Greetings and welcome to our course. The use of herbs in any fashion is a serious endeavor and should never be utilized without clear knowledge of the herb/s being used. Herbs are in many cases a natural drug and used the wrong way or in combination with the wrong herbs or commercial medicine, can result in serious illness and even death. Do not trifle with herbs. Herbs in fact are made up of many different compounds. The majority of the lessons in this course are to familiarize you with these different compounds and their significance within each herb. Enjoy...

Whispering Woods
Advanced Herb Course

Lesson One: Glossary

Aglycone: The non-sugar component of a glycoside molecule that results from hydrolysis of the molecule.

Alkaloid: Any of various organic compounds normally with basic chemical properties and usually containing at least one nitrogen atom in a heterocyclic ring, occurring chiefly in many vascular plants and some fungi.
Amine: Any of a group of organic compounds of nitrogen, that may be considered ammonia derivatives in which one or more hydrogen atoms have been replaced by a hydrocarbon radical.

Amino acids: Organic (carbon-containing) molecules that serve as the building blocks of proteins.

Anodyne: A compound capable of soothing or eliminating pain.

Antigen: A substance that is capable of eliciting an immune response.

Antioxidant: Any substance that prevents or reduces damage caused by reactive oxygen species (ROS) or reactive nitrogen species (RNS).

Antispasmodic: an agent that relieves or prevents spasms, especially of smooth muscle.

Catecholamines: Substances with a specific chemical structure (a benzene ring with two adjacent hydroxyl groups and a side chain of ethylamine) that function as hormones or neurotransmitters. Examples include epinephrine, norepinephrine, and dopamine.

Coenzyme: A molecule that binds to an enzyme and is essential for its activity, but is not permanently altered by the reaction. Many coenzymes are derived from vitamins.

Covalent Bonds: Covalent bonds are a chemical link between two atoms in which electrons are shared between them.

Enzyme: A substance that increases the speed of a chemical reaction without being changed in the overall process.

Exudate: A fluid with a high content of protein and cellular debris which has escaped from blood vessels and has been deposited in tissues or on tissue surfaces, usually as a result of inflammation.

Flavonoids: Any of a large group of water-soluble plant pigments, including the anthocyanins.

Fructose: A very sweet 6-carbon sugar abundant in plants.

Glucoside: Complexes of substances with glucose. A glycoside of which the main sugar component is glucose.

Glycoside: Any of a group of organic compounds, occurring abundantly in plants, that yield a sugar and one or more non-sugar substances on hydrolysis.

Homologous: Having the same appearance, structure or evolutionary origin.
Isomers: Compounds that have the same numbers and kinds of atoms but that differ in the way the atoms are arranged.

Metabolism: The sum of the processes (reactions) by which a substance is assimilated and incorporated into the body or detoxified and excreted from the body.

Monoamines: A group of organic, nitrogen-containing compounds to which adrenaline, noradrenaline, and serotonin belong.

Monoterpenes: These are a class of terpenes that consist of two isoprene units and have the molecular formula C10H16

Narcotic: An addictive drug, such as opium, that reduces pain, alters mood and behavior, and usually induces sleep or stupor.

Nucleotides: Subunits of nucleic acids. Nucleotides are composed of a nitrogen-containing base (adenine, guanine, cytosine, uracil or thymine), a 5-carbon sugar (ribose or deoxyribose), and one or more phosphate groups.

Phenolic compounds: Naturally occurring compounds present in grape skins and seeds and extracted from oak barrels.

Phytoestrogen: A naturally occurring compound of plants, such as soybeans, or plant products, that acts like estrogen in the body.

Phytotoxin: A substance toxic to plants. A toxin produced by plants.

Polysaccharide Gum: The sticky by-product of the decomposition of roots by microorganisms, which can bind soil minerals into aggregates.

Pyridine: Any of a class of aromatic compounds with a six-member aromatic ring composed of five carbon atoms and one nitrogen atom, making it a heterocyclic compound.

Pyrolysis: The chemical decomposition of organic materials by heating in the absence of oxygen or any other reagents, except possibly steam.

Organic: Refers to carbon-containing compounds, generally synthesized by living organisms.

Sedative: An agent or a drug having a soothing, calming, or tranquilizing effect.

Sesquiterpenes: These are a class of terpenes that consist of three isoprene units and have the molecular formula C15H24.

Teratogenic: Of, relating to, or causing malformations of an embryo or fetus.
Terpenes: These are a large and varied class of hydrocarbons, produced primarily by a wide variety of plants.

Quiz:

1. Anodyne is a compound capable of soothing or eliminating _____.
2. Monoamines is a group of organic, ______-containing compounds.
3. _______ _______ are present in grape skins and seeds.
4. Many coenzymes are derived from ________.
5. _______ is a group of organic, nitrogen-containing compounds to which adrenaline, noradrenaline, and serotonin belong.
6. Sesquiterpenes are a class of ________.
7. Flavonoids are any of a large group of water-soluble plant ________.

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Lesson Two
Aromatic compounds

In Rome the word cinnamon was equivalent to the current use of "sweetheart" or "darling".

Aromatic Compounds are any members of a large class of organic compounds whose molecular structure includes one or more planar rings of atoms. This list used to be limited to the pleasant-smelling chemicals derived from vegetables, but is now expanded to include a large class of compounds that includes benzene, toluene, naphthalene, and anthracene. All of these compounds are found in coal tar. Aromatic compounds usually contain but are not limited to six carbon atoms. A hexagonal structure is characteristic of many of the aromatic compounds.

Following are some of the more common Aromatic Compounds found in herbs.
Eugenol (yü-jä’nöl) (CH2CHCH2C6H3(OCH3)OH) 4-Allyl-2-methoxyphenol; 4-Allyl-guaiacol

Molecular weight: 164.21

Eugenol is found in cinnamon, clove and pimento; one of its medical qualities is a local anesthetic effect. It is a colorless or yellowish aromatic liquid with a spicy taste and odor. It is often used as a flavoring agent. It is also used as an analgesic in dentistry. Eugenol will darken and thicken when exposed to air.

Cloves

Menthol (men´thol) (Cinnamomum camphara) CH3C6H9 (C3H7) OH

Menthol is from Latin menta, "mint".
Formula: (1R, 2S, 5R)-2-isopropyl-5-methylcyclohexanol

Molecular Weight: 156.2652000

**Menthol** is an organic compound naturally occurring in mint plants. Menthol is a white crystalline organic compound resembling camphor that is extracted from oil of peppermint. This compound is solid at room temperature and melts slightly above. The main form of menthol occurring in nature is (-)-menthol, which is assigned the (1R,2S,5R) configuration. Menthol is used in perfumes, menthol cigarettes, mild topical anesthetic, and as a mint flavoring. Menthol is classed as an antipruritic, which reduces itching and thus is used for short-term relief of minor sore throat and minor mouth or throat irritation. It is sometimes called mint camphor.

![Peppermint](image)

**Peppermint**

**Anise (Pimpinella anisum) "Umbelliferae family"** C8H10O2

**Molecular Weight 138.16**
Having been mentioned by both Dioscorides and Pliny the Elder, anise was considered useful as a cure for sleeplessness.

The primary constituent of Anise is anethole, a sweet substance that solidifies at room temperature. Anise has a number of compounds including anethole (approximately 90%), gamma-himachalene and glucosides of phenylpropanoids, anisaldehyde, estragole, and myrcene.

The essential oil of Anise includes the following chemical compounds; α-pinene, camphene, β-pinene, linalool, cis-anethole, trans-anethole, safrole, anisaldehyde and acetoanisole.

Aniseed is used in produce alcoholic beverages, such as Arak from Morocco and Ouzo from Greece. 

The principal component of anise oil is a precursor that will eventually produce 2, 5-dimethoxybenzaldehyde.

Pimpinella anisum, are plants which have been used as estrogenic agents for centuries.

Anise is an annual herb of the parsley family.

Aniseed oil goes particularly well with other essential oils such as cardamom, caraway, cedar wood, coriander, dill, fennel, mandarin, petitgrain and rosewood.
Cinnamon (Cinnamomum verum) "Lauraceae family"

Molecular Weight: 132.16

In India Cinnamon is known as "Daalchini". Cinnamon was imported to Egypt from China as early as 2000 BCE.

It is well known that the emperor Nero burned a year’s supply of the spice at the funeral of his second wife, Poppaea Sabina. This act was carried out to indicate the extent of his remorse after he had kicked her to death.

Cinnamon contains cinnamaldehyde (C9H8O) or 3-phenylprop-2-enal. Cinnamaldehyde is yellowish oily liquid that is the main component in cassia oil as well as cinnamon bark oil and is used in flavoring compounds to impart a cinnamon flavor. Cinnamon oil contains 70% to 90% of cinnamaldehyde. Cinnamaldehyde is not soluble in water. It has a boiling point of 246 degrees Celsius and it has a Flash point of 71C and a Melting point of -8C. Chemical components of the essential oil include ethyl cinnamate, eugenol, cinnamaldehyde, beta-caryophyllene, and linalool and methyl chavicol. Cinnamaldehyde can be made synthetically but is more commonly obtained from the steam distillation of the oil of cinnamon bark.

Mace (Myristica fragrans) (nutmeg family)

Molecular Mass 192.211
The pericarp (fruit/pod) is used in Grenada to make a jam called Morne Delice.

Mace is the thin, bright red aril or lace-like covering over the shell of the Nutmeg. The mace aril encapsulates the endosperm, or nutmeg seed. Mace contains an organic compound known as myristin (C11H12O3), 4-Methoxy-6-prop-2-enyl-benzo [1, 3]dioxole. Myristicin is a naturally occurring methylenedioxyphenyl compound found in nutmeg. Myristicin is a weak inhibitor of monoamine oxidase which are enzymes that catalyze the oxidation of monoamines. The Nutmeg spice (5-15g) causes symptoms similar to atropine poisoning and it is thought that myristicin may be responsible, in whole or in part, for the toxicity of the spice. Intoxications with myristicin do not resemble the effects of MDMA or MMDA. Myristicin can, however, be converted into MMDA using a reaction similar to the one used to convert safrole into MDMA. As a methylenedioxyphenyl compound, myristicin gives rise to a type III spectrum with reduced cytochrome P-450 and can inhibit monooxygenations catalyzed by this cytochrome.
The main constituents in ginger are phenolic compounds such as gingerols and shogaols, and sesquiterpenes such as zingiberene. The main pungent flavor chemicals are the gingerols, which are not volatile. Chemically, gingerol (C15H22O4) 5-hydroxy-1-(4-hydroxy-3-methoxy-phenyl)-octan-3-one is a relative of capsaicin. Gingerol is normally found as a pungent yellow oil, but also can form a low-melting crystalline solid. Gingerol is converted to zingerone when it is heated during cooking. It is thought that gingerol has developed as a defense mechanism against herbivores.
The smell of garlic is caused by allicin, (C6H10OS2) (diallyldisulfide-S-oxide), 2-propene-1-sulfinothioic acid S-2-propenyl ester which is derived from precursors such as alliin (S-allyl-L-cysteine sulfoxide) by the enzyme alliinase which is released when the clove is broken up.

Allinase acts as a catalyst and results in the transformation of alliin into allicin (diallyl thiosulphinate).

When allicin degrades (such as when it is heated) it produces various diallyl sulphides, the most common of which is diallyl disulphide. Although the diallyl sulphides do not have the strong anti-bacterial and anti-fungal properties of allicin, they are still believed to have medical benefits especially as regards circulation and cholesterol.

The active compound resembles the well known drug N-acetyl-L-cysteine (Mucomyst), which has mucolytic and antioxidant properties.

Allicin is a harsh oxidizing agent and high amounts have been shown to aggravate the intestinal lining as well as the stomach.

If the allicin is absorbed by the liver in small amounts, it is completely metabolized or detoxified; however, absorbed in large amounts it may damage liver tissue. If it makes its way into the bloodstream, it may oxidize red blood cells.
Garlic

**Horse Radish: (Cochlearia Armoracia) Family Cruciferae**

Molecular Mass: 99.15

![Chemical Reaction Diagram]

Horse radish which is in the same family as Mustard and Wasabi contains the chemical compound "Allyl isothiocyanate". It is this compound which is responsible for the pungent taste of these plants.

Allyl isothiocyanate is a colorless to pale yellow liquid that is slightly soluble in water, but very soluble in most organic solvents.

When cut or grated, however, enzymes from the damaged plant cells break down sinigrin (a glucosinolate) which is decomposed in the presence of water by Myrosin, an enzyme also found in the root, to produce allyl isothiocyanate. Because the Sinigrin and Myrosin exist in separate cells, it is only the bruising of the cells that brings their contents together, thus resulting in a chemical reaction.

Allyl isothiocyanate can also be liberated by heating during distillation. The product obtained is known as volatile oil of mustard and is usually around 92% pure. Allyl isothiocyanate has a boiling point of 152°C.

Allyl isothiocyanate can also be produced synthetically, by the reaction of allyl iodide and potassium thiocyanate. The product obtained in this fashion is known as synthetic mustard oil.

Allyl isothiocyanate serves the plant as a defense against herbivores. It is interesting to note that this substance is harmful to the plant itself; hence it is stored in the harmless form of the glucosinolate, separate from the myrosinase enzyme.
Horse Radish

Quiz:

1. A _______ structure is characteristic of many of the aromatic compounds.

2. The primary constituent of Anise is _______.

3. The mace aril encapsulates the ________, or nutmeg seed.

4. _______ is yellowish oily liquid that is the main component in cassia oil as well as cinnamon bark oil.

5. _______ is a relative of capsaicin.

6. Allyl isothiocyanate can also be _______ by heating during distillation.

7. Myristicin is a naturally occurring ___________________ compound found in nutmeg.

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Lesson Four
Flavonoids and Flavonol

Flavonoids were discovered in 1938 CE when a Hungarian scientist named Albert Szent-Gyorgyi used the term "vitamin P" to describe them. Flavonoids are polyphenolic compounds with a C15 flavone skeleton. They represent a large group of secondary metabolites. In fact, Flavonoids consists of over 6,000 different substances found in virtually all plants. They are responsible for many of the plant colors. Flavonoids are usually classified into 6 main subgroups such as; Flavonol (Hydroxy derivatives of flavone), Flavones (skeleton: 2-phenylchromen-4-one), Isoflavones (skeleton: 3-phenylchromen-4-one), Flavonones (derivation by reduction of the 2(3) C=C bond), Flavanols (derivation by reduction of the keto group), and Anthocyanidins (aglycones of the glycoside anthocyanins).
Most flavonoids function in the human body as antioxidants. In this capacity, they help neutralize overly reactive oxygen-containing molecules and prevent them from damaging parts of cells. Flavonoids help to prevent the bad LDL cholesterol from forming oxidized LDL which forms plaques in arteries. Other studies show that flavonoids help to prevent heart attacks. Men with the highest consumption of flavonoids (from fruits and vegetables) have approximately half the risk of heart disease and cancer compared with those with the lowest intake. Flavonoids are reported to have antiviral, anti-allergic, antiplatelet, anti-inflammatory, and antitumor and antioxidant activities, Virtually all fruits, vegetables, herbs and spices contain flavonoids. Scultellaria root, cornus fruit, licorice, and green tea are examples of flavonoid-containing foods widely used in oriental medicine.
Quercetin is a phytochemical that is part of the coloring found in the skins of apples and red onions. Quercetin is a flavonoid and more specifically a flavonol. Quercetin acts like an antihistamine and an anti-inflammatory, and may help protect against heart disease and cancer. Studies show that Quercetin prevents damage to LDL cholesterol, and that people who eat diets high in flavonoids have lower cholesterol.

It is a powerful antioxidant, natural anti-histamine, and an anti-inflammatory. Do not take Quercetin without talking to your doctor first if you are taking: Cyclosporine (may interfere with the body's absorption), Neoral(R), Sandimmune(R), Sandimmune IV(R), Sangeya(R) Digoxin (Lanoxin(R) or infection medicines such as (ciprofloxacin (Cipro(R), gatafloxacin (Tequin(R), levofloxacin (Levaquin(R), norfloxacin (Noroxin(R), ofloxacin (Flexin(R), sparfloxacin (Zagam(R), trovafloxacin (Trovan(R).

Avoid Quercetin if you are pregnant or breast feeding or have liver disease.
Kaempferol:

![Kaempferol molecule](image)

Formula: C$_{15}$H$_{10}$O$_6$

Molecular Weight: 286.24

Kaempferol is a well known flavonoid. Kaempferol can be found in many natural sources including apples, onions, leeks, citrus fruits, grapes, red wines, Gingko Biloba, St. John's Wort. It is extracted as a yellow crystalline solid with a melting point of 276-278 °C. It is only slightly soluble in water but soluble in hot ethanol and diethyl ether. Kaempferol is what gives the flowers of Acacia decurrens and Acacia longifolia their color. Kaempferol is a strong antioxidant and helps to prevent oxidative damage of our cells, lipids and DNA. Kaempferol seems to prevent arteriosclerosis by inhibiting the oxidation of low density lipoprotein and the formation of platelets in the blood. Kaempferol can help to fight cancer because it reduces the resistance of cancer cells to anti-cancer drugs such as vinblastine and paclitaxel.
Acacia decurrens

Rutin: C₂₇H₃₂O₁₆

Formula: C₂₇H₃₀O₁₆·3(H₂O)

Molecular Weight: 664.57

Rutin is a bioflavonoid. Pure Rutin is a yellow or greenish-yellow, needle-shaped crystal. Rutin is a flavonol glycoside comprised of the Quercetin and the disaccharide rutinose (rhamnose and glucose). Rutin can be created by bonding a disaccharide onto the hydroxyl group of Quercetin. It has a melting point of 190°C. Rutin is found in many plants, fruits and vegetables. The richest source is buckwheat. Rutin has strong antioxidant properties and is important because it strengthens capillaries and can help people who bruise or bleed easily. Rutin also has anti-inflammatory effects. It may also help to prevent atherogenesis and reduce the cytotoxicity of oxidized LDL-cholesterol.

Rutin helps the body to utilize vitamin C and maintain collagen.

Avoid Rutin if you are pregnant or breastfeeding.
Apigenin: C15H10O5  5, 7-dihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one

Formula: C_{15}H_{10}O_{5}

Molecular Weight 270.23

Apigenin like most flavonoids has antioxidant, anti-inflammatory and anti-tumor properties. The flavonoid Apigenin has shown the ability to inhibit melanoma growth and metastatic potential. It has been shown to lower inflammation and oxidative stress, and exerts growth inhibitory effects on cancer cells.

Apigenin is found at high levels in parsley, thyme, peppermint. Apigenin is also found in a number of other herbs such as chamomile, lemon balm, vervain, yarrow. Apigenin is extracted as a yellow crystalline solid that is the aglycone of apiin. It has a melting point of 345-350 C.
Another flavone is Luteolin. And like most flavonoids, it has antioxidant, anti-inflammatory, and anti-tumor properties. Lutein is present in plants as a fatty-acid ester, with one or two fatty acids bound to the two hydroxyl-groups.
Luteolin is classified as an ingredient of expectorants which ejects phlegm or other material from the throat or lungs by decreasing its viscosity or stimulating secretion of mucus by the respiratory tract mucosa.
Luteolin is a potent hypoglycemic agent and improves insulin sensitivity. Luteolin also helps the body withstand radiation and chemotherapy.
Luteolin is found in high amounts in parsley, thyme, peppermint, basil, celery, artichoke.
In its physical state, Luteolin is a yellow crystalline powder. It has a melting point of 320°C.

Artichoke

Naringen: C27H32O14
Molecular weight 580.53

Naringen is a citrus flavonoid commonly found in grapefruit, and is responsible for grapefruit's distinctive bitter taste. Naringen is a bioflavonoid and is an efficient antioxidant which works synergistically with vitamin C and the proanthocyanidins to scavenge free radicals. Proanthocyanidins is a class of flavanols.

Naringin can increase the absorption of certain heart-related drugs (including nifedipine, felodipine and verapamil), as well as the antihistamine terfenadine.
Naringen has also been shown to exhibit cholesterol-lowering effects and is also an aldose reductase inhibitor, which means it may also play a role in battling retinal disease in diabetics. Naringen also helps to extend and increase the effects of certain compounds, including caffeine and vitamin C. Naringen is included in many dietary supplements due to its fat burning properties.

![Grapefruit](image.jpg)

**Catechins: Camellia sinensis**

Catechins are polyphenolic antioxidant plant metabolites, specifically flavonoids called flavan-3-ols. It is one of the tannic acids, extracted from catechu as a white, crystalline substance. They are present in numerous plant species, with the largest source in the human diet coming from various teas derived from the tea-plant "Camellia sinensis". Catechins are the major component of green tea extract. The four polyphenol Catechins in green tea include galallocatechin (GC), epigallocatechin (EGC), epicatechin (EC), and epigallocatechin gallate (EGCG). Green tea has about 27% Catechins, with Oolong tea (partially fermented) having about 23%, and Black tea (fermented) at approximately 4% catechins.
Catechins exert significant antioxidant power and may prove to be important heart healthy agents in combating lipid peroxidation within cell membranes lining arterial walls and reducing formation of atherosclerotic plaque.

**Camellia sinensis**

**Tangeritin:** C\textsubscript{20}H\textsubscript{20}O\textsubscript{7} 5, 6, 7, 8-tetramethoxy-2-(4-methoxyphenyl)-4H-1-benzopyran-4-one

Molecular Mass 372.37

Tangeritin is polymethoxylated flavones that are found in tangerine and other citrus peels. It is known as a Citrus bioflavonoid.

Tangeritin shows promise in protecting nerve cells, and may be useful in reducing the risk for certain cancers, especially in relation to the head and neck.

It acts to freeze cancer cells in phase G1 of the cell cycle, preventing replication. Tangeritin strengthens the cell wall and protects it from invasion. Tangeritin induced apoptosis in
leukemia cells while sparing normal cells. Tangeritin has induced apoptosis in leukemia cells while sparing normal cells. Tangeritin is also a possible cholesterol lowering agent. Tangeritin has a melting point of 155°C.

Quiz:

1. Flavonoids are usually classified into __ main subgroups.

2. The richest source of Rutin is ______.

3. Naringin can increase the absorption of certain _____-_____ drugs.

4. Quercetin is a ________ that is part of the coloring found in the skins of apples and red onions.

5. Flavonoids consist of over ______ different substances.

6. The flavonoid _________ has shown the ability to inhibit melanoma growth.

7. Catechins exert significant ________ power.
Amines: C2H5NH2

Amines are produced by the decay of organic matter. In particular amines are organic compounds that may be considered derivatives of ammonia (NH₃) in which one or more hydrogen atoms have been replaced by a hydrocarbon radical. The production of methane is an important and widespread form of microbial metabolism.

Amines resemble ammonia, wherein one or more hydrogen atoms are replaced by organic substituents such as alkyl and aryl groups. An important exception to this rule is that compounds of the type RC (O) NR₂, where the C (O) refers to a carbonyl group, are called amides rather than amines. Amines in which an N-H group has been replaced by an N-M group (M = metal) are also called amides.

In organic chemistry, compounds composed of carbon and hydrogen is divided into two classes: Aliphatic and Aromatic compounds, which contain benzene rings. Aliphatic amines arise when one of three hydrogen atoms in ammonia is replaced by organic substituents.

Secondary amines have two organic substituent bound to N together with one H. In tertiary amines all three hydrogen atoms are replaced by organic substituents. It is also possible to have four alkyl substitutes’ on the nitrogen. These compounds have a charged nitrogen center, and necessarily come with a negative counterion, so they are called quaternary ammonium salts.

The simplest aliphatic compound is methane (CH₄). Aliphatics include alkanes such as fatty acids and paraffin hydrocarbons, alkenes (such as ethylene) and alkynes (such as acetylene).

Most aliphatic compounds are flammable.

Aromatic amines have the nitrogen atom connected to an aromatic ring as in anilines. The aromatic ring strongly decreases the basicity of the amine, depending on its substituent. Aromatic amines are generally broken down into two classes;

**Heterocyclics**

In heterocyclic aromatics, one or more of the atoms in the aromatic ring is of an element other than carbon.

**Polycyclics**

Polycyclic aromatic hydrocarbons (PAH) are molecules containing two or more simple aromatic rings fused together by sharing two neighboring carbon atoms. The key aromatic hydrocarbons are benzene, toluene, ortho-xylene and para-xylene.

In general amines act as bases and are reasonably strong. Because amines are basic, they neutralize carboxylic acids to form corresponding ammonium carboxylate salts. Upon heating to 200 °C, the primary and secondary amine salts dehydrate to form corresponding amides.
Aniline: (phenylamine) C₆H₅NH₂

Aniline was first obtained in 1826 by the distillation of indigo. Its name is taken from the specific name of the indigo-yielding plant Indigofera anil (Indigofera suffruticosa). It is one of the simplest and yet one of the most important of the aromatic amines. Aniline is an amine of benzene. It is a primary aromatic amine whose molecule is formed by replacing one hydrogen atom of a benzene molecule with an amino group. Aniline has a boiling point of 184°C; and a melting point of -6°C. Aniline combines directly with alkyl iodides to form secondary and tertiary amines. Aniline is an oily liquid poisonous amine obtained especially by the reduction of nitrobenzene a (product of coal tar) and is used chiefly in the manufacturing of commercial dyes. Aniline is prepared commercially by the catalytic hydrogenation of nitrobenzene or by the action of ammonia on chlorobenzene. The reduction of nitrobenzene can also be carried out with iron borings in aqueous acid. Aniline is a known carcinogen.
Methylamine: CH₃NH₂

Methylamine is a derivative of ammonia, wherein one H atom is replaced by a methyl group. It is the simplest primary amine. Methylamine is used in the illegal manufacture of the drug MDMA (ecstasy) and Methamphetamine. Methylamine is instigated by the reaction of ammonia with methanol with zeolites as catalyst. It can also be readily prepared by the reaction of hydrochloric acid with hexamine or by the reaction of formaldehyde with ammonium chloride. In plants, methylamine serves as a buffering agent in the lumen of the chloroplast.

Marsh Woundwort

Ethanolamine: (monoethanolamine, MEA) (2-aminoethanol) C₂H₇NO

Molecular Mass 61.08
Ethanolamine is a toxic, flammable, corrosive, colorless, viscous liquid with an odor similar to ammonia. This family of simple lipids is mainly found as homologues of sphingosine, a c18-aminodiol. Sphingosine was discovered around 1880 CE by Thudichum J. This compound was isolated by Reindel in 1930 CE from yeast. Phytosphingosine is the counterpart of sphingosine in the plant world. Its distribution is not exclusively in plants since it was also detected in animal tissues. Monoethanolamine is produced by reacting ethylene oxide with ammonia. Ethanolamine is the second most abundant head group for phospholipids, substances found in biological membranes. Ethanolamine also refers to a class of antihistamines containing an ethyl-amine group attached to a diphenylmethane structure. Ethanolamine has a melting point of 10 - 12 C. and a boiling point of 170 C. It is harmful by ingestion, inhalation or if absorbed through the skin. Ethanolamine is a severe eye, skin and respiratory irritant. It is also corrosive and can cause burns.

Hawthorn

Histamine: C5H9N3

Molecular Mass 111.145
Histamine was first discovered in 1910 C.E. by Sir Henry Hallett Dale as a contaminant of ergot generated by bacterial action. The word histamine comes from "histos", which means tissue. By 1937 C.E., the first "antihistamine" had been synthesized by Etienne Fourneau, which was the H1 receptor antagonist, thymo-ethyl-diethylamine. In 1942 C.E., Bernard N. Halpem synthesized the first clinically used antihistamine - phenbenzamine.

Histamine is a biogenic amine involved in local immune responses as well as regulating physiological function in the gut and acting as a neurotransmitter. It is derived from the decarboxylation of the amino acid histidine, a reaction catalyzed by the enzyme L-histidine decarboxylase. In addition to the chemically synthesized antihistamines, there exist a fair number of plants and herbs that contain natural antihistamine compounds. It has a melting point of 83.5 °C and a boiling point of 209.5 °C. Histamine exerts its actions by combining with specific cellular receptors located on cells. The four histamine receptors that have been discovered are designated H1 through H4. H1 receptor, are found on the smooth muscle, endothelium, the central nervous system tissue. H2 is located on parietal cells. H3 are decreased neurotransmitters. H4 receptor are found primarily, in the thymus, small intestine, spleen, the colon. It has been noted that histamine is released as part of the human orgasm from mast cells in the genitals. Thus men with high histamine levels may suffer from premature ejaculations.
Tyramine: C₈H₁₁NO tyramine (4-hydroxy-phenethylamine, para-tyramine, p-tyramine)

Molecular Mass 137.179

Tyramine occurs widely in plants and animals and is metabolized by the enzyme monoamine oxidase. It is an intermediate product in the conversion of tyrosine (an amino acid present in many proteins) to epinephrine (an active hormone produced by the inner portion of the adrenal gland). Tyramine is also a normal substance in the body that helps support blood pressure. A large dietary intake of tyramine (or a dietary intake of tyramine while taking MAO inhibitors) can cause the tyramine pressor response, which is defined as an increase in systolic blood pressure (High blood pressure). Tyramine is also thought to trigger cluster headaches. Dietary tyramine intake has also been associated with migraine in certain folks. Aged cheeses have the highest levels of tyramine. Some foods contain bacterial enzymes that convert tyrosine (an amino acid in foods) to tyramine.
High tyramine foods should not be eaten by people who take MAO inhibitor medicine such as Nardil and Parnate.

St. Johns Wort

**Phenethylamine:** C₆H₅CH₂CH₂NH₂  2-phenylethylamine

Molecular Mass 121.18 g/mol

Phenethylamine is an aromatic amine, and is a colorless liquid at room temperature. Phenethylamine is the end product of phenylalanine in the putrefaction of tissue. It is soluble in water, ethanol, and ether. It is also a major component of chocolate. Phenethylamine is strongly basic and forms a stable crystalline hydrochloride salt with a melting point of 217 °C and a boiling point of 194 °C. Upon exposure to air, it forms a solid carbonate salt with carbon dioxide.

Some drugs that fall into the phenethylamine classification include all amphetamines (as well as methylphenidate), ephedrine, designer hallucinogens (2C-B, 2C-I etc.), mescaline, bupropion (Wellbutrin), and venlafaxine (Effexor), as well as the amino acids (D/L) Phenylalanine and L-Tyrosine. The adding of a methyl group adjacent to the amine produces phenylisopropylamine, or amphetamine.
Phenethylamine is a corrosive and can cause burns. If swallowed or inhaled it may cause allergic skin reaction.

![Mescaline](image)

**Propylamine: C₃H₉N (n-propylamine)**

Molecular Mass 59.11

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\[ \text{\text{CH₃\text{-}}C\text{-NH₂} \]}
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Propylamine is a clear colorless liquid with strong ammonia like odor with the tendency to turn pale yellow on prolonged storage. It has a boiling point of 48 °C. and a melting point of -83 °C. It is an amine in which propyl is attached to the nitrogen atom. Propylamine for the most part is used as a flavoring agent. Propylamine is highly flammable and readily forms explosive mixtures with air. It is harmful if swallowed or inhaled and causes burns if it comes in contact with the skin.
Cadaverine is the suggestive name given to the amine with technical name 1, 5-diaminopentane. It is produced in decaying flesh and has a particularly foul odor. Cadaverine is a toxic diamine which is similar to putrescine. A diamine is a type of polyamine with exactly two amino groups. It is the decarboxylation product of the amino acid lysine. Cadaverine also contributes to the odors of urine and semen. Cadaverine is found in some plants in trace amounts as a result of stress on the plant. Cadaverine is also known by the names 1, 5-pentanediamine and pentamethylenediamine. **Cadaverine is poisonous and irritating to the skin.**
The name indole is a portmanteau of the words "indigo" and "oleum", since indole was first isolated by treatment of the indigo dye with oleum.

Indole is a common floral essence compound and is a synomone in many species. A synomone is a chemical released by members of one species that affects the behavior of another species and benefits both parties. This compound appears to be derived from tryptophan.

Indole is solid at room temperature. It occurs naturally in human feces and has an intense fecal odor. At very low concentrations, however, it has a flowery smell, and is a constituent of many flower scents. It is found in Jasmine and Orange blossom.

Pure indole-3-carbinol is an off-white solid belonging to the group of indole. Indole-3-carbinol is only formed in these vegetable after crushing or during cooking. Indole-3-carbinol is one of the major anticancer substances found in cruciferous (cabbage family) vegetables.

It is a member of the class of sulfur-containing chemicals called glucosinolates. Indole has a melting point of 52 - 54°C and a boiling point of 253 - 254°C. Due to the electron-rich nature of indole, it is easily oxidized.
Indole is a major constituent of coal-tar.

Quiz:

1. Amines are organic compounds that may be considered derivatives of _______.
2. There are four histamine _______.
3. Monoethanolamine is produced by reacting _______ _____ with ammonia.
4. In general amines act as _____.
5. Histamine was first discovered in ____ C.E
6. Dietary tyramine intake has also been associated with _______ in certain folks.
7. Propylamine is an amine in which propyl is attached to the ________ atom.

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Lesson Six - Furanocoumarins
Furanocoumarins are a class of organic chemical compounds produced by a variety of plants. They are produced by plants as a defense mechanism against various types of predators ranging from insects to mammals. Some of the furanocoumarins are photoactive, as their toxicity is enhanced in the presence of ultraviolet radiation. They are biosynthesized through either the phenylpropanoid pathway or the mevalonate pathway. Phenylpropanoids, have a primary role in the structure and protection of the plant; phenylpropanoids also have an important effect on plant qualities such as texture, flavor, color, and processing characteristics. The mevalonate pathway produces isoprenoids that are vital for diverse cellular functions, ranging from cholesterol synthesis to growth control. This cellular metabolic pathway is present in all higher eukaryotes and many bacteria. The chemical structure of furanocoumarins consists of a furan ring fused with coumarin. The furan may be fused in different ways producing several isomers. Furanocoumarins are toxic compounds found primarily in species of the Apiaceae and Rutacea. The Apiaceae are mostly temperate herbs almost always with umbellate inflorescences comprising about 300 genera and 3,000 species that are commonly further distinguished by the presence of hollow stems and sheathing petioles. A few samples are; Water hemlock, Coriander, Cow parsnip, and Snakeroot. Members of the Rutacea family contain citrus and other species and include: Lime, Rue, Lemon and Mandarin Orange. By contrast with the simple hydroxycoumarins, furanocoumarins are generally lipid-soluble and can be isolated during extraction of dried plant material with ether or light petroleum. Furanocoumarins, can be detected by their blue, violet, brown, green or yellow colors, in UV light.

Following are some examples of Furanocoumarins:

Bergamottin: C21H22O4 (E)-4-[(3, 7-Dimethyl-2, 6-octadienyl) oxy]-7H-furo [3, 2-g][1]benzopyran-7-one

Molecular Mass 338.397
This is a natural furanocoumarin found principally in grapefruit juice. It is also found in the oil of bergamot, from which it was first isolated and from which its name is derived. To a lesser extent, bergamottin is also present in the essential oils of other citrus fruits.

Grapefruit juice has been found to significantly increase oral bioavailability of several drugs metabolized by cytochrome P450 3A4 through inhibiting the enzymatic activity and decreasing the content of intestinal P450 3A4. Bergamottin also results in increased glucuronidation of bergamottin analog. Thus caution should be taken when drinking grapefruit juice and taking certain medications.

![Water Hemlock](image)

**Psoralen:** C11H6O3 7H-furo [3, 2-g] chromen-7-one

Molecular Mass 186.17

Psoralene is the parent compound in a family of natural products known as furocoumarins. It is structurally related to coumarin by the addition of a fused furan ring, and may be
considered as a derivative of umbelliferone. They are a class of photo-mutagenic and photo-chemotherapeutic molecules that covalently modify nucleic acids.

Psoralen occurs naturally in the seeds of *Psoralea corylifolia*, as well as in the common Fig, Celery, Parsley and West Indian Satinwood. *Psoralea corylifolia* is an important plant in the Indian Ayurveda system of medicine and of Chinese medicine. The seeds of this plant contain a variety of coumarins including psoralen.

The seeds of *Psoralea corylifolia* contain the highest contents of psoralen (7.8 mg/g) and angelicin (2.3 mg/g)

It is widely used in PUVA treatment for psoriasis, eczema and vitiligo. PUVA is an acronym for psoralen (a light-sensitizing medication) combined with exposure to ultraviolet light which acts as an activator.

Although safe to mammals, it should be used with care since many furocoumarins are extremely toxic to fish.

**Fig Tree**

**Angelicin**: 2-oxo- (2H)-furo- (2, 3-h)-1-benzopyran

Molecular Mass: 214.221 g/mol
Angelicin and its methoxy derivatives occur in a number of plants belonging to the Umbelliferae family.

Some plants in this family are; Dong Dang Gui, Angelica, Chervil, Spear grass and Dill. Angelicin, in the presence of ultraviolet A radiation, is found to bind covalently to isolated DNA and to DNA in bacteria, yeast and cultured mammalian cells. Angelicin and its structural analogues are another Furanocoumarin used in the treatment of psoriasis. It is known as an anti-proliferative, antifungal and as an anti-inflammatory agent. It has also been suggested for the treatment of Thalassemia. And it has been found that angelicin and its structural analogues are capable of potentiating the expression of the gene for human gamma-globin.

6', 7'-Dihydroxybergamottin (DHB) C21H24O6

Molecular weight 372

6', 7'-Dihydroxybergamottin is a furanocoumarin that inhibits CYP3A4 and is found in grapefruit juice and Seville orange juice. Grapefruit juice increases the oral bioavailability of many CYP3A4 substrates, including cyclosporine. It appears to be the primary compound in grapefruit juice that is responsible for inhibition
of testosterone 6B hydroclase activity. Grapefruit juice reduces CYP3A activity to a significantly greater extent (p < 0.05) than does orange juice. In grapefruit, 6', 7' dihydroxybergamottin, which is implicated in drug interactions, is most concentrated in the rind or in oil extracted from the peel.

Grapefruit

Trioxsalen: (C14H12O3) 2, 5, 9-trimethyl-7-pyrano[5, 6-f]benzofuranone

Molecular Mass 228.243

Trioxsalen is a furanocoumarin and a psoralen derivative. It is obtained from several plants, mainly Psoralea corylifolia. Like other psoralen it causes photosensitization of the skin. Trioxsalen is used as a very strong medicine that increases the skin's sensitivity to sunlight. In addition to causing serious sunburns if not properly used, it has been reported to increase the chance of skin cancer and cataracts. In albinism, trioxsalen will increase the tolerance of the skin to sunlight, although no
pigment is formed. Trioxsalen is used in conjunction with ultraviolet light A (UVA). This mode of treatment is known as PUVA (psoralen plus ultraviolet light A).

Psoralea corylifolia

Quiz:

1. The chemical structure of furanocoumarin consists of a furan ring fused with ________.

2. Psoralene is the parent compound in a family of natural products known as _________.

3. Trioxsalen is a furanocoumarin and a ________ derivative.

4. The Apiaceae are mostly ________ herbs.

5. ________ _____ has been found to significantly increase oral bioavailability of several drugs.

6. Angelicin and its methoxy derivatives occur in a number of plants belonging to the ______ family.

7. Trioxsalen is used as a very strong medicine that increases the skin's sensitivity to _________.

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Lesson Seven: Proteins

Proteins were first described by the Dutch chemist Gerhardus Johannes Mulder and named by the Swedish chemist Jons Jakob Berzelius in 1838 CE. Lectins are sugar-binding proteins. Along with fat and carbohydrates, protein is a "macronutrient," meaning that the body needs relatively large amounts of it. But unlike fat and carbohydrates, the body does not store protein, and therefore has no reservoir to draw on when it needs a new supply. The basic structure of protein is a chain of amino acids. Every cell in the human body contains protein.

Amino acids are organic compounds made of carbon, hydrogen, oxygen, nitrogen, and (in some cases) sulfur bonded in characteristic formations. Strings of amino acids make up proteins, of which there are countless varieties. Of the 20 amino acids required for manufacturing the proteins the human body needs, the body itself produces only 12 amino acids.

Each amino acid contains an "amine" group (NH₃) and a "carboxy" group (COOH) (shown in black in the diagram). The amino acids vary in their side chains (indicated in blue in the diagram). The eight amino acids in the “orange area” are non-polar and hydrophobic. The other amino acids are polar and hydrophilic ("water loving"). The two amino acids in the “magenta box” are acidic ("carboxy" group in the side chain).
The three amino acids in the “light blue box” are basic ("amine" group in the side chain).

Glycoproteins are the proteins covalently attached to carbohydrates such as glucose, galactose, lactose, fucose, sialic acid, N-acetylglucosamine, N-acetylgalactosamine, etc. Glycolipids are carbohydrate-attached lipids. Their role is to provide energy and also serve as markers for cellular recognition. Collectively they are called glycoconjugates of which 11 percent of the human body is composed.
Figure 1-B-4. Structures of some sugar molecules.

Galactose

Glucose

Fucose

Lactose

α-D-N-acetylgalactosamine

α-D-N-acetylglicosamine

N-acetylneuraminic acid (sialic acid)
Lectins are proteins obtained particularly from the seeds of leguminous plants, but also from many other plant and animal sources, that have binding sites for specific mono or oligosaccharides (a saccharides of a small number of component sugars, either O or N linked to the next sugar) in cell walls or membranes. If the sugars are bound to proteins they are called glycoprotein or bound to fats they are called glycolipids.

Proteins initiate most allergic and antigenic responses.
Lectins are found in most types of beans, including soybeans. High levels of Lectins may be found in grains (wheat and wheat germ, quinoa, rice, buckwheat, oats, rye, barley, millet and corn), legumes (including peanuts and all dried beans), dairy (all milk products, milk, cheese, cottage cheese, yogurt, kefir), and plants belonging to the Nightshade family (includes potato, tomato, eggplant and pepper).

Dairy Lectins have been implicated in juvenile onset type I diabetes.
Wheat Lectins have been implicated in juvenile nephropathy.

Lectins from soy, peanut and other beans, wheat germ and wheat, milk, peanut oil and nightshades, in a variety of clinical studies have shown various types of damage to gut lining, joints, kidney, pancreas and brain.
Lectins found in peanut oil have been implicated in atherosclerosis.

Though not all Lectins are toxic, those that are have varying levels of toxicity. The reaction between the agglutinin and the cell membrane is believed to result in an alteration of the cell function thus producing the toxic effect. Only those cells bearing the specific receptor groups for the respective Lectins would be affected.

Lectins-containing plants have been found in many botanical groups including mono- and dicotyledons (a subclass of Angiosperms), molds and lichens, but most frequently they have been detected in Leguminoseae (Pea family) and Euphorbiaceae (Spurge family).

While the function of Lectins in plants is believed to be the binding of glycoproteins on the surface of cells, their role in animals also includes the binding of soluble extracellular and intercellular glycoproteins.

Lectins are also known to play important roles in the immune system by recognizing carbohydrates that are found exclusively on pathogens (disease producing organisms), or that are inaccessible on host cells.

Not much is known about the functions of Lectins in the organism they are formed. There is evidence that Lectins may be involved in the recognition between cells or cells and various carbohydrates containing molecules. This suggests that they may be involved in the regulating physiological functions.

They seem to play an important role in the defense mechanisms of plants against the attack of microorganisms, pests, and insects.

Fungal infection or wounding of the plant seems to increase Lectins.

One major property of Lectins is their specific saccharides binding sites. Some Lectins are composed of subunits with different binding sites. Many members of the lectinic protein family agglutinate (clump together) red blood cells. Lectins are hardy proteins that do not break down easily. They are resistant to stomach acid and digestive enzymes.

Dietary Lectins can dramatically reduce natural killer cell activity directly and through disruption of intestinal microvilli. Natural killer cells are one of the body’s most important defenses against viruses and other such invaders.

Biological activity of the Lectins may be attributed to the metal ions which are the essential part of the native structure of most leguminous Lectins. Lectins of soybean, peas, faba bean, lentils, and sainfoin have amino acids that are involved in metal binding, which are conserved.
It has been found that treatment with anti-lectin antibodies can suppress growth of tumor cells in agarose (linear galactan is created by purifying agar), and inhibit lung colonization in vivo.

Lectins have a potential use in cancer treatment strategies due to the fact that Lectins present on the surface of tumor cells are capable of binding exogenous carbohydrate-containing molecules and internalize them by endocytosis (the uptake of material into a cell by the formation of a membrane bound vesicle). A vesicle is a bubble of liquid/membrane-enclosed sac, that stores or transports substances within a cell.

Two of the most toxic Lectins are Abrin and Ricin. Abrin is a natural poison that is found in the seeds of a plant called the rosary pea or jequirity pea.

Ricin is a protein that is extracted from the castor bean (Ricinus communis). Ricin is a poison which is found naturally in castor beans.
Both proteins are composed of two peptide chains, signified as A-chain and B-chain, which are linked by a disulphide bond. Ricin was found by Hermann Stillmark in 1889 CE as the first plant Lectin from the seeds of the castor plant, Ricinus communis. Ricin is the only known toxin to exist naturally in large quantities. It is a by-product of castor oil.

Both Ricin and Abrin inhibit protein synthesis by inactivating the ribosomes. Also Lectins from green salads, fruits, spices, seeds, dry cereals and nuts (even after roasting) showed some presence of toxins.

Quiz:

1. Lectins are ______.

2. The function of Lectins in plants is believed to be the binding of __________.

3. Two of the most toxic Lectins are ____ and Ricin.

4. Dietary Lectins can dramatically reduce natural ______  ____ activity.
5. Not all Lectins are _____.

6. One major property of Lectins is their specific _______ - binding sites.

7. Collectively Lectins are called ____________.

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Lesson Eight

Glycosides

A glycoside is a compound that contains a constituent sugar, in which the hydroxyl group attached to the first carbon is substituted by an alcoholic, phenolic, or other group. They are named specifically for the sugar contained, such as glucoside (glucose), pentoside (pentose), fructoside (fructose) and so forth.

The glycoside molecule differs from polysaccharides in that glycosides are sugars that are bonded to a non-sugar. Thus they contain a carbohydrate and a non-carbohydrate residue in the same molecule.

The sugar group is known as the glycone and the non-sugar group as the aglycone or genin part of the glycoside. The glycone can consist of a single sugar group (monosaccharide) or several sugar groups (oligosaccharide).

There are many types and/or examples of glycosides. Some of these are:
Cardiac glycosides: are any of a group of glycosides occurring in certain plants, Foxglove (Digitalis), Dogbane (Strophanthus), and Urginea, which act on the contractile force of cardiac muscle; some are used as cardiotonics and antiarrhythmics. The most important of these cardiac glycosides are digitoxin, gitoxin, and gitaloxin. The most common drug made from these glycosides is Digitalis. These compounds are characterized by the steroidal cardenolide aglycone bonded at the C-3position to a sugar moiety which can range from a monosaccharide to a trisaccharide. Other plants, such as Strophanthus spp., Convallaria spp. (Lily of the Valley), Urginea spp. (Squill), Asclepias spp. (Milkweed), and Apocynum spp., also produce cardiac glycosides. Digitalis glycosides are any of a number of cardiotonic and antiarrhythmic glycosides derived from Digitalis purpurea (common Foxglove) and D. lanata. Digitalis glycosides such as digoxin (Lanoxin) and digitoxin (Crystodigin) have been used to treat heart failure for over 200 years.

Foxglove

Cyanogenic glycosides; these are generally found in Cassava and Bamboo shoots. The glycosides produced here are toxic compounds known as linamarin and taxiphillin which break down upon disruption of the plant cells to form hydrogen cyanide. Hydrogen cyanide is released from the cyanogenic glycosides when fresh plant material is macerated as in chewing, which allows enzymes and cyanogenic glycosides to come together, releasing hydrogen cyanide. Cyanogenic glucosides are derived from the protein amino acids L-Val, L-Ile, L-Leu, L-Phe, or L-Tyr and from the non-protein amino acid cyclopentenyl-Gly. Cyanogenic glycosides are widely distributed among 100 families of flowering plants. They are also found in some species of ferns, fungi and bacteria. The most important cyanogenic glucoside is amygdalin, which occurs in bitter almonds.
Nitrile Glucosides: Some common nitrile glucosides are rhodiocyanoside A, rhodiocyanoside D and menisdaurin. lotaustralín rhodiocyanoside A, and rhodiocyanoside D are derived from the amino acid L-Ile.

Nitrile glucosides have in a few cases been shown to co-occur with cyanogenic glucosides. Nitrile glucosides found in L. japonicus along with cyanogenic glucoside, showed cyanide potential within a couple days of sprouting. The cyanide potential increased with the growth and age of the plant. During the entire life cycle of L. japonicus, the cyanide potential is highest in newly formed tissues, e.g. cotyledons and primary leaves at the seedling stage and apical leaves and flowers at later developmental stages. No cyanide potential is detected in roots or in dry seeds at any time during development.

Alcoholic glycosides: One example of an alcoholic glycoside is salicin which is found in the genus Salix. Salicin is converted in the body into salicylic acid, which is closely related to aspirin and has analgesic, antipyretic and anti-inflammatory effects.
Flavonoid glycosides: Here the aglycone is a flavonoid. This is a large group of flavonoid glycosides. Examples include:

Hesperidin: aglycone - Hesperetin (found in citrus fruits), glycone: Rutinose (6-O-L-rhamnosyl-D-glucose)

Naringin: aglycone - Naringenin, glycone: Rutinose

Rutin: aglycone: Quercetin - (Quercetin is a phytochemical that is part of the coloring found in the skins of apples and red onions), glycone: Rutinose)

Quercitrin: aglycone - Quercetin glycone: Rhamnose (L-Rhamnose can be isolated from Buckthorn (Rhamnus) and poison sumac. It is also found as a glycoside in a variety of other plants).

Among the important effects of flavonoids is their antioxidant effect. Antioxidants are substances or nutrients which can prevent or slow the oxidative damage to our body. When
our body cells use oxygen, they naturally produce free radicals (by-products) which can cause damage to our system.
Antioxidants act as "free radical" scavengers, removing these harmful by-products from our bodies. They are also known to decrease capillary fragility, resulting in better health. Antioxidants are generally found in fruits and vegetables.

**Coumarin glycosides:**
Here the aglycone is coumarin. An example is apterin which is reported to dilate the coronary arteries as well as block calcium channels. Apertin can be found in the roots of (Angelica archangelica).
Other anticoagulants are bishydroxycoumarins (also known as dicumarol) that inhibits the formation of prothrombin in the liver. Sweet clover hay that has not been cured and dried properly can cause cattle to experience blood loss due to spontaneous hemorrhaging. Dicoumarol is also known as 3, 3′-methylene (4-hydroxycoumarin) and many different derivatives are made from this coumarin glycoside such as long-acting anticoagulants, rodenticides and superwarfarins.

![Angelica](image)

**Saponins:**
Saponin compounds are known to give a permanent froth when shaken with water. In fact, they get their name from the soapwort plant (Saponaria)
Saponins consist of a polycyclic aglycone that is either a choline steroid or triterpenoid attached via C3 and an ether bond to a sugar side chain.
They are known to cause hemolysis (break down) of red blood cells. Saponins increase blood supply to the internal organs through enhanced cardio-vascular function.
Saponins can be found in a wide range of plants such as tropical forage legumes, temperate forage legumes and rangeland weeds.
A couple of examples are, ginger which contains 28 saponins and Alfalfa which contains the saponins; medicagenic acid, soyasapogenol A, soyasapogenol B and lucernic acid.
The medicinal value of Saponins is due to their expectorant (bringing up mucus and other material from the lungs, bronchi, and trachea) effect.
Thioglycosides:
As the name implies, these compounds contain sulfur. Examples include sinigrin, found in black mustard (Brassica nigra) (Allyl isothiocyanate is the chemical compound responsible for the pungent taste of mustard, horseradish and wasabi), and sinalbin, found in white mustard (Brassica Alba). Sinalbin is related to Gluconasturtiin, which is a glucosinolate found in horseradish (Armoracia rusticana). Both of these compounds are responsible for producing a pungent taste.
Anthraquinone glycosides
These glycosides contain an aglycone group that is a derivative of anthraquinone which in turn are a important quinone derivative of anthracene.
They occur in aloes, cascara sagrada, senna, and rhubarb. They are used is a primary compound in many dyes and dye processes.
Anthraquinones are thought to be mutagenic and carcinogenic.

Phenolic glycosides: (simple)
Here the aglycone is a simple phenolic structure. An example is arbutin found in the Common Bearberry Arctostaphylos uva-ursi. It is known to have a urinary antiseptic effect.
Willows and many other members of the Salicaceae will often produce phenolic glycosides.

Quiz:
1. The most important of the cardiac glycosides are digitoxin, gitoxin, and _______.

2. One example of an alcoholic glycoside is _______.

3. Apterin is a _______ glycoside.

4. Anthraquinone is an important quinone derivative of ___________.

5. Thioglucoside glycosides contain _______.

6. Saponins are known to cause _______.

7. Among the important effects of flavonoids are their _______ effect.

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**Lesson Nine: Sesquiterpenes**

Sesquiterpenes are commonly found in higher plant forms. They are also found in certain invertebrates. Sesquiterpenes are hydrocarbons (terpenes) with 15 carbon atoms. They are naturally occurring alcohols that very rarely exist as volatile oils. Sesquiterpenes, along with monoterpenes, are an important constituent of essential oils in plants though from the same family of terpenes, Sesquiterpenes are larger molecules than monoterpenes.

When distilled from the plant matter, these compounds stimulate glands and the liver, and have anti-allergen, antispasmodic, and anti-inflammatory properties.
Sesquiterpenes are formed from three isoprene units. They may be acyclic, mono-, di-, or tricyclic; synthesized from farnesylpyrophosphate. In turn, farnesylpyrophosphate is a pyrophosphoryl derivative of farnesol. Farnesol is a colorless liquid extracted from oils of plants such as citronella, Neroli, and tuberose and is then used in perfumery. Sesquiterpenes are isolated from their natural sources by distillation with steam or by extraction. They are purified by vacuum fractional distillation or by chromatography. There are approximately 5000 known Sesquiterpenes.

Some of the common Sesquiterpenes are;

B-caryophyllene

Molecular Formula: C_{15}H_{24}

Molecular Weight: 204.35

Boiling Point: 129-130°C

B-caryophyllene; is a major constituent of the essential oils Clove, Black pepper, Marjoram, Peppermint, Spearmint, and Basil amongst others. There are two forms caryophyllene; A caryophyllene and B caryophyllene and they usually occur together with isocaryophyllene. Caryophyllene oxide was isolated from an unsaponified petroleum ether extract of the bark of Annona squamosa and studied for its analgesic and anti-inflammatory activity.
germacrene D

(1Z, 6Z)-1-methyl-5-methylened-8-propan-2-y1cyclopropane-1, 6-diene

Formula: C15 H24
Molecular Weight: 204.3510600

germacrene D: (1-methyl-5-methylene-8-(1-methylethyl)-1,6-cyclodecadiene); is a constituent of essential oils such as, Bee Balm and Golden Rod.
It has been established that three species of heliothine moths, the polyphagous Heliothis virescens and Helicoverpa armigera and the oligophagous Helicoverpa assulta have developed plant odour receptor neurones that respond to the sesquiterpene germacrene D aromadendrene: (1ar-(1alpha,4alpha,7alpha,7alpha,7beta,7alpha)-decahydro-1,1,7-trimethyl-4-methylene-1H-cycloprop[e].
It is found in many species of the Marigolds, Marjoram, Oregano, Juniper and Frankincense.
1, 4-Dimethyl-7-ethylazulene

Formula: C14 H16
Molecular Weight: 184.2768400
Boiling Point: 159.00 °C

Chamazulene is a constituent of chamomile extract. It is deep blue oil extracted from the chamomile flower. The allergenic properties documented for chamomile have been attributed to anthecotulid, a sesquiterpene lactone, azulines, and matricarin. Chamazulene may contribute to the anti-inflammatory activity of chamomile extracts by inhibiting the leukotriene synthesis and additional anti-oxidative effects. Thus chamazulene has antiallergic and anti-inflammatory properties. Chamazulene, alpha-bisabolol, and apigenin have the highest anti-inflammatory actions against pro-inflammatory agents. Chamazulene inhibits leukotriene B4 from forming intact cells with the inhibitory concentration at a dose of 2mcM in laboratory research.

Chamomile

Farnesol (dodecatrienol)

Formula: C15H25OH
Molecular Weight: 222.3663400
Boiling Point: 111 °C at 0.35 mmHg

Farnesol is a colorless liquid which is extracted from the oils of plants. These plants include citronella, Neroli, cyclamen, tuberose. It is also found in Bitter orange, Ginger, Jasmine, Hops, Beets and Juniper. It is a natural organic compound which is an acyclic sesquiterpene alcohol found as a colorless liquid. It is insoluble in water, but miscible with oils. It is used as a flavoring agent and in combination with another compound, as an insecticide for mites. It is a natural pesticide for mites and is a pheromone for several other insects. It is also used in perfumery. The pure substance farnesol was named (ca. 1900-1905 CE) from the type species Acacia farnesiana, the Farnese acacia, the flowers of which provided it commercially, as a floral essence. This particular acacia species in turn is named after Odoardo Cardinal Farnese (1573-1626 CE) of the notable Italian Farnese family which (from 1550 though the 17th century) maintained some of the first private European botanical gardens in the Farnese gardens in Rome.

Citronella
Picrotoxins

The name "picrotoxin" is a combination of the Greek words "picros" (bitter) and "toxicon" (poison).

![Picrotoxin molecule](image)

Formula: C30H34O13

Molecular weight: 600.58

Melting-point: 193° to 200°

Some of the most complex known sesquiterpenes are picrotoxins that are found in a variety of plant families. Picrotoxin is a plant alkaloid that is often used to block the activity of neuronal GABA and glycine receptors. It was first isolated by Boullay in 1812 CE. These compounds are found in honey made by bees from plants in the Coriariaceae family in New Zealand among other sources. Compounds of this series tend to be extremely toxic to humans. It is a poisonous bitter crystalline principle found especially in cocculus that is a compound of picrotoxinin and picrotin and is a stimulant and convulsant drug administered intravenously as an antidote for poisoning by overdoses of barbiturates. Spasms of the muscles of locomotion, with cold skin and deficient capillary circulation, are said to be benefited by cocculus. It is primarily obtained from the berry of a Southeast Asian vine (Anamirta cocculus). The seeds contain the very poisonous, bitter principle, picrotoxins. Picrotoxins are very hazardous in cases of ingestion, inhalation. They are hazardous in cases of skin contact (of eye contact (irritant). Severe over-exposure can result in death. In cases of poisoning by picrotoxins, the stomach should be washed out, and chloral hydrate and potassium bromide given.
Approximately 4000 sesquiterpene lactones are now known. These compounds are restricted in distribution; many have a pronounced bitter taste and most are relatively non-volatile crystalline solids. The greatest numbers are found in the Compositae family with over 3000 reported different structures. Some notable examples are; Chrysanthemum, Ragweed, Sagebrush, Wormwood, Mugwort, Boneset, Burdock, Chamomile, Artichoke and Sunflower. Some sesquiterpene lactones are:

Lactucin - C11H14O4

Lactucin is a white, crystalline substance, having a bitter taste and a neutral reaction, and forms one of the essential ingredients of lactucarium. Lactucin is one of the bitter principles of lactucarium, and may be obtained by extracting lactucarium, with cold alcohol of specific gravity 0.85. The most abundant substance in lactucarium, is lactucerin which constitutes half or more of its weight. It is obtained by extracting lactucarium with cold, then with boiling alcohol, which leaves caoutchouc undissolved; or by extracting lactucarium with a mixture of 1 part of chloroform and 3 parts of alcohol.
Lactucin is found in some varieties of lettuce and has been shown to have analgesic and sedative properties.

There is also Deoxy lactucin and Lactopicerin.

8-Deoxy lactucin

Formula: C_{15}H_{16}O_{4}

Molecular Weight: 260.2851

Deoxy lactucin is a principal bitter Sesquiterpene Lactone found in Chicory (cichorium intybus) and prickly lettuce (Lactuca serriola). The leaves and especially the roots of chicory contain high concentrations of bitter sesquiterpene lactones such as 8-deoxy lactucin.
Lactucopicrin (Intybin)

Molecular Weight: 410.417

Lactucopicrin is a bitter substance that has a sedative and analgesic effect, which acts on the central nervous system. Lactucopicrin has also been shown to act as an acetylcholinesterase inhibitor. As well as their traditional use as sedatives and analgesics, these plants have also been used as an anti-malarial, and both lactucin and lactucopicrin have demonstrated anti-malarial effects in vitro. Lactucopicrin is found in Blue daisy, Garden and Prickly lettuce.
Another sesquiterpene lactone is Artemisinin:

Formula: $C_{15}H_{22}O_5$

Molecular Weight: 282.332

Artemisinin (Qinghao) is used as a treatment for parasitic infections and malaria. It also protects against particular types of cancer, especially leukemia and colon cancer. Artemisinin is used to treat multi-drug resistant strains of falciparum malaria. It forms colorless, orthorhombic crystals that are soluble in alcohol, and more so in ethyl acetate. Artemisinin is a Lactone. A Lactone is a ring-structure that can form from a single molecule that has a carboxylic group (-C (O) OH), combining with an alcohol group (HO-C-), that eliminates a single molecule of water to form an ester linkage (-C (O)-OC-). It is cultivated from Sweet Wormwood (Artemisia annual). This bush was once popularly used in the production of absinthe, and currently is used to flavor some vermouth.
Formula: C15-H18-O4  
Molecular weight: 262.33  
Melting Point: 168 DEG C  

Helenalin is a sesquiterpene Lactone found in Wolves Bane (Arnica montana) and Aster (Arnica chamissonis foliosa), and is used as an anti-inflammatory remedy. Helenalin along with other sesquiterpene lactones selectively inhibit activation of the transcription factor NF-κB, a central mediator of the human immune response. 

**Helenalin is a highly toxic compound.**

Quiz:

1. Chamazulene is a constituent of _______ extract.

2. There are approximately _______ known sesquiterpenes.

3. Sesquiterpenes are naturally occurring _______.

4. Farnesol is used as an insecticide for _______.

5. Artemisinin is used to treat multi-drug resistant strains of falciparum _______.

6. Sesquiterpenes are formed from _______ isoprene units.

7. Aromadendrene is found in many species of the Marigolds, Marjoram, ________, Juniper and Frankincense.
Carotenoids are organic pigments that are naturally occurring in plants and some other photosynthetic organisms like algae, some types of fungus and some bacteria. There are over 600 known carotenoids; they are split into two classes, xanthophylls and carotenes. Carotenoids containing some oxygen are known as xanthophylls.

Xanthophylls are often yellow, hence their class name. Xanthophylls, along with carotenic pigments are seen when leaves turn orange in the autumn season. They are involved in photosynthesis along with green chlorophyll, which typically covers up the yellow except during the autumn season. Xanthophyll has a chemical formula of C40H56O2 and is found in the leaves of most plants. The group of xanthophylls is composed of lutein, zeaxanthin, and α- and β-cryptoxanthin.
Lutein from the Latin "lutea" (yellow) is an example of such a carotenoid. Lutein can be found in such substances as Kale, Egg Yolk, Marigold and Spinach from among others. Lutein was traditionally used in chicken feed to provide the yellow color of broiler chicken skin. Lutein has been linked to promoting healthy eyes through reducing the risk of macular degeneration. Lutein also filters the high-energy, blue wavelengths of light from the visible-light spectrum by as much as 90%. Blue light, in both indoor lighting and sunlight, is believed to induce oxidative stress and possible free-radical damage in human organs exposed to light, such as the eyes and skin.

Carotenoids are evidenced by the bright red, orange and yellow pigments displayed in some plants like carrots, tomatoes, sweet potatoes, cantaloupe, winter squash, parsley, green peas, pink grapefruit, Swiss chard, spinach, beet greens, pumpkin, watermelon, broccoli, mangoes, oranges, papaya and tangerines. You will also find them in okra, red peppers leafy green vegetable and even in fish liver oil. Most carotenoids are not damaged by cooking. Diets rich in carotenoids fight disease and in one study a high carotenoid diet actually helped reduce the risk of lung cancer in nonsmokers.

One particularly powerful carotenoid is lycopene. Lycopene is found in tomatoes and several other red fruits, though tomatoes are one of the best sources for lycopene. Lycopenes are bioflavonoids that are closely related to beta carotene, though it is twice as powerful as beta carotene at neutralizing free radicals. Lycopene has been found to reduce the risk of prostate and lung cancer. Beta-carotene is the most common form of carotene. It is a form of Vitamin A. Vitamin A is also known as retinol because it produces the pigments in the retina of the eye. Beta-carotene is an antioxidant. Increased amounts of beta-carotene can turn the color of skin to yellow or orange. The skin color returns to normal once the increased intake of beta-carotene is reduced.
Carotene is responsible for the orange color of the carrot and many other fruits and vegetables. It contributes to photosynthesis by transmitting the light energy it absorbs to chlorophyll. Beta-carotene is composed of two retinyl groups, and is broken down in the mucosa of the small intestine by beta-carotene dioxygenase to retinal, a form of vitamin A. Carotene can be stored in the liver and converted to vitamin A as needed, thus making it a pro-vitamin.

Large doses of vitamin A can cause birth defects.

The second most common form of carotene is Alpha-carotene which has a β-ring at one end and an ε-ring at the other.

Alpha-carotene is one of the most abundant carotenoids in the diet. It can be converted in the body to an active form of vitamin A, a nutrient important for vision, immune function, and skin and bone health.

Alpha-carotene has less than half the vitamin A activity of the major vitamin A precursor, beta-carotene.

Carotenes typically contain only carbon and hydrogen. Carotenes are carotenoids containing no oxygen.

In human blood serum, lycopene is the dominant carotenoid and constitutes approximately 50 percent of all carotenoids found in the serum. Lycopene appears in slightly higher concentrations in the prostate. As you grow older, the lycopene serum values are found to decrease as the risk of prostate cancer increases.

Astaxanthin

Formula: \( \text{C}_{40}\text{H}_{52}\text{O}_4 \)
Molecular Weight: 596.8

Astaxanthin is a naturally occurring carotenoid pigment and a powerful biological antioxidant. Astaxanthin exhibits strong free radical scavenging activity and protects against lipid peroxidation and oxidative damage of LDL-cholesterol, cell membranes, cells, and tissues.

Though Astaxanthin is a carotenoid it belongs to a much larger class of phytochemicals known as terpenes. Terpenes are a large class of hydrocarbons, produced by a wide variety of plants, particularly conifers.

![Zeaxanthin](image)

**Zeaxanthin**

Formula: C40H52O4

Molecular Weight: 596.8

Zeaxanthin is one of the two carotenoids contained within the retina of the eye, with lutein being the other. Together they absorb blue light, and because they both powerful antioxidants, it has been hypothesized that they protect the retina. It is harvested primarily from dark green, leafy vegetables such as spinach, collard greens, kale, mustard greens, and turnip greens.

Chicken egg yolks are a rich food source of lutein and zeaxanthin; the average amount of lutein in chicken egg yolk is approximately 290 micrograms per yolk, and the average amount of zeaxanthin, approximately 210 micrograms per yolk.

Some carotenoids are produced by bacteria to protect themselves from immune attack, such as MRSA. The golden pigment of S. aureus allows it to survive attack by Lactobacillus (lactic acid) as well as the human immune system. Some sources of carotenoids are carrots, sweet potatoes, spinach, kale, collard greens, tomatoes as well as many other fruits and vegetables. Although there are more than 600 carotenoids, there are six that account for the majority of carotenoids in the human diet. They are; alpha-carotene, beta-carotene, beta-cryptoxanthin, lycopene, lutein, zeaxanthin.

There is growing scientific evidence that women who have a diet rich in carotenoids have substantially lower risk of breast cancer.
Quiz:

1. A high carotenoids diet actually helped reduce the risk of lung cancer in _________.

2. Lutein is from the Latin, ________.

3. There are over ____ known carotenoids.

4. Lycopenes are closely related to ________.

5. The second most common form of carotene is ____________.

6. Carotene is responsible for the color, ______ in fruits and vegetables.

7. In human blood serum, ________ is the dominant carotenoids.

Whispering Woods Advanced Herb Course

Lesson Eleven

Steroidal Compounds

Steroid like compounds called "sterols" (Phytosterols) are present in a number of medicinal herbs. Sterols are similar in structure with steroids and are considered to be derivatives of the steroids. Plant sterols are almost identical in chemical structure to cholesterol and are processed by the body in the same way. They function as cholesterol-lowering agents in blood by blocking the absorption of cholesterol from food during digestion and also by blocking the re-absorption of cholesterol manufactured in the liver. They are known as anti-inflammatory and analgesic agents. Plant sterols are extracts of certain plants that, when ingested, inhibit the absorption of cholesterol in the small intestine. There are over 60 types of plant sterols. Sterolins are glucosides, which are molecular structures joined to the sterol. Sterolin is easily destroyed, and without it, the sterol does not have the same immune-enhancing benefits. In nature, plants never contain sterols only. The sterols are always associated with their glucoside sterolin.
Beta-sitosterol (C29H5O) is the most commonly studied sterol compound. Beta-sitosterol is one of several sterols with chemical structures similar to that of cholesterol. It differs from cholesterol by the presence of an extra ethyl group. It is white in color and waxy in nature. It has shown to be effective in reducing serum cholesterol levels. The cholesterol lowering property of beta-sitosterol is the result of a lower absorption of cholesterol. Beta-Sitosterol is a key ingredient in natural prostate health. It is useful in easing symptoms of benign prostatic hyperplasia (BPH). Beta-sitosterol also acts against cancer. It is found to reduce the growth of human prostate and colon cancer cells. And it acts against lymphocytic leukemia. Beta-sitosterol is found in plants such as; Saw Palmetto, Pumpkin Seed, and Wolf Berries, Wheat Germ, Rice Bran and soybeans. It is also found in Corn oils.
Disogenin is another sterol compound present in a number of herbs such as Hedichyum spicatum, Trigonella foenum- graecum, Pueraria tuberosa & Dioscorea villosa. Disogenin is used in making the bio-identical sex steroid hormones estradiol and progesterone. It is also the base molecule for progesterone. Diosgenin is thought to cause an inhibition of the growth of fibroblast-like synoviocytes from human rheumatoid arthritis, with apoptosis induction associated with cyclooxygenase-2 (COX-2) up-regulation. Wild Yam (Dioscorea villosa) root comes from a vine-like herb common to the eastern United States. The root material is very hard and woody. Formerly the virtues of the plant were extracted by soaking it in whisky for up to a month. It has been grown commercially in Mexico since the discovery that it contains steroidal compounds which can be processed into pharmaceutical steroids. The active ingredient in wild yam is the steroid Saponin; diosgenin. Diosgenin does not exist freely in wild yam but rather as the saponins dioscin and gracillin. Diosgenin suppresses 3-hydroxy-3-methylglutaryl CoA reductase expression and induces apoptosis in HCT-116 human colon carcinoma cells.
Smilax officinalis (Sarsaparilla) is a medicinal herb that is known to contain steroid like compounds—saponin glycosides and according to some studies, the herb contains male hormones. It also has been used in herbal medicine as an anti-inflammatory agent in curing arthritis and rheumatism. Rubus idaeus, commonly called Raspberry, is also known to contain such compounds.

Another excellent herb is Buffalo gourd. The Navajo used the gourds as ritualistic rattles. The crushed leaves act as a very useful insecticide. The oil is used in cosmetics. The fruit is a useful soap and the root can be used as laundry soap and shampoo. The gourd will clean up grease spots on wooden floors and it can be used as a spoon or ladle.

Among the active chemical constituents in buffalo gourd are cucurbitacins B, D, and E, which are concentrated in the roots and fruits of the plant. Cucurbitacins are toxic tetracyclic triterpenes which are also known as the Bitter Principle.

Buffalo Gourd
Cardioactive glycoside

Digitalis purpurea, Stropanthus gratus and Urginea indica are reputed remedies as cardiac tonics. They are used in congestive cardiac failure. All of them contain steroid saponins as active constituents.

Calotropis procera is known to contain the cardioactive glycoside calotropine, which has shown an antitumor effect in vitro on human epidermoid carcinoma cells of the rhinopharynx. Another herb that contains calotropine is Blood flower (Asclepias curassavica). It also acts as an expectorant and diuretic.

Calotropis procera
Shatavarins I and IV are two major steroidal saponins found in the roots of Asparagus racemosus (Shatavari).
Shatavari; which contains the shatavarins I and IV (asparinin B) are considered to be the main Ayurvedic rejuvenating female tonic for overall health and vitality. The powdered dried root of Asparagus racemosus is used in Ayurveda for dyspepsia (acid regurgitation) and to increase milk secretion in a lactating woman.
The botanical name of Shatavari is Asparagus racemosus and it belongs to family Litiaceae. Saponins are present in all species of Asparagus, but variations are found, in different species from different parts of the world.
In Sanskrit, Shatavari means "she who possesses a hundred husbands."

Asparagus
Sitosterol is a compound found in many plants. It is commonly extracted from wheat germ oil, corn oil, and other grain or nut oils. In the beta form, it has anti-cholesterolemic qualities.

Beta sitosterol is a plant-derived sterol, also known as a phytosterol. There is a scientific study that shows the combination of beta-sitosterol, saw palmetto, and stinging nettle was helpful in prostate enlargement. Another scientific study shows beta sitosterol may inhibit 5-alpha reductase in prostate tissue.

It blocks cholesterol absorption resulting in lower serum cholesterol levels. It has shown to improve lipid-protein (HDL, LDL) profiles. It has been used to treat prostate problems like benign prostatic hypertrophy (BPH) and help increase urine flow. It may reduce the growth of prostate and colon cancer cells. It may help normalize blood sugar and insulin levels in Type II diabetics.

Beta sitosterol is found in high amounts in nuts and amaranth. Like other crystalline alcoholic sterols, Sitosterol resembles cholesterol in their properties. Cholesterol serves as a precursor of steroid hormones (estrogens, androgens, glucocorticoids, and mineralocorticoids) and bile acids.

Use during pregnancy is not recommended.
Wheat Germ

Formula: C\textsubscript{28}H\textsubscript{48}O

Molecular Weight: 400.68

Melting Point: 156-160 °C

Campesterol was first isolated as a sterol from Wild Mustard (Brassica campestris). It is one of the 40 or so phytosterols found in plants. Campesterol, a plant sterol in nature, is known to have cholesterol lowering and anti-carcinogenic effects. Some studies have shown that phytosterols such as campesterol help to reduce cholesterol because it helps inhibit the way the body absorbs bad cholesterol from red meat and fatty foods, but this is not conclusive. **On the other hand, too much phytosterol can in fact cause**
a fatty build-up on the artery walls that can lead to heart problems.
Campesterol can be found in margarines, vegetable oils, seeds, nuts, fruits, vegetables, beans and avocados.

Wild Mustard

In addition to the above samples of sterols, there are naturally occurring non-delta-5 plant sterols. They are cycloartenol, 24-methylene cycloartenol, cycloeucalenol, and obtusifoliol.

Quiz:
1. Sterols are known as anti-inflammatory and _______ agents.
2. Plant sterols are almost identical in chemical structure to _______.
3. Beta-Sitosterol is a key ingredient in natural _______ health.
4. _______ serves as a precursor of steroid hormones.
5. In Sanskrit, Shatavari means "she who possesses a _______ _______.
6. The botanical name of ________ is Asparagus racemosus.
7. Campesterol was first isolated as a sterol from _______ _______. 
Making Essential Oils

The most important production method for Essential oils is distillation. The basic principle of distillation is the same but it is carried out in different ways depending on the botanical material and the condition of the material.

Three types of distillation are used:

Water
Water and steam
Direct steam

Distillation is basically, producing steam. The steam is passed through the herbal material. The steam carries the Essential oil from the plant in suspension which means the droplets of Essential oils are not dissolved in the steam but remain separate as droplets of oil. When the steam is cooled it reverts to the liquid state which is water and in most cases the oil floats on the surface of the water. The oil is then separated from the water by dripping or pouring.

Water distillation is used when the plant material has been dried and will not be damaged by boiling. It is also used for powdered materials such as powdered almond, and flowers, such as orange and rose, that need to float freely as they tend to lump together when just steam is passed through them. The material comes into direct contact with the boiling water and much care needs to be taken that the water does not boil away and cause the plant material to burn. Another example of oil prepared by this method is turpentine gum. Turpentine gum is collected from a species of Pine (Pinus palustris) and the gum, wood chips and pine needles are placed in the distilling chamber with rain water. This mixture is heated until the plant and oil are condensed in the condensing chamber. Turpentine oil is not affected by very excessive heat.

The second method of distillation is water and steam. This is used for either fresh or dried plant material that would be damaged by boiling. The plant material is supported on a perforated grid. The water level is below the grid and low pressure, wet steam passes through the plant material. The most important aspect of this method is that the steam is never really hot and always at low pressure. Cinnamon and clove oils are prepared by this method.

Direct steam distillation is similar to the second method but the steam is hotter and passed through the plant material at a higher pressure. This method is used for fresh plant
material that has a high boiling point such as seeds, roots and wood. It is also used for fresh plant material such as peppermint and spearmint. The crop is cut and placed in a metal distilling tank on a truck. It is then taken to the distilling tank on the truck. Steam is forced through the fresh herbs and the oil droplets are carried by the steam through a vapor pipe at the top of the tank onto a cool condensing chamber.

Cold Pressing or Expression:
This method is mainly used to prepare citrus oils such as orange, lemon and tangerine. One method involves puncturing the oil glands by rolling the fruit over sharp projections that actually pierce the oil glands. The fruit is then pressed which removes the oil from the glands. It is then washed off with a fine spray of water.

The juice is extracted by another tube. The oil is then separated from the water by rotating it at a very high speed. Another method involves separating the peel from the fruits and then cold pressing them. The Essential oil is collected along with small amounts of juice, which is separated.

Enfleurage:
This is an old method which was used in the production of perfumes and pomade extracts for perfumery. Flower petals such as rose or jasmine are layered onto warm oils, cold fat or wax. This process is repeated each day until the base is saturated with the Essential oil. The resulting waxes or pastes contain up to 1 percent of Essential oil. The Essential oil is then extracted from the wax with a volatile liquid such as ethyl alcohol. In the final step the ethyl alcohol is evaporated at low temperatures and reduced pressure so that the pure Essential oil remains as a fairly thick liquid. Cold enfleurage has the advantage that even the most delicate components of the flower oils are preserved. The disadvantages are that it is not very effective and it is very expensive. Flower oils prepared with this method do not contain terpene-hydrocarbons, which indicates that these compounds are not present as such in the flower, but form during distillation.

Solvent Extraction
This is the most widely used modern method to prepare oils from flowers. The petals are mixed into a volatile solvent such as petroleum, ether or benzene, until the Essential oil is completely dissolved in the solvent. The solution is then filtered and the solvent is evaporated at reduced pressure. The result of solvent extraction is a concrete. The solvent is removed from the concrete by vacuum pressure without the use of heat to avoid any harmful effect to the oil. The concentrated essence that results is called an absolute. Absolutes are highly concentrated flower products without the natural waxes.

The main advantage of extraction over distillation is that uniform temperatures are maintained throughout the process. High temperatures during the distillation process can produce altered chemical composition of the oil which alters the natural odor. However, this method is expensive compared to distillation, and chemicals or solvents used in the process may still be present after evaporation.

How to Make Your Own Aromatherapy Oils:
Gather a collection of clean, sterilized bottles and jars. These can be recycled jam jars, and glass bottles, but you need to wash them thoroughly in hot soapy water, then boil in a large saucepan for 20 minutes in order to sterilize them.

Start out with one cup of plant material. At first try using aromatic plants like lavender, Rose petals or rosemary. These will give you oil that can be put to many uses around the home.

You can use baby oil or almond oil for cosmetics, safflower or canola for general purposes, and olive oil for cooking.

Place the plant material in your jar or bottle. If you are using a bottle, you can push stems of lavender or rosemary into the bottle.

Now pour the oil over the plant material, making sure the bottle or jar is full. As a rough rule of thumb, use two cups of oil to one cup of plant material. You don’t need to warm the oil before you pour it in the bottle or jar.

Now cap the container tightly and place it in a warm spot. This could be a sunny place on the windowsill, or in a warm cupboard. Leave the oil to infuse for a few days, or until the plant material begins to brown. Take the cap off and sniff, if it is not strong enough for you, strain the liquid, fill the jar with fresh plant material, and pour the strained oil back over it. Leave for another few days. Repeat this until the mixture is the aroma that you want.

If the plant material used is very strong, jasmine, you should get a good scent after changing the plant material only once or twice.

When the preferred aroma has been obtained, strain thoroughly and put in a clean bottle. Keep your oil in a cool place. The oil can be used in lotions and creams which call for scented oil.

To make a wrinkle cream, add the contents of six Vitamin E oil capsules. You can use any strong scented flower petals such as honeysuckle, marigold, violets and so forth.

For culinary use, put some sprigs of rosemary, thyme or basil, into a tall bottle, and pour in good quality cooking oil such as safflower or olive oil. You can also add garlic, chilies or other seasonings as you prefer. Leave it in a place where the sun can warm the bottles for a couple of weeks.

You can use the same method for making aromatic vinegar. Choose a good quality wine or apple cider vinegar and pour it over your herb sprigs. Leave it set for a few days in a warm place.
# A General list of Essential Oils and their distillation methods

<table>
<thead>
<tr>
<th>Essential Oils</th>
<th>Origin</th>
<th>Principal Constituents</th>
<th>Source</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANGELICA ROOT</td>
<td>France</td>
<td>a - Pinene, limonene, a &amp; b-phellandrene,</td>
<td>Rhizomes</td>
<td>Steam Distilled</td>
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<tr>
<td>Angelica archangelica</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANISE STAR</td>
<td>China</td>
<td>Trans-anethole, anisaldehyde, d-3-carene,</td>
<td>Fruit</td>
<td>Steam Distilled</td>
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<tr>
<td>Ilicium verum</td>
<td></td>
<td>Linalool, cineole, ocimene, citronellol</td>
<td>Flowering tops</td>
<td>Steam Distilled</td>
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<tr>
<td>BASIL (linalool c.t.)</td>
<td>France</td>
<td>Eugenol, chavicol, myrcene</td>
<td>Leaves</td>
<td>Steam Distilled</td>
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<tr>
<td>Ocimum basilicum</td>
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<td></td>
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<tr>
<td>BAY LEAF</td>
<td>W. Indies</td>
<td>Benzoic acid, benzyl benzoate, benzyl alcohol Linalyl acetate, linalool, 5-methoxypsoralen</td>
<td>Resin</td>
<td>Solvent Extraction</td>
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<tr>
<td>Pimenta racemosa</td>
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</tr>
<tr>
<td>BENZOIN resinoid</td>
<td>Sumatra</td>
<td>Linalyl acetate, linalool, 1,8-Cineole, a-terpineol, terpinyl acetate</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
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<tr>
<td>Styrax benzoin</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BERGAMOT</td>
<td>Ivory Coast</td>
<td>Linalyl acetate, linalool, 1,8-Cineole, a-terpineol, terpinyl acetate</td>
<td>Zest of the fruit</td>
<td>Vacuum Distilled</td>
</tr>
<tr>
<td>Citrus bergamia</td>
<td>Italy</td>
<td>Linalyl acetate, linalool, 1,8-Cineole, a-terpineol, terpinyl acetate</td>
<td>Dried Fruit</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>BERGAMOT F.C.F.</td>
<td></td>
<td></td>
<td></td>
<td>Steam Distilled</td>
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<tr>
<td>Citrus bergamia</td>
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<tr>
<td>BLACK PEPPER</td>
<td>India</td>
<td>1,8-Cineole, a-terpineol, terpinyl acetate</td>
<td>Leaves &amp; twigs</td>
<td>Steam Distilled</td>
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<tr>
<td>Piper nigrum</td>
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<td></td>
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<tr>
<td>CAJUPUT</td>
<td>Vietnam</td>
<td>1,8-Cineole, a-terpineol, terpinyl acetate</td>
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<tr>
<td>Melaleuca leucadendron</td>
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<tr>
<td>CAMPHOR WHITE</td>
<td>China</td>
<td>1,8-Cineole, camphor, a &amp; b-pinene</td>
<td>Branches</td>
<td>Steam Distilled</td>
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<tr>
<td>Cinnamomum camphora</td>
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<tr>
<td>CARDAMON</td>
<td>Sri Lanka</td>
<td>a-Terpenyl acetate, terpinene, 1,8 cineole Carotol, bisabolene, b-pinene</td>
<td>Dried Fruit</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Elettaria cardamomum</td>
<td></td>
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<td>Steam Distilled</td>
</tr>
<tr>
<td>CARROT SEED</td>
<td>France</td>
<td>Atlantol, a &amp; b-atlantones, cedrol Cedxrol, a &amp; b-cedrene, thujopsene</td>
<td>Dried seeds</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Daucus carota</td>
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<td>Steam Distilled</td>
</tr>
<tr>
<td>CEDAR ATLAS</td>
<td>Morocco</td>
<td></td>
<td>Wood</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Cedrus atlantica</td>
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</tr>
<tr>
<td>CEDAR VIRGINIAN</td>
<td>U.S.A.</td>
<td></td>
<td>Wood</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Juniperus virginiana</td>
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<td>Steam Distilled</td>
</tr>
<tr>
<td>CHAMOMILE</td>
<td>Egypt</td>
<td></td>
<td>Flowering tops</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>GERMAN</td>
<td></td>
<td></td>
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<tr>
<td>Matricaria chamomilla</td>
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<td>MAROC</td>
<td>Morocco</td>
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<td>Flowering tops</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Ormenis multicaulis</td>
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<td>CHAMOMILE</td>
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<tr>
<td>ROMAN</td>
<td>England</td>
<td></td>
<td>Flowering tops</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Anthemis nobilis</td>
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<td>Plant Name</td>
<td>Country</td>
<td>Properties</td>
<td>Part</td>
<td>Distillation Method</td>
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<tr>
<td>CINNAMON LEAF</td>
<td>Madagascar</td>
<td>Eugenol, caryophyllene, linalool</td>
<td>Leaves</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Cinnamomum</td>
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<tr>
<td>zeylanicum</td>
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<tr>
<td>CITRONELLA</td>
<td>Madagascar</td>
<td>Geraniol, citronellol, citronellal</td>
<td>Grass</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Cymbopogon nardus</td>
<td></td>
<td>Linalool, linalyl acetate, sclareol</td>
<td>Flowering tops</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>CLARY SAGE</td>
<td>France</td>
<td>Eugenol, b-caryophyllene, nerol</td>
<td>Flowering tops</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Salvia scalaria</td>
<td></td>
<td>Linalool, geraniol, bornol</td>
<td>Fruit</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>CLOVE BUD</td>
<td>Comores</td>
<td></td>
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<td>Steam Distilled</td>
</tr>
<tr>
<td>Eugenia caryophyllata</td>
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</tr>
<tr>
<td>CORIANDER</td>
<td>Romania</td>
<td>a-Pinene, delta-3-carene, terpinolene</td>
<td>Needles &amp; cones</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Coriandrum sativum</td>
<td></td>
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<tr>
<td>CYPRESS</td>
<td>France</td>
<td>Carvone, anethole, phellandrene</td>
<td>Fruit/seed</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Cupressus sempervirens</td>
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<td>Elemol, a-phellandrene, terpinolene</td>
<td>Resin</td>
<td>Steam Distilled</td>
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<tr>
<td>DILL SEED</td>
<td>France</td>
<td>1,8-Cineole, a-pinene, globulol</td>
<td>Leaves &amp; twigs</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Anethum graveolens</td>
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<tr>
<td>ELEMI</td>
<td>Philippines</td>
<td>Citronellal, citronellol, geraniol</td>
<td>Leaves &amp; twigs</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Canarium commum</td>
<td>S America</td>
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<tr>
<td>EUCALYPTUS</td>
<td>Portugal</td>
<td>1,8-Cineole, a-terpineol, phellandrene</td>
<td>Leaves &amp; twigs</td>
<td>Steam Distilled</td>
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<tr>
<td>Eucalyptus globulus</td>
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<tr>
<td>EUCALYPTUS</td>
<td>Australia</td>
<td>1,8-Cineole, limonene, isovaleraldehyde</td>
<td>Leaves &amp; twigs</td>
<td>Steam Distilled</td>
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<tr>
<td>CITRIODORA</td>
<td>Australia</td>
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<td>Eucalyptus citriodora</td>
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<td>EUCALYPTUS</td>
<td>S America</td>
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<td>RADIATA</td>
<td>Eucalyptus radiata</td>
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<td>SMITHII</td>
<td>Australia</td>
<td>1,8-Cineole, limonene, isovaleraldehyde</td>
<td>Leaves &amp; twigs</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Eucalyptus smithii</td>
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<tr>
<td>FENNEL SWEET</td>
<td>France</td>
<td>Anethole, fenchone, limonene</td>
<td>Fruit</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Foeniculum vulgare</td>
<td></td>
<td>a &amp; b-Pinene, bornyl acetate, limonene</td>
<td>Needles &amp; twigs</td>
<td>Steam Distilled</td>
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<tr>
<td>FIR SILVER</td>
<td>Russia</td>
<td>a &amp; b-Pinene, dipentene, obibanol</td>
<td>Resin</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Abies alba</td>
<td>Somalia</td>
<td>d-Cadinene, b-pinene, 1,3,5-undeca triene</td>
<td>Oleoresin</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>FRANKINCENSE</td>
<td>Iran</td>
<td>Citronellol, geraniol, 10-epi-g-eudesmol</td>
<td>Leaves &amp; stems</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Boswellia carterii</td>
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<tr>
<td>GALBANUM</td>
<td>Egypt</td>
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<tr>
<td>Ferula galbaniflua</td>
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<tr>
<td>GERANIUM</td>
<td>Reunion</td>
<td>Citronellol, geraniol, guaiadiene</td>
<td>Leaves &amp; stems</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Pelargonium graveolens</td>
<td></td>
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<tr>
<td>GERANIUM</td>
<td>Reunion</td>
<td>Citronellol, geraniol, guaiadiene</td>
<td>Leaves &amp; stems</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>BOURBON</td>
<td>Pelargonium capitatum x radens</td>
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<tr>
<td>GINGER</td>
<td>Cochin</td>
<td>b-Phellandrene, gingerol, a&amp;b-zingiberene</td>
<td>Rhizomes</td>
<td>Steam Distilled</td>
</tr>
<tr>
<td>Plant Name</td>
<td>Country/Region</td>
<td>Main Constituents</td>
<td>Part Used</td>
<td>Extraction Method</td>
</tr>
<tr>
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</tr>
<tr>
<td>GRAPEFRUIT</td>
<td>S America</td>
<td>Myrcene, d-limonene, nookatone</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neryl acetate, a &amp; b pinenes, nerol, g-curcumene, b-diketones</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>HELICHRYSUM</td>
<td>France</td>
<td>Linalool, 1,8-cineole, eugenol</td>
<td>Woods &amp; leaves</td>
<td>Steam distilled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iso- Pinocamphone, pinocamphone, sabinene</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>JASMINE 10% &amp; 5%</td>
<td>Egypt</td>
<td>Benzyl acetate, jasmone, indole</td>
<td>Flowers</td>
<td>Solvent Extraction</td>
</tr>
<tr>
<td>JUNIPER BERRY</td>
<td>Italy</td>
<td>a-Pinene, terpinen-4-ol, sabinene</td>
<td>Berries</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>JUNIPER NEEDLE</td>
<td>France</td>
<td>a-Pinene, terpinen-4-ol, limonene</td>
<td>Needles/Leaves</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LAUREL LEAF</td>
<td>Morocco</td>
<td>1,8-Cineole, linalool, eugenol</td>
<td>Leaves/Branches</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LAVANDIN SUPER</td>
<td>France</td>
<td>Linalyl acetate, linalool, 1,8 cineole</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LAVENDER</td>
<td>Bulgaria</td>
<td>Linalool, linalyl acetate terpinen-4-ol</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>BULGARIAN</td>
<td>Croatia</td>
<td>Linalyl acetate, linalool, terpinen-4-ol</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LAVENDER</td>
<td>England</td>
<td>Linalyl acetate, linalool, b-caryophyllene</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>ENGLISH</td>
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<td>Linalyl acetate, linalool, b-caryophyllene</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LAVENDER FRENCH</td>
<td>France</td>
<td>Linalyl acetate, linalool, b-caryophyllene</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LAVENDER High</td>
<td>France</td>
<td>Linalyl acetate, linalool, borneol, 3-octanone</td>
<td>Flowering tops</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LEMON</td>
<td>Italy</td>
<td>Citral, citronellal, d-limonene</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
</tr>
<tr>
<td>LEMONGRASS</td>
<td>Cochin</td>
<td>Citral, methyl heptenone, geranyl acetate</td>
<td>Grass</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LIME</td>
<td>Peru</td>
<td>p-Cymene, a-terpineol, terpinolene</td>
<td>Zest of the fruit</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LINALOE WOOD</td>
<td>India</td>
<td>Linalool, Linalyl acetate, a-terpineol, geranyl acetate, geraniol</td>
<td>Wood</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>LITSEA CUBEBA</td>
<td>China</td>
<td>Geraniol, neral, geranial, citronellal</td>
<td>Fruits</td>
<td>Steam distilled</td>
</tr>
<tr>
<td>MANDARIN</td>
<td>Italy</td>
<td>d-Limonene, methyl</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
</tr>
<tr>
<td>Name</td>
<td>Origin</td>
<td>Constituents</td>
<td>Plant Part</td>
<td>Method</td>
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<td>--------------------------</td>
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<tr>
<td>Citrus reticulata</td>
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<td>anthranilate</td>
<td>Foliage</td>
<td>Steam</td>
</tr>
<tr>
<td>MANUKA</td>
<td></td>
<td>Leptospermone, calamene, calmene</td>
<td>Foliage</td>
<td>Distilled</td>
</tr>
<tr>
<td>Leptospermum scoparium</td>
<td></td>
<td>Tairawhitii</td>
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<tr>
<td>MARJORAM SWEET ORiganum majorana</td>
<td>Egypt</td>
<td>Terpinen-4-ol, g-terpinene, caryophyllene</td>
<td>Dried flowers</td>
<td>Steam</td>
</tr>
<tr>
<td>MARJORAM WILD Thymus masticina</td>
<td>Spain</td>
<td>1,8-Cineole, a-pinene, a-terpineol</td>
<td>Dried flowers</td>
<td>Steam</td>
</tr>
<tr>
<td>MELISSA BLEND Blended</td>
<td>France</td>
<td>Citronellal, geraniol, geranyl acetate</td>
<td>Blended</td>
<td>Distilled</td>
</tr>
<tr>
<td>MELISSA TRUE Melissa officinalis</td>
<td>France</td>
<td>trans-Geraniol, neral t-geraniol, caryophyllene</td>
<td>Flowering tops</td>
<td>Steam</td>
</tr>
<tr>
<td>MYRRH</td>
<td>Somalia</td>
<td>Furanoeudesma-1,3-diene, lindestrene</td>
<td>Resinoid</td>
<td>Steam</td>
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<tr>
<td>Commiphora myrrha MYRTLE</td>
<td>Tunisia</td>
<td>1,8 Cineole, myrtenyl acetate</td>
<td>Leaves &amp; twigs</td>
<td>Steam</td>
</tr>
<tr>
<td>Myrtus communis NEROLI</td>
<td>Tunisia</td>
<td>Linalool, nerol, nerolidol, geraniol</td>
<td>Flowers</td>
<td>Distilled</td>
</tr>
<tr>
<td>Citrus aurantium v. amara</td>
<td>Tunisia</td>
<td>1,8-Cineole, terpeneol, viridiflora</td>
<td>Leaves &amp; twigs</td>
<td>Steam</td>
</tr>
<tr>
<td>NEROLI</td>
<td>Madagascar</td>
<td>a-Pinene, sabinene, myristicin</td>
<td>De-shelled seeds</td>
<td>Steam</td>
</tr>
<tr>
<td>NEROLI 10% &amp; 5% Citrus aurantium v. amara</td>
<td>Tunisia</td>
<td>Linalool, nerol, nerolidol, geraniol</td>
<td>Flowers</td>
<td>Distilled</td>
</tr>
<tr>
<td>NIAOULI Melaleuca viridiflora</td>
<td>Indonesia</td>
<td>1,8-Cineole, terpeneol, viridiflora</td>
<td>Leaves &amp; twigs</td>
<td>Steam</td>
</tr>
<tr>
<td>NUTMEG</td>
<td>Indonesia</td>
<td>a-Pinene, sabinene, myristicin</td>
<td>De-shelled seeds</td>
<td>Steam</td>
</tr>
<tr>
<td>Myristica fragrans ORANGE BITTER</td>
<td>W. Indies</td>
<td>d-Limonene, myrcene, decanal</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
</tr>
<tr>
<td>Citrus aurantium ORANGE SWEET</td>
<td>Brazil</td>
<td>d-Limonene, myrcene, octanal</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
</tr>
<tr>
<td>Citrus sinesis PALMAROSA</td>
<td>India</td>
<td>Geraniol, geranyl acetate, linalool, b-caryophyllene</td>
<td>Grass</td>
<td>Steam</td>
</tr>
<tr>
<td>Cymbopogon martinii PARSLEY SEED</td>
<td>Hungary</td>
<td>a-Pinene, myristicin, apioi</td>
<td>Seeds</td>
<td>Distilled</td>
</tr>
<tr>
<td>Petroselinum sativum PATCHOULI</td>
<td>Indonesia</td>
<td>a-Bulnesene, a-guaiene, a-patchoulene</td>
<td>Dried leaves</td>
<td>Steam</td>
</tr>
<tr>
<td>Pogostemon cablin PEPPERMINT</td>
<td>England</td>
<td>Menthol, menthofuran, menthone</td>
<td>Flowering tops</td>
<td>Steam</td>
</tr>
<tr>
<td>Mentha piperita PETITGRAIN</td>
<td>Paraguay</td>
<td>Linalyl acetate, linalool, geranyl acetate</td>
<td>Leaves &amp; twigs</td>
<td>Steam</td>
</tr>
<tr>
<td>Citrus aurantium PINE NEEDLE</td>
<td>Europe</td>
<td>a &amp; b Pinenes, d-3-carene, sylvestrene</td>
<td>Needles</td>
<td>Distilled</td>
</tr>
<tr>
<td>Pinus sylvestris RAVENSARA</td>
<td>Morocco</td>
<td>Madagascarpinenes, b-myrcene, p-cymene</td>
<td>Leaves</td>
<td>Steam</td>
</tr>
<tr>
<td>Ravensara aromatica ROSE 10% &amp; 5%</td>
<td>Morocco</td>
<td>Phenylethyl alcohol,</td>
<td>Flowers</td>
<td>Distilled</td>
</tr>
<tr>
<td>Plant Name</td>
<td>Country</td>
<td>Extracted Compounds</td>
<td>Extraction Method</td>
<td>Material Used</td>
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<tr>
<td>----------------------</td>
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<td>------------------------------</td>
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<tr>
<td>Rosa centifolia</td>
<td>Tunisia</td>
<td>citronellol, farnesol, 1,8 cineole, a-pinene, bornyl acetate</td>
<td>Flowering tops</td>
<td>Flowers</td>
</tr>
<tr>
<td>ROSEMARY</td>
<td>Tunisia</td>
<td>Citronellol, geraniol, nerol</td>
<td>Flowers</td>
<td>Flowers</td>
</tr>
<tr>
<td>Rosmarinus officinalis</td>
<td>Tunisia</td>
<td>Linalool, a-terpineol, geranyl acetate</td>
<td>Wood</td>
<td>Wood</td>
</tr>
<tr>
<td>ROSE OTTO</td>
<td>Bulgaria</td>
<td>1,8 Cineole, b-thujone, borneol</td>
<td>Dried leaves</td>
<td>Dried leaves</td>
</tr>
<tr>
<td>Rose damascena</td>
<td>Bulgaria</td>
<td>Carvone, cineole, myrcene</td>
<td>Heartwood</td>
<td>Heartwood</td>
</tr>
<tr>
<td>ROSEWOOD</td>
<td>Brazil</td>
<td>a-Santalol, b-santalol, epi-santalol</td>
<td>Flowering tops</td>
<td>Flowering tops</td>
</tr>
<tr>
<td>Aniba rosaeodora</td>
<td>Tunisia</td>
<td>Carvone, cineole, myrcene</td>
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<tr>
<td>SAGE</td>
<td>England</td>
<td>a &amp; b Pinenes, bornyl acetate</td>
<td>Needles &amp; twigs</td>
<td>Needles &amp; twigs</td>
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<tr>
<td>Salvia officinalis</td>
<td>India</td>
<td>cis-b-Ocimene, dihydrotagetone</td>
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<tr>
<td>SANDALWOOD</td>
<td>India</td>
<td>Terpinen-4-ol, g-terpinene, 1,8-cineole</td>
<td>Leaves &amp; twigs</td>
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<tr>
<td>Santalum album</td>
<td>India</td>
<td>Thymol, p-cymene, carvacrol</td>
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<td>Flowering tops</td>
</tr>
<tr>
<td>SPEARMINT</td>
<td>U.S.A.</td>
<td>Linalool, linalyl acetate, terpinen-4-ol</td>
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<tr>
<td>Mentha spicata</td>
<td>Canada</td>
<td>Thymol, p-cymene, carvacrol</td>
<td>Flowering tops</td>
<td>Flowering tops</td>
</tr>
<tr>
<td>SPIKENARD</td>
<td>Canada</td>
<td>Valeramone, elemol, allo-aromadendrene</td>
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<tr>
<td>Nardostachys jatamansi</td>
<td>India</td>
<td>Vetiverone, vetiverol, vetriveniene</td>
<td>Rhizomes</td>
<td>Rhizomes</td>
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<tr>
<td>SPRUCE</td>
<td>India</td>
<td>Chamazulene, sabinene, a &amp; b pinenes</td>
<td>Dried herb</td>
<td>Dried herb</td>
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<tr>
<td>Picea species</td>
<td>U.S.A.</td>
<td>Linalool, methyl benzoate, geranyl acetate</td>
<td>Flowers</td>
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<tr>
<td>TAGETES</td>
<td>Egypt</td>
<td>p-Cresyl methyl ether, methyl benzoate</td>
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<td>Flowers</td>
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<tr>
<td>Melaleuca alternifolia</td>
<td>Australia</td>
<td>Terpinen-4-ol, myrcene, a-pinene</td>
<td>Flowers</td>
<td>Flowers</td>
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<tr>
<td>TEA TREE</td>
<td>Japan</td>
<td>g-Terpinene, myrcene, a-pinene, limonene</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
</tr>
<tr>
<td>TAGETES glanduifera</td>
<td>Japan</td>
<td>Terpinen-4-ol, myrcene, a-pinene</td>
<td>Flowers</td>
<td>Flowers</td>
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<tr>
<td>THYME RED</td>
<td>S. America</td>
<td>Thymol, p-cymene, carvacrol</td>
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<tr>
<td>Thymus vulgaris</td>
<td>Spain</td>
<td>Valeramone, elemol, allo-aromadendrene</td>
<td>Rhizomes</td>
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<tr>
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<td>Chamazulene, sabinene, a &amp; b pinenes</td>
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<td>(linalool c.t.)</td>
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<td>Flowering tops</td>
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<tr>
<td>Thymus vulgaris</td>
<td>Spain</td>
<td>Valeramone, elemol, allo-aromadendrene</td>
<td>Rhizomes</td>
<td>Rhizomes</td>
</tr>
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<td>Thymol, p-cymene, carvacrol</td>
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<td>Spain</td>
<td>Valeramone, elemol, allo-aromadendrene</td>
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<tr>
<td>VETIVER</td>
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<td>Flowers</td>
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<tr>
<td>Vetiveria zizanoides</td>
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<td>g-Terpinene, myrcene, a-pinene, limonene</td>
<td>Zest of the fruit</td>
<td>Expressed</td>
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<td>YARROW</td>
<td>Hungary</td>
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<td>Hungary</td>
<td>Valeramone, elemol, allo-aromadendrene</td>
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<td>YLANG YLANG</td>
<td>Comores</td>
<td>Thymol, p-cymene, carvacrol</td>
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<td>Valeramone, elemol, allo-aromadendrene</td>
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<td>Japan</td>
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<tr>
<td>Citrus junos</td>
<td>Japan</td>
<td>Valeramone, elemol, allo-aromadendrene</td>
<td>Rhizomes</td>
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</tr>
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</table>
Quiz:

1. Water distillation is used when the plant material has been dried and will not be damaged by ______.

2. Rose oil is distilled by the Solvent or ________ methods.

3. Cold enfleurage has the advantage that even the most delicate components of the flower oils are ________.

4. The source of Lemon essential oil is from the _____ __ __ ___.

5. As a rough rule of thumb, use ___ cups of oil to one cup of plant material.

6. The _____ and _____ of Spruce are used to make essential oil.

7. For cosmetics you would use ___ oil or _____ oil.

Whispering Woods Advanced Herb Course

Lesson Thirteen

Herb Contraindications

In this lesson you will be given twelve examples of common herbs and their Contraindications. There are of course hundreds of contraindications between herbs and commercial medicines. As an herbalist you have a responsibility to do the research and to be keenly aware of the composition of the type of herbs that you may be utilizing. As you will see from the examples provided in this course, the utilization of herbs should be tempered by knowledge of these herbs and their uses.
Chamomile - Chamomile may increase the amount of drowsiness caused by some drugs. Examples include benzodiazepines such as lorazepam (Ativan®) or diazepam (Valium®), barbiturates such as phenobarbital, narcotics such as codeine, some antidepressants, and alcohol. Chamomile’s high content of the amino acid, tryptophan, has been used for sleeplessness and insomnia since the 1600s CE.

Caution is advised while driving or operating machinery.

In theory, chamomile may increase the risk of bleeding when used with anticoagulants or antiplatelet drugs. Some examples include aspirin, anticoagulants ("blood thinners") such as warfarin (Coumadin®) or heparin, anti-platelet drugs such as clopidogrel (Plavix®), and non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen (Motrin®, Advil®) or naproxen (Naprosyn®, Aleve®).

Limited laboratory and animal research suggests that chamomile may interfere with the way the body processes certain drugs using the liver's "cytochrome P450" enzyme system. As a result, the levels of these drugs may be increased in the blood, and may cause increased effects or potentially serious adverse reactions.

Be aware that many tinctures contain high levels of alcohol and may cause vomiting when taken with metronidazole (Flagyl®) or disulfiram (Antabuse®).

An extract containing Marticaria chamomile, Sideritis euboea, Sideritis clandestine, and Pimpinella anisum was associated with selective estrogen receptor modulator (SERM) properties against osteoporosis.

Theoretically, chamomile may interact with SERM drugs like raloxifene (prescription drug used for osteoporosis) or tamoxifen (a prescription drug used for cancer).
St. John’s Wort (Hypericum perforatum) - The flowers are used and they affect the lungs, kidney and bladder.
The active constituents are Essential oil including germacrene and sesquiterpenes, tannins, flavonoids including rutin phlobaphene, polyphenolic flavonoid derivative, hyperoside, rhodan, red diathrones, hypericin, pseudohypericin, resins, pectin, carotenoids, xanthones, stearic, myric and palmic acids and phloroglucinal derivatives.

Do not use this herb during pregnancy due to its emmenagogue and abortifacient effects.
Do not combine use of this herb with therapeutic ultraviolet light or solarium therapy, as the hypericin content increases photosensitivity to UVA.
Do not use this herb for severe depression or combine it with any anti-depressant medication nor should it be used with monoamine oxidase inhibitors (MAO inhibitors) as they may be potentiated.
Do not combine this herb with alcohol or resperine, as an extract from this herb is known to enhance the sleeping time from narcotic effects of alcohol and antagonize the effects of resperpine.
Do not use this herb where there is chronic liver or kidney disease, as these organs appear unable to detoxify a build-up of hypericin.
Do not combine this herb with amino acid supplements.
Do not use this herb where there is estrogen driven cancer of the reproductive system.
Do not combine this herb with any prescribed or self administered medication, as this herb has the potential to alter the rate at which many drugs are metabolized.
Do not combine this herb with the herb Yohimbe, which also contains Monoamine oxidase.
Do not combine this herb with any medication to control epilepsy.
Do not combine this herb with the asthma medication Theophylline or with any migraine control medications.
Do not combine this herb with Warfarin or Heparin.
Do not combine this herb with any treatment for HIV.
Lavender (Lavandula angustifolia) - Animal studies suggest that lavender used as aromatherapy or by mouth may increase the amount of drowsiness caused by some drugs. Examples include benzodiazepines such as lorazepam (Ativan®) or diazepam (Valium®), barbiturates such as phenobarbital, narcotics such as codeine, some antidepressants, and alcohol. Drowsiness caused by some seizure medicines may also be increased. **Caution is advised while driving or operating machinery.**

In theory, lavender may add to the effects of cholesterol-lowering drugs. Lavender may have additive effects when used with prescription antidepressant medications, such as the tricyclic antidepressant imipramine.

Black Cohosh - The potential estrogen-like effects of black Cohosh remain debated, and the active chemical contents of black Cohosh have not been clearly identified. Although recent studies suggest no significant effects of black Cohosh on estrogen receptors in the body, caution is warranted in people taking both black Cohosh and estrogens due to unknown effects.
The influence of black Cohosh in combination with tamoxifen is not clear in studies, and it is not known if tamoxifen counteracts the effects of black Cohosh. One trial suggests that black Cohosh may not be useful in the short-term treatment of tamoxifen-related hot flashes, although further study is needed in this area.

Black Cohosh may lower blood pressure, and therefore should be used cautiously with other hypotensive agents, such as beta-blockers like metoprolol (Lopressor®, Toprol®) or propranolol (Inderal®) and calcium-channel blockers like diltiazem (Cardizem®, Tiazac®) or verapamil (Isoptin®, Calan®).

Black Cohosh may contain small amounts of salicylic acid, and may increase the anti-platelet effects of other agents such as aspirin.

Black Cohosh may alter the way the liver breaks down or metabolizes certain drugs. In theory, due to possible alcohol content in some tinctures of black Cohosh, combination with disulfiram (Antabuse®) or metronidazole (Flagyl®) may cause nausea and vomiting.

Burdock - Based on animal research and limited human study, burdock may either lower or raise blood sugar levels. Caution is advised when using medications that may also affect blood sugar. Patients taking drugs for diabetes by mouth or insulin should be monitored closely by a qualified healthcare provider.

Burdock has been associated with diuretic effects (increasing urine flow) in one human report, and in theory may cause excess fluid loss (dehydration) or electrolyte imbalances (for example, changes in potassium or sodium levels in the blood). These effects may be increased when burdock is taken at the same time as diuretic drugs such as chlorothiazide (Diuril®), furosemide (Lasix®), hydrochlorothiazide (HCTZ), or spironolactone (Aldactone®).

Based on limited human evidence that is not entirely clear, burdock may have estrogen-like properties, and may act to increase the effects of estrogenic agents including hormone replacement therapies such as Premarin® or birth control pills.

Based on animal research, burdock may increase the risk of bleeding when taken with drugs that increase the risk of bleeding. Some examples include aspirin, anticoagulants ("blood thinners") such as warfarin (Coumadin®) or heparin, anti-platelet drugs such as clopidogrel (Plavix®), and non-steroidal anti-inflammatory drugs such as ibuprofen (Motrin®, Advil®) or naproxen (Naprosyn®, Aleve®).
Tinctures of burdock may contain high concentrations of alcohol (ethanol), and may lead to vomiting if used with disulfiram (Antabuse®) or metronidazole (Flagyl®).

Hops (Humulus lupulus) - Hops may cause mild central nervous system (CNS) depression (drowsiness, slowed breathing and thinking), and may add to the effects of drugs that also cause CNS depression or sedation. Examples include benzodiazepines such as lorazepam (Ativan®) or diazepam (Valium®), barbiturates such as Phenobarbital, narcotics such as codeine, some antidepressants, and alcohol.

Caution is advised while driving or operating machinery.

Based on preliminary animal studies, hops may lower blood sugar levels in normal individuals, but may actually increase blood sugar in those with diabetes.

Caution is advised when using medications that may lower blood sugar. Patients taking drugs for diabetes by mouth or insulin should be monitored closely by a qualified healthcare provider.

Laboratory research shows that estrogen-like substances in hops may have stimulatory or inhibitory effects on estrogen-sensitive parts of the body.

It is not clear what interactions may occur when used with other hormonal therapies such as birth control pills, hormone replacement therapy, tamoxifen, or aromatase inhibitors like letrozole (Femara®).

Hops may interfere with the way the body processes certain drugs using the liver's "cytochrome P450" enzyme system. As a result, the levels of these drugs may be decreased in the blood, and reduce the intended effects. If you are using any medications, check the package insert and speak with your healthcare provider or pharmacist about possible interactions.

Taking phenothiazine anti-psychotic drugs with hops is said to possibly increase the risk of hyperthermia, although there are no reliable human studies in this area.

Many tinctures contain high levels of alcohol, and may cause nausea or vomiting when taken with metronidazole (Flagyl®) or disulfiram (Antabuse®).
Hops compounds have also been shown to reduce triglycerides and free fatty acid blood levels and therefore may have additive effects with cholesterol-lowering drugs such as lovastatin (Mevacor®).

Licorice (Glycyrrhiza glabra) - In general, prescription drugs should be taken one hour before licorice or two hours after licorice because licorice may increase the absorption of many drugs. Increased absorption may increase the activities and side effects of some drugs (for example, nitrofurantoin). Phosphate salts have been shown to increase licorice absorption. Liver metabolism of certain drugs may be affected by licorice but further study is needed before a conclusion can be drawn.

Because the toxicity of digoxin (Lanoxin®) is increased when potassium levels are low, people who take digoxin and are interested in using licorice should discuss this with their health care provider.

Other drugs that may increase the tendency for irregular heart rhythms are also best avoided when using licorice.

Licorice may reduce the effects of blood pressure or diuretic (urine-producing) drugs, including hydrochlorothiazide and spironolactone. Use of licorice with the diuretics hydrochlorothiazide or furosemide (Lasix®) may cause potassium levels to fall very low and lead to dangerous complications. Other drugs that can also cause potassium levels to fall too low and are best avoided when using licorice include insulin, sodium polystyrene (Kayexalate®), and laxatives.

Chewing tobacco may increase the toxicity of licorice gums by causing electrolyte disturbances.

Licorice may increase the adverse effects associated with corticosteroids such as prednisolone, and monoamine oxidase inhibitors such as Isocarboxazid (Marplan®), phenelzine (Nardil®), or tranylcypromine (Parnate®). Agents acting on serotonin may also interact with licorice.

Licorice may reduce the effects of birth control pills, hormone replacement therapies, or testosterone therapy.

In theory, licorice may increase the risk of bleeding when used with anticoagulants (blood thinners) or antiplatelet drugs. Examples include warfarin (Coumadin®), heparin, clopidogrel (Plavix®), or aspirin.
Milk Thistle (Silybum marianum) - Animal studies suggest that milk thistle may interfere with the way the body processes certain herbs or supplements using the liver's "cytochrome P450" enzyme system. As a result, the levels of other herbs or supplements to be too high in the blood. It may also alter the effects that other herbs or supplements have on the P450 system, such as bloodroot, cat's claw, chamomile, chaparral, chaste berry, damiana, Echinacea angustifolia, goldenseal, grapefruit, licorice, oregano, red clover, St. John's Wort, wild cherry, and yucca.

Milk thistle may lower blood sugar levels. Caution is advised when using herbs or supplements that might also lower blood sugar. Blood glucose levels may require monitoring, and doses may need adjustment. Some examples include: Aloe vera, American ginseng, bilberry, bitter melon, burdock, fenugreek, fish oil, gymnema, horse chestnut/horse chestnut seed extract (HCSE), marshmallow, milk thistle, Panax ginseng, rosemary, Siberian ginseng, stinging nettle, vitamin E.

Milk thistle may interact with hormonal agents. Silymarin and vitamin E have been reported to prevent amiodarone toxicity in animal studies. Milk thistle may chelate iron and slow calcium metabolism.
Red Clover (Trifolium pratense) - The flowers are the part used from this herb. Red Clover affects the liver, heart and lungs. Its active constituents are flavonoids, phenolic acid including salicylic acid, volatile oil including methyl salicylate and benzyl alcohol, sitosterol, starch and fatty acids. **Do not use this herb during pregnancy.**

It has been strongly suggested that one should not use this herb with estrogen driven cancers (gynaecological), however phyto-oestrogens stimulate Beta receptors (selective estrogen modulators) and help cancer protection and don't over stimulate tissue. In fact they offer protection, whereas other estrogen’s e.g. PCB's in plastics stimulate and bind with 'A' Beta receptors.

It is suggested that during the early stages of cancer the use of red clover supports the immune system, blocking the growth of cancer cells. However during the advanced stages of estrogen driven cancers it is advisable to use low doses only.

**Do not combine this herb with Heparin or Warfarin due to the coumarin content, which may increase risk of bleeding.**

![Passionflower](image)

Passionflower (Passiflora incarnata) - Certain substances (harmala alkaloids) with monoamine oxidase inhibitory (MAOI) action have been found in small amounts in some species of Passiflora. Although levels of these substances may be too low to be cause noticeable effects, in theory, use of passion flower with MAOI drugs may cause additive effects. MAOI drugs include Isocarboxazid (Marplan®), phenelzine (Nardil®), and tranylcypromine (Parnate®). Based on animal research, use of passion flower with alcohol or other sedative-hypnotic drugs may increase the amount of drowsiness caused by some drugs. Examples include benzodiazepines such as lorazepam (Ativan®) or diazepam (Valium®), barbiturates such as phenobarbital, narcotics such as codeine, some antidepressants, and alcohol. **Caution is advised while driving or operating machinery.**

Passionflower may in theory increase the risk of bleeding when taken with drugs that increase the risk of bleeding. Some examples include aspirin, anticoagulants ("blood
thinners") such as warfarin (Coumadin®) or heparin, anti-platelet drugs such as clopidogel (Plavix®), and non-steroidal anti-inflammatory drugs such as ibuprofen (Motrin®, Advil®) or naproxen (Naprosyn®, Aleve®). Many tinctures contain high levels of alcohol, and may cause nausea or vomiting when taken with metronidazole (Flagyl®) or disulfiram (Antabuse®).

Sage (Salvia officinalis) - The leaf is used with this herb. It affects the lungs and the stomach. The active constituents are volatile oil including thujone, borneol, salviol, cineol, camphene, pinene, humulene, salvene, sabinol, linalool, saponins, flavonoids, diterpene bitters, triterpenoids including oleonolic acid, ursolic acid, resin, oestrogenic phytosterols, calcium oxalate, phosphoric acid, salts, minerals, including calcium, iron, phosphorous, magnesium, zinc, as well as vitamins A, C, riboflavin and niacin.

**Do not use this herb during pregnancy due to the volatile oil thujone, which has emmenogogue and arbortifacient effects.**

One should not use this herb during lactation as it reduces milk production nor should it be used long term, as it may induce epileptiform cramps. Do not combine this herb with Warfarin and other anticoagulant medication, due to its coumarin-like content which may cause bleeding, although no specific studies have been carried out on this herb. Caution should be shown while using this herb due to its thujone content.
Horehound (White) (Marrubium vulgare Labiatae) because white horehound is thought to be an expectorant in the treatment of cough or congestion, its use with cold medications that have expectorant ingredients may cause added effects.

White horehound may reduce the effects of some medications given for vomiting (serotonin receptor antagonist drugs such as granisetron and ondansetron), migraine headache (ergot alkaloids such as bromocriptine, dihydroergotamine, or ergotamine), and antidepressants that possess serotonin activity (selective serotonin reuptake inhibitors (SSRIs) like Prozac®, Paxil®, or Zoloft®).

White horehound may interact with the ability of the body to excrete penicillin. The reported ability of white horehound to cause diarrhea may cause an excessive response when combined with stool softeners or laxatives.

Large amounts of white horehound may increase the risk of abnormal heart rhythms and should be avoided by people treated with drugs that affect heart rhythm. White horehound when combined with medications that lower blood pressure may cause a larger than expected drop in blood pressure.

White horehound contains glycoside compounds that act on the heart and these could affect the activity of glycoside medications such as digoxin (Lanoxin®).

White horehound may increase the action of the hormone aldosterone on the kidneys and it may interact with some diuretic medications.

Based on some studies, white horehound may lower blood sugar levels. Caution is advised when using medications that might also lower blood sugar.

Patients taking drugs for diabetes by mouth or insulin should be monitored closely by a qualified healthcare professional.

White horehound may also interact with medications used to treat thyroid disorders such as iodine, liothyronine (T3, Cytomel®); methimazole (Tapazole®); propylthiouracil (PTU); thyroxine (T4, Levoxyl®, Synthroid®); Thyrolar® (T4 plus T3).

White horehound may contain estrogen-like chemicals that either have stimulatory or inhibitory effects on estrogen-sensitive parts of the body. It is unclear what effects may occur in people using hormonal therapies such as birth control pills or hormone replacement therapy. Based on some studies, white horehound may lower cholesterol or triglyceride blood levels and therefore may have additive effects with other drugs with similar actions.
Quiz:

1. Burdock may have ____ like properties.

2. Taking phenothiazine anti-psychotic drugs with hops is said to possibly increase the risk of __________.

3. The toxicity of digoxin (Lanoxin®) is increased when _______ levels are low.

4. St Johns’ Wort, affects the lungs, kidney and ______.

5. Sage has emmenagogue and _______ effects.

6. Hops may interfere with the way the body processes certain drugs using the liver's "__________________" enzyme system.

7. White horehound may interact with the ability of the body to excrete ________.

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Whispering Woods Advanced Herb course

Final Exam

1. Kaempferol is a strong ________.

2. Luteolin is classified as an ingredient of ________.

3. The key aromatic hydrocarbons are benzene, ________, ortho-xylene and para-xylene.

4. Phytosphingosine is the counterpart of ___________in the plant world.

5. High tyramine foods should not be eaten by people who take ___ ________ medicine.

6. _________ is a major component of chocolate.
7. Eugenol will darken and thicken when exposed to ____.

8. The chemical structure of furanocoumarin consists of a ____ ring fused with coumarin.

9. Do not combine ST. Johns Wort with ____ supplements.

10. Sesquiterpenes are formed from three ________ units.

11. In theory, lavender may add to the effects of ______ - _______ drugs.

12. Indole is a member of the class of sulfur-containing chemicals called ________.

13. Each amino acid contains an _______ group and a "carboxy" group.

14. Milk thistle may lower ______ levels.

15. Apigenin has shown the ability to inhibit _________ growth.

16. Hops may cause mild central nervous system ________.

17. Among the important effects of flavonoids is their _________ effect.

18. White horehound may increase the action of the hormone ________.

19. Covalent bonds are a chemical link between two atoms in which ________ are shared between them.

20. Rutin helps the body to utilize vitamin C and maintain ______.

21. Use of licorice with the diuretics hydrochlorothiazide or furosemide may cause ______ levels to fall very low and lead to dangerous complications.

22. The main constituents in ginger are ________ compounds.

23. Amphetamines fall under the _________ classification.

24. If it makes its way into the bloodstream, ______ may oxidize red blood cells.

25. It is suggested that during the early stages of cancer the use of red clover supports the immune system, blocking the growth of ________.

26. Willows and many other members of the Salicaceae will often produce phenolic _______.

27. Though Astaxanthin is a carotenoid it belongs to a much larger class of phytochemicals known as _________. 
28. Glycoproteins are the proteins covalently attached to ________.
29. Campesterol was first isolated as a sterol from ______ ______.
30. Allyl isothiocyanate can be liberated by heating during ____________.
31. Deoxylactucin is a principal bitter Sesquiterpene Lactone found in ________.
32. Green tea has about ___ Catechins.
33. Although safe to mammals, _______ is extremely toxic to fish.
34. Aromatic compounds usually contain but are not limited to six _____ atoms.
35. Fungal infection or wounding of the plant seems to increase ______.
36. When making aromatherapy oils, you can use baby oil or almond oil for ________.
37. Histamine was first discovered in _____ CE.
38. Monoterpenes: These are a class of terpenes that consist of two isoprene units and have the molecular formula ________.
39. The crushed leaves of Buffalo gourd are a very useful ________.
40. Water distillation is used when the plant material has been dried and will not be ______ by boiling.
41. Anise is considered useful as a cure for ____________.
42. Indole is a common ________essence compound.
43. Methylamine is a derivative of ________.
44. Black Cohosh may _____blood pressure, and therefore should be used cautiously with other hypotensive agents.
45. ________ is the suggestive name given to the amine with technical name 1, 5-diaminopentane.
46. Rutin can be created by bonding a disaccharide onto the ______ group of Quercetin.
47. Digitalis glycosides such as _____and ______ have been used to treat heart failure for over 200 years.
48. Saponins increase ______ _______ to the internal organs through enhanced cardiovascular function.
49. The essential oil of Ginger is made from the _______.

50. ___________ is used in the illegal manufacture of the drug MDMA (ecstasy) and Methamphetamine.

51. Grapefruit juice reduces CYP3A activity to a significantly greater extent than does _____ juice.

52. Aged cheeses have the highest levels of _________.

53. Sage contains the volatile oil; _________.

54. Two of the most toxic Lectins are Abrin and _____.

55. The _______ can consist of a single sugar group (monosaccharide) or several sugar groups (oligosaccharide).

56. Along with fat and carbohydrates, protein is a _______.

57. Menthol is classed as a _________.

58. Luteolin has a melting point of ____.

59. Coriander originates from _________.

60. The two classes of Cartenoids are xanthophylls and _________.

61. _____ is known as a Citrus bioflavonoid.

62. According to some reports burdock may have estrogen-like properties

63. __ amino acids required for manufacturing the proteins the human body needs.

64. Lectins are sugar-binding _________.

65. Quercetin is a ___________ that is part of the coloring found in the skins of apples and red onions.

66. Trioxsalen is a furanocoumarin and a _________.

67. Cadaverine is a toxic _________.

68. Angelicin and its structural analogues are another ___________ used in the treatment of psoriasis.

69. Bergamottin is a natural furanocoumarin found principally in _________ juice.
70. Histamine exerts its actions by combining with specific cellular ________ located on cells.