Illustration:

Morning Glories, *Ipomoea* spp.
Agrimony contains:
- Up to 10% condensed tannins (proanthocyanidins)
- ~ 20% polysaccharides
- Flavonoids including quercetin
- Flavone glycosides of luteolin & apigenin
- Triterpenes including ursolic acid

Agrimony is astringent & has traditionally been used as an anti-tumor agent. Quercetin is carcinostatic; the flavones are anti-inflammatory & anticarcinogenic; ursolic acid is a cytotoxic, antileukemic triterpenoid saponin also found in Ligustrum.
Astragalus

- Stimulates non-specific immunity
- Deep immune system tonic
- Antioxidant
- Adjunct therapy for cancer
- Astragaloside III is one of many saponins in the root

Illustrations:

TR: *Astragalus membranaceous* dried root slices.
BR: Astragaloside III, one of the 40 or so triterpene saponins in Astragalus root.

Astragalus root contains:
- Polysaccharides
- Astragalosides & other saponins
- Flavonoids

The whole herb is hepatoprotective, antioxidant, anticarcinogenic, & immunostimulant; it attenuates the side-effects of chemotherapy.

In combination with Ligustrum, Astragalus is used for breast, cervical, & lung cancers.

See: http://www.mcp.edu/herbal/astragalus/astragalus.PDF
Bloodroot: Isoquinoline Alkaloids

- Major constituents: sanguinarine & chelerythrine
- Potent alterative; has been used for cancer
- Antifungal, antibacterial, anti-inflammatory
- Highly effective against dental plaque bacteria

Illustrations:

L: Sanguinarine, an isoquinoline alkaloid.
R: Bloodroot, *Sanguinaria canadensis* [Walcott/SWSBM].

Bloodroot is a Native American herb containing a complex mixture of isoquinoline alkaloids including sanguinarine, sanguilutine, sanguirubine, chelerythrine, chelilutine, & chelirubine.

Used only in small doses; it is toxic in excess. Irritant to the skin & mucous membranes.

Illustrations:

Background: Chaparral or Creosote Bush (*Larrea* spp.) from Utah, USA.
Inset: Nordihydroguaiaretic acid, a lignan.

About half of the leaf-surface resin consists of the lignin nordihydroguaiaretic acid (NDGA).
Methyl esters of quercetin & other flavonoids make up the other half.
NDGA is a lipoxygenase inhibitor & antioxidant.
The flavonoids are anti-inflammatory, antioxidant, & carcinostatic.

See: [http://carcin.oupjournals.org/cgi/content/abstract/20/4/599](http://carcin.oupjournals.org/cgi/content/abstract/20/4/599)
Illustrations:

T: *Echinacea purpurea*
B: Cichoric acid

Spotlights: Phenylpropanoid moieties

Cichoric acid is a caffeic acid derivative found as a major constituent of *E. purpurea* & a minor constituent of *E. angustifolia*. It contributes to the immunostimulant properties.


Isobutylamides in Echinacea

- Isobutylamides are a type of alkylamide
- Echinacea purpurea & E. angustifolia have the highest concentrations
- Contribute to immunomodulating effect
- Stimulate phagocytosis
- COX-2 inhibitors (anti-inflammatory)

Illustrations:

TL: *Echinacea purpurea* flower bud
TR: *Echinacea purpurea*, full bloom [NGS/SWSBM]
BL: An isobutylamide from Echinacea
    Spotlight: unusual triple carbon-carbon bonds make a straight region in the molecule
BR: A line drawing of the same molecule

Echinacea has ~ 12 different alkylamides (isobutylamides are one type of alkylamide).
High levels of alkylamides accumulate in the roots & flowers of *E. purpurea* & *E. angustifolia*.

See: http://www.thorne.com/altmedrev/fulltext/ech.html (Kerry Bone)
See:
http://www.naturalproducts.org/inpr/mono_html/echin_html/echin_chem1.html
Immunomodulating Polysaccharides

- Stimulate non-specific immunity
- Echinacea: glucuronoarabinoxylans (glucuronic acid + arabinose + xylose) & arabinorhamnogalactans (arabinose + rhamnose + galactose) & arabinogalactans
- Others in Eleuthero, Baptisia, Calendula, Panax ginseng
- Larix (Larch) has arabinogalactans

Illustrations:
Background: Echinacea angustifolia
Inset: Baptisia pods & foliage

Immunomodulating polysaccharides in Echinacea include PS I (a 4-O-methylglucuronoarabinoxylan) & PS II (an acidic arabinorhamnogalactan).

See: http://www.thorne.com/altmedrev/fulltext/ech.html (Kerry Bone)
See: http://www.naturalproducts.org/inpr/mono_html/echin_html/echin_chem1.html
See: http://link.springer-ny.com/link/service/journals/00253/contents/02/01076/s00253-002-1076-7ch002.html
Arzneimittelforschung 1985;35(7):1069-75
See: http://biology.campbell.edu/~nemecz/George_home/references/Echinacea.html
See: http://www.hort.purdue.edu/newcrop/proceedings1999/v4-450.html

Also see: Luettig B, Steinmuller C, Gifford GE, Wagner H, Lohmann-Matthes ML.
Green Tea

- Flavanols, flavonols, lignans, ellagitannins
- Antioxidants, anti-inflammatories
- Help prevent cancers, atherosclerosis, arthritis, Alzheimer’s disease

Illustrations:
- Background: Green Tea (*Camellia sinensis*) leaves
- L: Catechin, a flavanol
- R: Infusion of Green Tea

Constituents in Green Tea:

**Flavanols:**
- Catechin
- Epicatechin
- Epicatechin gallate
- Epigallocatechin gallate
- Epigallocatechin digallate

**Flavonols:**
- Myricetin
- Quercetin

**Ellagitannins**

**Lignans:**
- Secoisolariciresinol
Illustrations:

Flavanols in Green Tea, *Camelia sinensis*

1. Epicatechin
   
   Spotlight: An –OH group, which contributes to the antioxidant activities of these molecules; as more –OH groups are added to the molecule, the overall antioxidant power increases.

2. Epicatechin gallate (ECG) has an additional ‘gallate’ group (from gallic acid) at position 3.

3. Epigallocatechin gallate (EGCG) has gained an –OH group on its B ring, like gallic acid has.

4. Epigallocatechin digallate (EGCGD) has two gallate groups & the extra –OH group.
Illustrations:

Flavanols in Green Tea, *Camellia sinensis*

1. Epicatechin

   Spotlight: An –OH group, which contributes to the antioxidant activities of these molecules; as more –OH groups are added to the molecule, the overall antioxidant power increases.

2. Epicatechin gallate (ECG) has an additional ‘gallate’ group (from gallic acid) at position 3.

3. Epigallocatechin gallate (EGCG) has gained an –OH group on its B ring, like gallic acid has.

4. Epigallocatechin digallate (EGCDG) has two gallate groups & the extra –OH group.
Illustrations:

Flavanols in Green Tea, *Camelia sinensis*

1. Epicatechin

   Spotlight: An –OH group, which contributes to the antioxidant activities of these molecules; as more –OH groups are added to the molecule, the overall antioxidant power increases.

2. Epicatechin gallate (ECG) has an additional ‘gallate’ group (from gallic acid) at position 3.

3. Epigallocatechin gallate (EGCG) has gained an –OH group on its B ring, like gallic acid has.

4. Epigallocatechin digallate (EGCDG) has two gallate groups & the extra –OH group.
Illustrations:

Flavanols in Green Tea, *Camelía sinensis*

1. Epicatechin

   Spotlight: An –OH group, which contributes to the antioxidant activities of these molecules; as more –OH groups are added to the molecule, the overall antioxidant power increases.

2. Epicatechin gallate (ECG) has an additional ‘gallate’ group (from gallic acid) at position 3.

3. Epigallocatechin gallate (EGCG) has gained an –OH group on its B ring, like gallic acid has.

4. Epigallocatechin digallate (EGCDG) has two gallate groups & the extra –OH group.
Illustrations:

Background: Green Tea (*Camellia sinensis*) leaves.

L: Quercetin, a flavonol, has 2 –OH groups.

   Spotlight: An –OH group, which contributes to this molecule’s antioxidant properties.

R: Myricetin, a flavonol found especially in Green Tea; it has 3 –OH groups.

The difference between a flavanol & a flavonol is that the latter has a =O at position 4 on the central ring, as well as a double bond between carbons 2 & 3.
Illustrations:

L: Privet, *Ligustrum sinense* [Lindman/Stueber]

R: Ursolic acid, a cytotoxic, antileukemic triterpenoid saponin; it occurs with a similar triterpenoid, oleanolic acid.

In combination with Astragalus, Ligustrum is used for breast, cervical, & lung cancers; it also treats leukopenia & stimulates T-cells & killer cell activity.
Illustrations:

TL: Reishi mushroom, *Ganoderma lucidum*
R: Maitake mushrooms, *Grifola frondosa.*

Beta-1,3-glucans (β-1,3-glucans) from medicinal fungi (Reishi [*Ganoderma lucidum*], Maitake [*Grifola frondosa*], Shiitake [*Lentinus edodes*]) & yeast (*Saccharomyces cerevisiae*) stimulate macrophage activity & non-specific immunity. These molecules are long chains of simple sugar subunits & are known as polysaccharides.

Traditionally, these mushrooms are known as “deep immune system tonics.”
Illustrations:

TR: Mistletoe, *Viscum album* [Köhler/Stueber]

**Lectins**

Lectins are non-enzymatic proteins or glycoproteins that can specifically & reversibly bind to oligosaccharide sites on cell membranes. Most lectins of higher plants are formed in the seeds during ripening & degrade during germination. Many of these substances are mitotic, toxic, or can agglutinate erythrocytes; some contribute immunostimulant actions.

**Mistletoe** (*Viscum album*) contains lectins designated ML I (‘viscumin’), ML II & ML III; *in vitro* studies demonstrate cytotoxicity to human leukemia cells at very low concentrations; immunostimulating properties have also been observed; used in Germany as an antitumor pharmaceutical; these lectins are also toxic to healthy cells at higher concentrations; not a home remedy, but can be used by experienced practitioners.

German Commission E lists *Viscum* as a “palliative therapy for malignant tumors via non-specific immunostimulation.”
Pau D’Arco

- Complex mixture of quinones
- Antioxidant
- Anti-inflammatory
- Anticarcinogenic
- Antitumor
- Immunomodulating
- Lapachol & beta-lapachone are highly active compounds

Illustrations:

TR: Pau D’Arco or Taheebo, *Tabebuia impetiginosa.*
BR: Lapachol, a naphthoquinone.

Lapachol & beta-lapachone are naphthoquinones; they occur along with anthraquinones.
Quercetin is also present.
Illustrations:

L: Vincristine, a potent anticarcinogenic alkaloid in Madagascar Periwinkle. As an isolated substance, it is used in chemotherapy. It occurs along with vinblastine & a number of other alkaloids.

R: Periwinkle, *Vinca minor* [Thomé/Stueber] The plant shown is a relative of Madagascar Periwinkle, *Catharanthus roseus* (Formerly known as *Vinca rosea*). Catharanthus looks very similar, but has rosy-colored flowers.

The whole plant has been used, in small doses, in traditional herbal medicine. The extracted & purified alkaloids are employed in medical chemotherapy.
Illustrations:

1: Pokeberries from *Phytolacca americana*.
2: Betanidin, a betacyanin from Pokeberries.

Poke root (tincture, oil) & leaves (poultice) have traditionally been used for cancers & as potent immunostimulants & lymphatic cleansers. The magenta pigment in the berries has recently been shown to be a powerful antioxidant & anticarcinogenic substance.

Betalains occur only in the order Caryophyllales, where they replace anthocyanins.

Betalains are a group of nitrogenous water-soluble pigments, derived from tyrosine via L-Dopa. Some authors classify them not as alkaloids, but as amino acid derivatives. There are two groups of betalains: the red/purple betacyanins & the yellow betaxanthins. They generally occur as glycosides, & may be complexed with phenylpropanoids.
Illustrations:

1: Pokeberries from *Phytolacca americana.*
2: Betanidin, a betacyanin from Pokeberries.

Poke root (tincture, oil) & leaves (poultice) have traditionally been used for cancers & as potent immunostimulants & lymphatic cleansers. The magenta pigment in the berries has recently been shown to be a powerful antioxidant & anticarcinogenic substance.

Betalains occur only in the order Caryophyllales, where they replace anthocyanins.

Betalains are a group of nitrogenous water-soluble pigments, derived from tyrosine via L-Dopa. Some authors classify them not as alkaloids, but as amino acid derivatives. There are two groups of betalains: the red/purple betacyanins & the yellow betaxanthins. They generally occur as glycosides, & may be complexed with phenylpropanoids.
Red Root

- Ceanothus is a lymphatic system stimulant & cleanser
- Alterative
- Increases T-cell activity
- Betulinic acid is anti-tumor

Illustrations:

L: Betulinic acid, a triterpenoid, has antitumor activity; it occurs with its relative, betulin.
R: Red Root or New Jersey Tea, Ceanothus americanus.

See: http://www.botanical.com/botanical/mgmh/r/redrot09.html
See: http://www.ibiblio.org/herbmed/eclectic/kings/ceanothus.html
Schizandra: Lignans

- Contains ~ 30 lignan-type compounds
- Schizandrin, gomisin
- Antioxidant
- Hepatoprotective
- Adaptogenic

Illustrations:

L: Schizandra (*Schizandra sinensis*) dried berries.
R: Schizandrin B, aka Deoxygomisin A; one of many related compounds with similar structures. They are complex lignan derivatives.

Schizandra is known as an immune system tonic & adaptogen.
Sheep Sorrel

- Part of traditional cancer formulas
- Emodin & rhein are anticarcinogenic
- Quercetin glycosides are carcinostatic
- Oxalic acid may potentiate other constituents in formulas

Illustrations:

- Background: Sheep Sorrel (*Rumex acetosella*) patch in Colorado, USA.
- L: Emodin, an anthraquinone with anticarcinogenic properties.
- TR: Sheep Sorrel leaf.
- BR: Oxalic acid, an organic acid.

Emodin, rhein, & aloe-emodin are anticarcinogenic anthraquinones found in this plant.

Hyperin (quercetin-3-galactoside) is a flavonol glycoside that has antioxidant & carnosstic properties.

Many plants traditionally used for cancer have oxalic acid as a constituent; its function in this context is not yet understood.

See: http://www.ibiblio.org/herbmed/eclectic/kings/rumex-acet.html#rumex-acetosella
Stillingia

- Alterative
- Blood purifier
- Part of Hoxsey formula
- Diterpene esters are irritant, but may be anticarcinogenic

Illustrations:

TR: Phorbol, the basis of several diterpene esters found in Stillingia. They may be involved in the anti-cancer properties of this plant.

BR: Stillingia or Queen's Delight, Stillingia sylvatica.

Stillingia is traditionally known as a potent alterative & blood purifier. The diterpenes are irritant & potentially toxic & so must be used in small doses only. This plant is included in the Hoxsey formula, a traditional folk remedy for cancer.
Violet

- Vitamin C & carotenoids are antioxidant
- Flavonoids include kaempferol & quercetin, rutin, cyanin, ferulic acid
- Flavonoids are antioxidant, carcinostatic
- Eugenol is antioxidant & antimitotic

Illustrations:

L: Eugenol is an oil-soluble phenylpropanoid, which is a type of phenolic acid.

M: Violet, Viola spp.
R: Kaempferol is a flavonol, a type of flavonoid.

Violets also contain the flavonoids quercetin, ferulic acid, & cyanin; a glycoside of salicylic acid, & mucilage (heteropolysaccharides).
It has traditionally been used for bronchial ailments & in cancer therapy.
Yellow Dock

- Emodin & related glycosides are aperients
- Anti-carcinogenic

Illustrations:

L: Emodin is an anthraquinone
TR: Yellow Dock (Rumex crispus) seeds
BR: Yellow Dock leaves

Yellow Dock is traditionally used as a mild aperient, liver tonic, iron tonic (for anemia), & cancer-preventative herb. It is also employed as part of alterative formulas to support immune system function.