Illustration:

Morning Glories, *Ipomoea* spp.
Constituents: Major Categories

- Carbohydrates
- Lipids
- Amino acids & derivatives
- Phenolic compounds
- Terpenoids
- Steroids
  - steroidal saponins
  - phytosterols
  - cardiac glycosides
- Alkaloids
Illustrations:

L: Cholesterol, an animal steroid
R: Beta-sitosterol, the corresponding plant steroid

Spotlights: four fused rings form the basic steroid skeleton
Steroidal Saponins

- Steroidal (spirostan/e) skeleton has 27 carbons
- Five rings (pentacyclic) most common
- Most have 3 - 5 sugars attached
- Usually occur in bulbs, seeds, or roots
- Similar properties to triterpenoid saponins

Illustrations:

L: Sarsaparilloside (from *Smilax*)
   Spotlight 1: Pentacyclic steroidal moiety
   Spotlight 2: Sugar moieties
R: Sarsaparilla, *Smilax officinalis* or *S. aristolochiaeefolia*
Illustrations:
1. American Wild Yam, *Dioscorea villosa*
2. Diosgenin, a steroidal saponin aglycone

Diosgenin is the aglycone.
American Wild Yam (aka Colic Root, Rheumatism Root) has relatively low levels of steroidal saponins compared to *D. mexicana*.
Soybeans are now used as the main commercial source of saponins for synthetic purposes.
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Illustrations:

Background: *Eleutherococcus senticosus* (Eleuthero, formerly called Siberian Ginseng) leaves

TL: *Eleutherococcus senticosus* flower

BL: American Ginseng (*Panax quinquefolius*) root

Eleutheroside E series are lignans; B series are phenylpropanoids. *Eleutherococcus* is not a species of *Ginseng*, but is in the same botanical family; the name alludes to its similar adaptogenic properties. The saponins in Eleuthero are not steroidal, but are triterpenoid. It appears here because the actions of the two plants are similar. Steroidal saponins & triterpenoid saponins are quite close in structure.
Steroids: Phytosterols

- Beta-sitosterol, campesterol, stigmasterol most common
- May exist as glycosides or esters w/fatty acids (e.g., daucosterol is a glycoside of beta-sitosterol)
- Important components of plant cell membranes (like cholesterol in animal cell membranes)
- Hormone-like activities in plants
- Phytostanols are closely related

Illustration:
Campesterol
Miscellaneous Steroids

- Estrone (identical to one of the human estrogens) is found in the Pomegranate: ancient fertility legends?
- Gugulipid (the resinous fraction from Commiphora mukul) contains guggulsterones & guggulsterols; highly effective Ayurvedic remedy for high cholesterol & triglyceride levels

Illustrations:
- L: Guggulsterone
- TR: Pomegranate, *Punica granatum* [Illustration by Pierre Joseph Redouté (1759 - 1840)]
- BR: Oleoresin from *Commiphora mukul*, aka Guggul; source of guggulsterones
Steroids: Phytosterols

- Sterol & stanol esters are added to foods (e.g., margarine) to lower cholesterol absorption
- Largest commercial source: pulp mill byproduct (endocrine disruptors in fish, frogs, etc.)
- Secondary source: soybeans
- ↓ cholesterol absorption, but high levels may be a risk factor for CHD
- ↓ serum levels of fat-soluble vitamins
- Possible phytoestrogenic effects in humans – evidence mixed

Illustration:

*Soybeans, Glycine max*
Phytosterols & the Prostate

- Saw Palmetto berries
- Nettle root
- *Pygeum africannum* (Prunus africana)
- Pumpkin seeds
- Swedish Pollen extract
- Anti-inflammatory effect may be due to inhibition of local prostaglandins
- Beta-sitosterol prescribed in Germany for BPH

Illustration:

*Pygeum africana* [Photo courtesy of Bryan Dailey, http://www.css.cornell.edu/research/prunus/]

Phytomedicines composed primarily of beta-sitosterol are prescribed in Germany to improve the symptoms of benign prostatic hyperplasia.
Phytosterols in Adaptogens

- Eleuthero
- Ginseng
- Licorice
- Sarsaparilla
- Avena (milky seed)
- Phytosterols in these herbs may be involved in the adrenotonic & adaptogenic properties

Illustrations:

TR: *Panax ginseng* root
BR: Candy made with Licorice (*Glycyrrhiza glabra*) extract
Cardiac Glycosides

- Small doses used clinically for controlling congestive heart failure
- Larger doses are cardiac poisons
- Native peoples use/d them as arrow poisons
- Steroidal glycosides with an extra lactone ring attached

Illustration:

Digitoxin, a cardiac glycoside

Spotlight 1. Four fused rings of the basic steroid skeleton

Spotlight 2. Additional lactone ring (4 carbons & 1 oxygen) gives this molecule its potency as a cardiac agent

Spotlight 3. Sugar moiety
Cardiac Glycosides in Lily of the Valley

- ~ 40 different glycosides based on several different aglycones; variable
- Convallatoxin highly active, but generally no more than 10% of the amount ingested can be absorbed
- Positive inotropic effect; used for mild cardiac insufficiency

Illustration:
Lily-of-the-Valley, Convallaria majalis [Thomé/Stueber]
Cardiac Glycosides in Digitalis

- Foxglove has ~ 30 different cardenolides including digitoxin/digitalin, gitoxin, & gitaloxin
- Powerful cardiac agents that ↑ contractility of heart muscle, ↑ cardiac output, ↑ cardiac work capacity, ↓ heart rate, ↓ arterial resistance; narrow range of safety
- ‘Purified’ glycosides currently used in medicine; whole leaf previously used

Illustrations:

Foxglove, *Digitalis purpurea*
Digitalis for Dropsy

- William Withering (a prominent physician in his time) is credited with ‘discovering’ digitalis as a cure for dropsy in 1775.
- In reality, he learned it from a local ‘gypsy’ or ‘old woman’ who was curing cases of heart failure with a formula including Foxglove ... an ‘old family recipe’

Illustrations:

1. Portrait of William Withering
2. Foxglove, Digitalis purpurea

Dropsy was the old name for edema due to congestive heart failure. See: http://www.ibiblio.org/herbmed/eclectic/kings/digitalis.html for Eclectic use of Digitalis.
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Cardiac Glycosides in Milkweeds

- Found in all species of Asclepias
- Components of the milky latex
- Toxic to vertebrates, but not to butterflies

Illustrations:

L: Showy Milkweed, *Asclepias speciosa*

TR: Monarch butterflies accumulate aspecioside, a cardiac glycoside from Milkweed, as a defense from predators

BR: Butterfly weed, *Asclepias tuberosa*