoretic.
* "Acetylcholine agonist" or cholinergic or Atropine antagonist.

PYRIDINE - PIPERIDINE

pyridine

piperidine

PYRIDINE :

* Pyridine is a nitrogen compound containing six membered heterogenous, organic compou

* Pyridine is toxic, colourless, flammable liquid.

* In nature, a pyridine chemical compound found in tobacco leaves, distributed a nicotin.

* In plant body, nicotine biosynthesis from "Ornithine aminoacid" and "Nicotinic acid" and Lysine.

PIPERIDINE :

* This moiety found in Lobelia plant occured as Lobeline and biosynthesized from Ornithine, Lysine aminoacid.

Ex: Tobacco

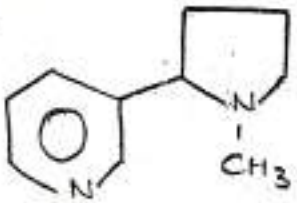
Lobelia

TOBACCO (Ornithine Lysine Aminoacid)	LOBELIA (Ornithine Lysine Aminoacid)
Biological Source : Tobacco consists of dried leaves of "Nicotiana tobacco", belonging to family "Solanaceae".	Common Name: * Indian tobacco * Asthma weed Biological Source: Lobelia consists of dried aerial parts of Lobelia inflata, belonging to family of "Lobeliaceae / campanulaceae".
Geographical source : India, All European countries	Geographical source: central USA India, Afganisthan, Iran, Iraq, Holland
Morphology : The word Nicotine derived from John Nicot a portgnese who introduced tobacco plant to all European countries.	Morphology: STEM : Green, cylindrical shape LEAF : Ovate-oblong Dorsiventral, assymetrical base FLOWERS : White Blue in colour FRUITS : Reddish brown, bilocular Each fruit contains about 500 small seeds, ellipsoidal and Compressed
* Green to plale brown in colour * Dorsiventral leaf * Lanceolate leaf shape * Nicotinic odour * Bitter taste	

* The active phytochemical compound presents or distributed much more in seed compare to all plant parts.
* Irritant odour and taste.

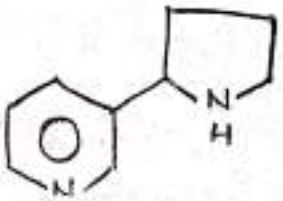
CHEMICAL CONSTITUENTS:

* Alkaloids
* True alkaloids
* Pyridine-Pyrolidine alkaloids
* Nicotine
* Nicotinic acid



methylated Pyrolidine

Nicotine:

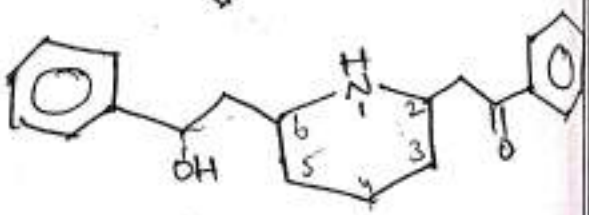


Non-methylated Pyrolidine

Nicotinic acid

CHEMICAL CONSTITUENTS:

* Alkaloids
* True alkaloids
* Piperidine alkaloids
* Lobeline



→ white amorphous powder is freely soluble in wat

→ Optically active — having 2-oxo-2-phenyl ethyl-at 2-hydroxy-2-phenyl ethyl-

→ Nicotinic Ach receptor agon

Uses:

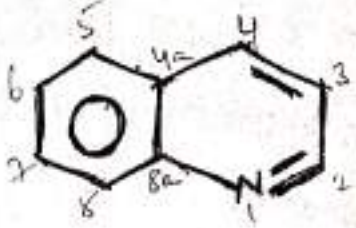
* Expectorant
* Diuretic
* Anti-inflammatory
* CNS stimulant
* Cvs stimulant
* Nicotine drug is quick acting poisons chemical cpd, 40mg per kg body weight of dose can cause death.
* The combination of atropa leaves and tobacco leaves are used to treat peptic ulcers.

Uses:

* Actions similar to Nicotine, but it is less potent
* Used in asthma as a bronchodilator, expectorant.
* Respiratory System stimulant
* Lobeline Hcl. used to cure loss of consiousnes for infants.
* Anti-inflammatory.
* Diuretic
* The precautions to be needed for lobeline being as a potent toxic drug.
* Anti-epileptic.
* Lobeline has multiple mechanisms of action,

Alone → Dopamine agonist
Combination → Dopamine antagonist

(3). QUINOLINE



* Quinoline is a bicyclic nitrogenous heterocyclic compound, containing one nitrogen atom.

* The important quinoline drugs like "Quinine and Quinidine" obtained from Cinchona stem and root bark.

Eg: Cinchona
Camptotheca (Cancer tree, Happy tree)

CINCHONA (Tryptophan Aminoacid)

COMMON NAME:

Peru bark

Jesuits bark

Ceylon bark

BIOLOGICAL SOURCE:

Cinchona consists of dried stem and root bark of "Cinchona calisaya,
Cinchona ledgeriana,
Cinchona officinalis,
Cinchona succirubra"
belonging to family 'Rubiaceae'.

GEOGRAPHICAL SOURCE:

Peru, South America, Bolivia, Columbia,

MORPHOLOGY:

Countees Cinchona — Wife of Viceroy peru

↓

Cinchona

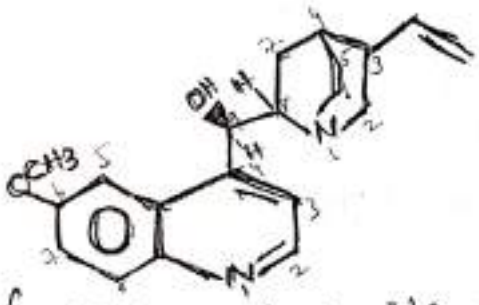
* Reddish brown in colour - Outer - grey; Inner: pale yellowish brown to deep reddish brown
* Inner surface varies to all varities.
* Quill ; double quill shape
* chavactevistic odour
* Bitter and Astringent taste
* The outer surface of bark lichens & mosses.

MICROSCOPY:

CHEMICAL CONSTITUENTS:

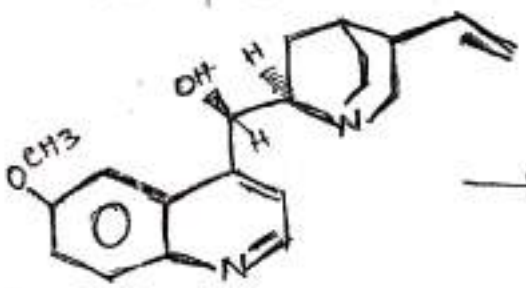
* Alkaloids
* True alkaloids
* Quinoline chemical group of alkaloids
* from cinchona bark 30 alkaloids have been isolated, among all quinine and quinidine cinchonidine cinchonine.
* Quinine and Quinidine both are stereo-isomers.

Quinine → bitter white CH3O
→ Blue fluorescence
Quinine sulphate – $C_{20}H_{24}N_2O_2 \cdot H_2SO_4 \cdot 2H_2O$



→ Quinine

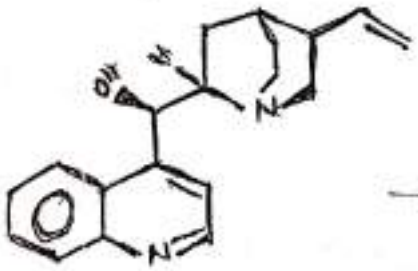
(*) 6- Methoxy-cinchonidine



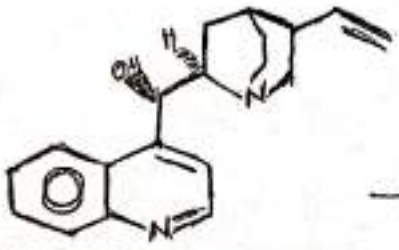
→ Quinidine

(*) 6- Methoxy cinchonine

Cinchona bark



→ Cinchonidine



→ Cinchonine

Quinine & Quinidine- their sulphates are more significant.

*Cinchona bark contains tannins, condensed tannins. *Glycoside – Quinovin

Uses:

* Before world war-II, cinchona was a drug of choice as "Artimalarial drug".
* Used in malaria.
* Bitter stomachic or bitter tonic
* Analgesic, Antipyretics
* Quinidine drug employed as "Artiarrhythmic" in cardiac fibrilation and
* Used as Cardiac depremant drug, valuble in prevention of atrial fibrillation.

(*) Cuprea bark: Remija pedunculata – substituent.

OPIUM (Tyrosine Aminoacid)

COMMON NAME:

Opium latex

Raw opium

BIOLOGICAL SOURCE:

Opium consists of dried latex obtained by incision from unriped capsules of "Papaver somniferum", belonging to the family "Papaveraceae". The dried latex obtained by spontaneous evaporation.

GEOGRAPHICAL SOURCE:

India, Turkey, Europe, Afganisthan, Russia Iran and Pakistan, China.

Papaver Somniferum - Album - India
Variety

Papaver somniferum - glabrum - Turkey

Papaver somniferum - nigrum - Europe

CULTIVATION AND COLLECTION:

The cultivation of opium plant dates back 3400 BC

* Hippocrates = Father of medicine who documented the narcotic properties of opium.

* Alexander - who introduced the opium plant in India and Europe

* Friedrich W. Sertuerner - who identify and isolated the active chemical compound, "Morphium" after morpheus (the god dream).

* In 18th century the usuage of opium was banned in china due to uncontrolable addiction.

* In 19th century the US government made easy availability and us army provided with sufficient opium capsules, and later on caused army disease or solider disease.

* Being a potent narcotic drug of opium cultivation and coltiv. collection governed by respective governments.

* In India the cultivation and other aspects governed by NDPSA -1985 act of Indian government.

(NDPSA = Narcotic Drug and Psychotropic Substance Act).

* In India the opium cultivated in Madhya pradesh, Rajasthan, Uttar pradesh and major supplies for global pharmaceutical industries.

CONDITIONS TO BE PROVIDED FOR CULTIVATION :—

1) Highly fertile loamy soil, (well drained)
2) pH = 7
3) Preferable seed propagation
4) Cool temperature, without freezing temperature
5) Nitrogen and phosphorous fertilizers, higher influence on the yield of latex.
6) Collect the latex during the months of November to March.
7) Highly matured unripe capsules produced maximum amount of latex which is characterised by the color change from dark green to light green.
8) At this stage collect the latex with specified needle, by making of vertical incision. This incision process continued for 2 days and collect the fresh latex in plastic containers.
9) The storage and processing of collected latex was done by "GHAZIPUR OPIUM FACTORY" 1860, British established located in Uttar pradesh. This is the biggest legal opium factory in India.

10) Colour of dried latex is pale brown,
characteristic odour,
Bitter taste.

CHEMICAL CONSTITUENTS :

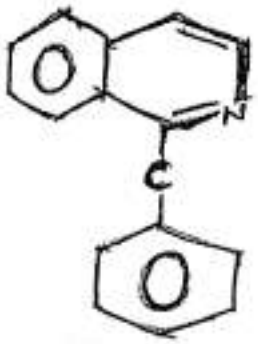
Opium

I - phenanthrene

Ex: Morphine,
Codeine,
Thebaine

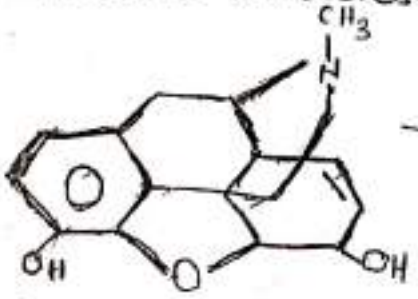
* Strong bases,
monoacidic alkaloids.

II - Benzylisoquinoline



Ex: Papaverine
Narcotine

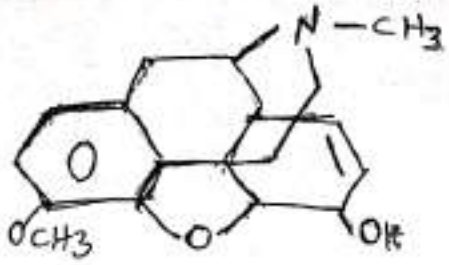
* Weak bases,
monoacidic alkaloids



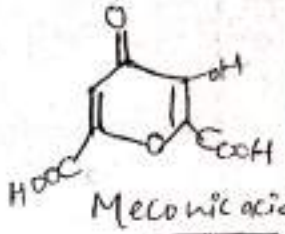
— Morphine

* opioid agonist

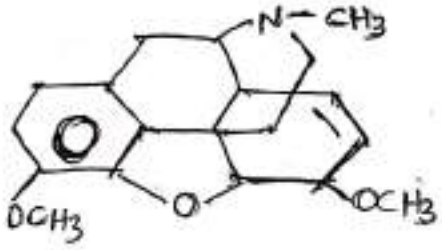
= Rigid pentacyclic structure
– Benzene, 2-partially unsaturated cyclohexane, piperidine & Tetrahydrofuran



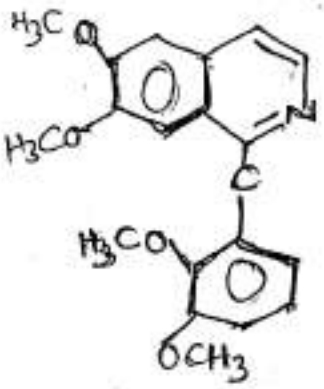
→ Codeine



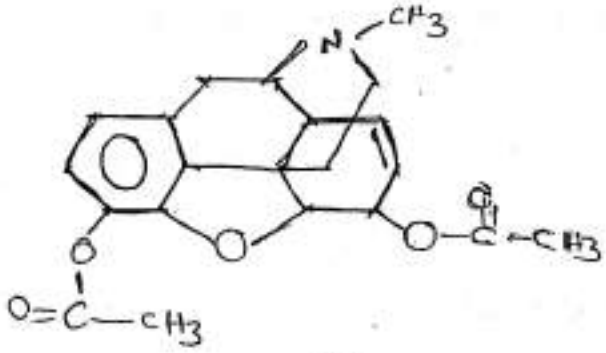
Meconic acid



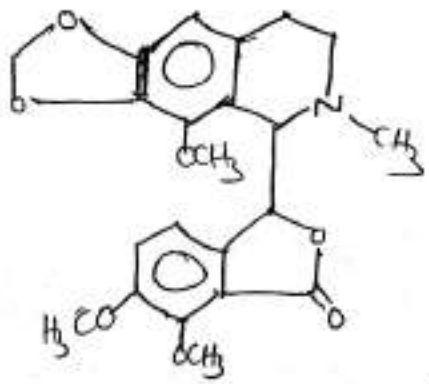
→ Thebaine



Papaverine



Heroin (Diacetyl Morphine)



Narcotine [Noscapine] — Antitussive / cough suppressant

① Hypnotic, sedative & Analgesic

Uses:

* Narcotic
* Sedative
* Hypnotic
* Analgesic
* Morphine is a potent, narcotic drug and analgesic.
* Codeine is a mild analgesic drug used in cough mixture - Antitussive, potent than Aspirin.
* Heroine is more potent, narcotic, than morphine, more potent, analgesic than aspirin.
* Papavevin is a non - ——— narcotic and smooth muscle relaxant drug.
* Morphine and narcotine are more drug abuse and toxic.
* Semi-sythetic opium alkaloids can be called as "opiods".
* Narcotine - has a specific depressant action on cough reflex.

IPECAC

(Dihydroxy phenyl alanine + Dopamine)

COMMON NAME :

Ipecacuanha

BIOLOGICAL SOURCE:

Ipecac consists of dried root and rhizomes of "Cephaelis ipecacuanha" (Brazilian)
"Cephaelis acuminata" belonging to the family of 'Rubiaceae'. (panama)

GEOGRAPHICAL SOURCE :

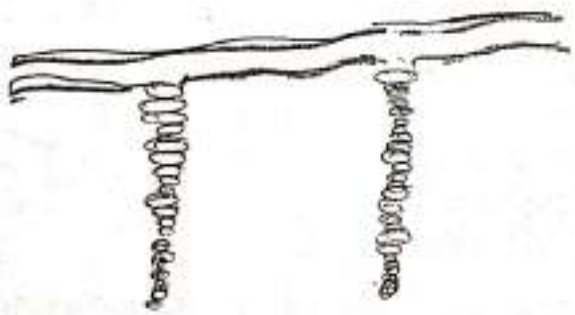
North America, Malaysia
Brazil,
India

MORPHOLOGY :

(P) (B) Roots

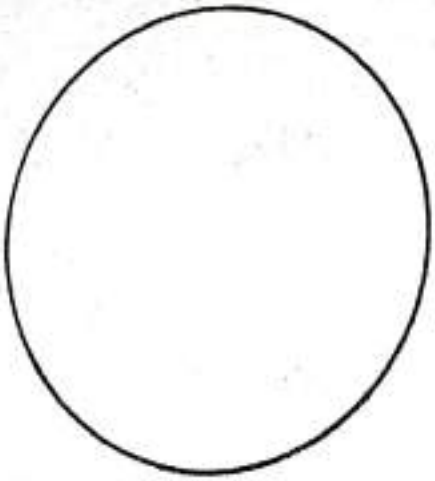
* Grey to brown in colour
* cylindrical in shape
* odourless
* Irritant, bitter taste
* (The root surface has annulated rings) Brazilian

(*) panama - characterised by the absence of annulations.



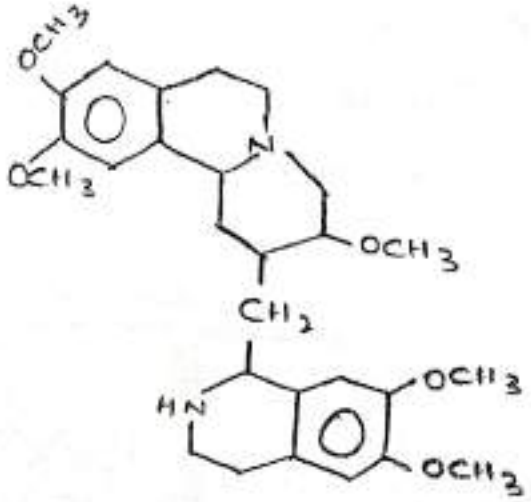
A. Jated rings

MICROSCOPY:

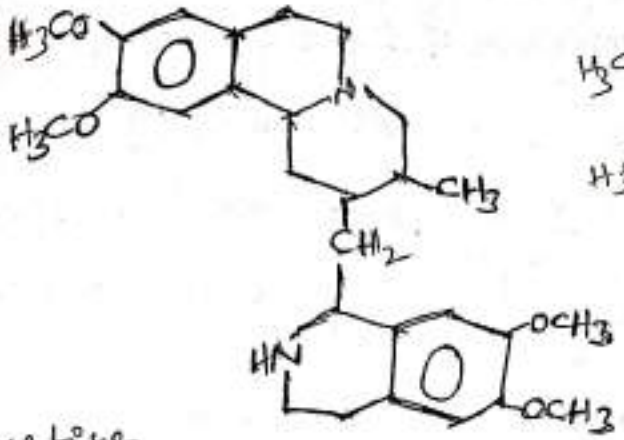


CHEMICAL CONSTITUENTS:

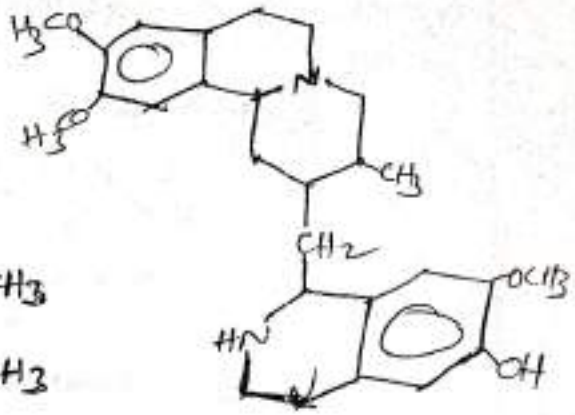
* Alkaloids
* True alkaloids
* Isoquinoline alkaloids
* Cephaline and Emetin
* Psychotrine and methyl psychotrine
* Volatile oils
* Tannins
* Glycosides



CEPHALINE



Emetine



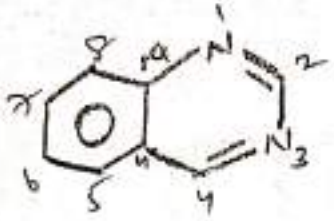
Cephaeline

Uses:

* Expectorant and Emetic.
* Emetin shows that more expectorant activity, weak emetic activity than cephaline.
* Antiprotozoal used in amoebic dysentry - E.HCl
* In Amoebic dysentry emetin HCl given by intravenous route and emetic bismuth iodide by oral route.
* Psychotvine and its methyl ether are selective inhibition of HIV.
* Emetin inhibits protein synthesis in Eukaryotic cells but not prokaryotic cells.
* Emetin used as an amebicide in many different preparations and may cause serious cardiac, hepatic, renal damage and violent diarrhea and vomiting.

(4) QUINAZOLINE

(Anthranilic acid + Ornithine)



- Aromatic, Heterocyclic
- Light yellow crystalline
- Soluble in water
- 1, 3, - diaza napthalene

Ex: Vasaka

VASAKA (anthranilic acid + ornithine amino acid)

COMMON NAME:

Arusaa, Malabarnut, Adulsa.

BIOLOGICAL SOURCE:

Vasaka consists of dried leaves of "Adhatoda Vasica" belonging to the family of 'Acanthaceae'.

GEOGRAPHICAL SOURCE:

India

Thialond, Srilanka, Malaya.

Pakisthan

MORPHOLOGY:

* Dorsiventral leaf

(palisade cell will only present on upper surface of leaf)

* Lanceolate shape
* Symmetrical base

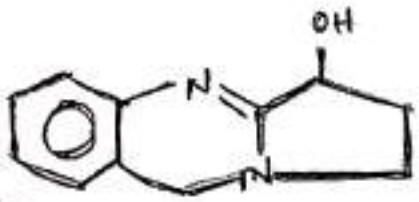
* crenate margin, acuminate apex
* Bitter taste
* odourless
* length of leaf is 10-50cm length, width - 4-10cm

MICROSCOPY:

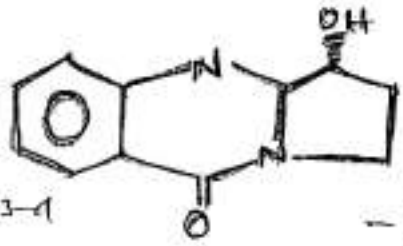
CHEMICAL CONSTITUENTS:

pegagaine = Vasicine

* Alkaloids
* True alkaloids
* Quinazoline alkaloids
* Vasicine and Vasicinone [2-2.5.1.]
* It contains flavinoides.
* It also contains phytosterols, fatty acids.



Tetra hydro pyrrole – Quinazoline-3-1



– Broncho dilator.

Vasicine ⟶ Vasicinone

[cardiac depressant] [A weak cardiac stimulant]

Uses:

* Vasaka plant have been known to "Indian medicine" (or) "Indian system of medicine" since 5000 Bc.
* Expectorant and bronchodilator. (1:1)
* Bromohexine HCl is a semi sythetic derivative of vasicine can alter the structure and function of respiratory track secretions and decreases the viscosity of sputum.
* Anti-inflammatory, Anti fungal.
* Vasicinone usded to decrease high BP.
* It is used as trypsine enzyme activator (TEA).
* Vasicine also shows oxytocic property.

(5.) INDOLE

(Tryptophan Aminoacid)

Ex: Rauwolfia - Apocyanaceae
Vinca - Apocyanaceae
Nux Vomica - Loganiaceae
Ergot - Clavicipitaceae, Graminae / poaceae
Graminae

Benzo-pyrrole

Rauwolfia

COMMON NAME:

Indian snake root,
Serpagandha,
chota chand

BIOLOGICAL SOURCE:

It consists of dried roots and rhizomes of "Rauwolfia serpentina", belonging to the family of 'Apocyanaceae'.

GEOGRAPHICAL SOURCE:

India - UP, WB, TN, Bihar, KA, MH
North Australia,
Thailand,
Indonesia

Vinca

COMMON NAME:

Catharanthus,
Periwinkle,
Madagascar,
Billaganneru

BIOLOGICAL SOURCE:

It consists of whole herb of "catharanthus roseus" belonging to the family of 'Apocyanaceae'.

GEOGRAPHICAL SOURCE:

Vinca plant cultivated in botanical gardens of all european countries. It is distributed as garden plant

MORPHOLOGY:

* cylindrical shape
* Grey to yellow colour-Brow
* characteristic odour.
* Bitter taste.
* Perrinial plant

MICROSCOPY:

CHEMICAL CONSTITUENTS:

* Alkaloids
* True alkaloids
* Indole group of alkaloid
* Reserpine & Ajmaline
* photosterols, fatty acids
* unsaturated alcohols; sugars

MORPHOLOGY:

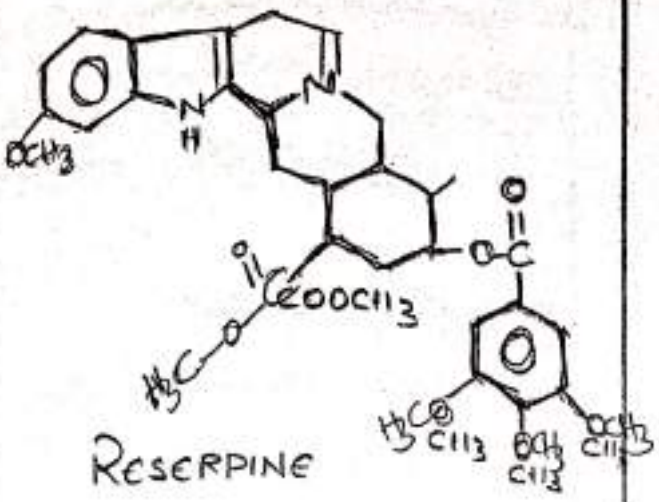
* Dorsiventral leaf Stem
* ovate shape Root-gr
* symmetrical base
* Entire margin Odourless
* Round apex Bitter tas
* flowers are in pink colour

MICROSCOPY:

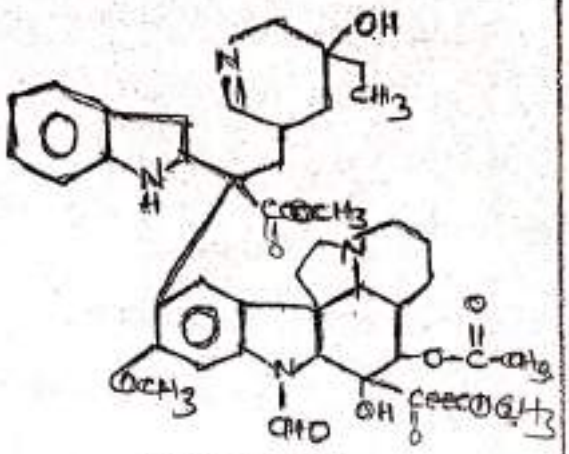
CHEMICAL CONSTITUENTS

* Alkaloids
* True alkaloids
* Indole alkaloids
* Vincristine } dimeric
* Vinblastine } indole-dihydro indole

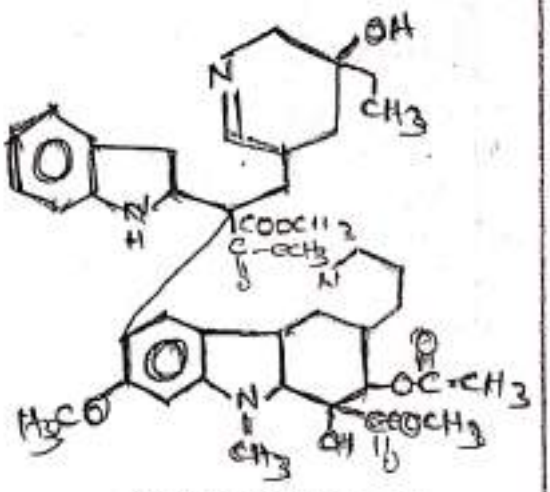
possess oncolytic activity.



RESERPINE



Vincristine



Vinblastine

Uses:

* Antihypertensive.
* Sedative & hypnotic.
* Used in various neuro-psychriatric disorders
  - In mild anxiety
  - transquilliser.

Uses:

* Anticancer.
* Antitumor
* cytotoxic drug
* In European countries a leaf juice is used in diabetics and toothache problems.
* Vincristine Sulphate, Vinblastine Sulphate → Antineoplastic agents
* Anti HT and Antidiabetic

Nux Vomica

COMMON NAME:

Poison nut

Crow fig

BIOLOGICAL SOURCE:

Nux-vomica consists of dried ripe seeds of "Strychnous nuxvomica" belonging to the family of 'Loganiaceae'.

Strychnos = poisonous

Nuxvomica = a nut with vomiting effects

GEOGRAPHICAL SOURCE:

India, Srilanka

All European countries,

Burma.

MORPHOLOGY:-

* Grey to greenish colour.
* Disc shape flat,
* odour less
* Bitter taste; intensely Bitter

ERGOT

COMMON NAME:

Rye ergot

BIOLOGICAL SOURCE:

Ergot consist of dried sclerotium of fungus, "Claviceps purpurea", belonging to the family of 'clavicipitaceae' develop on ovary of rye (or) rice plant of "Secale cereal" belonging to the family of 'Graminae (or) poyaceae'

GEOGRAPHICAL SOURCE:

Commonly ergot is cultivated and collected from the members of Graminae family.

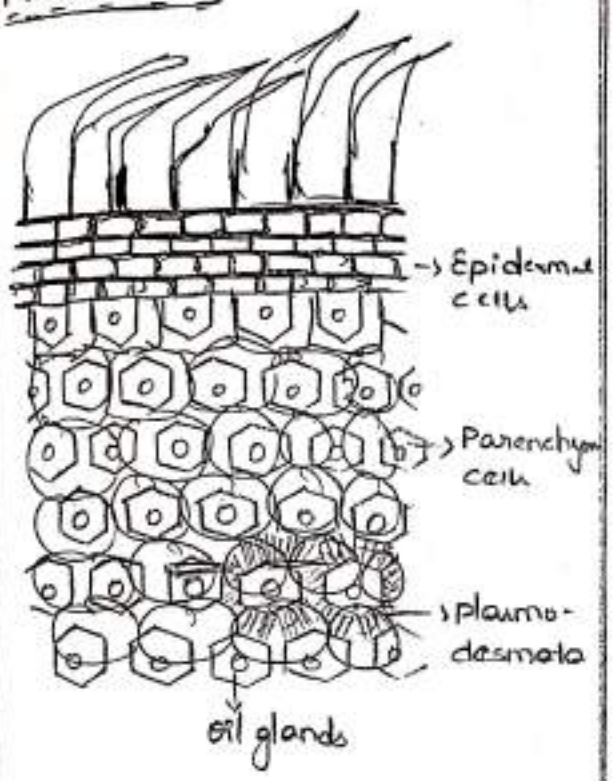
Switzerland, UK.

MORPHOLOGY:

* Brown to black colour.
* Fusiform & slightly curved at both ends.
* Unpleasant taste.
* Unpleasant odour.

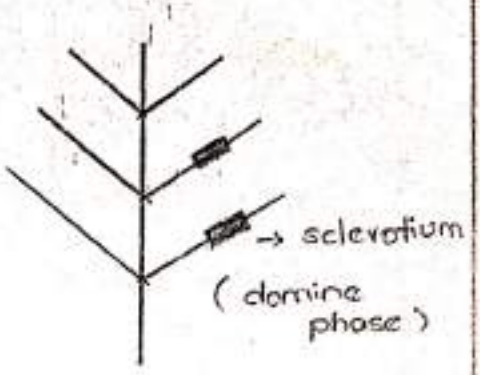
* surface has numerous, silky hairs, radiating from centre (or) hilum.

MICROSCOPY:



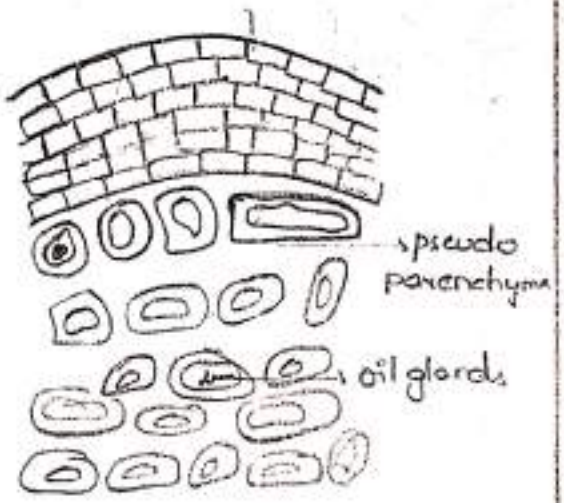
CHEMICAL CONSTITUENTS:

* Alkaloids
* True alkaloids
* Indole group of alkaloids
* Strychine
* Brucine
* Strychine is more bitter and toxic drug than brucine.



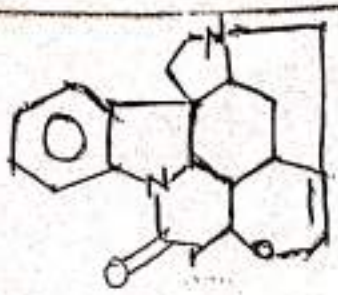
MICROSCOPY:

SCLEROTIUM OF ERGOT

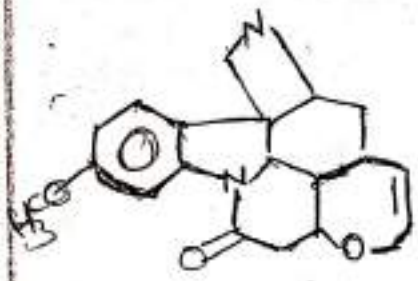


CHEMICAL CONSTITUENTS:

* Alkaloids
* True alkaloids
* Indole group of alkaloids.



Strychnine



Brucine

Glycosides — togarin, Chlorogenic acid

Uses:

* Bitter tonic
* Acts as appetizer.
* CNS & respiratory system stimulant.
* Cardiotonic
* In large doses it may cause tetanus.
* Brucine possesses very less physiological actions than Strychnine.

Ergot alkaloids

- Ergotamine
- Ergometrine
- Ergotoxine

Water Soluble

- L-Ergotamine
- D-Ergotamine

Water insoluble

- L-Ergoptine
- D-Ergo

Active

- L-Ergosinine
- D-Ergosinine
- L-Ergometrine
- D-Ergometrine

Uses:

* Traditionally used in post partum - haemorrhage
* Oxytocine like action.
* Ergometrine derivative cpds has specific analgesic action in migrane.
* Ergotamine derivative Cpds act as psychomimetic action.

IDENTIFICATION TEST:

STRYCHINE:

Ammonium vandate + conc H_2SO_4 + Alcoholic solution of powder drug.

↓

Lemon yellow colour.

BRUCINE:

Conc. H_2SO_4 + Alcoholic solution of powder drug

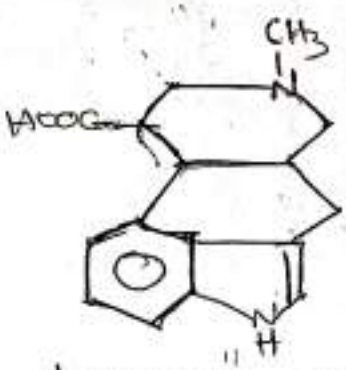
↓

Orange yellow colour

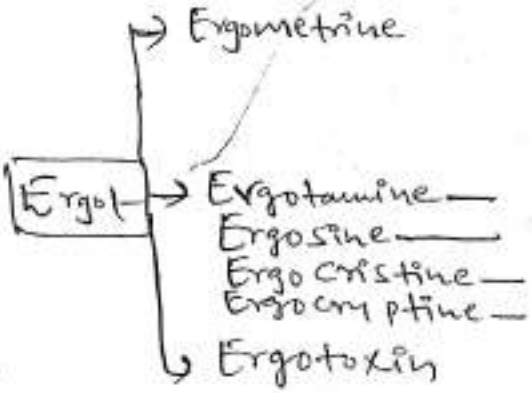
ADULTERANT:

Strychnous potatorium

* Lysergic acid dimethyl amide shows that psychomimetic action.



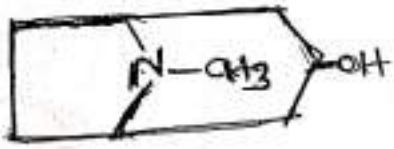
lysergic acid.



* Ergometine & Methy ergometine — stimulate the contractions of Uterine muscles.

(6.) TROPANE

(Ornithine Aminoacid)



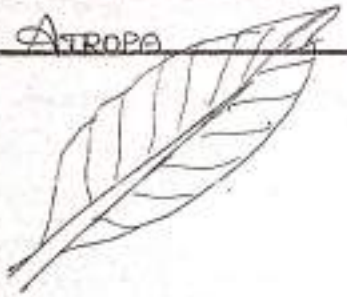
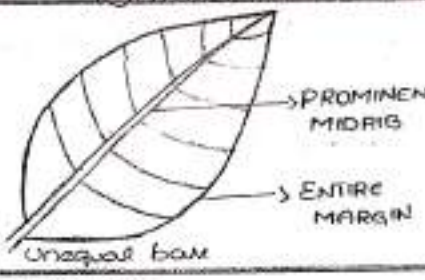
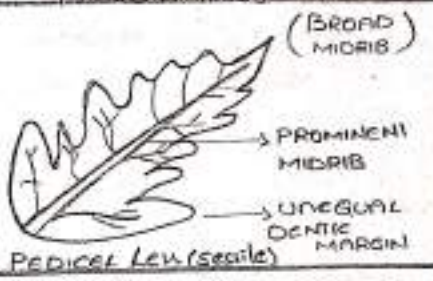
Tropane / Tropine

(8-aza bicyclo octane)

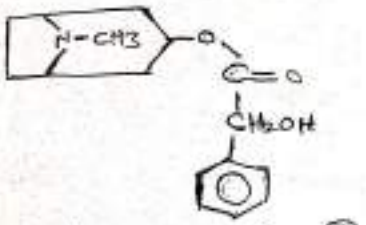
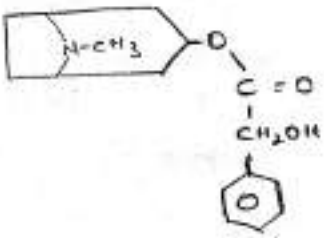
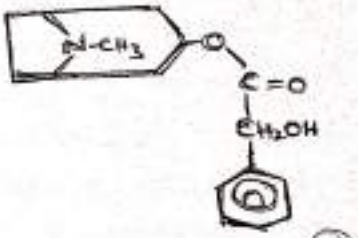
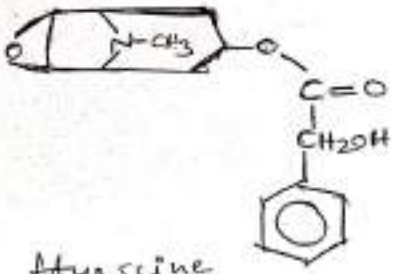
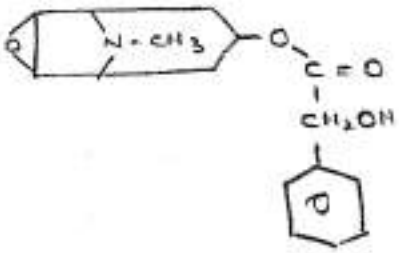
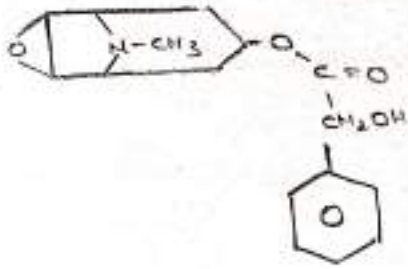
Ex: SOLANACEAE - Atropa
Datura
Hyoscyamus

Erythoxylaceae - Coca

ATROPA	DATURA	HYOSCYAMUS
COMMON NAME: Deadly night shade leaf, Black poison berry	COMMON NAME: Angel's trumpet	COMMON NAME: Henbane leaf
BIOLOGICAL SOURCE: Atropa consists of dried leaves and flowering parts of "Atropa belladonna", (E) belonging to the family of 'Solanaceae'. A. acuminata (I)	BIOLOGICAL SOURCE: Datura consists of dried leaves and flowering parts of 'Datura metel', 'Datura stramonium', belonging to the family of 'Solanaceae'.	BIOLOGICAL SOURCE: Hyoscyamus consists of dried leaves and flowering parts of "Hyoscyamus niger," belonging to the family of 'solanaceae'.
GEOGRAPHICAL SOURCE: US, Canada, Europe, England, India	GEOGRAPHICAL SOURCE: England, Germany, India, Srilanka	GEOGRAPHICAL SOURCE: USA, central Europe, siberia
MORPHOLOGY: - ovate * Dorsiventral leaf. * Pale green in colour, Dull green to yellowish green * Unpleasant odour * Bitter taste * Perinneal herb.	MORPHOLOGY * Dorsiventral leaf, Entire margin * green in colour * unpleasant odour * Very bitter taste & odour * Annual herb	MORHOLOGY: * Dorsiventral leaf * pale green in colour * ~~unpleas~~ strong odour * Ovate * short petiole, acute triangular lobes

ATROPA	DATURA	HYOSCYAMUS
		
MICROSCOPY: * Dorsiventral leaf * presence of covering and granular trichomes * Anisocytic and some of anomocytic stomata. * Presence of micrasphenoidal crystals.	MICROSCOPY: * Dorsiventral leaf * Presence of covering and granular trichomes * Anisocytic stomata present * Presence of microsphenoidal (sandy) crystals	MICROSCOPY: * Dorsiventral leaf * presence of covering and granular trichomes * Anisocytic stomata * Presence of microsphenoidal crystals

ATROPA	DATURA	HYOSCYAMUS
 Anisocytic stomata  Anomocytic stomata	 Anisocytic stomata	 Anisocytic stomata
CHEMICAL CONSTITUENTS: * Alkaloids * Tropane alkaloids * True alkaloids * L - Hyoscyamine * Hyoscine (Scopolamine) * ± Atropine (Racemix mixture) of Levo-Hyoscyamine.	CHEMICAL CONSTITUENTS: * Alkaloids * Tropane alkaloids * True alkaloids * L - Hyoscyamine * Hyoscine (Scopolamine) * ± Atropine	CHEMICAL CONSTITUENTS: * Alkaloids * Tropane alkaloids * True alkaloids * L - Hyoscyamine * Hyoscine (Scopolamine) * ± Atropine

ATROPA	DATURA	HYOSCYAMUS
 L-Hyoscyamine (*)	 L-Hyoscyamine	 L-Hyoscyamine (*)
 Hyoscine (scopolamine)	 Hyoscine	 Hyoscine
± Hyoscyamine = Atropine		

Atropa	Datura	Hyoscyamus
Uses: * It is a parasympatholytic drug with anticholinergic properties * Used to reduce the secretion such as sweat, saliva and gastric juice. * Used as antidote in opium and chloral hydrate poisoning. * Leaves are mainly used as internal preparations which are used as sedatives * Roots mainly used for external preparations.	Uses: It is a * parasympatholytic with anticholinergic and central nervous system depressant effect. * Used in cerebral excitment * Used in treatment of asthma and cough * Hyoscine hydrobromide is used in motion sickness, gastric (or) duodenal ulcers. * Atropine and hyoscine are used for large extent in opthalmic practice (or) preparation to dilate pupil of the Eye. * Along with morphine, it is used as preoperative medications.	Uses: * Used to counteract gripping due to purgatives * Expectorant * Antispasmodic * Anti asthmatic * It resembles belladona and atropa in action, but is some what weakes. * It shows weaker thera-peutical actions than Atropa and Datura.

24

COCA

COMMON NAME:

Java coca;

Bolivian coca;

Peru coca;

Cocaine

BIOLOGICAL SOURCE:

Coca consists of dried leaves and flowering parts of "Erythroxylon coca" and (Bolivian) "Erythroxylon truxillense", belonging to the family of 'Erythroxylaceae'. (Peruvian)

GEOGRAPHICAL SOURCE:

Native to ~~Java~~, Bolivia, Peru, Ceylon, Indonesia, colombia; cultivated in Java, Srilanka, India

MORPHOLOGY:

* Isobilateral
* odourless
* Bitter taste
* Greenish to brown colour.
* Coca leaves at first slightly aromatic causing numbness of the tongue.

(B)

elliptical shape

(Oval)

(P) (Isobilateral)

smaller than boilivia

Entire margin

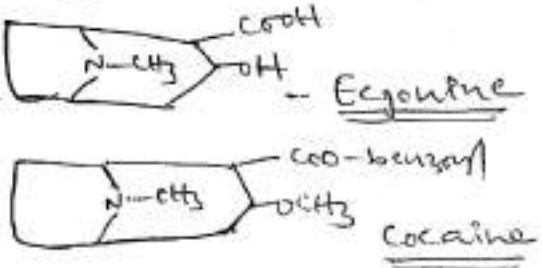
ovate (Elliptical)

MICROSCOPY :- Isobilateral paracytic stomata, donot show Trichomes.

cocaine + H_2SO_4 $\xrightarrow{\Delta}$ followed by add^n & mixing & water

CHEMICAL CONSTITUENTS :- Alkaloids, Tropane, Tme.

* Cocaine - (Methyl benzoyl) — ⊕Methyl benzoate fmcl.
* Methylated cocaine
* Ecogonine



Ecgonine

Cocaine

USES :

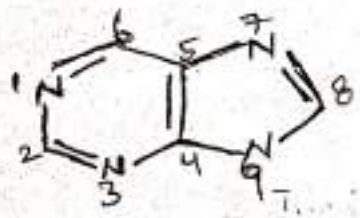
* Local anaesthetic & lead molecule for synthetic anaesthetia.

* It reduces the sedative and respiratory depressant~~stimulant~~ actions of morphine and other allied drugs due to CNS stimulant actions of cocaine.

* Because of its toxic, additive property, it's use is now almost confined to opthalmic, ear, nose and throat surgery.

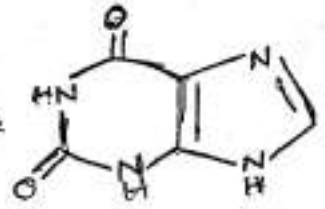
* Cocaine - commonly inhaled as smoke / dissolved acid injected into a vein → mental effects: lost of contact ε reality, intense feeling of happiness; physical :- fast heart rate, sweating, large pupils

PURINE ALKALOIDS



(Pyrimidine + Imidazole)

degradation



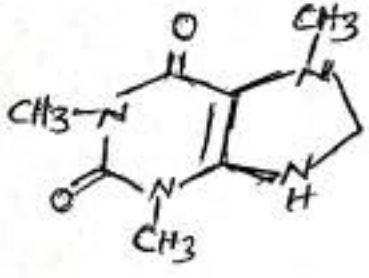
Xanthine

→ Uricacid

Ex: kola seeds
Coffee
Tea

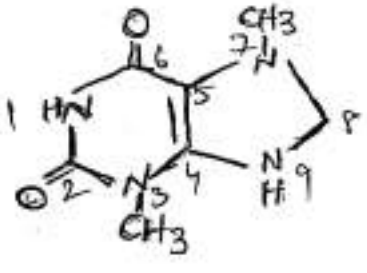
Methylated xanthines

Caffeine



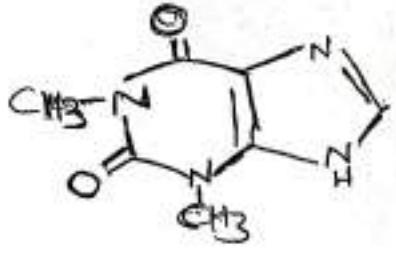
1,3,7 trimethyl xanthine

Theobromine



3,7 dimethyl xanthine

Theophylline



1,3 dimethyl xanthine

* Do not respond with general alkaloid chemical tests like;
Mayer's, dragendroff's, Wagner's, Hager's test.
* It has specific chemical test ie., "Murexide test".

① Murexide test = powder drug + potassium chlorate + Hydrochloric acid

↓

Heated to dryness

↓

purple blue colour produced
when solution exposed to NH_3 Vapour

↓

On addition of Alkali

↓

Purple —— Disappears.

② Caffeine also produces white precipitate with tannic acid solution.

Caffeine

More - CNS stimulant
Less - diuretic

Theobromine

Both stimulant & diuretic equally, smooth muscle relaxant

Theophylline

More - Diuretic
Less - CNS stimulant

Effect	Caffeine	Theobromine	Theophylline	
CNS Stimulation	+++	+	++	
RS - Stimulation	+++	+	++	
Diuresis	++	+	+++	
Cardiac Stimulation	+	++	+++	← Coronary dilation
Skeletal Muscle Stimulation	+++	+	+++	
Smooth Muscle relaxation	+	+	+++	

Coffee (Caffeine)	Tea (Theophylline)
COMMON NAME: Kaapi (Siddha) Arabian coffee seeds	COMMON NAME: Unavi – Chaai
BIOLOGICAL SOURCE: coffee consists of dried and fresh coffee beans of "coffea arabica", belonging to the family of 'Rubiaceae'/'coffeaceae'.	BIOLOGICAL SOURCE: Tea consists of dried and fresh leaf and leaf buds of "Theasinensis", belonging to the family of 'Theaceae' {Camellia-sinensis}
GEOGRAPHICAL SOURCE: India, Brazil, Mexico, Srilanka, Nepal * In 1652, first coffee shop opened in London.	GEOGRAPHICAL SOURCE: India (Tamil Nadu), Karnataka, Nepal, Brazil, srilanka, Africa, china, Japan, Indonesia
MORPHOLOGY: coffeea arabica is evergreen small herb grown about 5m height, flowers are white in colour, leaves are arranged opposite to each other. * Drupe fruit, it has two locules composed of two seeds – green, dark brown pleasant (or) aggreable odour, Bitter taste	MORPHOLOGY: – Small evergreen herb * Lanceolate (or) elliptical shape * Entire margin * Acute apex * Green colour – Dark green * slight odour * Bitter taste * Isobilateral leaf.

Coffee

* Beans are pale green to yellow then becomes black colour during roasting process, kernel is dark brown colour, hard to touch.
* Bitter taste.

CHEMICAL CONSTITUENTS:

* Alkaloids
* Pseudo alkaloids
* purine base alkaloids
* caffeine (63%) — salt of chlorogenic acid
* Theobromine — Caffeol — furfural, methyl mercaptan
* Theophylline
* sugars
* caffeol
* Readily soluble in hot water
* Tannins (10 - 13%)
* ~~caffiene~~
* Resins
* Wax compounds, fatty acids (10 - 15%)
* Proteins (20%)

Tea

* young leaves are hairy and older leaves are glabrous.

CHEMICAL CONSTITUENTS:

* Alkaloids, gallotanic acid (15+),
* Pseudo alkaloids — thease - Enzyme.
* caffiene (1-3%) — polyphenols - >45%
* Theophylline — epicatechin gallate, Epigallocatechine gallate
* Theobromine
* Proteins
* Flavonoids

  Quercetin - Green tea

  Antioxidants, Anticancer, Antidiabetic

* The possible beneficial effects of drinking Green tea, which possesing mixture of polyphenol shows that strong antioxidant property, inhibition of free radicles, prevent the genetic haemochromatosis.

Coffee

* On average 1 cup of coffee approximately containing 60-120 mg of caffiene, in tea decotion it contains 30-35 mg of caffiene

Uses:

1 cup of coffee — 60-120 mg of caffeine

* CNS stimulant
* Diuretic
* flavouring agent
* Antiasthmatic
* Anti carcinogenic
* Anti cancer
* Anti narcotic

* According to WHO, Coffee drinking is not responsible for breast cancer and may protect against colon cancer and rectum
Caffeic acid & Chlorogenic a — Anti carcinogen
* Chlorogenic acid — mi eg — Inhibit — G-6-p, which lower hepatic glucose production, Caffeine seems to stimulate pancreatic — β-cells to secrete Insulin.

Tea

* Lower the problems of certain cancers, Anti inflammatory, improve the insulin function, promote the mouth health and potentially decreases the heart problems.

USES:

* CNS stimulant, Astringent
* Diuretic
* Anti oxidant
* Anti cancer
* Anti diabetic

* In china used for — diarrhea dysentery
* Chinese green Tea — anti cancer
* Japanese green Tea — hepatoprotective

KOLA

COMMON NAME:

Kola nut

BIOLOGICAL SOURCE:

Kola consists of dried and fresh cotyledons of seeds of "Colanitola" (~~Sterculiantheia~~ Cola) belonging to the family of 'Sterculiaceae'.

GEOGRAPHICAL SOURCE:

Brazil, Mexico, Jamaica, Srilanka

European countries

MORPHOLOGY:

* Green to brown colour.
* Aggreable odour and taste
* Ever green plant fruits, along with green colour shiny surface. [12-20 M]
* seed 4-8 per Carpel
* Ovoid in shape; with red to white colour.
* Nuts are bitter taste when taken at first but they leave a sweet taste in the mouth later. [become more aromatic as they Age].

CHEMICAL CONSTITUENTS:

* Alkaloids
* Pseudo alkaloids
* Caffiene (1-2%)
* Theobromine
* Theophylline, Tannins

* fatty acids
* Volatile oils
* 13.5% of water,
  19.5% of crude protiens,
  13.5% of fat, 45% of sugars.

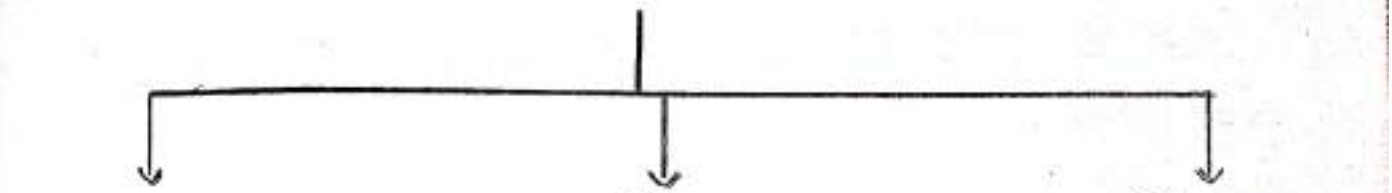
Uses:

* CNS stimulant
* Diuretic
* They improve the mental state.
* Now- ~~oeldrive~~ stimulant and used mechanically for diahrrea.

(9). STEROIDAL ALKALOIDS

Ex: Kurchi - Apocynaceae
Ashwagandha - Solanaceae
Solanum - Solanaceae

Steroidal Alkaloids



C_{24}
* steroidal skeleton + Nitrogen

Ex: Kurchi

C_{28}
* steroidal skeleton + Nitrogen

Ex. Ashwagandha
Veratrum

C_{27}
* steroidal skeleton + Nitrogen + Glycoside structure (Sugar)

Ex: Solanum

SOLANUM

COMMON NAME:

Yellow berried plant, Pinnamulaka
wild egg plant, Nelamulaka
Kantakaari (Ayurveda) Vankuda

BIOLOGICAL SOURCE:

Solanum consists of dried and fresh fruits of "Solanum xanthocarpum", belonging to the family of 'Solanaceae'.

GEOGRAPHICAL SOURCE:

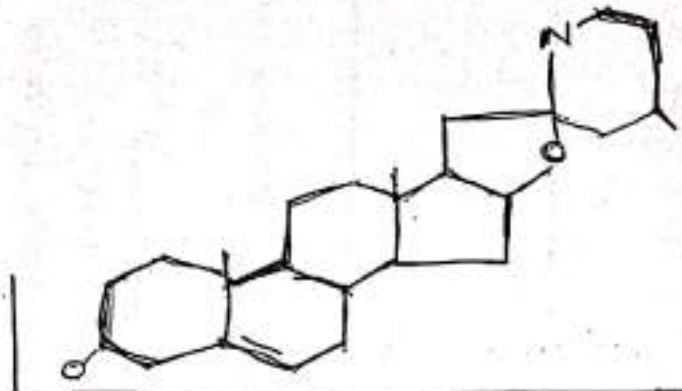
Throughout India, Europe

MORPHOLOGY: — Annual herb

* Yellowish in colour / dull black
* Ovate shape
* Drupe fruit
* odourless
* Bitter taste

CHEMICAL CONSTITUENTS:

* Alkaloids - 3.5%
* True alkaloids
* Steroidal alkaloids
* Solanine ⟶ Solasoidine + 3 glucose units + Rhamnose
* fatty acids like oleic, palmitine, steric acids.
* The mixture of fatty acids and steroidal glycoalkaloids cause the depletion of histamine in lung tissue



Solanidine

Glucose
Rhamnose
~~Glucose~~
Glucose

α- Solanine

Uses:

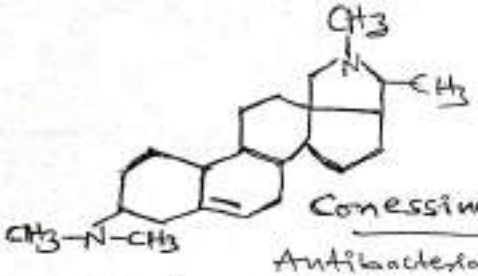
* Expectorant, Stimulant —
* Respiratory system stimulant
* Used in Asthma
* Anti inflammatory
* Diuretic — to cure dropsy.
* Used in partial synthesis of steroidal hormone.
* Laxative
* Used against rhematism.
* (Both glycoalkaloid and fatty acid fractions — causes liberation of histamine from chopped lung tissue. / depletion of Histamine)
* Hypotensive action

KURCHI	ASHWAGANDHA
COMMON NAME: Holarrhena, Kutaja (A) Kerchi bark Easter tree	COMMON NAME: Indian Ginseng, Vaajkari clustered cherry bark clustered winter cherry
BIOLOGICAL SOURCE: It consists of dried stem bark of "Holarrhena antidysentrica, belonging to the family of 'Apocynaceae'.	BIOLOGICAL SOURCE: Stem barks and It consists of dried fresh of root of "Withania Somnifera", belonging to the family of 'Solanaceae'.
GEOGRAPHICAL SOURCE: India (Himalaya, Kashmir) Afghanistan	GEOGRAPHICAL SOURCE: India (UP, AP) All European countries
MORPHOLOGY: * Brown in colour * Bitter taste * odourless * curved at both ends. * Outer surface is longitudinally wrinkled and bears horizontal lenticels * Curved shape.	MORPHOLOGY: * Grey to buff colour, unbranched * conical shape * odourless / fresh root-s smell similar * Bitter taste to urine of horse. * Root has crown which contains rootlets and scars.

KURCHI	ASHWAGANDHA
MICROSCOPY:	MICROSCOPY:
CHEMICAL CONSTITUENTS: * Alkaloids * True alkaloids * steroidal alkaloids * Kurchicin / conessine * Tannins / fatty acids	CHEMICAL CONSTITUENTS: * Alkaloids — steroidal lactones * True alkaloids * steroidal alkaloids

KURCHI

* Con-S-enine substituted by N,N-dimethyl amine at-5C



Conessine

Antibacterial
Anti helminthic
H_3-receptor antagonist

It is a tertiary amine compound.

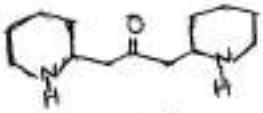
Uses:

* Used in chronic amoebiasis as antidiarheal drug | In amoebic dysentery
* Important ingredient in "kutajarishta" used in chronic amoebiasis.
* Diuretic.
* Immunostimulant — property

ASHWAGANDHA

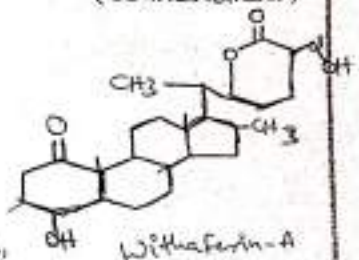
Ashwagandha

- Root Alkaloids
  - Ex: Anaferine



*Flavinoids like, Quersitine, Gallotannins, fixed oils.

- Steroidal lactones (withanolides)



Withaferin-A

Uses:

* Immunomodulatory, CNS, CVS, RS stimulant.
* Aphrodisiac (sex stimulant)
* Adaptogen
* Antibacterial, Antiviral, Antifungal agent
* Anti inflammatory, Hepatoprotective
* API recommends in Impotency.

BIOLOGICAL AMINES / AMINO ALKALOIDS

Dopamine ← Locophora — Mescaline — Tyrosine
Adrenaline ← Ephedra — Ephedrine
Anti Cancer & Gout ← Colchicum — Colchicine
phenylanaline amino acids

EPHEDRA (phenylalanine aminoacid)

COMMON NAME:
Mattaung

BIOLOGICAL SOURCE:
Ephedra consists of dried young stems of "Ephedra gerardiana", belonging to the family of 'Ephedraceae'.

GEOGRAPHICAL SOURCE:
China, Pakistan, India Afghanisthan

MORPHOLOGY:- Gymnosperm plant
* Grey to greenish colour
* stem is cylindrical in shape
* Nodes and internodes present. each node has two small scaly leaves

COLCHICUM

COMMON NAME:
Meadow Saffron Seeds
Autumn crocus.

BIOLOGICAL SOURCE:
Colchicum consists of dried seeds and corms of "Colchicum autamnale", belonging to the family of 'Liliaceae'.

GEOGRAPHICAL SOURCE:
All European Countries
India

MORPHOLOGY: - Seeds - very hard
* Reddish brown in colour
* odourless
* Bitter taste
* ovate shape

Ephedra

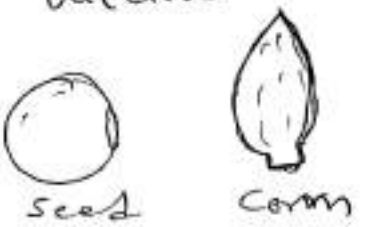
* Characteristic odour
* Bitter taste

MICROSCOPY OF EPHEDRA

Colchicum

Corms:—

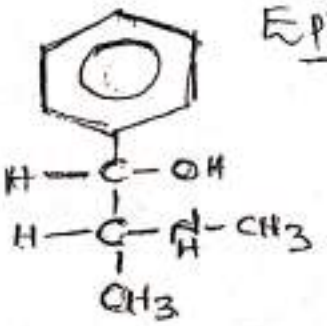
- yellowish brown
- odourless
- Bitter and acrid
- sub erect form, ovate in outline



CHEMICAL CONSTITUENTS:

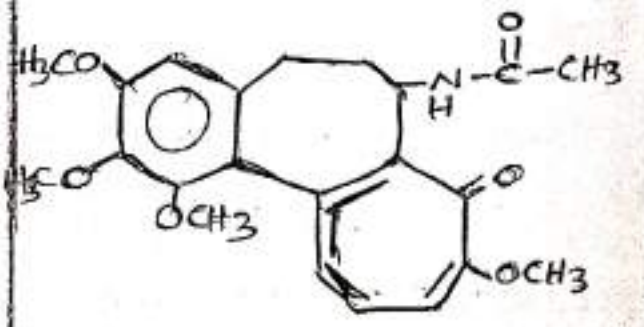
* Alkaloids
* Proto alkaloids
* Ephredrine, pseudoephedrine

Ephedrine



CHEMICAL CONSTITUENTS

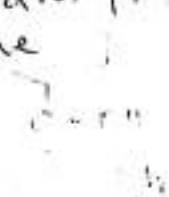
* Alkaloids
* Proto alkaloids
* Colchicine (tropolone) (0.8%)



Tropolone

Ephedra

* Ephedrine is-1-phenyl-1-hydroxy-2-Methylamino propane



→ Nor-ephedrine, N-Methyl ephedrine

→ Ephedrine + water + dil. HCl + $CuSO_4$ + NaOH → violet colour

Uses:

* Used in the asthma as a branchodilator.
* Vasoconstrictor
* It has actions like adrenaline neurotransmitter
* sympathomemitic (or) acts as parasympathomimetic (lytic)
* Expectorant
* Emetic
* have hypotensive effects.
* As compared to adrenaline the onset of action for ephedrine is slow, but the effect is much prolonged.

Dose:- Ephedrine HCl / sulphate - 25-30mg 6-8 times a day

- 0.1ml of 1-3%. - 2-3 times a day. I.V

Colchicom

Colchicine → pale yellow crystal freely soluble in alc & chloroform

→ Alc + colchicine
↓
treated with $FeCl_3$
↓
Red colour

Uses:

* Used in gout and rheumatic pains.
* It has the ability to dissolve the accumulated uric acid crystals at joints.
* Anti-inflammatory agent.
* Used in chronic constipation.
* Anti cancer
* Used as Mutagen
* It is one of toxic alkaloid and should not be used in pregnant women and the person who were suffered with kidney problems.

Chemical Tests for Opium

Often opium alkaloids are associated with meconic acid in plant body. According to the presence or absence of meconic acid, can identify the opium alkaloids.

① Opium powder + water

↓

filtration

↓

filtrate

↓

To the filtrate

add $FeCl_3$

↓

Deep reddish purple

↓

Opium present

② Opium powder + Conc. H_2SO_4 / HNO_3

↓

Lemon-orange red color

↓

presence of morphine and

absence of codiene

③ Powder drug + Potassium ferri cyanide
+ $FeCl_3$

↓

Reddish - brown colour

↓

Presence of morphine and
absence of codeine

④ Powder drug + HCl + Potassium ferricyanide

↓

Lemon - yellow colour

↓

Presence of papaverin
absence of morphine and codeine

CINCHONA TEST

1) THALLAEQUIN TEST:

Powder drug + Water + Conc. H_2SO_4

↓

Add slowly bromine solution,
till acquired permanent yellow colour

↓

Add NH_3

↓

Green colour

2) Powder drug, moisture with glacial acetic acid and heat for 2-5 min and observed the presence of blood red colour spots on walls of test tube.

↓

Presence of Quinine and Quinidine

Veratrum

V. viride

American / Green hellebore

* dried rhizome
* Liliaceae - Melanthiaceae
* USA

perennial

- Brown
- unpleasant
- Acrid
- subcylindrical

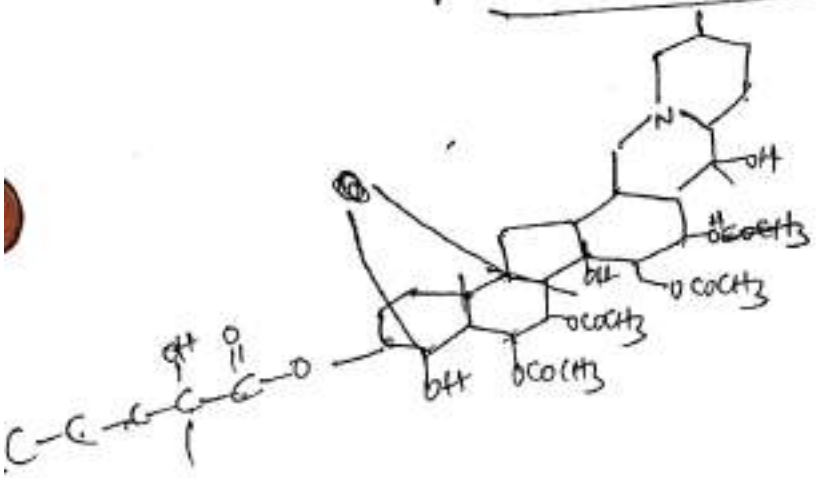
V. album

White hellebore
European

—
—
— Europe

- Brown
- unpleasant
- Bunny, acrid
- Tuberous, fleshy

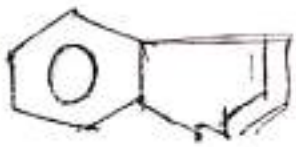
proveratrine A & B



5. INDOLE

(Tryptophan Aminoacid) + Mevalonic acid

Ex: Rauwolfia - Apocyanaceae
Vinca - Apocyanaceae
Nux Vomica - Loganiaceae
Ergot - clavicipitaceae, Graminae / poaceae
Graminae



Benzo-pyrrole

Rauwolfia - Endangered in India

COMMON NAME: Serious risk of extinction / Endangered

Indian snake root,
Sarpagandha,
chota chand

BIOLOGICAL SOURCE:

It consists of dried roots and rhizomes of "Rauwolfia serpentina", belonging to the family of 'Apocyanaceae'.

GEOGRAPHICAL SOURCE:

India - UP, WB, TN, Bihar, KA, MH
North Australia,
Thailand,
Indonesia
Pakistan

Vinca

COMMON NAME:

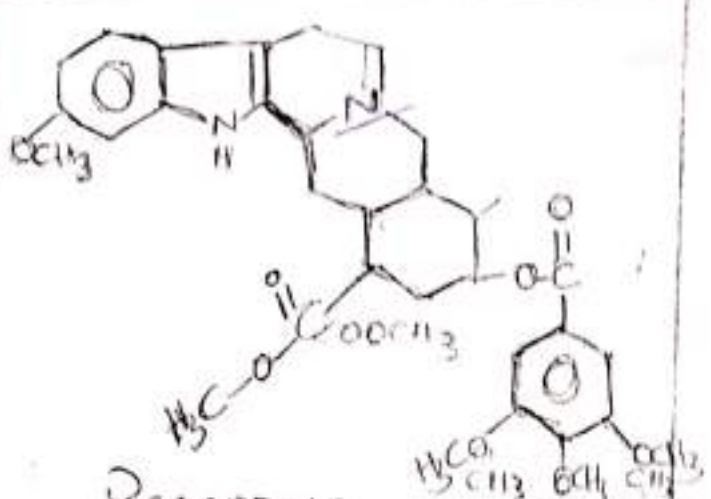
Catharanthus,
Periwinkle,
Madagascar,
Billagannеru

BIOLOGICAL SOURCE:

It consists of whole herb of "catharanthus roseus" belonging to the family of 'Apocynaceae'.

GEOGRAPHICAL SOURCE:

Vinca plant cultivated in botanical gardens of all european countries.
It is distributed as garden plant.



RESERPINE

Indole - piperidine - trimethoxy benzoic acid

* ajmaline, ajmalicine, yohimbine serpentine

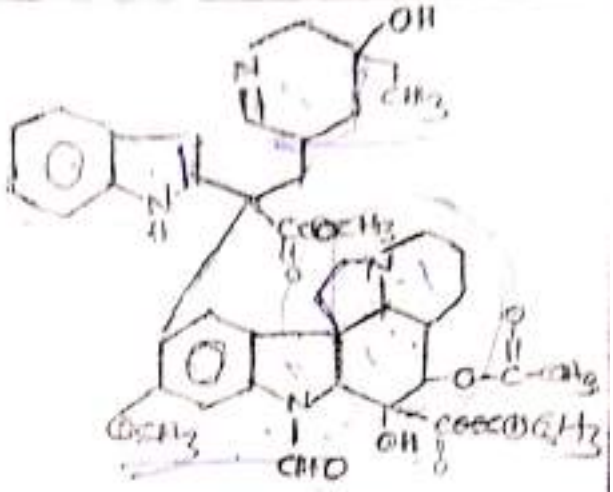
* Syrosingopine — Methyl Carbox- carbethoxy Syringopine reserpate

- less sedative action, used in mild/moderate H.T.

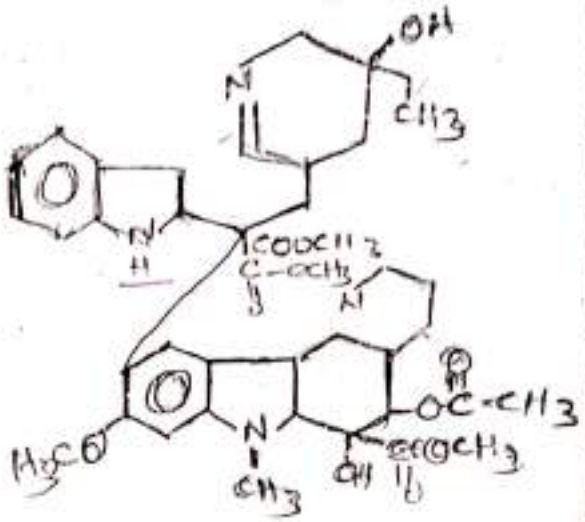
* Reserpine + vanillin in acetic ↓ violet red colour

Uses:

* Antihypertensive.
* Sedative & hypnotic
* Used in various neuro-psychiatric disorders
  - In mild anxiety
  - transquilliser.
* Ajamaline = quinidine = CA
* R. vomitoria (African-R)
  R. tetraphylla
  R. densiflora



Vincristine



Vinblastine

Uses:

* Anticancer
* Antitumor
* cytotoxic drug
* In European countries o. leaf juice is used in diabetics and toothache problems.
* Vincristine Sulphate, Vinblastine Sulphate → Antineoplastic agents
* Anti HT and Antidiabetic

Nux Vomica

COMMON NAME:

Poison nut

Crow fig

BIOLOGICAL SOURCE:

Nux-vomica consists of dried ripe seeds of "Strychnos nuxvomica" belonging to the family of 'Loganiaceae'.

Strychnos = poisonous

Nuxvomica = a nut with vomiting effects

GEOGRAPHICAL SOURCE:

India, Srilanka

All European countries,

Burma.

Mainly Collected in India & Exported from Chennai, Bombay Cochin

MORPHOLOGY:- Extremely hard

* Grey to greenish colour.
* Disc shape. flat, 10-30 mm & 4-6 mm
* odour less when dry, but if ed in water, left for a day/two, then develop a very unpleasant
* Bitter taste; Intensely, very toxic Bitter

ERGOT

COMMON NAME:

Rye ergot

BIOLOGICAL SOURCE:

Ergot consist of dried sclerotium of fungus, "Claviceps purpurea", belonging to the family of 'clavicipitaceae' develop in the ovary of the rye on ovary of rye (or) rice plant of "Secale cereal" belonging to the family of 'Graminae (or) poyaceae'

GEOGRAPHICAL SOURCE:

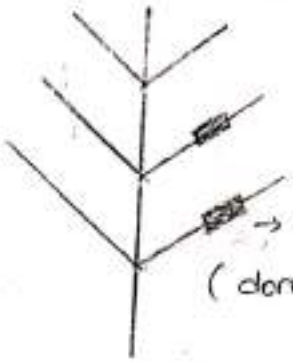
Commonly ergot is cultivated and collected from the membord of Graminae family.

Switzerland, UK. / Hungary

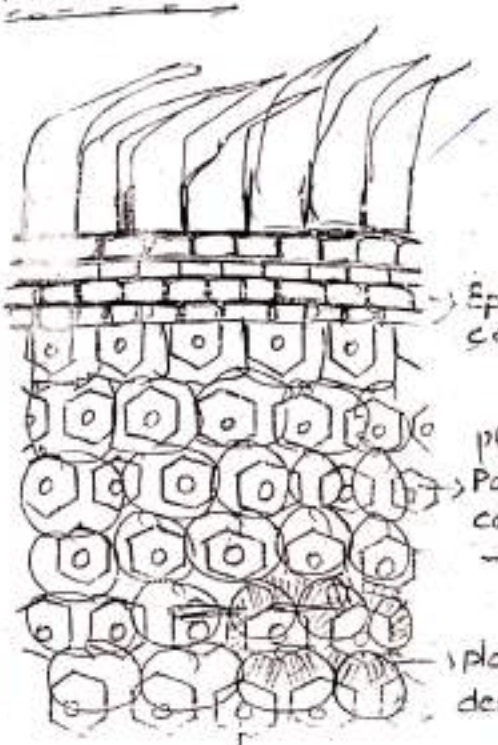
MORPHOLOGY:- 1-4 cm long 2-7 mm broad

* Brown to black colour.
* Fusiform & slightly curved at both ends.
* Unpleasant, bitter-toxic taste.
* Unpleasant odour.

* Surface has numerous silky hairs, radiating from centre (or) hilum
* powder + NaOH → develop a strong odour of Trimethylamine



MICROSCOPY:



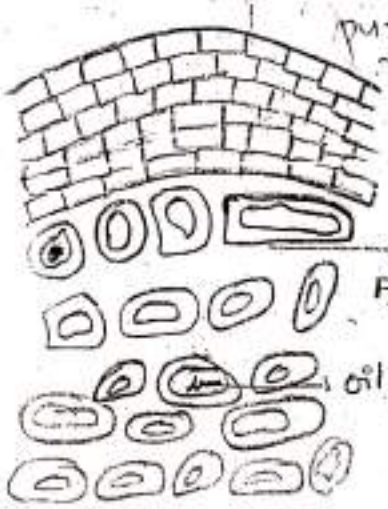
Cellulose & lignin – absent

CHEMICAL CONSTITUENTS:

* Alkaloids 1.8–5.3%
* True alkaloids
* Indole group of alkaloids
* Strychine – phagocytosis cells much more active (1.23%)
* Brucine (1.55%)
* Strychine is more bitter and toxic drug than brucine.

MICROSCOPY:

SCLEROTIUM OF ERGOT



Contain protein, fixed oil
packed with R.E. cells
Refractive walls

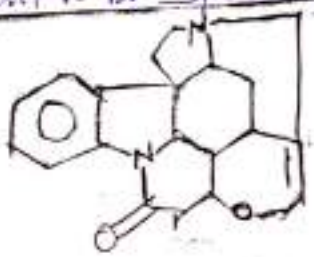
CHEMICAL CONSTITUENTS:

* Alkaloids – 0.1–0.25%.
* True alkaloids
* Indole group of alkaloids.
* Ergot alkaloids – Ergolines

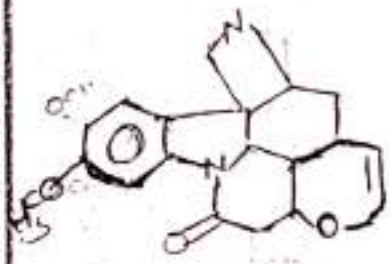
(1) Clavine-type – are derivatives of 6,8, dimethyl ergoline – mycelium of Ergot

(2) Lysergic acid – peptide – pharmacologically active – Ergot sclerotium

(CDC (Centers for Disease Control & Prevention)



Strychnine — Monoterpenoid heterocyclic indole



Brucine

Glycosides — togenin, Chlorogenic acid

Uses:

* Bitter tonic, Analeptic (Rodenticide)
* Acts as appetizer.
* CNS, CVS & respiratory system stimulant
* Cardiotonic
* In large doses it may cause tetanus.
* Brucine possesses very less physiological actions than Strychnine.

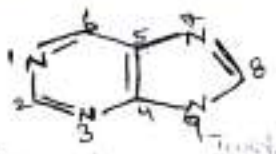
Ergot alkaloids

- Ergotamine
- Ergometrine
- Ergotoxine
  - Water insoluble
    - L-Ergoptine
    - D-Ergol
  - Water soluble
    - L-Ergotamine
    - D-Ergotamine
  - Active
    - L-Ergosinine
    - D-Ergosinine
    - L-Ergometrine
    - D-Ergometrine

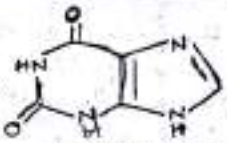
Uses:

* Traditionally used in post partum - haemorrhage.
* Oxytocine like action.
* Ergometrine derivative cpds has specific analgesic action in migrane.
* Ergotamine derivative Cpds act as psychomimetic action.

(8) PURINE ALKALOIDS



degradation



→ Uricacid

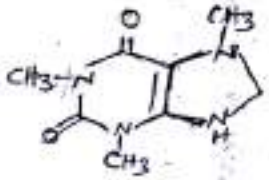
Ex: Kola seeds
Coffee
Tea

Xanthine (Do not occured in free state and found in)

P: (Pyrimidine + Imidazole)

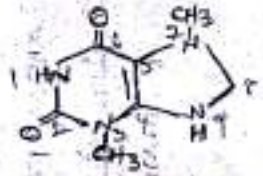
Methylated xanthines

Caffeine



1,3,7 trimethyl xanthine

Theobromine



3,7 dimethyl xanthine

Theophylline

1,3 dimethyl xanthine

* Do not respond with general alkaloid chemical tests like; Mayer's, Dragendroff's, Wagner's, Hager's test.
* It has specific chemical test i.e., "Murexide test".

① Murexide test = powder drug + potassium chlorate + Hydrochloric acid

↓

Heated to dryness

↓

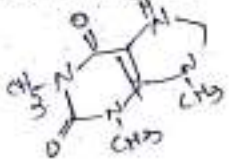
purple blue colour produced when solution exposed to NH_3 vapour

↓

on addition of Alkali

↓

Purple ——— Disappears.



② Caffeine also produces white precipitate with tannic acid solution.

Caffeine	Theobromine	Theophylline
More - CNS stimulant Less - diuretic	Both stimulant & diuretic equally, smooth muscle relaxant	More - Diuretic Less - CNS stimulant

Effect	Caffeine	Theobromine	Theophylline	
CNS stimulation	+++	+	++	
KS - stimulation	+++	+	++	
Diuresis	++	+	+++	
Cardiac stimulation	+	++	+++	← Coronary dilation
Skeletal Muscle Stimulation	+++	+	+++	
Smooth Muscle relaxation	+	+	+++	

SOLANUM

COMMON NAME:

Yellow berried plant, Pinnamulaka
wild egg plant, Nelamulaka
Kantakaari (Ayurveda) Vankuda

BIOLOGICAL SOURCE:

Solanum consists of dried and fresh fruits of "Solanum xanthocarpum", belonging to the family of Solanaceae.

GEOGRADHICAL SOURCE:

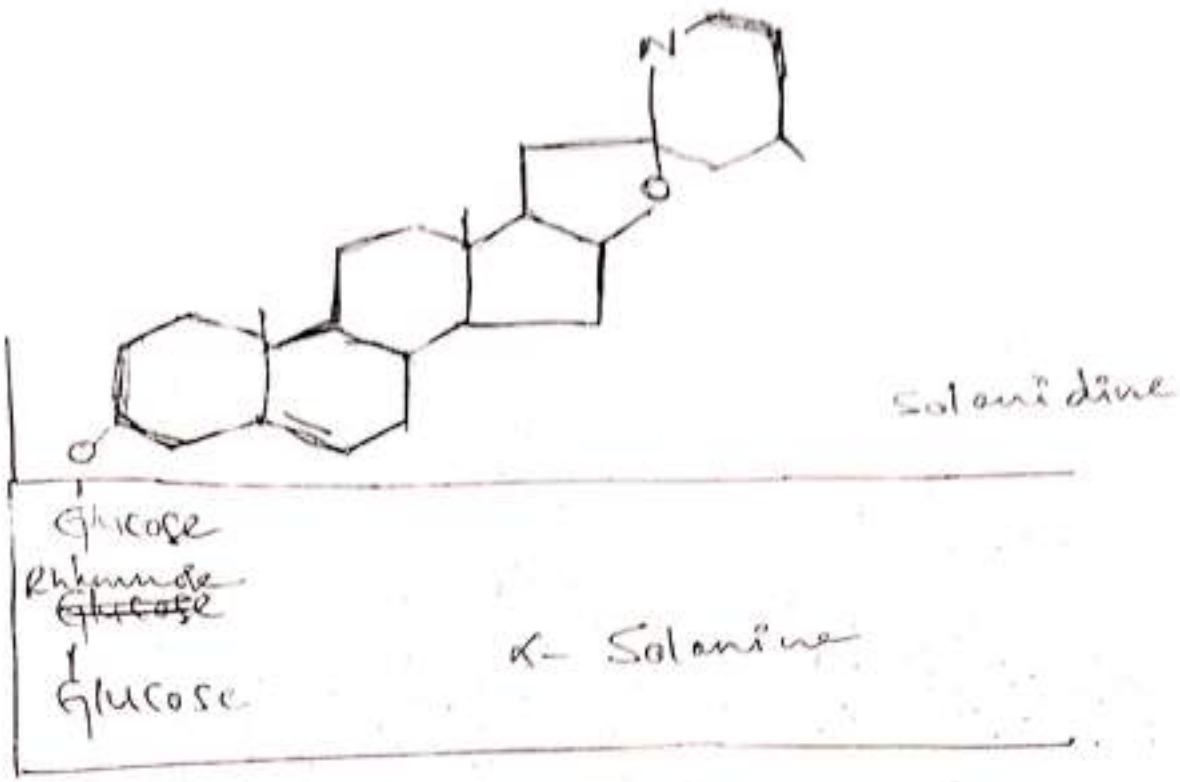
Throughout India, Europe

MORPHOLOGY: — Annual herb

* Yellowish in colour / dull black
* Ovate shape
* Drupe fruit
* odourless
* Bitter taste

CHEMICAL CONSTITUENTS:

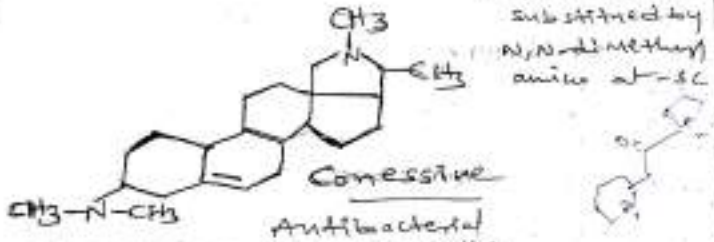
* Alkaloids - 3.5%
* True alkaloids
* Steroidal alkaloids
* Solanine → Solasoidine + 3 glucose units + Rhan
* fatty acids like oleic, palmitine, steric acids.
* The mixture of fatty acids and steroidal glycoalkaloids cause the depletion of histamine in lung tissue



Uses:

- * Expectorant, Stimulant
- * Respiratory system stimulant
- * Used in Asthma
- * Anti inflammatory
- * Diuretic — to cure dropsy.
- * Used in partial synthesis of steroidal hormone.
- * Laxative
- * Used against rheumatism.
- * (Both glycoalkaloid and fatty acid fractions — causes liberation of histamine from chopped lung tissue. / depletion of Histamine)
- * Hypotensive action

KURCHI



* Con-Seniine substituted by N,N-di Methyl amino at-3C

Conessine

Antibacterial
Anti helminthic
H_2-receptor antagonist

It is a tertiary amino compound.

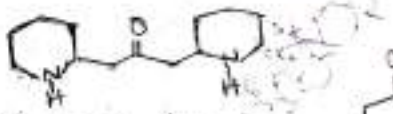
Uses:

* Used in chronic amoebiasis as antidiahorral drug / in amoebic dysentery
* Important ingredient in "Kutajarishta" used in chronic amoebiasis.
* Diuretic
* Immunostimulant — property

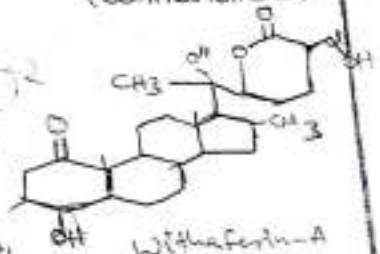
ASHWAGANDHA

Ashwagandha

- Root Alkaloids
  eg: Anaferine



- steroidal lactones (withanolides)



*flavinoids like, Quersitine, Gallotannins, fixed oils.

Withaferin-A

Uses:

* Immunomodulatory, CNS, CVS, RS stimulant.
* Aphrodisiac (sex stimulant)
* Adoptogen
* Antibacterial, Antiviral, Antifungal agent
* Anti inflammatory, hepatoprotective
* API recommends in impotency.

[C] AN INTRODUCTION TO BIOGENESIS OF PHYTOPHARMACEUTICALS

The living plant may be considered as a biosynthetic laboratory not only for the primary metabolites like sugars, amino acids and fatty acids that are utilized as food by man, but also for a multitude of secondary products of pharmaceutical significance such as glycosides, alkaloids, flavonoids, volatile oils, etc. A higher plant is a solar-powered biochemical factory which manufactures both primary and secondary metabolites from air, water, minerals and sunlight. Primary metabolites are substances that are widely distributed in nature, occurring in one form or another in virtually all organisms and are needed for general growth and physiological development, because of their basic cell metabolism. Secondary metabolites are biosynthetically derived from primary metabolites but are more limited in distribution, usually being restricted to a taxonomic group. They may represent chemical adaptations to environmental stresses, or they may serve as defensive, protective or offensive chemicals against microorganisms, insects and higher herbivorous predators. They are sometimes considered to be waste or secretory products of plant metabolism. In terms of cellular economy, secondary products are in general expensive to produce

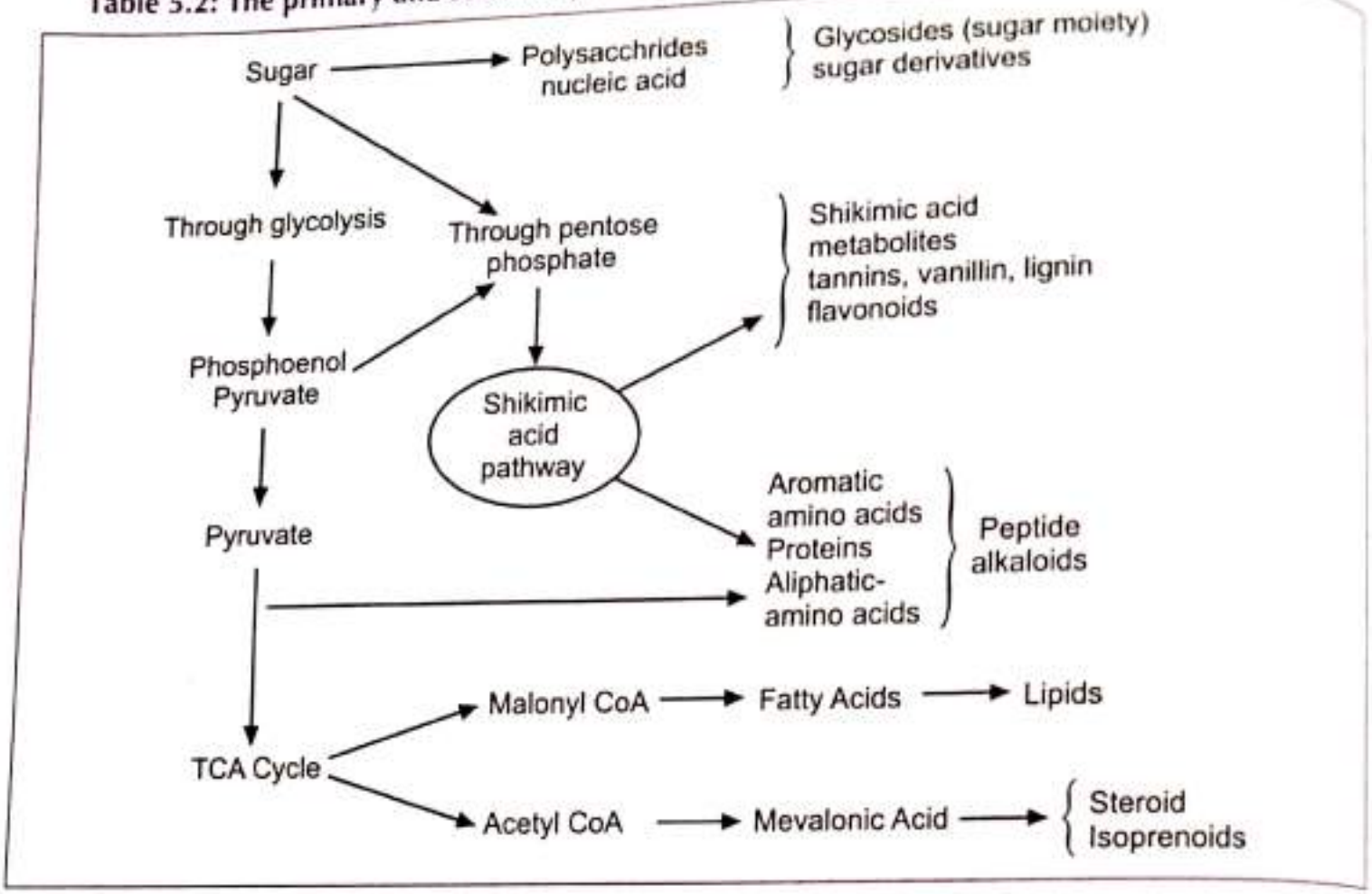
and accumulate, and are, therefore frequently present in plants in much smaller quantities than are primary metabolites.

The photosynthetic process in green plants is essential for all animal life on earth, since it initiates conversion of solar energy into organic carbon compounds which in turn are used to produce essential foods. The photosynthetic sequence in green plants is capture of light and use of its energy to liberate molecular oxygen from water to synthesize organic compounds from carbon dioxide, nitrate and sulphate. The major source of carbon is usually glucose, which is photosynthesized in green plants. The recent advances in the field of biochemistry have greatly clarified enzyme-catalyzed and interrelated reactions resulting in formation of primary metabolites and their role in the synthesis of secondary products, many of which are used by man. Since these secondary products do not occur in all plants, their biochemistry was ignored until several decades by those interested in chemical plant physiology. Nevertheless, many of them are extremely important as pharmaceutical agents.

The various biosynthetic reactions occurring in plant cells are enzyme-dependent, wherein enzymes act as catalysts of metabolism and it is through the control of enzymatic activity that plant metabolism is directed into specific biosynthetic pathways. The enzymatic reactions are reversible and in plants, many a time, the secondary metabolites are synthesized and hydrolyzed under the influence of more or less specific enzymes.

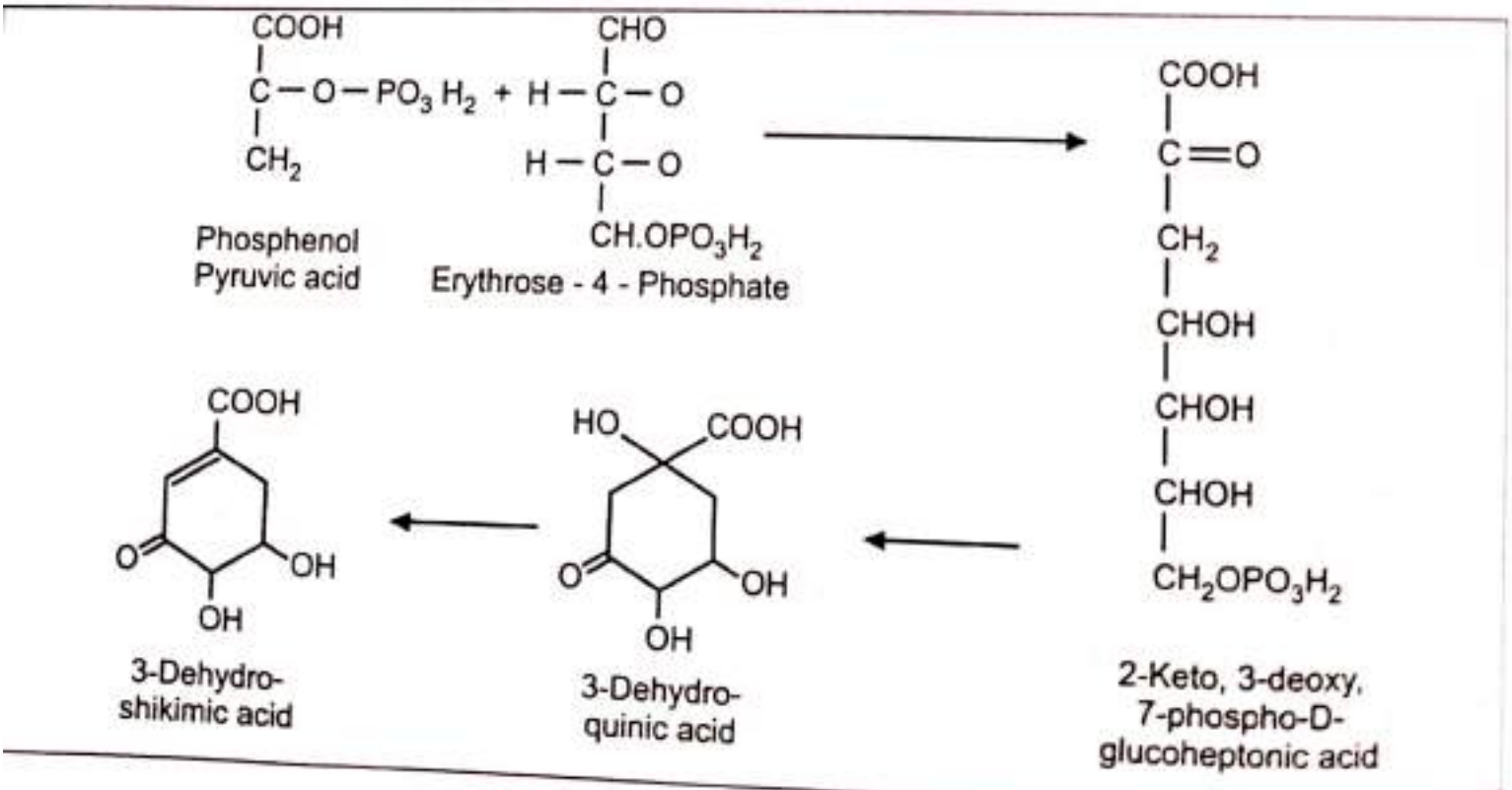
The elucidation of biosynthetic pathways in plants for the production of various plant metabolites has been extensively examined by means of isotopically labelled precursors. With the advancement of tracer technology, it is possible to incorporate isotopes into presumed precursors of plant metabolites and use as markers in biogenetic experiments. With the use of radioactive carbon (14_C) and hydrogen (3_H) and to a lesser extent sulphur (^{36}S) and phosphorous (^{32}P), it is possible to understand various biosynthetic pathways. A labelled nitrogen atom may give more specific information about the biosynthesis of alkaloids, proteins and amino acids. The most notable success by use of isotopically labelled precursors was achieved by Birch in the biosynthetic investigations of mould metabolites such as 6-methylsalicylic acid and griseofulvin from ^{14}C-labelled acetate.

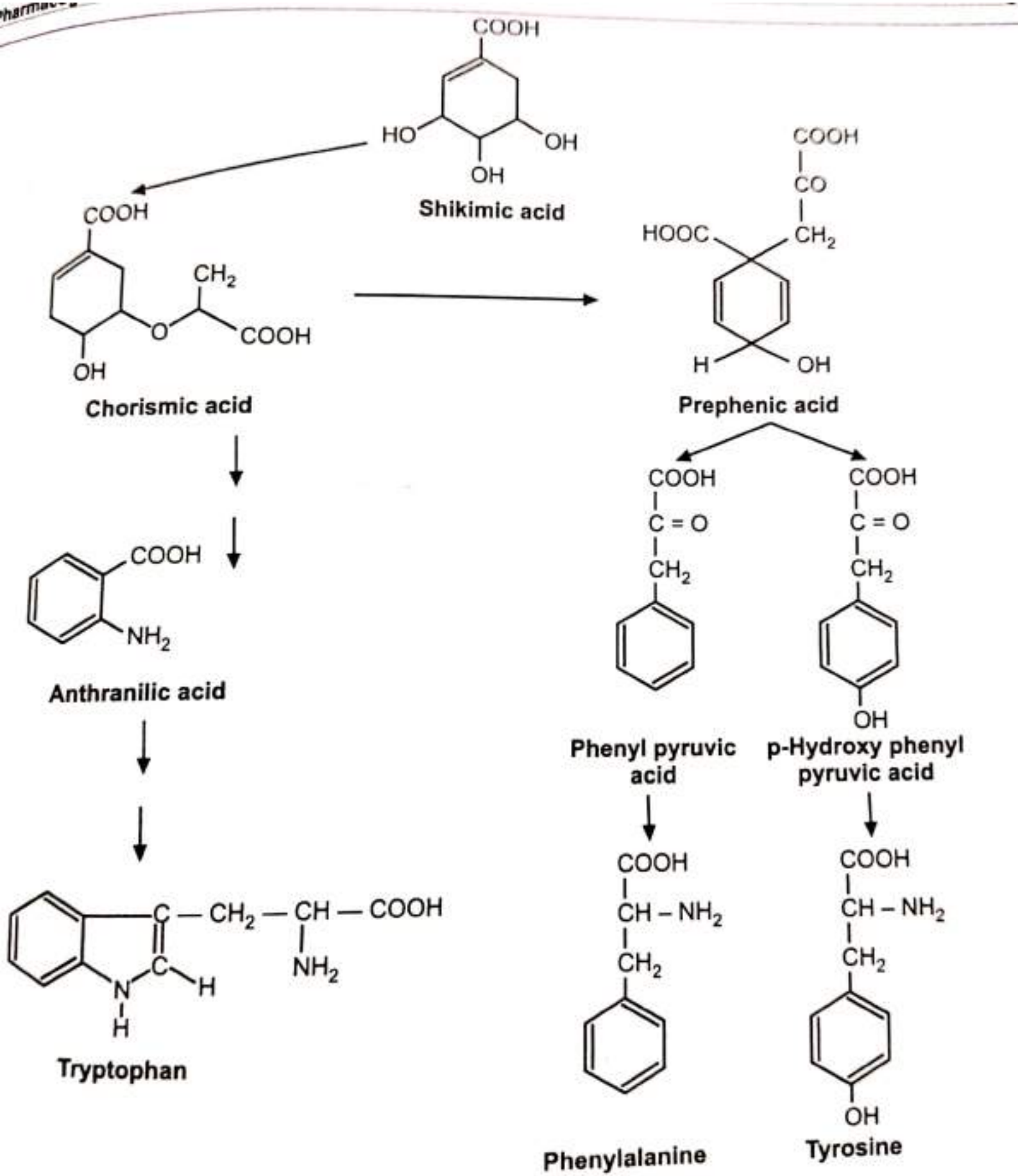
The basic carbon reduction cycle by which carbon dioxide is converted to sugar phosphates is of primary importance, both as an energy yielding process and also as a source of various metabolic intermediates. Two biosynthetic pathways of special importance in breakdown of sugar are pentose phosphate cycle (direct pathway) and glycolysis. The hexose phosphate is oxidized first into carbon-dioxide and pentose phosphate in direct pathway. The pentose phosphate formed due to biosynthetic degradation may then be utilized as such or otherwise converted by a series of metabolic reactions into triose phosphate or by a reversal of glycolysis, into a hexose; however, in glycolysis, hexose phosphate is split hydrolytically to yield triose phosphate, which can then be oxidized. Although the total number of natural products for which biosynthetic investigations have been carried out are quite limited compared with the diversity and number of natural products, our accumulation of knowledge in biogenetic field makes it possible to predict the gross biogenetic origin of practically all plant products.



SHIKIMIC ACID PATHWAY

The Shikimic acid is a key intermediate from carbohydrate for the biosynthesis of $C_6 - C_3$ units (phenylpropane derivatives). Besides serving as precursor for the biosynthesis of amino acids, Shikimic acid is also an intermediate in production of tannins, flavones, coumarins and vanillin.





Production of Amino Acids by Shikimic Acid Pathway

1. BIOSYNTHESIS OF GLYCOSIDES

BIOSYNTHESIS OF GLYCOSIDES

The metabolic process of glycoside formation essentially consists of two parts: The first part of biosynthesis is the reactions by means of which various type of aglycones are formed, where as the other part of biosynthesis process takes into account metabolic pathway involving coupling of aglycones with sugar moiety. The synthesis of glycosides in plant cells involves interaction of nucleotide glycoside such as UDP-glucose with alcoholic or phenolic group of second compound aglycones. Such glycosides, called as O-glycosides, are commonly found in plant. The other

glycosides also occur in nature in which the linkage is through carbon (C-glycosides), nitrogen (N-glycosides) or sulphur (S- glycosides).

The principal pathway of glycoside formation involves the transfer of uridylyl group from uridine triphosphate (UTP) to sugar-1-phosphate and the enzymes catalyzing this reaction are known as uridylyl transferases. The subsequent reaction controlled by enzymatic system glycosyl transferases involves transfer of sugar from uridine diphosphate to aglycone moiety resulting in formation of glycoside.

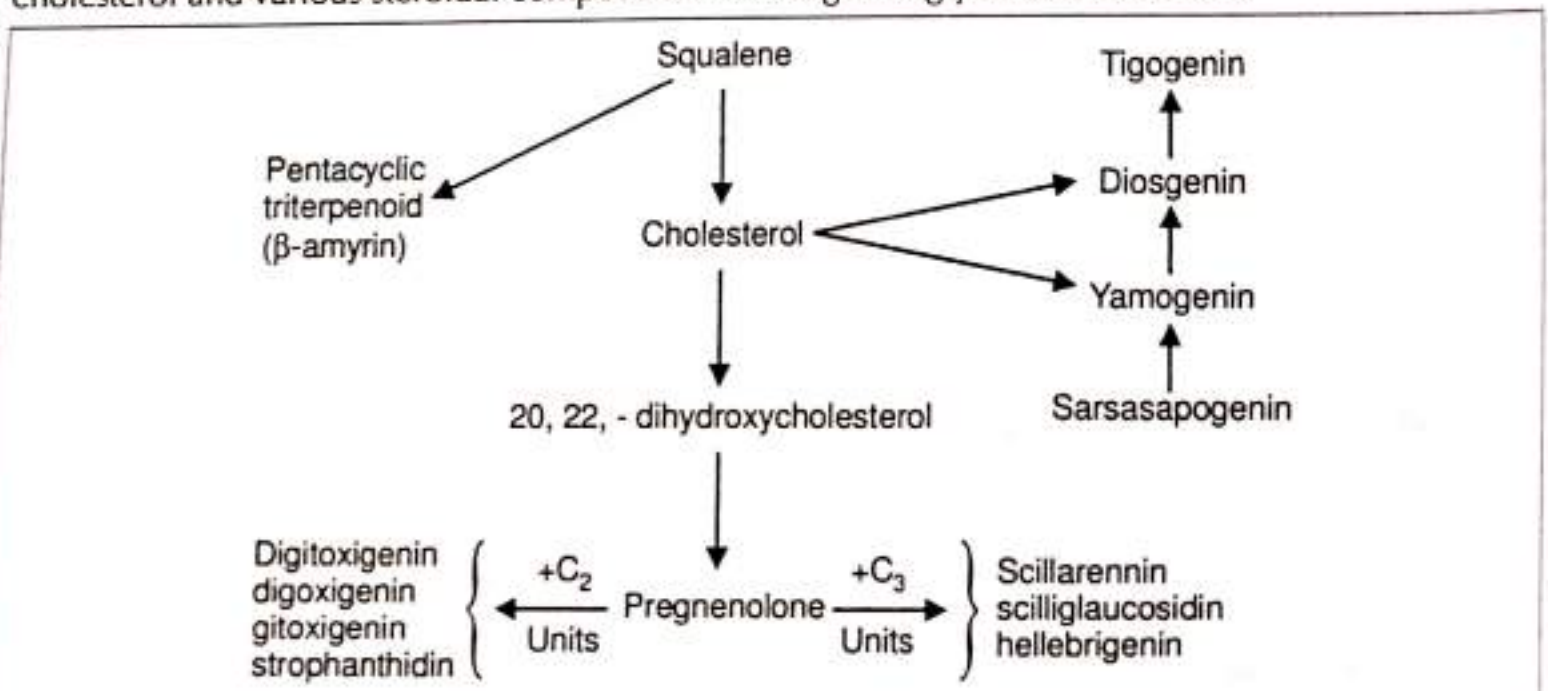
(1) UTP + sugar 1 - phosphate $\xrightleftharpoons{\text{uridylyl transferases}}$ UDP - sugar + PP_1

(2) UDP - sugar + aglycones $\xrightleftharpoons{\text{glycosyl transferases}}$ glycoside + UDP

The sugars present in glycosides may be monosaccharides such as rhamnose, glucose and fucose or deoxysugars such as digitoxose or cymarose as in cardiac glycosides.

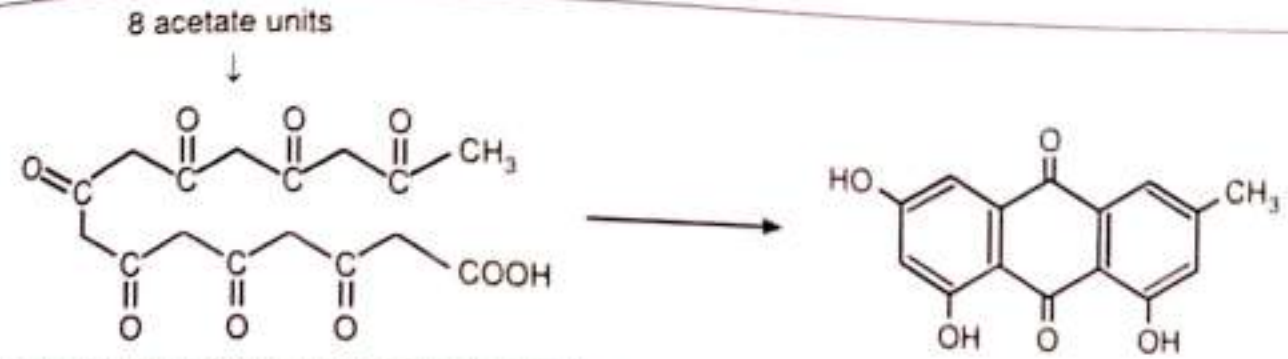
The aglycones of cardio-active glycosides are steroidal in nature. They are the derivatives of cyclopentenophenanthrene ring containing an unsaturated lactone ring attached to C_{17}, a 14 – *alpha* hydroxyl group and a cisjuncture of rings C and D. The knowledge of steroidal biosynthesis is derived from studies of cholesterol production through acetate → mevalonate → isopentenyl pyrophosphate → squalene pathway. The biosynthesis of cholesterol involves cyclization of aliphatic triterpene-squalene.

In plants, sapogenins occur in the form of their glycosides, i.e. saponins. The neutral saponins are derivatives of steroids with side chains whereas acid saponins possess triterpenoid structures. The main pathway for biogenesis of both types of sapogenins is similar. However, a branch occurs, probably after formation of triterpenoid hydrocarbon-squalene which leads to cyclic triterpenoids in one direction and spirochaetal steroids in other direction. The bioproduction of squalene, cholesterol and various steroidal compounds including the aglycones is outlined.



Some secondary products of cholesterol metabolism

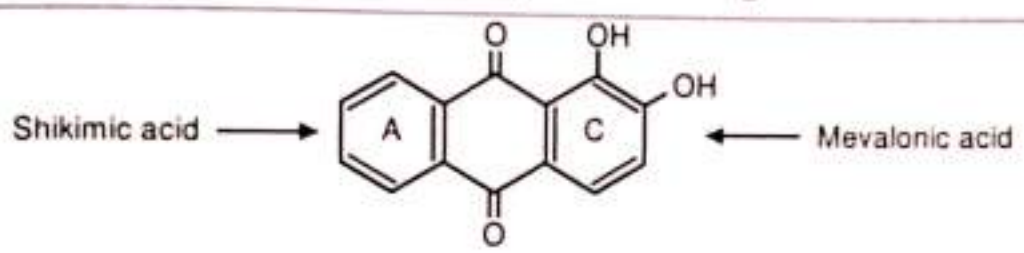
The knowledge of biosynthesis of anthracene aglycones has been obtained from studies with micro-organisms, especially *Penicillium islanidicum*. An intermediate polyketomethylene acid is probably produced from 8 acetate units which on intramolecular condensation forms anthraquinone.



Poly-β-ketomethylene acid intermediate **Emodin and other related derivatives**

Biosynthesis of Emodin and Related Compounds

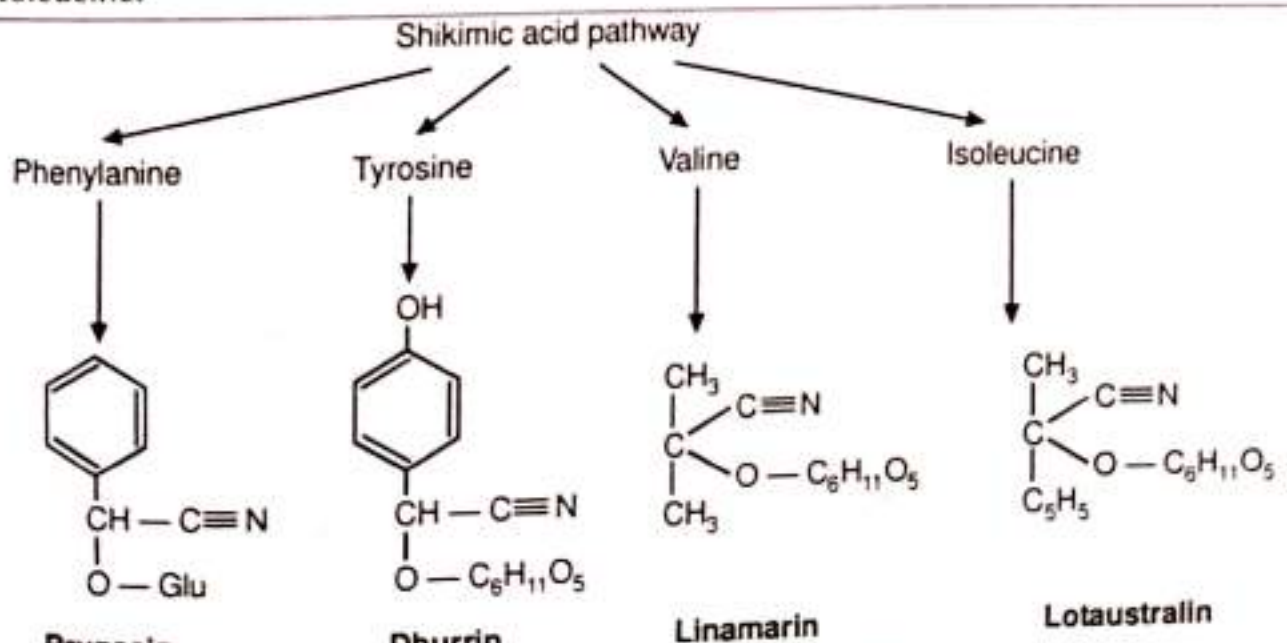
A second metabolic pathway for production of anthraquinone is through Shikimic acid as operative in some plants of Rubiaceae. The biosynthesis of alizarin reveals that ring A is derived from Shikimic acid, while mevalonic acid is incorporated into ring C.



Alizarin

Biosynthesis of Alizarin from *Rubia tinctorum (Rubiaceae)*

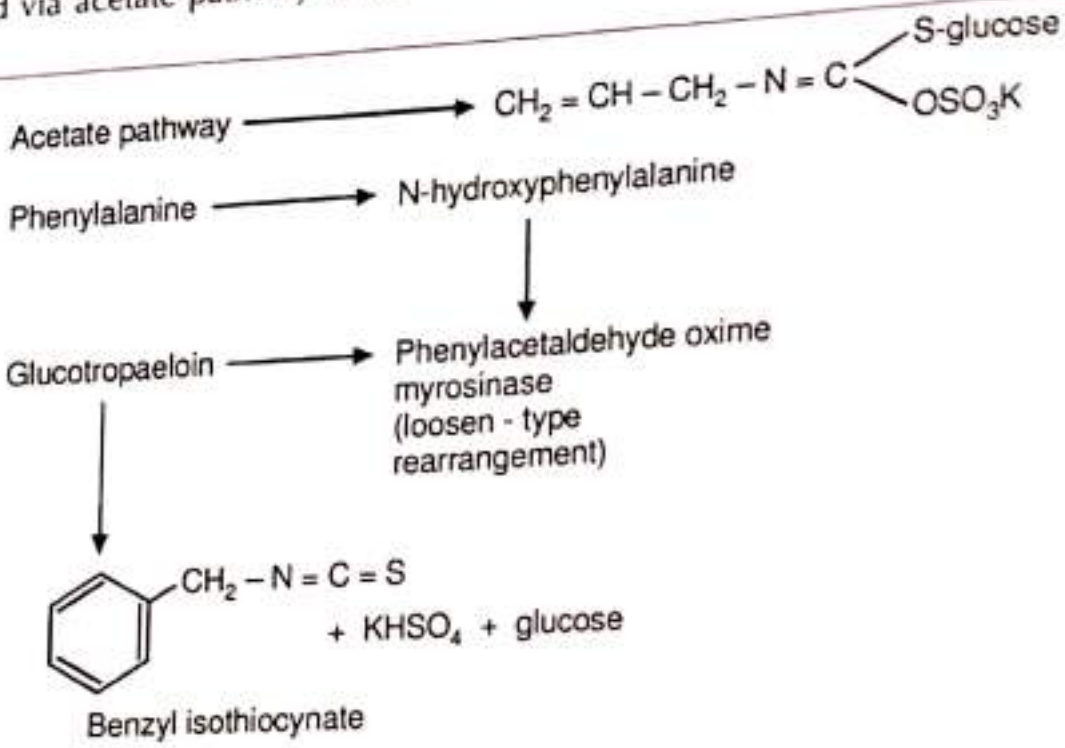
The aglycones of pharmaceutically significant cyanogenetic glycosides are phenylpropanoid compounds derived from amino acids phenylalanine and tyrosine which are the products of Shikimic acid pathway. The aglycones of linamarin are derived from valine and that of lotaustralin from isoleucine.



Prunasin **Dhurrin** **Linamarin** **Lotaustralin**

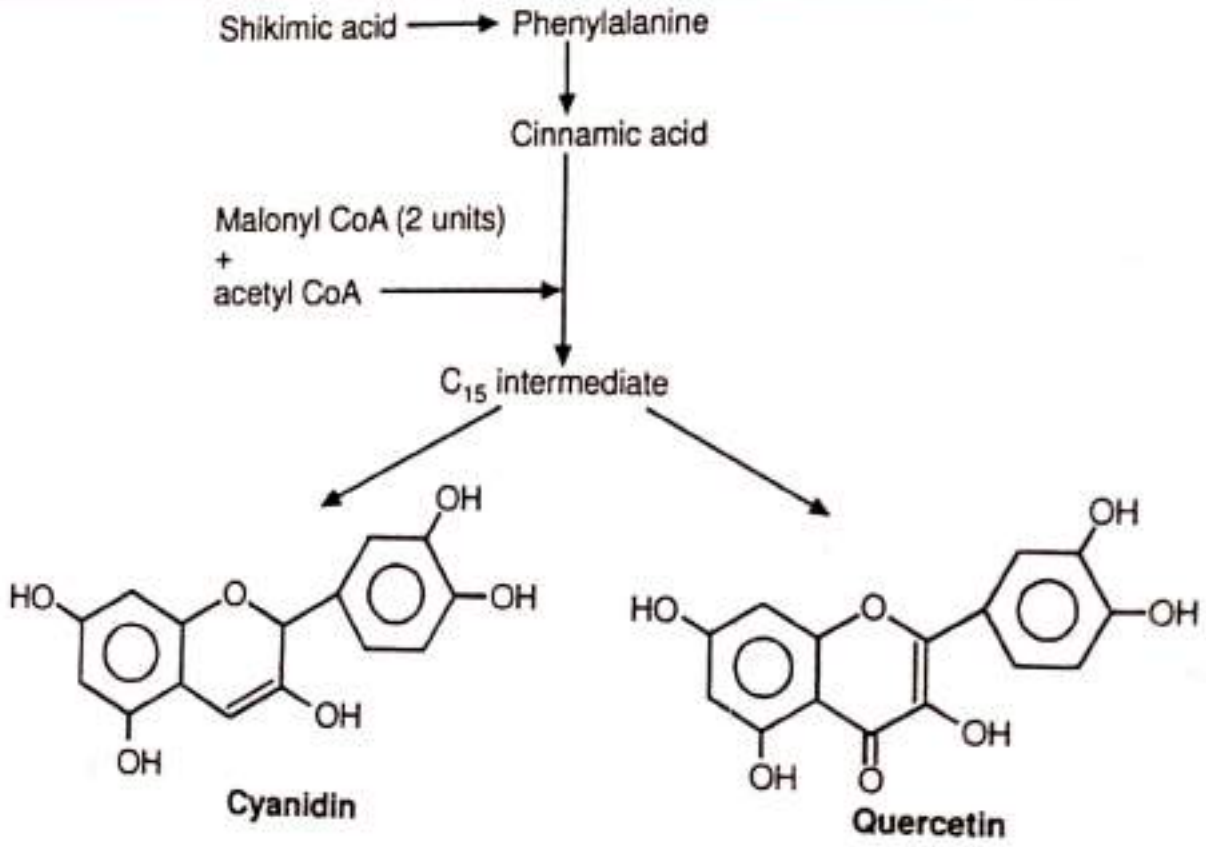
Biosynthesis of Cyanogenetic Glycosides

The aglycones of isothiocynate glycosides may consist of either aliphatic derivative biosynthesized via acetate pathway or aromatic derivatives produced biosynthetically via Shikimic acid route.



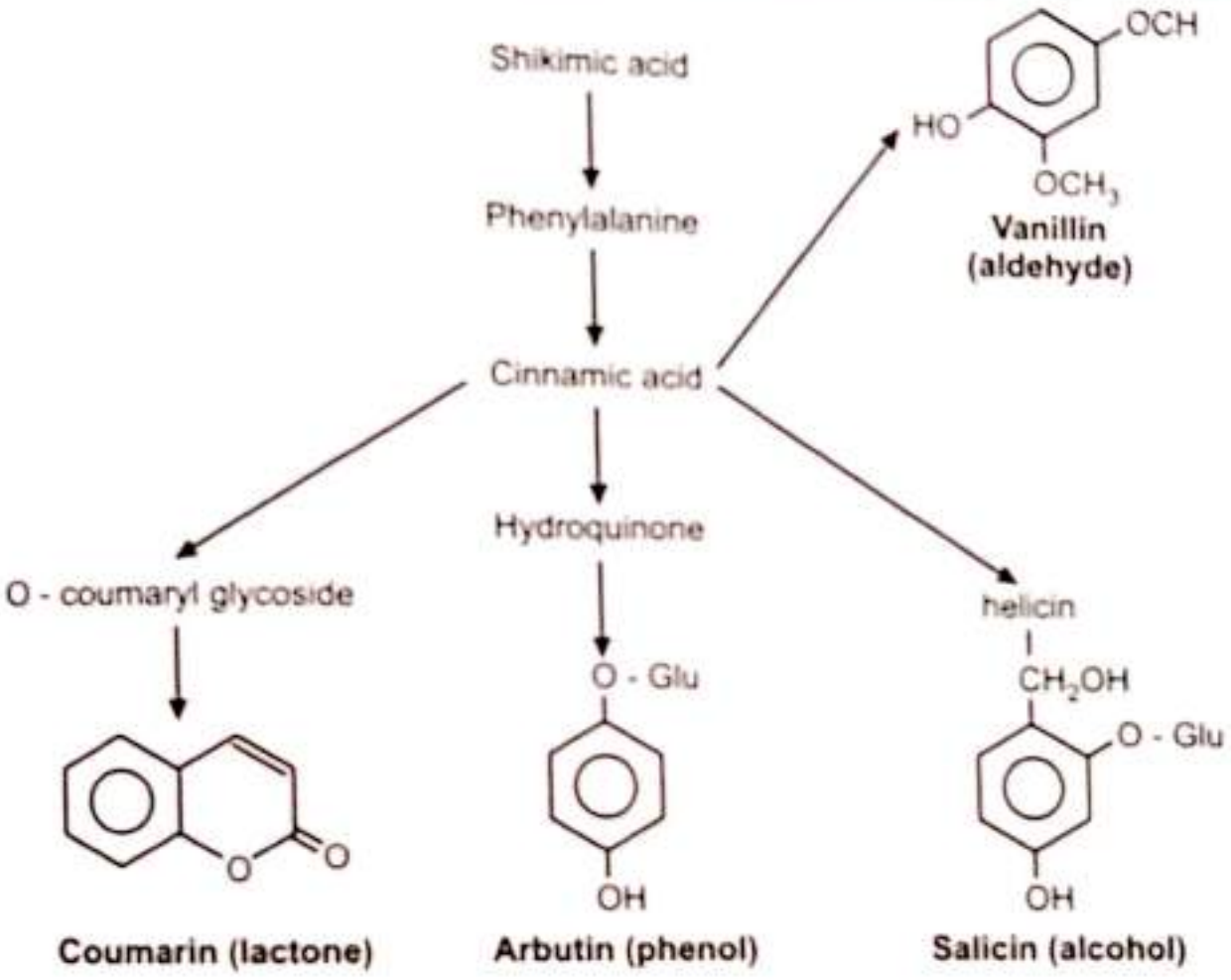
Biosynthesis of Isothiocynate Aglycone

The aglycones of flavones glycoside are derived from both acetate metabolism and Shikimic acid pathway. The A ring arises by head-to-tail condensation of two malonyl Co-A units and acetyl Co–A. The B ring and C_3 unit come from a C_6 - C_3 precursor, which may be cinnamic acid itself.



Biosynthetic pathways to Flavonoids Aglycones

The aromatic nuclei of alcohol, aldehyde, lactone and phenol glycosides are derived from C_6 - C_3 precursors formed via Shikimic acid pathway.



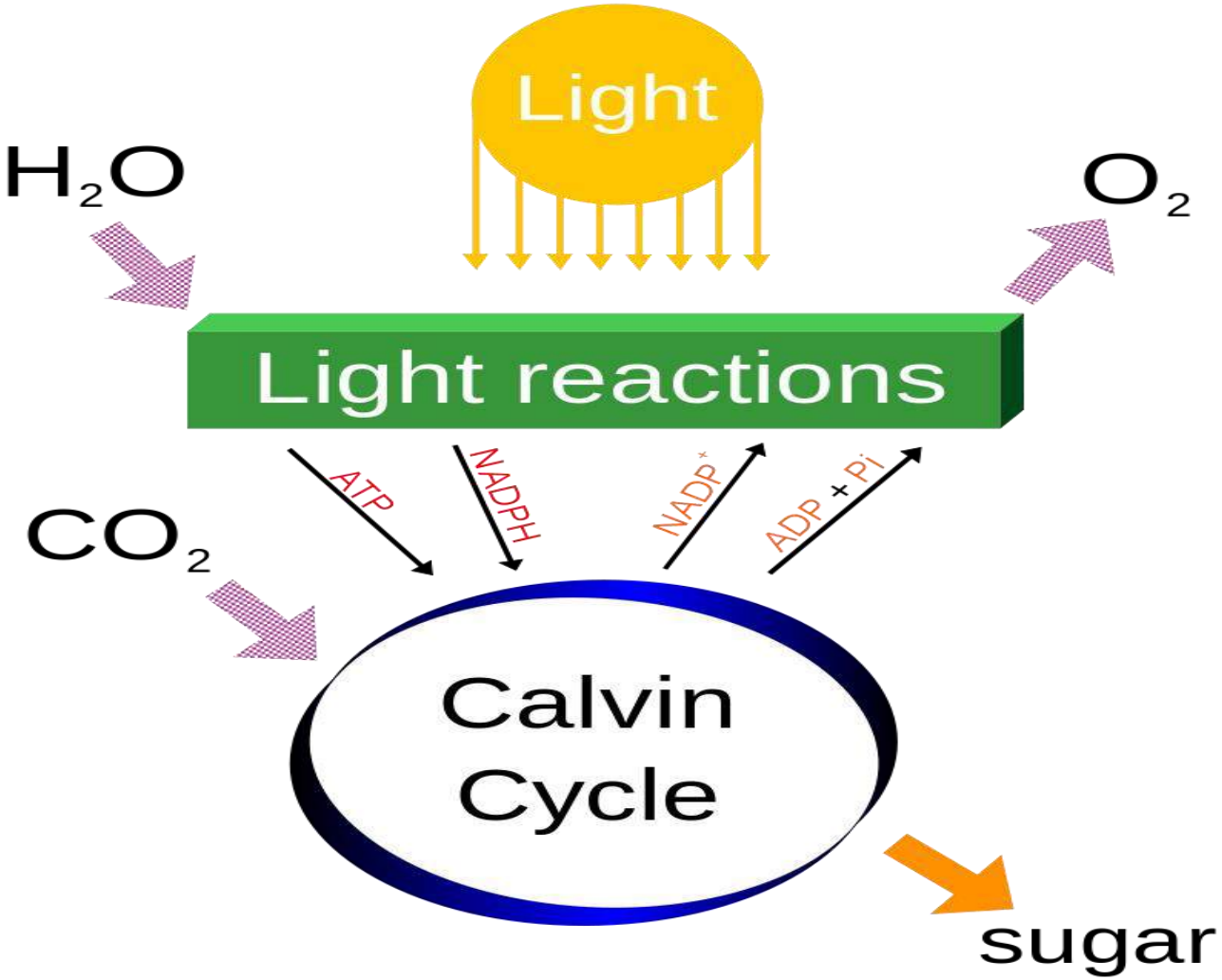
Biosynthesis of Lactone, Phenol, Alcohol and Aldehyde Glycosides

UNIT 5A

Biosynthetic Metabolic Pathways for Production of Secondary Metabolites

WhatisBiosynthesis?

- ✓ **Biosynthesis** is a process of forming larger organic compounds from small subunits within a living organism. Biosynthesis is mainly done by enzymes.
- ✓ Biosynthesis is also known as anabolism since simple compounds are joined together to form macromolecules by enzymes.
- ✓ As an example, photosynthesis occurs inside the chloroplast.
- ✓ The light energy is converted into chemical energy during photosynthesis.
- ✓ The larger molecule glucose is biosynthesized from water and carbon dioxide by photosynthetic organisms.(ATP, Enzyme, Cofactors)


Light
H_2O
O_2
Light reactions
ATP
NADPH
$NADP^+$
ADP + Pi
CO_2
Calvin Cycle
sugar

Biosynthesis of Primary Metabolites

- ✓ Living plants are solar-powered biochemical and biosynthetic laboratory which manufactures both primary and secondary metabolites from air, water, minerals and sunlight.

✓The **primary metabolites** like sugars, amino acids & fatty acids that are needed for **general growth** & **physiological** development **of plant which** distributed **in nature** & also utilized **as food by man**.

- ✓ The **secondary metabolites** such as **alkaloids**, **glycosides**, **Flavonoids**, **volatile oils** etc are biosynthetically derived from primary metabolites.

✓**Biosynthetic reactions** are **replica** of common organic reactions like catalytic reactions, phosphorylation, hydride transfer, oxidation,

- ✓elimination, acylation, alkylation, reduction, condensation, rearrangement etc.

Metabolism & Metabolic Pathways

- **Cell Metabolism:** Process by which living cell process nutrient molecule &living state.
- **Metabolic Pathway:** A complete set of chemical reactions that occur in living cells, allowing cells to grow and reproduce, maintain their structures, and respond to their environments.
- Living cell **require energy** for biosynthesis, transport of nutrient, motility and maintenance.
- Energy is obtained from the catabolism of carbon compounds (carbohydrate)
- Carbohydrates are synthesized from CO_2 and H_2O in the present of light by photosynthesis.

Types of Metabolism

Catabolism

Metabolic reactions in the cell that degrade a substrate into smaller / simpler products. ~ produce energy to the cell

$$\text{Glucose} \rightarrow CO_2$$

Anabolism

Metabolic reactions that result in the synthesis of larger / more complex molecules. ~ requires energy

glucose to glycogen

Metabolites

- ✓ Metabolites are the intermediates & products of **metabolism**.
- ✓ The term metabolite is usually restricted to small**molecules**.
- ✓ A **primary metabolite** is **directly involved** in the normal growth, development, and reproduction.
- ✓ A **secondary metabolite** is **not directly involved** in those processes, but usually has important **ecological** function.

Difference between Primaryand secondary metabolites

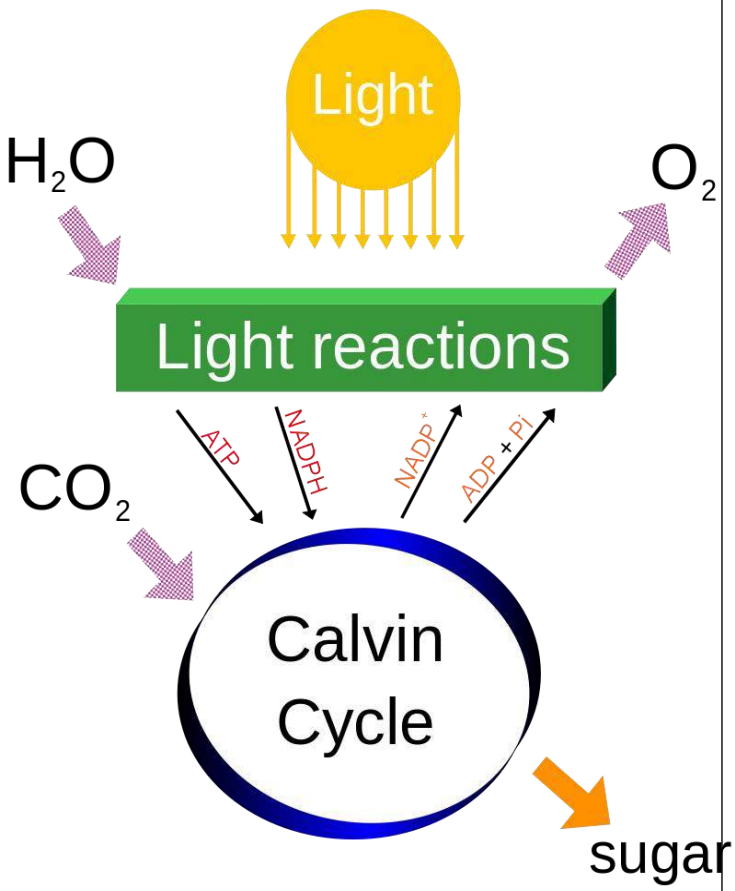
Primary metabolites	Secondary metabolites
1) They are involved in normal growth, development and reproduction.	1) They are not directly involved in the normal growth, development and reproduction.
2) Examples for primary metabolites are carbohydrates, fats and proteins.	2) Examples for secondary metabolites are alkaloids, tannins, resins, gums and latex etc.
3) They are not poisonous.	3) Some of these compounds are poisonous.

Importance of photosynthesis in formation of primary metabolites

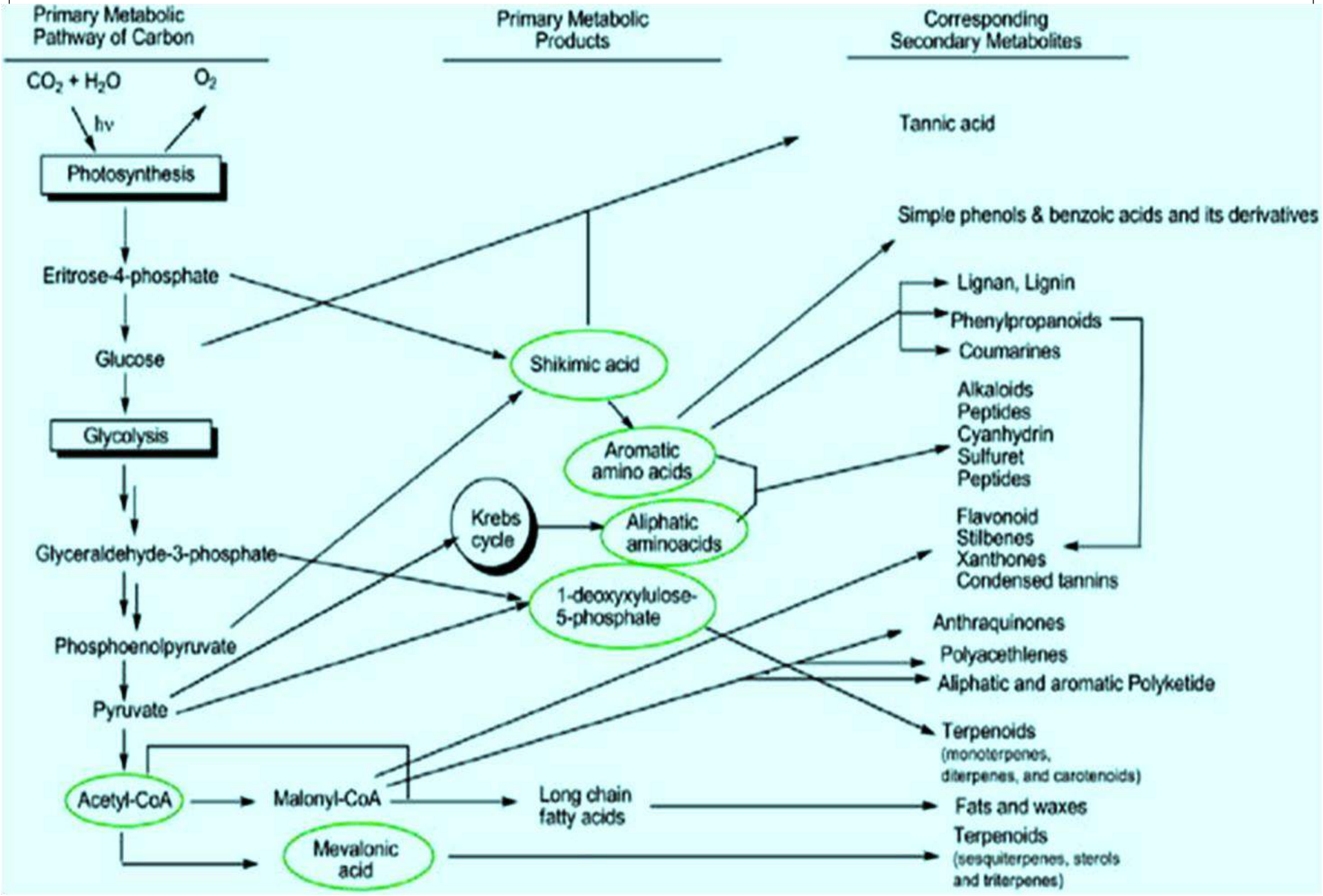
- ✓ Photosynthesis is the process where plants convert **sunlight** into **energy**, then **store** it as **carbohydrates**, **sugars**, such as **glucose**.
- ✓ Photosynthesis may be the most important process in ecosystems, both brings in energy needed within the ecosystem, and produce oxygen (O_2) needed for **cellular respiration,** and the production of more ATP.
- ✓ Photosynthesis has **three** basic steps:
- ✓ Energy is captured from the sunlight.
- ✓ **Light** energy is **converted** into **chemical** energy in the form of ATP and NADPH.
- ✓ **Chemical** energy is **used** to power the **synthesis** of **organic molecules** (e.g. carbohydrates) from carbon dioxide (CO_2).

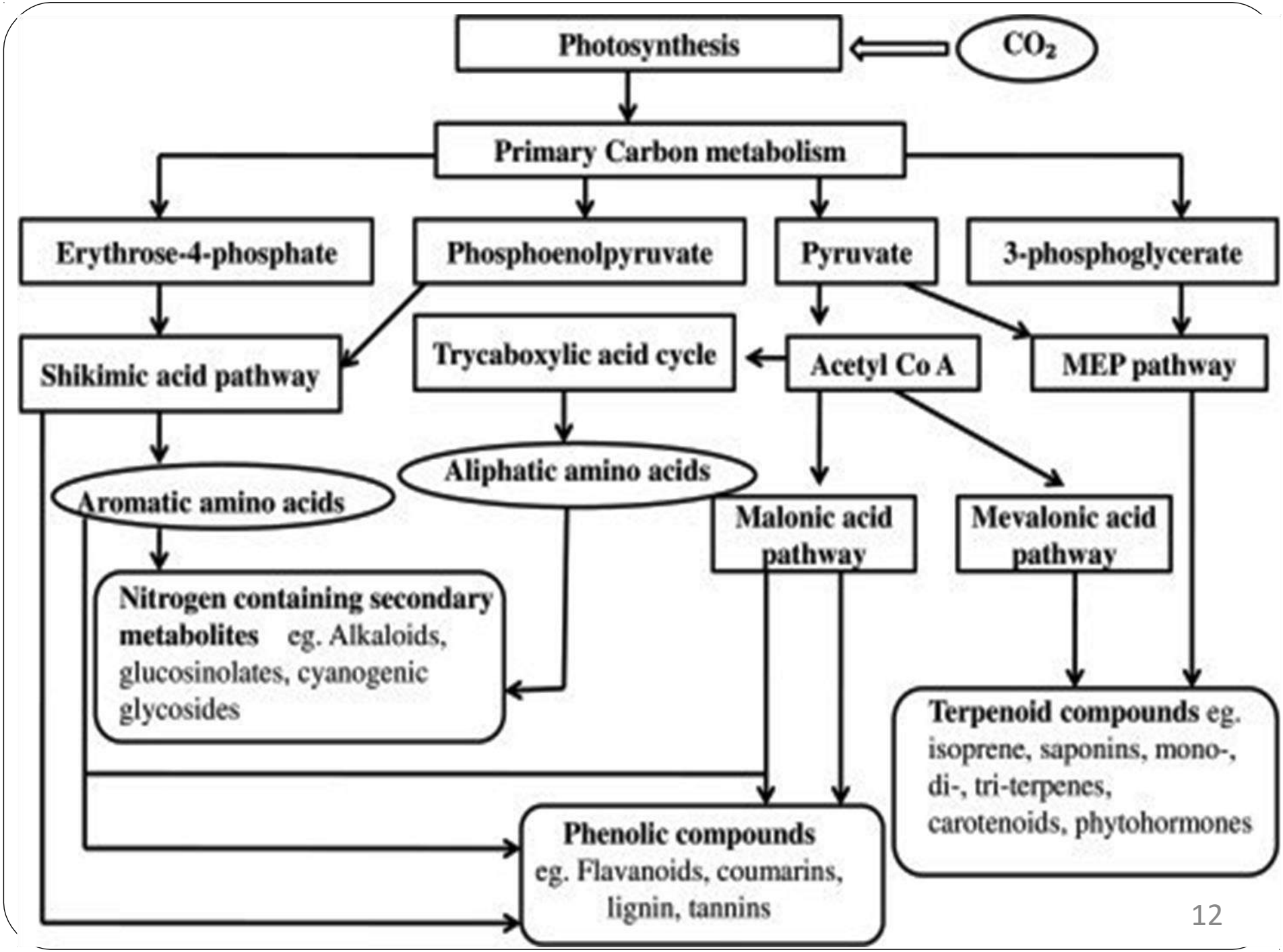
Photosynthesis

- H_2O + light + ADP + P ---> O_2 + ATP + e-
- After the above steps occur in photosystem II, the electron is finally sent to photosystem I, where the following happens.
- e- + $NADP^+$ + H ---> NADPH
- Now there are two high energy molecules, fully charged and ready to be used. Plants make more energy that it needs immediately, so the NADPH and ATP are used to make glucose as follows:
- CO_2 + ATP + NADPH ---> $C_6H_{12}O_6$
- This happens in **Calvin cycle.**



Primary and Secondary metabolites derived from carbon metabolism




Photosynthesis
CO_2
Primary Carbon metabolism
Erythrose-4-phosphate
Phosphoenolpyruvate
Pyruvate
3-phosphoglycerate
Shikimic acid pathway
Trycaboxylic acid cycle
Acetyl Co A
MEP pathway
Aromatic amino acids
Aliphatic amino acids
Malonic acid pathway
Mevalonic acid pathway
Nitrogen containing secondary metabolites eg. Alkaloids, glucosinolates, cyanogenic glycosides
Terpenoid compounds eg. isoprene, saponins, mono-, di-, tri-terpenes, carotenoids, phytohormones
Phenolic compounds
eg. Flavanoids, coumarins, lignin, tannins

Biosynthetic Pathway of Secondary Metabolites

It involves 3 basic mechanism:

1. **Shikimic acid Pathway**---Phenoilic amino acids, alkaloids,

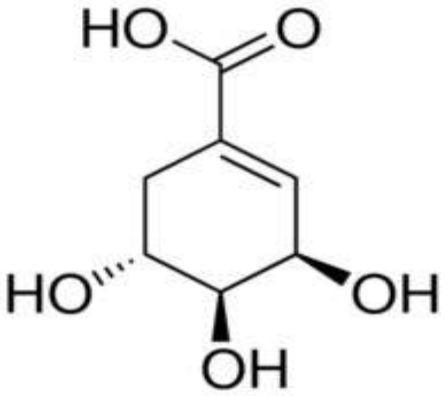
   Flavonoids, Glycosides.

2. **Acetate-mevalonate pathway---**Terpenoids

   (Volatile oils, coumarins, phytohormones, carotenoids).

3. **Acetate malonate pathway---**Fatty acids (lipids).

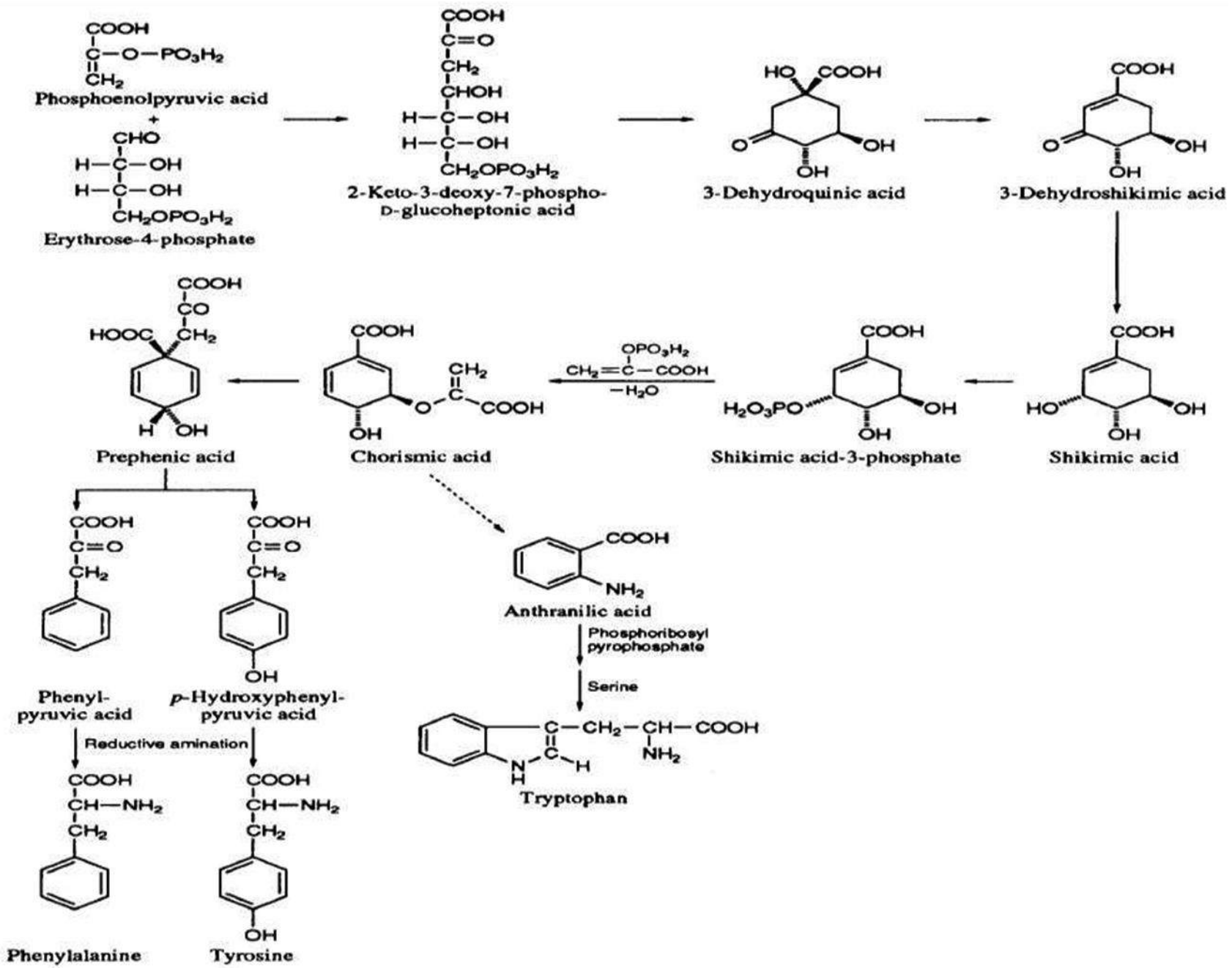
Shikimic acid



- ✓ Commonly known as its anionic form **shikimate, is a cyclohexene, a cyclitol and** a **cyclohexanecarboxylic acid**.
- ✓ Its name comes from the Japanese flower *shikimi the Japanese star anise, Illiciumanisatum), from which it was first isolated in 1885 by Johan Fredrik Eykman.*
- ✓ The elucidation of its structure was made nearly 50 years later.
- ✓ Shikimic acid is also the glycoside part of some hydrolysable tannins.

1. Shikimic Acid Pathway

- ✓ The Shikimic acid pathway is a key intermediate from carbohydrate for the biosynthesis of C_6-C_3 units (phenyl propane derivative).
- ✓ The Shikimic acid pathway converts simple **carbohydrate** precursors derived from glycolysis and the pentose phosphate pathway to the **aromatic amino acids**.
- ✓ The **shikimate pathway** is a **7** step metabolic route used by *bacteria, fungi, Algae, parasites, and plants for the biosynthesis of aromatic amino acids* (*phenylalanine, tyrosine, and tryptophan).*
- ✓ This pathway is not found in animals; therefore, phenylalanine and tryptophan represent *essential amino acids that must be obtained from the animal's diet.*
- ✓ Animals can synthesize tyrosine from phenylalanine, and therefore is not an essential amino acid except for *individuals unable to hydroxylate phenylalanine to tyrosine).*


Phosphoenolpyruvic acid
+
Erythrose-4-phosphate
2-Keto-3-deoxy-7-phospho-D-glucoheptonic acid
3-Dehydroquinic acid
3-Dehydroshikimic acid
Shikimic acid
Shikimic acid-3-phosphate
Chorismic acid
Prephenic acid
Phenyl-pyruvic acid
p-Hydroxyphenyl-pyruvic acid
Reductive amination
Phenylalanine
Tyrosine
Anthranilic acid
Phosphoribosyl pyrophosphate
Serine
Tryptophan

Pathway:

- Starting Point in The Biosynthesis of Some Phenolics *Phenyl alanine and tyrosine are the precursors used in the biosynthesis of* phenylpropanoids.
- The phenylpropanoids are then used to produce the *flavonoids, coumarins, tannins and lignin*.
- Gallic acid biosynthesis Gallic acid is formed from *3-dehydroshikimate by the action of the enzyme shikimate dehydrogenase to produce 3,5-didehydroshikimate*.
- *The latter* compound spontaneously rearranges to gallic acid.
- **Other compounds**
- **Shikimic acid is a precursor for:**
- Indole, indole derivatives and aromatic amino acid tryptophan and tryptophan derivatives such as the psychedelic compound dimethyltryptamine. &many alkaloids and other aromatic metabolites.

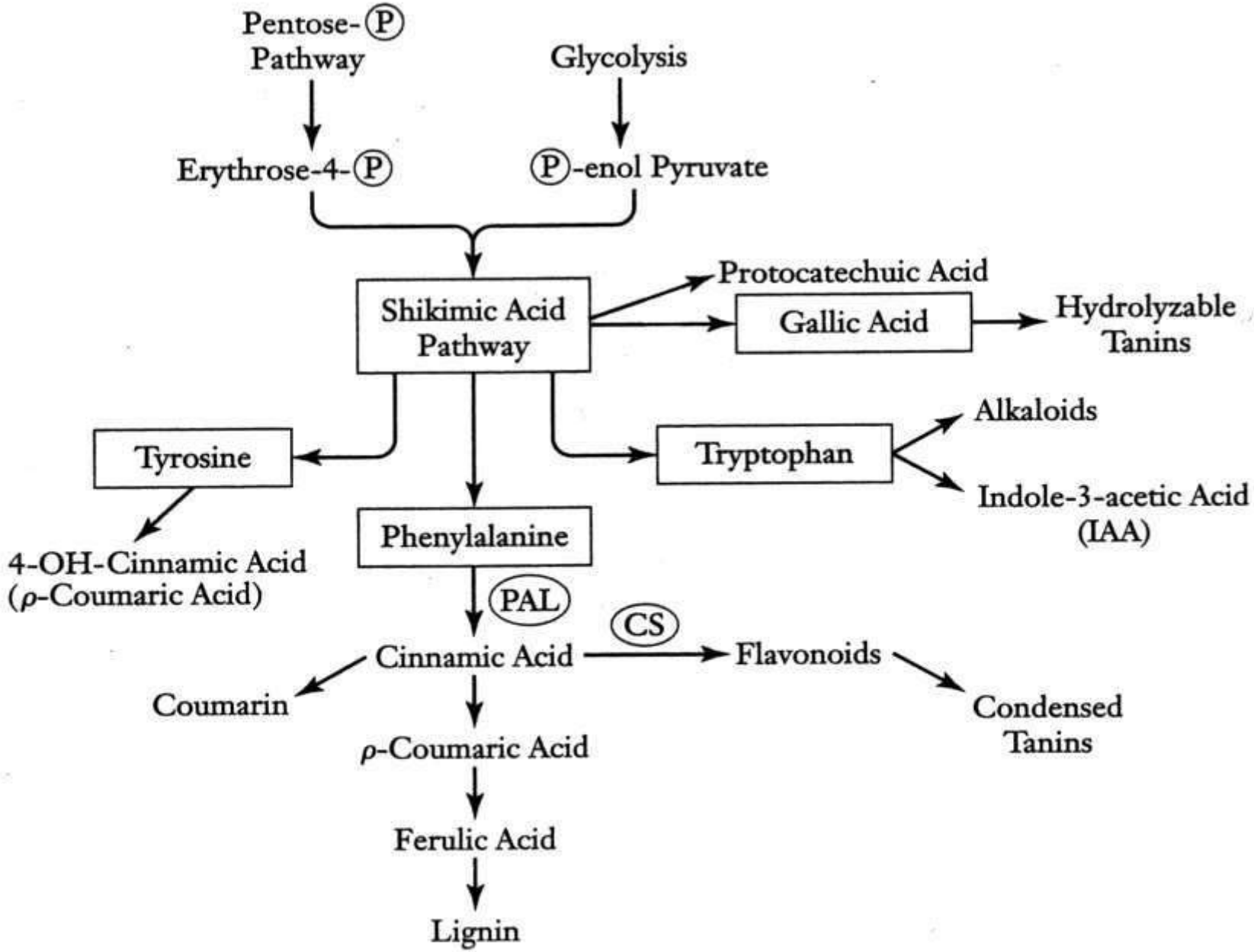
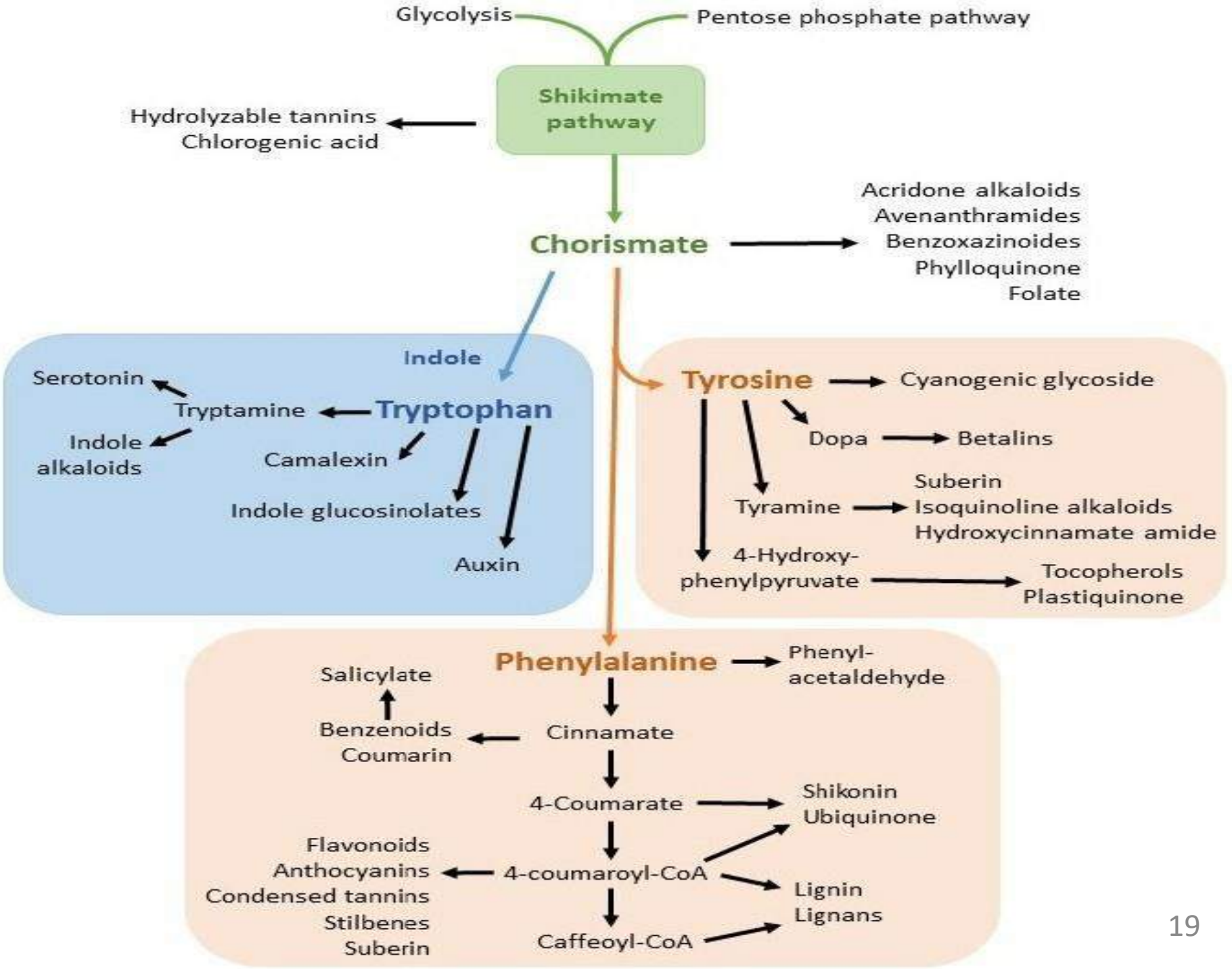


FIGURE 14.14 The central role of the shikimic acid pathway in the synthesis of various primary and secondary metabolites. PAL = phenylalanine ammonia lyase. CS = chalcone synthase.


Glycolysis
Pentose phosphate pathway
Shikimate pathway
Hydrolyzable tannins
Chlorogenic acid
Chorismate
Acridone alkaloids
Avenanthramides
Benzoxazinoides
Phylloquinone
Folate
Indole
Serotonin
Tryptamine
Tryptophan
Indole alkaloids
Camalexin
Indole glucosinolates
Auxin
Tyrosine
Cyanogenic glycoside
Dopa
Betalins
Tyramine
Suberin
Isoquinoline alkaloids
Hydroxycinnamate amide
4-Hydroxy-phenylpyruvate
Tocopherols
Plastiquinone
Phenylalanine
Phenyl-acetaldehyde
Salicylate
Benzenoids
Coumarin
Cinnamate
4-Coumarate
Shikonin
Ubiquinone
Flavonoids
Anthocyanins
Condensed tannins
Stilbenes
Suberin
4-coumaroyl-CoA
Lignin
Lignans
Caffeoyl-CoA

Shikimic acid Uses:

- ✓ In the pharmaceutical industry, shikimic acid from the Chinese star anise (*Illicium verum) is used as a base material for production of oseltamivir* (influenza)
- ✓ **Target for drugs**
- ✓ Shikimate can be used to synthesize (*6S)-6-Fluoroshikimic acid, an* antibiotic which inhibits the aromatic biosynthetic pathway.
- ✓ *Shikimic acid is a precursor for:*

  Indole derivatives and aromatic amino acid tryptophan and tryptophan derivatives such as the psychedelic compound dimethyl tryptamine. & many alkaloids and other aromatic metabolites.

UNIT 5 - C

Preliminary Phytochemical Screening Studies of Plant Extracts

Phytochemicals have two categories:

Primary & Secondary constituents.

- *Primary metabolites:* Carbohydrates, Proteins, Enzymes
- *Secondary metabolites:* Alkaloids, Glycosides, Tannins, Volatile oils, Resins, Flavonoids, Steroids, Lipids.

Qualitative analysis

- Steroids
- Reducing sugars
- Triterpenoids
- Sugars
- Alkaloids
- Phenolic compounds
- Flavonoids
- Saponins
- Tannins
- Anthroquinones
- Amino acids

Quantitative analysis

- Determination of total alkaloids
- Total flavonoids
- Total phenolics
- Total saponins
- Total tannins
- Total glycosides

Qualitative Analysis- Preliminary Screening Reagents

SL.No.	Phytoconstituents	*Tests*
1	Alkaloids	Mayer's test
		Dragendroff's test
		Hager's test
		Wagner's test
2	Carbohydrates	Molisch's
3	Reducing sugars	Fehling's test
		Benedict's test
4	Saponins	Foam test
		Forth test
5	Phytosteroids	Salkowski's test
		LibermannBurchard's test
6	Phenols	Ferric chloride test
		Lead acetate test
7	Tannins	Ferric chloride
8	Flavanoids	Lead acetate test
		Alkaline reagent test
9	Cardiac glycosides	Killer-Kallani test
10	Protein &amino acids	Millons test
		Biuret's test
		Ninhydrin's test
11	Terpenoids	Salkowski's test
12	Fixed oils and fats	Sport test
		Saponification test
13	Gum and mucilage	Ruthenium red solution

I. Detection of Alkaloids

- The individual extract is dissolved in dilute hydrochloric acid and filter.
- The filtrate was further tested with following reagents for the presence of alkaloids.

Dragendroff's Test:

- Filtrate was treated with potassium bismuth iodide solution (Dragendroff's reagent).
- Formation of orange red precipitate indicated the presence of alkaloids.

Hager's Test:

- Filtrate was treated with saturated aqueous solution of Picric acid (Hager's reagent).
- Presence of alkaloids were confirmed by the formation of yellow coloured precipitate.

Mayer's Test:

- Filtrate was treated with Formation of a whitish yellow or cream coloured precipitate indicated the presence of alkaloids.
- Potassium mercuric iodide solution (Mayer's reagent).

Wagner's Test:

•Filtrate was treated with saturated aqueous solution of Iodine-Potassium Iodide solution (Wagner's reagent) &Formation of reddish brown precipitate indicated the presence of alkaloids

Specific chemical tests for Alkaloid crude drugs

1. **Van Urk's Test- Ergot alkaloids**

Ergot powder gives a blue colour with p-dimethyl amino benzaldehyde

2. **Nuxvomica – Strychnine & Brucine alkaloids**

Stain the TS of seed with ammonium vandate & sulphuric acid (Manddin's reagent)- endospermic cells become purple due to the presence of Strychnine.

Stain the TS of seed with con. Nitric acid, endospermic cells become yellow colour due to the presence of Brucine.

3. **Ipecacuanha-Ipecac-Emetine & cephaaline alkaloids**

To the addition of sulphuric acid & sodium molybdate (Frohde's reagent) to a small quantity of emetine gives bright green colour

4. Opium alkaloids general test- Meconic acid test

The general test to detect opium is by testing presence of meconic acid. The alkaloids are present as the salts of meconic acid. Opium is dissloved in water & to the filtrate, ferric chloride solution is added by which deep reddish purple colour is obtained, which persists even on addition of HCl.

Morphine when sprinkled on nitric acid gives orange red colour, **codeine** does not respond to this test.

Papaverine solution in HCl gives a lemon yellow colour with potassium ferricyanide solution.

5. Tropane alkaloids- Vitali Morin test

The Tropane alkaloid is treated with fuming nitric acid, followed by evaporation to dryness & addition of methanolic KOH solution to an acetone solution of nitrated residue. Violet colour take place due to tropane derivative

6. Quinoline alkaloids- Cinchona- Thalleoquin test:

***Quinine*:** The Powdered drug gives emerald green colour with bromine water & dilute ammonia solution.

Quinidine: Solution gives a white precipitate with silver nitrate solution, which is soluble in nitric acid.

7. Purine Alkaloids- Murexide Test

Coffee/tea/kola powder is taken in a petridish to which HCl & potassium chlorate are added & heated to dryness. A purple colour is obtained by exposing the residue to vapours of dilute ammonia. The purple colour is lost on addtion of NaOH/KOH.

II. Detection of Saponins

Hemolytic test

- Add 0.2 ml solution of saponin (prepared in 1% normal saline) to 0.2 ml of v/v blood in normal saline and mix well, centrifuge and note the red supernatant compare with control tube containing 0.2ml of 10% blood in normal saline diluted with 0.2ml of normal saline.

Foam Test:

- Small quantity of the extract was shaken with 2 ml of water.
- Persistence of foam produced for ten minutes indicated the presence of saponins.

III. Detection of Tannins

1. Goldbeater's skin test:

A small piece of goldbeater skin (membrane prepared from the intestine of an ox) is soaked in 20% hydrochloric acid, ringed with distilled water and placed in a solution of tannin for 5 minutes. The skin piece is washed with distilled water and kept in a solution of ferrous sulphate. A brown or black colour is produced on the skin due presence of tannins.

2. Match stick test (Catechin test):

A match stick is dipped in aqueous plant extract, dried near burner and moistened with concentrated hydrochloric acid. On warming near flame, the matchstick wood turns pink or red due to formation of phloroglucinol.

3. Gelatin test:

To a solution of tannin, aqueous solution of gelatin and sodium chloride are added. A white buff coloured precipitate is formed.

4. Chlorogenic acid test

An extract of chlorogenic acid containing drug is treated with aqueous ammonia. A green colour is formed on exposure to air.

5. Phenazone test:

A mixture of aqueous extract of a drug and sodium acid phosphate is heated and cooled and filtered. A solution of phenazone is added to the filtrate. A bulky coloured precipitate is formed.

IV. Detection of Flavonoids

Alkaline Reagent Test

- Treat the extract with few drops of sodium hydroxide solution.
- Formation of intense yellow colour, which becomes colourless on further addition of dilute acid, indicated the presence of flavonoids.

Shinoda test

- To the test solution add few Mg strips & concentrated HCl dropwise, pink/crimson red/occassionally green to blue color appears after few minutes

Ferric chloride Test:

- Add a few drops of ferric chloride solution to the extract solution.
- Development of intense green colour indicates the presence of flavonoids.

V. Detection of Cardiac Glycosides

- ✓**Steroidal moiety –** *LB test*
- ✓**Deoxy Sugar moiety-** *Keller Killiani test*
- ✓**Lactone ring-** *Baljet test and Legal's test*

1. Keller-Killani test

Treat the extract with 2 ml of glacial acetic acd containing one drop of ferric chloride solution. Transfer to a small test tube, add carefully 0.5ml of con. sulphuric acid by the side of the test tube. Acetic acid layer shows **blue colour.**

2. LB test:

Extract of powdered drug when treated with acetic anhydride and con.sulphuric acid given Bluish green colour.

3. Legal's test

Treat the test solution with pyridine and add alkaline sodium nitroprusside solution, blood red colour appears

4. Baljet's test:

Extract of powdered drug when treated with picric acid, orange colour is formed.

VI. Detection of Anthraquinone Glycosides

1. Borntranger's test:

Powdered drug is boiled with dilute sulphuric acid. Filtered and cooled. The filtrate is extracted with chloroform or benzene and dilute ammonia is added to it. The ammonical layer becomes pink to red due to the presence of anthraquinones derivative.

2. Modified Anthraquinones test:

Take 0.1 gm of drug and add 5ml of 5% solution of ferric chloride and 5ml dilute hydrochloric acid and heat on boiling water-bath for 5 minutes, cool the solution and shake gently with an organic solvent like benzene. Separate the organic solvent layer and add an equal volume of dilute ammonia. A pinkish red colour is formed in ammonical layer. This test is **of C. glycoside.**

ALOE CHEMICAL TESTS

The chemical tests for aloe are performed either for general detection or detection of specific variety of aloes.

(A) General test:

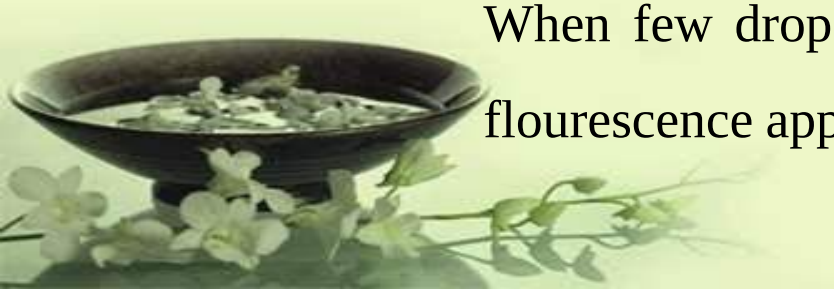
For these, 1 gm of powder is boiled with 10ml water & filtered with help of kieselguhr. The filtrate is used for bromine & borax test (Schoenteten's reaction)

***Bromine* test:**

Freshly prepared bromine solution is added to a small quantity of above filtrate. The test gives a pale yellow precipitate of tetrabromalin.

***Borax test (Schoenteten's reaction*):**

Littile quantity of above filtrate is treated with borax and shaken well till the borax dissolves. When few drops of this solution are added to a test tube nearly filled with water, a green flourescence appears.



(B). Special test:

These tests are meant for distinguishing different varieties of Aloe.

1. **Nitrous acid test:**

   Curacao aloe- sharp pink to carmine colour
   cape aloe- faint pink colour
   Socotrine & Zanzibar aloe - very less change in colour

2. **Nitric acid test:**

   Curacao aloe- deep brownish red colour
   cape aloe- brownish colour changing to green
   Socotrine - pale brownish to yellow colour
   Zanzibar aloe - yellowish brown colour

3. **Cupraloin test (Klunge's iso barbaloin test):**

   Curacao aloe- wine red colour persisting 4 hrs
   cape aloe- faint colouration rapidly changing to yellow
   Socotrine - No colour
   Zanzibar aloe - No colour