Saponin glycosides

* **Saponins** are a group of amorphous colloidal glycosides which is widely distributed in the higher plants.

* Have ability to form lasting foam when shaking in aqueous solution.

* They are excellent emulsifying agents (modify surface tension).

* Formerly used as detergents to replace soap (e.g., quillaia).

* Saponins are colorless and optical active. They form colloidal solution with water and are soluble in alcohol and dilute alcohols.

* Saponins have haemolytic properties, they precipitate the cholesterol and lethicines that exist in the membranes of the red blood cells and thus haemoglobin is liberated. So, saponins are extremely toxic when injected into the blood stream. However, they are not harmful when taken orally. Sarsaparilla, for example, is rich in saponins but is widely used in the preparation of non-alcoholic beverages. The fact that a plant contains haemolytic substances is not proof that it contains saponins, & in the species examined by Wall (1961) only about half of those containing hemolytic substances actually contained saponins. Toxicity is minimized during ingestion by low absorption.

* Saponins have a high molecular weight & are highly polar.

* Saponins are difficult to purify. However, they precipitated from solutions containing them by the addition of a solution of the sterol, filtering off the insoluble sterol-saponin compound and boiling it with toluene which resolves the compound again into sterol (which is soluble in toluene) and saponin (which is insoluble in toluene).

* Often they occur as a complex mixture with the components differing only slightly from one another in the nature of the sugar present, or in the structure of the aglycone.

* A number of sapogenins are collectively referred to as sapogenins are in themselves not used as therapeutic agents, serve as a useful starting material for the chemical synthesis & the practical production of a number of steroidal hormons which are medicinally important agents. Much of the recent researches conducted on the saponin-containing plants was to discover a precursor for cortisone. This substance was originally isolated from the adrenal cortex & later synthesized from certain bile acids of cattles. Since these sources limit the supply of cortisone. "Academic industrial & governmental research agencies" have examined many species of plants, practically those containing steroidal sapogenins as an important requirement based on its having (OH) groups in the (3 & 11) positions on the molecule or having the ability to be readily converted to this structure. The most outstanding plant steroids for cortisone production are: diosgenin, sarsapogenin, hecogenin, getogenin, & smilagenin.

* Some of our valuable food materials contain significant amount of saponins e.g. beans, lentils, soybeans, spinach & oats.

Chemically: -

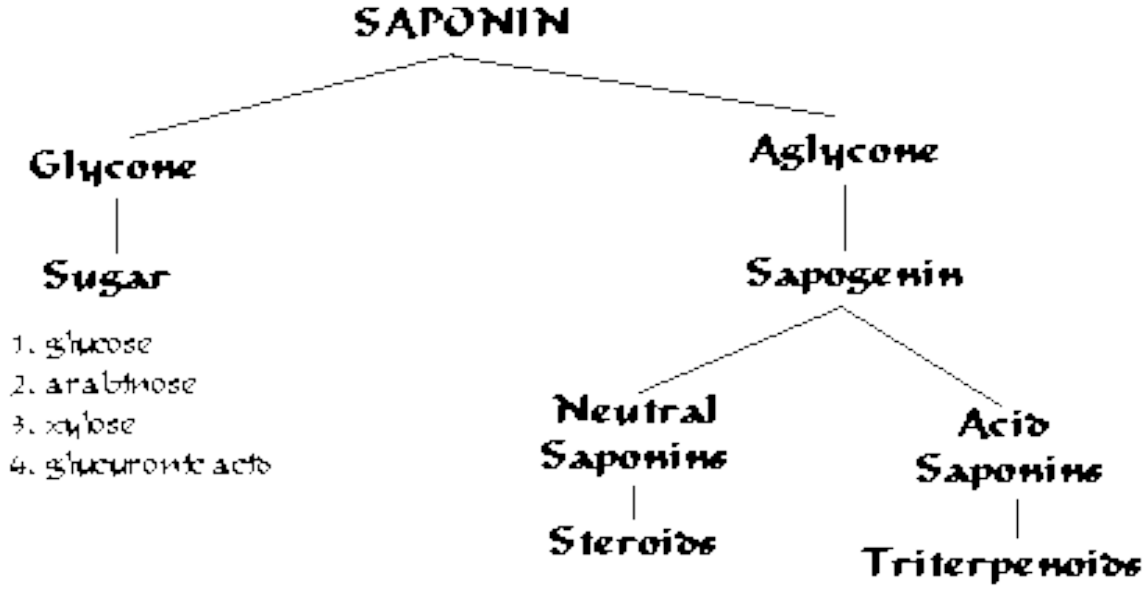
Saponins are classified according to the **genin** part into:

1- Neutral (Steroidal type C25) commonly tetra cyclic triterpenoids. They are derivatives of steroids with a spiroketal side chain.

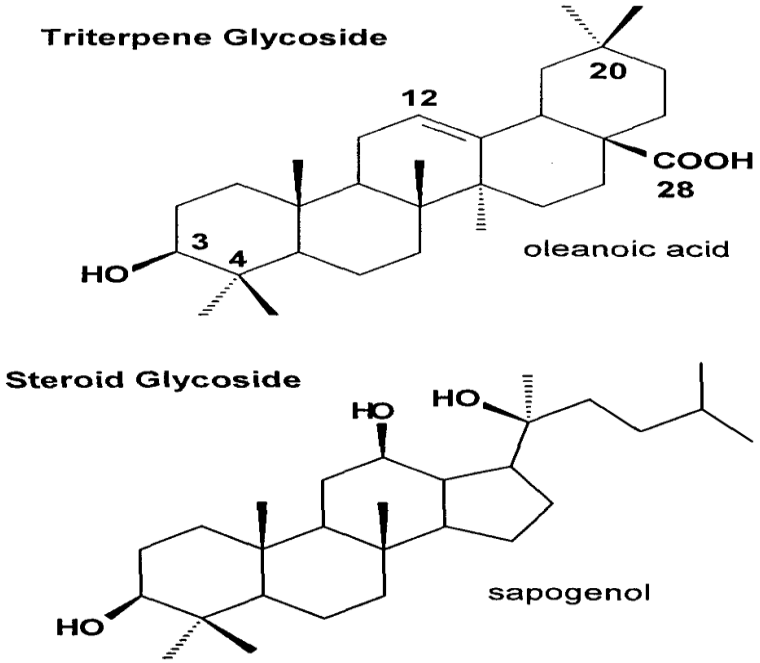
2- Acid saponins (pentacyclic triterpenoidal type C30).

Both types of saponins have the glycosidic linkage at position 3. Both have a common biogenetic origin via mevalonic acid & isoprenoid units.

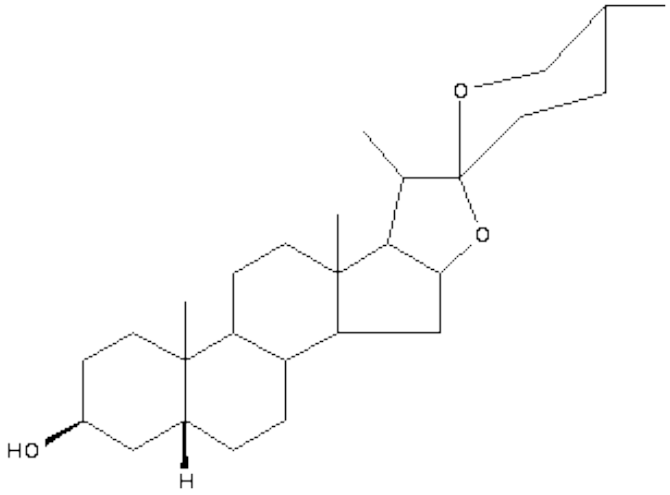
The steroidal saponins are widely distributed in nature than the pentacyclic triterpenoid type. Steroidal saponins are of great pharmaceutical importance because of their relationship to compounds such as sex hormones, cortisone, diuretic steroids, vitamin D, & the cardiac glycosides. Some are used as starting materials for the synthesis of these compounds. Diosgenin is the principle sapogenin used by industry.



The structures of both types of saponins are shown below:

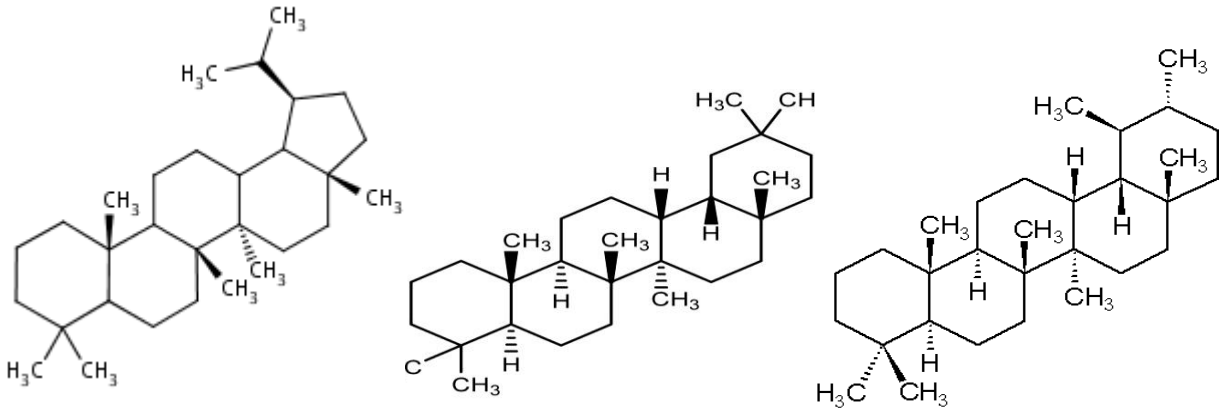


As with cardiac glycosides, the stereochemistry of the molecule is of some importance, although not so much so for cortisone manufacture. Neutral saponins differ only in their configuration at carbon atom 3, 5 & 25 & this implies the name spirostan.



Spirostan

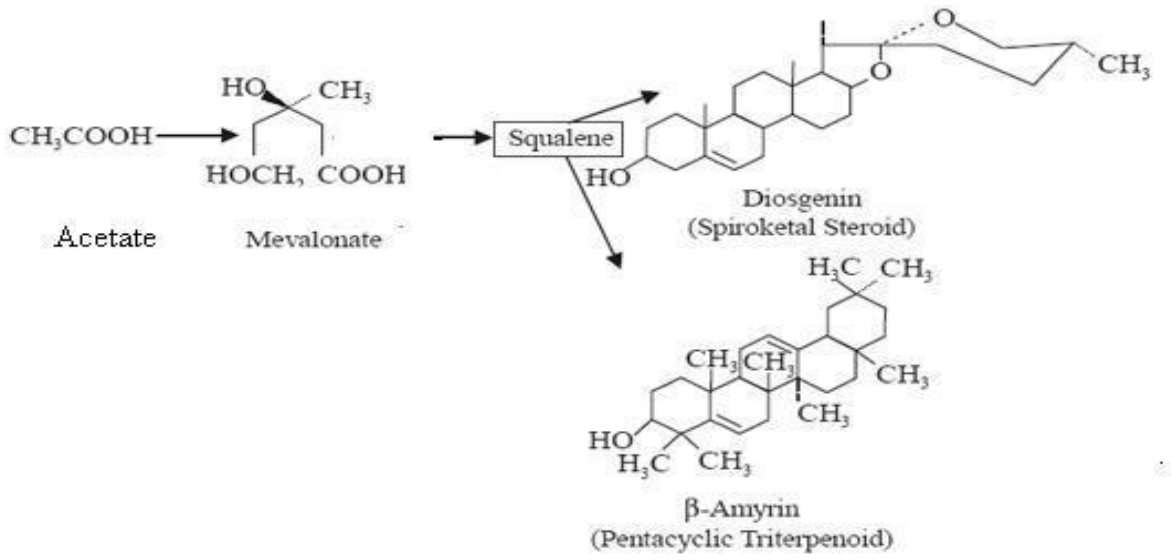
The pentacyclic triterpenoid skeletons exemplified by **lupane, α-amyrin, & β-amyrin**.



Lupane **Oleanane (β-amyrin)** **Ursane (α-amyrin)**

Biosynthesis:

The biosynthesis of the neutral saponin was discussed before. For the acid saponin less was known, but labeled acetate & mevalonate have been shown to be incorporated into such compounds. The pathway may be concluded to be the same for both & involve the head-to-tail coupling of acetate units.



Saponins **increase** the rate of absorption of many pharmacological active substances (e.g., cardiac glycosides).

Many saponin-containing drugs are used as **expectorants** (e.g., Ipeca, Senaga and liquorice) as their contents of **saponins stimulate bronchial secretion** and also activate the ciliary epithelium of the bronchi.

Drugs containing saponin glycosides: -

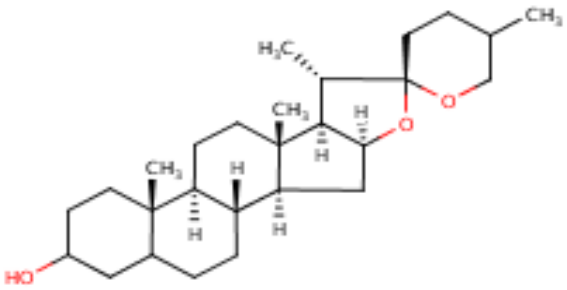
1) Sarsaparilla

Is the dried root of Smilax *aristolochiafolia* & many other species F: Liliaceae

Images of Sarsaparilla

Constituents:

The chief constituents are sarsapogenin (the sapogenin of sarsaponin), smilagenin (isosarsapogenin), sitosterol & stigmasterol.

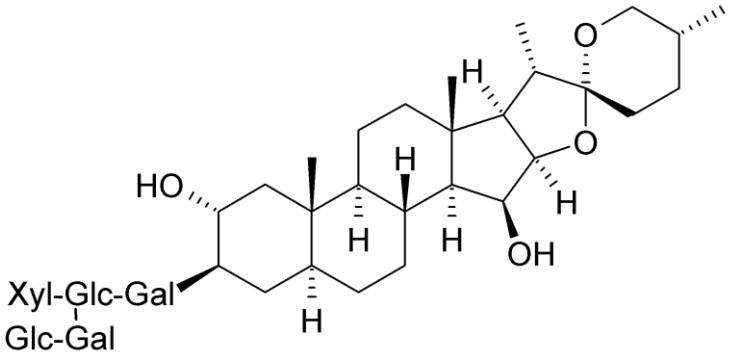


Sarsapogenin

Uses: as a flavoring agent

2) Digitonin

Is a glycoside obtained from ***Digitalis purpurea***; the aglycone is **digitogenin,** a **spirostan** steroid. Used as a detergent, it effectively water-solubilizes lipids. As such, it has several membrane-related applications in biochemistry, including solubilizing membrane proteins, precipitating cholesterol, and permeabilizing cell membranes. Digitonin is a useful analytical tool in certain widely used procedure for the quantitative estimation of cholesterol & other β-hydroxy sterol, because of its ability to form insoluble equimolar complex with such sterols. Also it could be used as an isolation procedure for such sterols, which then can be liberated from the complex. Digitonin is sometimes confused with the cardiac drug digoxin (sometimes also called digitalis or digitoxin), but has no heart-related effects.



Digitonin

3) Glycyrrhiza (licorice root)

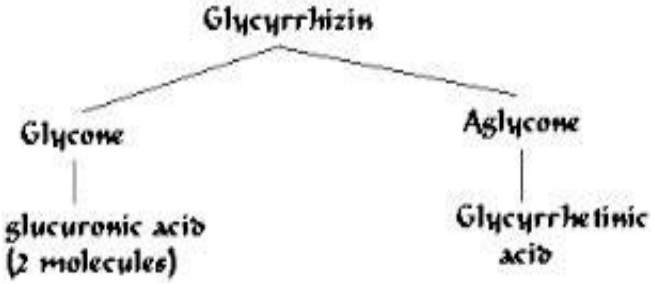
Is the dried rhizomes & root of ***Glycyrrhiza glabra*** F: Leguminosae (Fabaceae). Glycyrrhiza is of Greek origin & means sweet root, glabra means smooth, & refers to the fruit of this species which is a smooth pod.

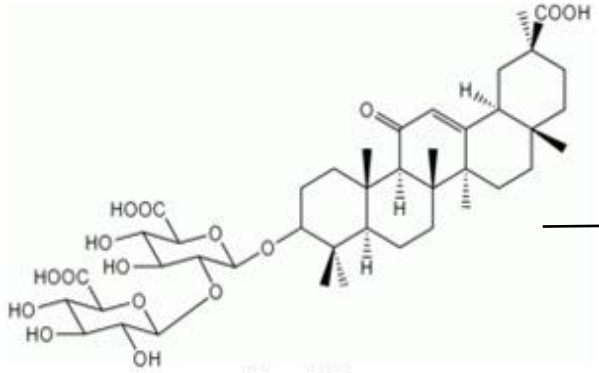
Until 1870 Spain produced practically the entire world's supply. Now Turkey, Greece, & Asia minor supply most of the licorice.

Images of Glycyrrhiza glabra

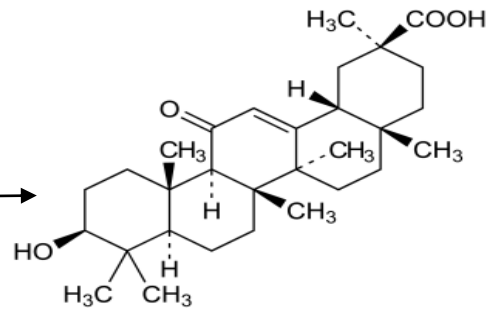
Constituents

Contain a saponin like glycoside, glycyrrhizin which is 50 times as sweet as sugar. Upon hydrolysis the glycoside losses its sweet taste being converted to the aglycone glycyrrhetinic acid plus two molecules of glucoronic acid. In addition, it contains flavonoids glycosides.





Glycyrrhizin



Glycyrrhetinic acid

Besides being a valuable flavouring and sweetening agent, it is employed to mask the taste of bitter drugs, liquorice has demulcent, expectorant and antispasmodic action. Commercially licorice is added to chewing gums, chocolate, candy, cigarettes, chewing tobacco, smoking mixtures, to beer to increase foaming & imparts a better taste. All these activities attributed to the saponin, glycyrrhizin. Recently, glycyrrhizin was shown to be effectively in gastric ulcer treatment and have a cortisone like action in rheumatic arthritis and other inflammatory diseases.

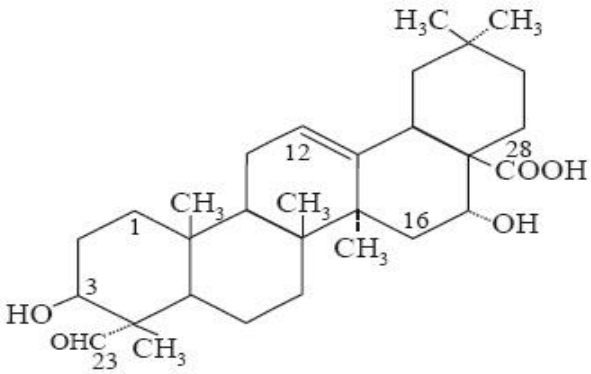
4) Quillaia bark (soap bark)

Is the bark of *Quillaia saponaria* F: Rosaceae , it has been used by the natives for washing silk & wool.


Images of quillaia

Constituents

The principle constituents of quillaia bark are two colorless, amorphous, toxic glycosides; quillaic acid & quillia sapotoxin. Commercial saponins are obtained from quillaia bark. Quillaia sapotoxin on hydrolysis yield quilliac acid.



Quillaic Acid

Uses:

Quillaia is used as stimulant & expectorant, externally as detergent & local irritant. For manufacture of soap, in mineral water industry, shampoo liquids, etc…

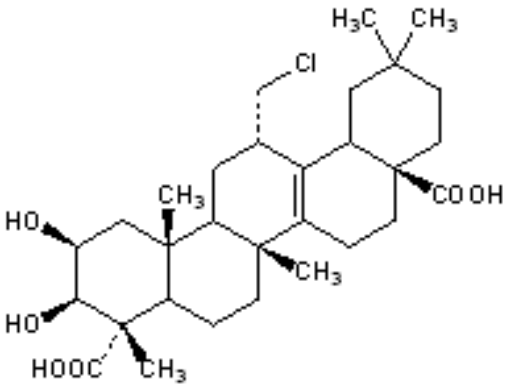
5) Senega (snake root)

Senega is the dried root of *Polygala senega* F: Polygonaceae. The root was used by the Indians as a remedy for snakebites.

Images of senega & its root

Constituents:

As a principle constituent senegin about 4% & polygalic acid about 5.5%.



Senegenin

Uses:

As a stimulant, expectorant in bronchitis.

6)Fenugreek

Is the dried seeds of *Trigonella foenum-graecum* F: Leguminoseae. Fenugreek is a potential source of diosgenin. India, Morocco, & Egypt are among the important producers.

Images of trigonella & its seeds

Constituents:

The main constituents is diosgenin. The diosgenin yield is increased by fermentation prior to acid hydrolysis.

Uses:

In addition to its use as a spice & potential source of diosgenin, fenugreek is widely employed in traditional systems of medicine. Its anti-diabetic, cholesterol-lowering, anti-inflammatory, anti-pyretic, anti-ulcer, & anti-cancer properties have been demonstrated.

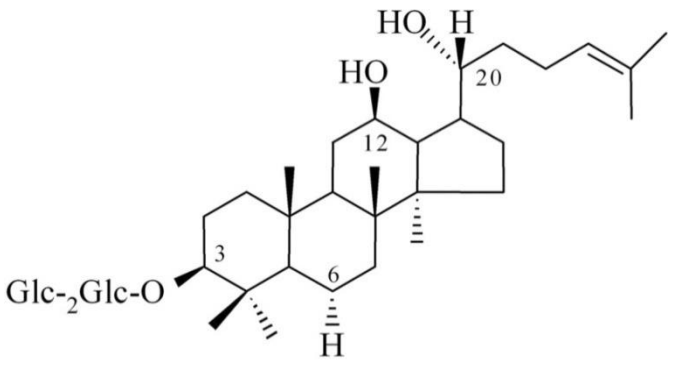
7) Ginseng

Ginseng is the dried root of ***Panax ginseng*** (Araliaceae) . Folk medicine attributes various benefits to oral use of American ginseng and Asian ginseng (*P. ginseng*) roots, including roles as aphrodisiac, stimulant, type II diabetes treatment, or cure for sexual dysfunction in men.

Ginseng may be included in small doses in energy drinks or herbal teas, such as ginseng coffee. It may be found in hair tonics and cosmetic preparations, as well, but those uses have not been shown to be clinically effective.

Constituents:

panax ginseng -contains saponin glycoside – ginsenoside (panaxoside) a triterpenoid steroidal nucleus



20(*S*)-Ginsenoside Rg_3

Ginseng root uses:

1.stimulant 2. Tonic 3. anti-stress 4. adaptogenic agent.

Images of Panax ginseng aerial & root

Saponins drugs officially in the B.P and U.S.P:

1- Quillaia bark: used as emulsifier.

2- Liquorice root: used as flavouring agent and expectorant.