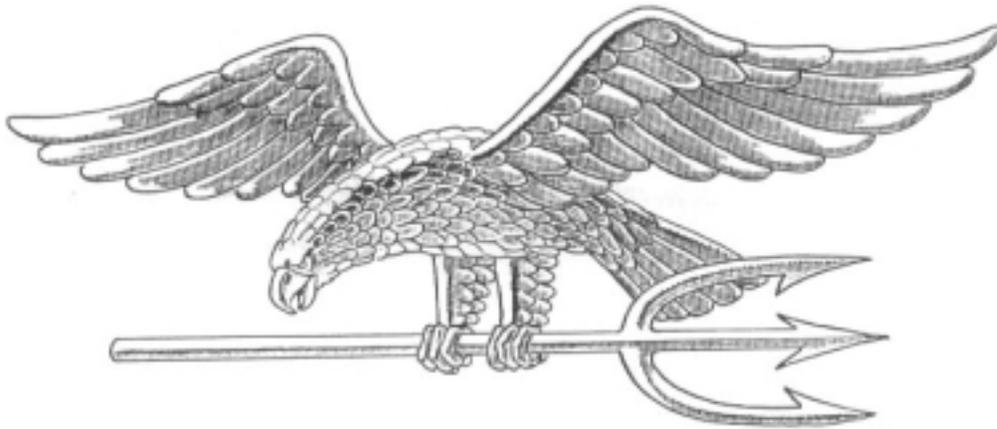


**Scientific Principles  
Of Improvised  
Warfare & Home Defense**

**Advanced Biological Weapons Series**

**Volume 6-B  
Plant Based Weapons**



**In the immortal words of Socrates “I Drank What”**

**Scientific & Technical Intelligence Press 2000**

**By Timothy W. Tobiason**

## **Dedication**

**After two years of constant surveillance and harassment by an FBI led task force and being banned from selling my books in Iowa I decided to begin writing the “politically Incorrect” series of weapons books under the acronym of STIP. I have had the US Army and FBI outside my home over the writing of these books.**

**This book is dedicated to the US Government and it’s law enforcement branches that believes dangerous knowledge is only for their eyes and not the publics. With Syphilis tests on it’s black colored citizens, radiation experiments on hospitalized subjects, bacteria distribution on the general public, WACO, and many other incidents in which the government did what it wished to its citizens, it is hard to pretend that “We the People” actually have rights where the government is concerned.**

**In my opinion, we live under a “By, For, and of Itself” government that concerns itself primarily with the well being of itself and its electoral bodies wealthy constituents. We live under the illusion of Freedoms, Rights, and Protections. This government, like all others, quietly does what it wishes to the citizens that say or do things it doesn’t like.**

**In order to aid the people of this nation in protecting itself from this government and other forms of tyranny, I write books on how people can arm themselves with the dangerous knowledge of how to build their own weapons. This is one of those books.**

**“All Americans Have the Right to Know Everything that this Government Knows How To Do to Us.” And I intend to see that they have this knowledge!**

**I have also dedicated this book to an overzealous tax collector from the State of Iowa who has barred me from selling there for about \$20 in sales tax. Poor people are not helpless when government bullies become intoxicated over the power given to them by a few words on a piece of paper and use them to push their financially defenseless citizens around. We can fight back!**

**Timothy W. Tobiason**

## Introduction

Biological Weapons are unique in the field of warfare. They have been used to poison, assassinate, decimate armies and cities, and change the course of history for thousands of years.

Bio-weapons are generally invisible and self-reproducing. They are easily hidden and camouflaged. They can be grown, mass produced and used by anyone. They can be mailed to anyone, anywhere on earth in pure form and be grown by the recipients quickly with little training. Entire armies can be built virtually overnight from nearly nothing.

This is the seventh volume of the “Scientific Principles of Improvised Warfare and Home Defense Series”. It is the second of the Biological Weapons series. The first, Volume 6A dealt with the recovery, cultivation and production of Bacteria and their toxic products. This second volume covers a wide range of Plants and substances they produce that can be used as weapons. The most important of these being direct poisons and the dermal irritants that can be used to enhance other categories of weapons. Dermal irritation that causes scratching enables the skins protective barrier to be broken by the target themselves. This allows subcutaneous inoculation of other biological or chemical weapons greatly enhancing their effects.

The third in the Bio-warfare series (Volume 6-C) will cover Mold and Fungi Weapons. Although these are considered members of the plant kingdom, their living characteristics are sufficiently different to be dealt with separately.

The fourth book (Volume 6-D), if it is written, will cover “The Organization & Conduct of Biological Warfare”. Where the first three volumes deal with where to find, how to grow, and how to produce the organisms and their toxins, they do not teach how to fight with them. This 4<sup>th</sup> volume will cover all aspects of strategy, tactics, army building, training, supplying, weapons delivery and so on.

It is also possible to write a 5<sup>th</sup> volume in this series detailing virus and genetically or otherwise modified bacteria, molds and plants. Imagine flowers with Botulinum toxin as a protein portion of a pollen. Imagine gas gangrene produced by air breathing bacteria transforming almost all life to food and sweeping the planet clean of species like the comet that ended the dinosaurs reign (All the upper life forms on the planet would perish). Imagine molds that decay living human beings like the dead wood tissues they currently consume. Imagine no more. The patents and technology are already here.

For governments intoxicated with their own power and self importance, it should be obvious by now how easily and quickly they can be swept from history. Perhaps they should concern themselves more with fair laws for everyone instead of rigging the system for the own exclusive benefit. Then I could concern myself with writing and selling books that enhance life rather than destroy it.

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# Chapter 1

## A Short History of Plants Used as Weapons

At the start of the first Indiana Jones movie, we see “Indy” escaping a booby-trapped cave with his archaeological prize only to encounter his guide full of poison darts. The guide drops over dead in seconds while surrounded by the native Indians.

The scene may be fictional but is rooted in fact. For centuries, the Indians of the Amazon and Orinoco valleys and the Guianas used small bamboo darts whose tips are covered with a brownish layer of flying death that they would shoot from blow guns. The plant extract is known to the public and scientists as “Curare”. When fired at animals or humans, the result is rapid paralysis and death. It is highly potent and the effects are rapid. When used for hunting, the animals (or people) could be safely eaten because Curare is not absorbed from the digestive tract. This practice would become the stuff of legend and lore for centuries. By the 18<sup>th</sup> century scientists would finally isolate it from a number of plant species and find uses for its components in medicines.

Curare is a sticky black mixture that comes from the vines of *Chondodendron tomentosum* and *Strychnos guianensis*. The vine is squeezed and pounded into a pulpy mass. Water is mixed to filter out the poison juice which is heated in a pot. Some additives are included to enhance the poison. The mass is boiled until it thickens to a dark goo. It is stored in a pot to dry and becomes brittle. A drop of water is added to make it gummy again so it can be put on the point of arrows and darts. The Indians are so skilled at the dose preparation that they can kill instantly or use it to only paralyze and capture their prey.

One of the earliest recorded references to a plant poison comes from the Ebers papyrus of 1550 BC of a plant which derived its name from the Greek Fate “Atropos”. The plant is known today as *Atropa belladonna* or deadly nightshade. It has a long history of its use as a poison and has entered the literature of notable authors from Pliny to Shakespeare. It has been used in poisons, medicines for the eyes and respiratory infections. It produces psychosis when used in small doses over several months and can be used to counter the effects of nerve gas.

During the reign of Duncan I, king of Scotland (who was later murdered by Macbeth), and a short time before William the Conqueror, England was invaded by the Danes. A truce was soon called as each side could not achieve its goals. The Scots, during the truce, offered the Danes a hearty supply of wines and ales. Mixed into it were small amounts of a purplish liquor from a plant that was well known to them. The Danes drank heavily, became intoxicated and then driven mad by the poisonous juice. The Scots descended on their camp and killed almost all of them. Only a few made it back to their ships and escaped the slaughter. Today, we derive digitalis from the plant, Belladonna or the deadly Nightshade.

The ancient epic of Homer describes “Black was the Root, but Milk White the flower. Moly the name, to mortals hard to find.” He was describing a substance known for centuries as “Monkshood”. Many varieties grew in gardens and the countryside and was long known before the Christian era as the Queen Mother of poisons. Like many other ancient poisons, it would have medicinal properties when used in small quantities and found use in ancient medicine cabinets as a cardiac sedative. It would be associated with witchcraft and sorcery, be used by wolf hunters who tipped their arrows with the poison from the plant and the plant soon became known as “Wolfsbane”. Its poison would become known as “aconite” and was regarded as the most potent of the poisons in ancient times. Medea put liquid into a cup to poison Theseus, and old men on the Aegean island of Keos who could no longer work were also given it to drink as a form of euthanasia.

Another plant, related to the potato is thick and tuberous. The root is flesh colored and about a foot long. Its overall image is that of a human being and found its name rooted in that image. Used in occult traditions and witchcraft, it would be applied as an anesthetic and if used in too large a dose it would put the patient to sleep for good. It was highly prized in the arsenal of ancient alchemists, was believed to be an aphrodisiac in small doses as well as a narcotic and became known as “Mandrake”.

The root of another plant that even today is sometime mistaken as edible found its way into the play Macbeth. When applied in ointment, it supposedly gave the recipient the ability to fly. When used in combination with other plant extracts and oils it would produce hallucinations that gave the sensation of flying. When taken internally it would kill. The root of the Hemlock has been known as a potent poison in this fashion for centuries. The water Hemlock, a member of the carrot family is widespread throughout the Northern Hemisphere. The long fleshy roots look and smell like wild parsnip and produce a 30% fatality rate among those who mistakenly eat it. Those who survive experience such intense pain that they wish they had died. Hemlock is known in France as “dead tongue” because of its paralyzing effect on the voice.

The poison Hemlock is also known as “Fools Parsley” because of foragers who mistook it for that.. All the plant parts contain poison that attacks the central nervous system and paralyzes the lungs. The best known execution by suicide in history was that of Socrates in 399 BC. He drank a brew of hemlock juice, he laid back. His legs grew heavy and he could not move them. Slowly, numbness moved from his feet upward and as paralysis reached his trunk he remembered an old debt and asked a friend to repay it for him. Then he passed into history. [It is interesting that the Greeks and Romans did not consider it dishonorable to commit suicide with plant poisons. These included the Greek philosophers Theramenes and Phocion]

The spores of a fungus that grows on cereal grains, especially rye would germinate and begin to grow when the weather becomes warm and wet. It would produce several potent drugs and poisons. When the rye is harvested and baked with the fungus from rye flour, one of its substances transforms into a chemical called lysergic acid diethylamide or LSD. The fungus is known as ergot. In 1722, Rye infected with ergot would be eaten by a Russian army preparing to fight the Ottoman Turks. It would kill more than 20,000 soldiers and the battle would not take place. A plant grown biological poison decimated and entire army.

It also has been noted in history books for leaving dead and crazed people in its wake as "'The Saint Anthony' Fire" because of the burning sensation felt by its victims and the belief that prayers to St. Anthony would cure it.

Ergot would constrict blood flow in the extremities so severely that hands and feet would turn gangrenous and fall off. It would trigger muscle spasms and hallucinations. John Fuller's 1968 book cited above described the horror visited on the people of Pont Saint-Esprit. Dogs attacked trees, hundreds of villagers became hysterical and psychotic. Hundreds became temporarily mad and experienced symptoms for months. It has even been implicated in causing many of the observed symptoms that led to the Salem Witch's trials.

The leaves and stems of the Pokeweed plant are edible, but only during the spring. By fall, they become poisonous. Its berries are very toxic when green but safe in small amounts when ripe. Late in the season they can poison again. The ability to obtain lethal poison changes with the seasons with this plant.

Alkaloids in the vines, leaves and sprouts of tomatoes and potatoes have been extracted and used as poisons to kill. Rhubarb leaves are laced with oxalic acid which burns the mouth and kills if several leaves are eaten. The acid crystallizes in the kidneys and ruptures the tubules.

The pits of apples, apricots, peaches, plums, and cherries contain small quantities of prussic acid (cyanide) which can be extracted and concentrated into a lethal weapon.

A plant known as the larger fruited nightshade produces a fruit that has been known historically as the "mad apple". *Melanzana* is the name given to it by the Italians and until the 19<sup>th</sup> century it was thought that the fruit was highly poisonous. Today we know that it is only the vine that is highly toxic and we eat the fruit with the more appealing name of eggplant.

The common potato (*Solanum tuberosum*) produces toxins in the flower, leaf and stem but not in its ripe tuber.

Dieffenbachia has pretty leaves and a stalky stem which contain calcium oxalate. If the greenery is chewed, the tiny and needle sharp crystals lodge in the tongue, lips and cheeks causing them to swell. The throat can swell to the point of not being able to talk and even suffocating the victim. At the Nuremburg war crime trials it was learned that Hitler considered adding dieffenbachia to the food of the imprisoned Jews as a method of torture.

Yews are common throughout America and yet have been known to be deadly since Roman times and was noted by the Roman poet Virgil who wrote about the "baleful yew". It contains the alkaloid taxine that produces burns the stomach lining, causes convulsions, coma and death. The poison is found in all plant parts but is least concentrated in its red berries.

Oleander is a deadly plant with yellow, white, pink, and red flowers. People have used its twigs to roast marshmallows and have died after eating the marshmallow that contained tiny traces of the plant. Its clear gummy sap contains glycosides that kill with a single drop. Oleander is used as a colorful hedging along property lines and highway dividers.

An ornamental shrub called mountain laurel which has been the state flower of Connecticut has glossy leaves and abundant white and pink flowers. The leaves contain a resinous toxin called andromedotoxin and these were chewed by eastern woodland Indians to commit suicide.

One of the most well known, popular and easiest to obtain poisons is produced by the Castor plant. Its seeds or beans contain castor oil and are grown commercially for this purpose. The beans are sold by garden and hardware stores for use by homeowners as ornamentals and houseplants. If the beans are chewed they will kill because the tissue contains the poison "Ricin". The poison destroys cells and as few as three beans are fatal. A fatal dose has no antidote or treatment. It was a favorite assassination tool of the Soviet KGB who injected it into the skin of defectors using a needle in the tip of an umbrella. X rays in one of the victims turned up a tiny metal capsule in the targets leg with traces of Ricin. One man died of the exposure. A second was saved by extraction of the capsule before all its deadly poison could be dispersed.

The Jequirty plant produces a red and black pea that is nearly as toxic. Two or three peas will kill an adult. Its toxin destroys red blood cells. The poison cannot pass through its outer shell so if the peas are swallowed whole the person is safe. If they are chewed they become ill and may die.

The Jimson weed belongs to the *Datura* group which is part of the *Nightshade* family. Its stands about four feet high with pointed green leaves growing on branched stems. The flowers are white and trumpet shaped. Thieves in medieval Asia and Europe drugged their victims with *Datura* extracts. Juice from the *Thorn Apple* was placed on the mothers nipple to feed and kill unwanted infants in that age. The Chinch Indians of the Columbian Highlands would sedate human sacrifices with extracts from *Datura* and bury them alive.

In 1676, a rebellion in Jamestown caused the British government to dispatch troops to control the local population. Seamen in the British force decided to forage in the countryside for some pot herbs and found a plant that looked like spinach. After the meal they turned into "natural fools" for several days. Some stripped and ran around naked, others made animal noises and one blew feathers into the air. Most recovered in eleven days with no memory of what had happened. The plant became known as the Jamestown weed and since changed into the Jimson Weed.

Poison Oak, Poison Sumac and Poison Ivy lead the field in the causing of human misery among the plant kingdom and have affected nearly half of all people living in the US at one time or another. The sticky sap of the plants contain urushiol, a toxin that oozes from the from broken stems, vines, berries or leaves.

Once molecules of urushiol penetrate human skin the body reacts with little effect the first time. Each time afterwards, a new contact often produces the “terrible itch” which can occur on any part of the body as an allergic reaction to subsequent exposures. Each new exposure usually produces a greater effect on those sensitive to it. Urushiol particles can be carried on the fur of dogs, in the air from smoke of burning plant parts and inhaled, touch the shoes or clothing of the target and without coming in direct contact can produce a new attack.

The old folk saying “three leaves, let it be” applies to three leaflets on each stalk of the poison ivy and poison oak. Poison Ivy grows best in damp shady woodlands. Poison Sumac in swampy areas and Poison Oak along the West Coast of the United States.

Sap from the buttercup and manchineel contains toxins that burn and blister in a fashion resembling mustard gas. The apples of the manchineel can be fatal but are so bitter that they are often spit out. All plants that produce rashes and burns can be used in combination with other biological’s to help penetrate the skin barrier and produce deadly infection.

The Upas tree found in southern Asia, Borneo and Java produces one of the deadliest toxins among the plant kingdom. Its sap is harmless by contact or ingestion but if it enters the bloodstream it paralyzes the heart in minutes. In 1776 a native sultan in Java discovered that thirteen of his concubines were having affairs with other men. He had all of them lashed to stakes and each were jabbed between their breasts with a point dipped in the Upas sap. In seconds the women were writhing in agony and minutes later all were dead.

Nux vomica is another deadly tree belonging to the Genus *Strychnos*. It is native to India and Sri Lanka and contains one of the deadliest and most well known poisons called strychnine. It produces spasms in the lower jaw muscles similar to that of tetanus and giving the appearance of a fatal “death grin”. Strychnine is found in the bark and seeds of the nux-vomica.

A thick vine grows in West Africa similar to Wisteria. It is a member of the Pea family and is called *Physostigma venenosum* and it produces large kidney shaped beans about an inch long. The toxin it contains is an alkaloid that causes paralysis of the respiratory system. The first beans to reach the western world were shipped from the Nigerian seaport of Calabar in 1840 and were given the name “Calabar Beans”. As few as six beans was sufficient to kill. It is also known by the name “ordeal bean” because of its use as a lie detector by West African tribes. People suspected of crimes were judged by the ordeal of drinking poison made from the beans. If they vomited up the poison they were judged innocent. If it stayed down they were deemed guilty and the poison usually killed them before sentence would be passed. This was a common practice throughout much of Africa.

On Madagascar, a tree of the dogbane family, *Tanghinia venenifera* produces a fruit with a poison in the seeds that paralyzes the heart. It was used as an instrument of state policy to suppress dissidents. The judicial system gave those accused a choice to drink the poison, be speared, or take their chances with the crocodiles which swarmed in the rivers. Mild doses caused vomiting and heavy doses killed. The local authorities would bring opponents into court on charges and force them to drink the poison. Whether they lived or died depended on the dose the authorities would choose. The tree became known as the ordeal tree. When the French established a protectorate in Madagascar in 1885, they began to cut down the trees to prevent its continued use as a popular poison.

Since ancient times, almost all poisons used by people as a weapon or state officials as policy were plant based toxins. Man, since the dawn of civilization learned to dip the tips of spears and swords in plant poisons to make the smallest scratch fatal. Even in 20<sup>th</sup> century warfare, pygmy warriors carrying bows and poisoned arrows went into combat with the Zairian army during fighting with Katangese rebels in the Shanga region. Although they never met in battle, the rebels who had routed the Zairian army to that point were so intimidated by the little men with poison arrows that they lost heart at the news of their approach. It was a potent psychological weapon much like the fear of Anthrax is today in America.

A decade before that, a poisoned tip arrow killed the chief of staff of the Congolese army as he led a column in the jungle. Bungi sticks used in Vietnam years later would have a similar effect although bacteria rather than poisons were used. Aborigines in Borneo and Malaya fought for the allies killing many Japanese soldiers with poison and silent darts with the tips dipped in monkshood.

The ancient story from Bronze Age Greece tells of Achilles being struck in the heel by an arrow from the Trojan prince Paris, which killed him. Since the use of poisoned arrows was well known it had to be poison that killed him and even in this century we still use the expression "Achilles Heel" when we talk of some ones weakness. Homer mentions that Ulysses knew how to poison arrows with Monkshood.

Ancient Egyptian scrolls warn "Pronounce not the name of I.A.O. under the penalty of the peach" which was a dire reference to being poisoned with cyanide extracted from the leaves and pit of the peach.

Poisoning has long since been an instrument of policy among the ruling classes of the world. The Persian Queen Statira was poisoned with a toxin believed to be aconite that was smeared on the knife she used to cut her food. The king of Pergamus experimented with a huge array of poisons on his enemies. In Imperial Rome, poisoning became such an important tool that the leading families hired professional poisoners as a regular part of their staffs.

The most notorious of these of these was a woman named Locusta who was regularly hired to eliminate the husbands of wealthy women. Her clients included Agrippina the Younger, who was the wife of the emperor Claudius. Locusta is believed to have used Belladonna which was her favorite poison. The only one left in the way of the throne was the dead emperor's son by a former wife, Messalina. Locusta was again hired to clear the way. The son Britannicus was attending a royal banquet and hot water was poured for him to drink. Finding it a bit too warm he asked a slave to pour some cold water into it. The poisoned water was added and Britannicus drank it. He immediately had a seizure, could not talk, and struggled to breathe. In a few moments he died. It was believed that cyanide was used this time to finish him off quickly. Upon Britannicus' death, Agrippina's son Nero became emperor of Rome.

In 1500 BC, a man called Melampus lived at Pylos in Peloponnesus. He went to the center of science at that time which was in Egypt and studied medicine. One thing he discovered was a plant that had cathartic properties on goats who had eaten it. The plant was named Melampodium after him. We know it today as the hellebore or Christmas Rose. It has a terrible odor and was known to kill worms so it was administered in careful doses to people for that purpose. In accidental ingestion it has caused total hair loss, nail loss and skin to peel and was often fatal.

The late Middle ages and Renaissance were known as the "age of poisoning" since the use of poison as a form of murder peaked in this time period. The penalty for being caught though was harsh. A maidservant who poisoned three employers in 1542 was convicted and boiled alive. Except for Arsenic, all poison used in this time period were extracted from plants. The public fear of poisoning was so great in the 16<sup>th</sup> century that scholars were discouraged from writing scientific papers on poisoning and how to detect it. (In a similar fashion as the US government today). William Shakespeare was one of the rare exceptions who had the courage to include the reality of the practices of his time in his plays.

In 1513, the professional Italian poisoner John of Ragubo described how fees were calculated. His schedule included 50 Venetian ducats for the Marquis of Mantua, 60 ducats for the Duke of Milan, 100 ducats for the Pope, 150 ducats for the King of Spain, and 500 ducats for the Turkish Sultan.

Rulers employed poisoners themselves or were experts in the field and did their own dirty work. Charles of Navarre hired a poisoner to kill the dukes of Burgundy, Berry, and Bourbon, and Valois who was the brother of the King of France. The plot was foiled and the assassin executed.

In 1216, England's King John kidnapped and imprisoned the beautiful daughter of the Baron Lord Robert of Fitzwalter for spurning his advances. His troops seized her father's castle and she was made as uncomfortable as possible in the tower of London. Finally, he had her poisoned with a tainted egg.

Charles IX of France was among the deadliest poisoners who tested his potions on unsuspecting servants. He learned the science from his mother Catherine de' Medici who her protestant critics called the "sceptered sorceress of Italia's land. According to tradition, she tested her poisons using food baskets for the poor. She would then visit them and record the results.

One of the common tricks of the time was to place the poison on the pages of a book the target was reading. As they turned the pages they would moisten their fingers on their lips and slowly accumulate the poison in their mouths. Catherine is believed to have eliminated the future mother in law of her son who voiced objections to their planned marriage in this manner.

Almost all of the well known leaders and personalities of this time were well indoctrinated in the use of poisons. The bastard brother of Catherine, born of a black slave poisoned his cousin to protect an overlordship and then poisoned his mother hoping to conceal his origin.

Perhaps the most famous family of poisoners in history were a rival of the Medicis in Italy and their name has since become synonymous with the term. The family is the “Borgais” whose house originated in Spain and reached its peak on the Italian boot. Pope Alexander VI, with his children Lucrezia and Cesare have been linked to incest, and many acts of poisoning as well as other crimes. Yet despite the great fame and notoriety associated with their name historians consider them to be fairly representative of how powerful families of that day and time behaved. They also used direct means of assassination such as dagger and sword. It has been speculated that Alexander VI died at the hand of a poisoner who tainted wine he drank just before his death in 1503.

From the 15<sup>th</sup> to the mid 18<sup>th</sup> centuries, two schools of poisoning flourished on the Italian peninsula. The government of the city states Council of Ten recognized and used the first of these schools. Centered in Venice, it would strike far and wide. It was to this council that John of Raguba presented his fee list mentioned earlier for murdering heads of state.

A 16<sup>th</sup> century writer, J. Baptista Porta described the second school at Naples that used Strychnine, Belladonna, Aconite, Jimson Weed, and Hemlock individually and in combinations. One recipe described a mix of honey, bitter almonds, arsenic, caustic lime, powdered glass and the English Yew that was made into pills.

In the late 1600’s, French police began an investigation into a ring of fortune tellers and would result in the famous “affair of the Poisons”. The central figure was the wife of a bankrupt jeweler named Catherine Deshayes who dispensed charms (and poisons). She and her daughter were arrested with several more women and priests and eventually drew in many famous nobility, prominent individuals and even Louis XIV himself. Her daughter had in fact been hired by the Marquis de Montespan, a mistress to the King to poison the King himself but was arrested the day before the attempt was to take place in 1679. Once the whole affair became known, the King stopped the investigation and sent his mistress into retirement.

When the Europeans colonized Asia they soon found that the indigenous peoples were already skilled in the art of poisoning themselves. Professional criminals called the Thuggee (modern language uses the word “thug”) would use Datura including Jimson Weed to drug travelers and rob them. They could disguise the seeds by mixing them with curry and offer them to groups in trade.

During the 19<sup>th</sup> century, Burmese commandos contaminated British water supplies with monkshood roots turning them into death traps. Indian hill tribesmen used it to kill elephants and tigers. In India as in Europe, the wealthy used it to kill relatives and faithless spouses. Powdering the root made it look like pepper and it was easily disguised in it and applied to foods.

By the 20<sup>th</sup> century, modern laboratory practices made it possible to separate poisons in their pure forms rather than as concentrates. A Belgian nobleman, Count Bocarme, became the first to be convicted in court of using a purified material to murder. He learned chemistry and purified Nicotine from tobacco. His poison in pure form was forced down the throat of his brother in law who died quickly. A famous chemist named Stas was called in on the case and found the pure nicotine on the victims body and the floor where the corpse was discovered. Toxicology finally reached a point where it could make the use of poisons much riskier to the practitioners and this method of murder would soon be in decline.

For most of the 20<sup>th</sup> century deliberate plant based poisoning has been in decline with the exception of narcotic use (which is considered accidental). The narcotic effects of plants was illustrated in color in motion pictures for the first time in the Wizard of Oz when Dorothy encounters a patch of poppies and falls into a deep sleep from the plants dreamy vapors. Of course the Poppy was well known throughout history and yields Opium from which entire armies have been sedated before battle, the Opium war was fought, and which entire nations have become addicted for commercial purposes. Morphine and Codeine are useful medicines which the modern poppy has been used to produce in its place.

A deliberate substitution of industrial grade rapeseed oil occurred in 1981 that hospitalized around 12,000 people in Spain. Many contracted cancer, went insane or slowly withered away. They had all purchased a bargain brand of Olive Oil that had been sold by shady dealers. It contained the inedible rapeseed oil which is normally used as a drying oil in paints. Mixed with other edible oils it was easily disguised and afflicted thousands. The lethal dose was estimated at about a cup per adult individual.

## Chapter 2

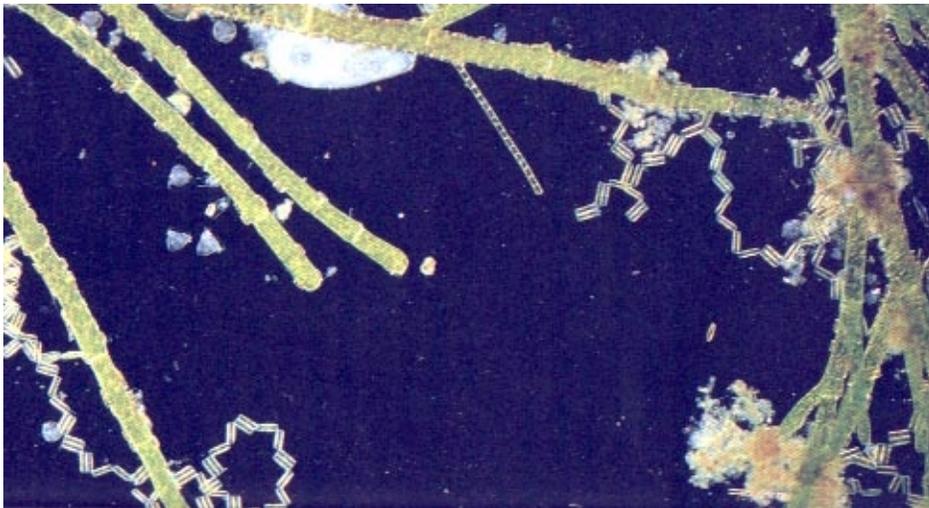
### Basic Plant Biology & Identification

Plants live in virtually every habitat on earth. There are more than 300,000 known species of plants and all other life on earth directly or indirectly depends on plants for food.

Plants are defined as an organism that contains a green pigment called chlorophyll, which converts sunlight into energy through a process known as photosynthesis. This process allows plants take sunlight and carbon dioxide from the atmosphere and convert it to glucose. Then they form the other structures of their bodies. Most plants form a rigid wall around themselves made of cellulose which makes them different from all other life. They produce roots which anchor them to the ground and draw in water and minerals. Plants live through different life spans. Some last only one growing season (a few weeks) while others live for years (perennials).

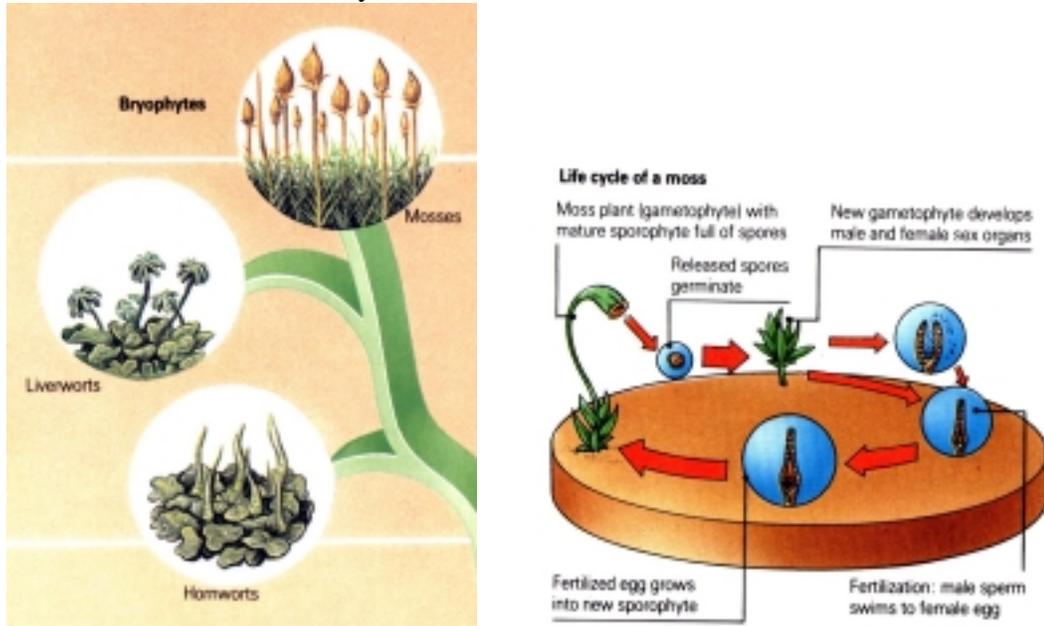
Biologists divide all plants on earth into five categories. These are-

1. Algae      These are the simplest forms. More than half are single cells, most of the rest form multi-cell filaments or plates. Some seaweeds form multiple structures.

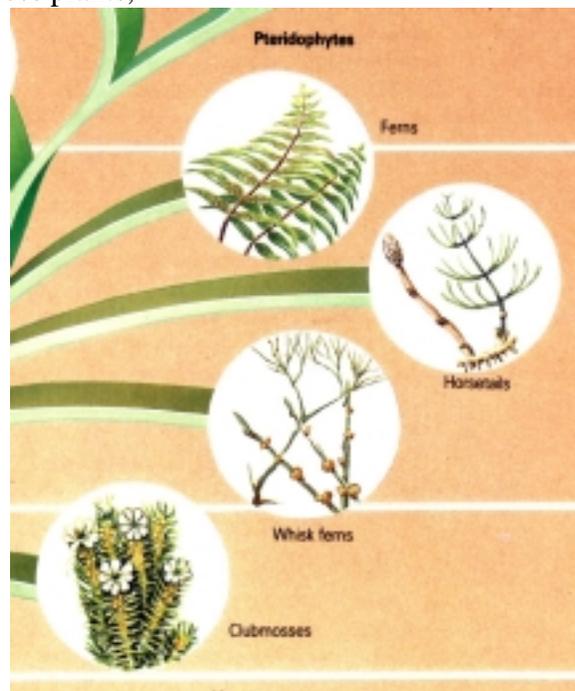


Chains of fresh water Diatoms-microscopic single celled algae

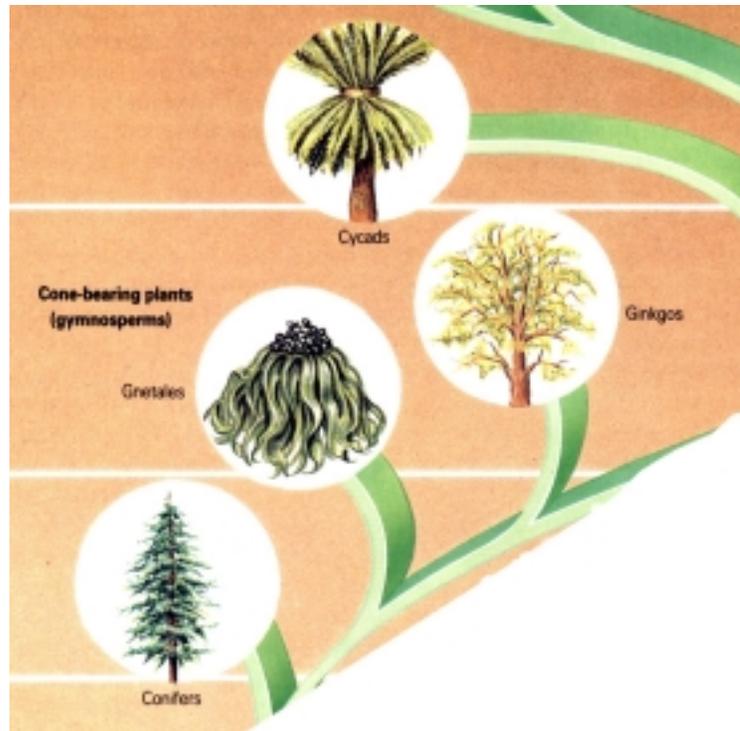
2. The Bryophytes which include more than 16,000 species of Moss, Hornworts, and Liverworts. They usually live in marshy ground. The spore bearing Bryophytes include sexual and asexual reproduction in their life cycles.



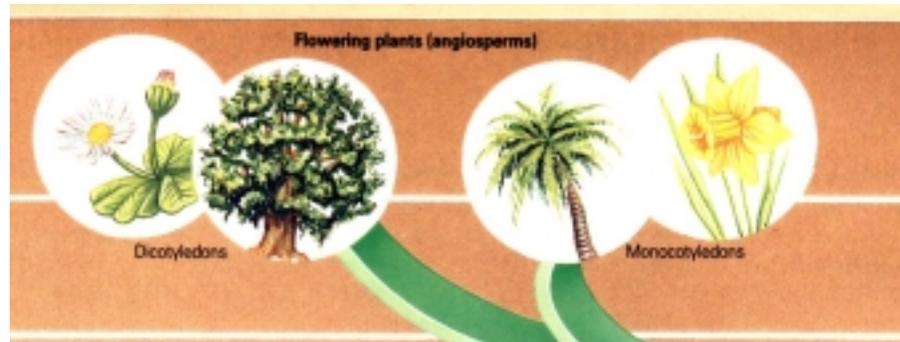
3. Pteridophytes Include Ferns, Horsetails, and Clubmosses and are also seedless plants,



4. The Gymnosperms Include the Conifers or Cone Bearing Plants



5. The Angiosperms which includes all Flowering Plants



Angiosperms are divided into the monocotyledons and dicotyledons which means that the shoots produced by the germinating seed has one (mono) or two (di) leaf-like organs (cotyledons).

The monocotyledons include grasses, lilies, orchids and palm trees.  
The dicotyledons include dandelions, clover, beech and oak trees.

## The Identification and Classification of Plants (Taxonomy)

Each plant is known by its genus and species name (as well as its popular name).

The **Genus** is a group of structurally related species.

A **Species** is a group of plants with more or less identical parts and capable of interbreeding.

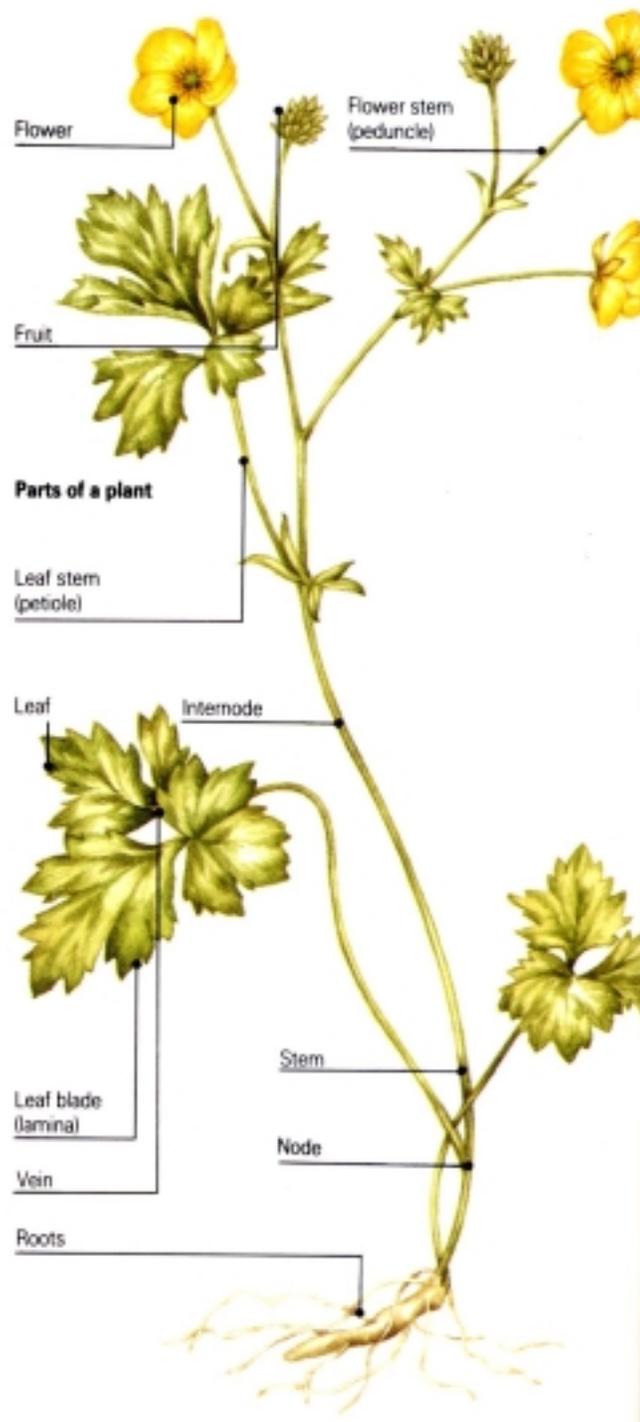
| <u>Category</u> | <u>Taxonomic Group (Scientific Name)</u> | <u>Comments</u>                |
|-----------------|--|--------------------------------|
| Division        | Anthrophyta (Angiosperms)                | Flowering Plants               |
| Class           | Dicotyledones                            | Has two seed leaves            |
| Order           | Asterales                                |                                |
| Family          | Compositae                               | Popular name –Daisy Family     |
| Genus           | Bellis                                   |                                |
| Species         | Bellis perennis                          | Daisy                          |
| Variety         | Bellis perennis var. aucubaefolia        | Natural Variant                |
| Cultivar        | Bellis perennis ‘Double Bells’           | Artificially bred double daisy |

Every plant can be accurately identified by a description of each of its physical parts and characteristics which are catalogued in huge volumes in every library. In this chapter we will describe the general features needed to correctly identify many plants. Later in the book you will see photos of various poisonous plants and you will be able to tell them apart by their structural differences and appearance.

The plant identifying features section is broken into the following parts-

1. General information
2. Roots, stems & buds
3. Leaves- Twig & leaf Arrangement  
Leaf Forms  
Leaf Shapes  
Leaf Margins  
Leaf Apices & Bases  
Leaf Lobing
4. Surface Features & Colors
5. Flower Parts & Inflorescences (clusters)  
Flower Colors  
Flowering Time  
Number of Petals
6. Seed Producing Parts
7. Plant - Growth habit (Annual, Biennial, Perennial)  
Growth Habitat  
Size
8. Glossary of Terms

# 1. General Plant Features and Parts



These are the main parts of a typical dicotyledon.

Each part of the plant has a special function to perform. Above the ground are the green stems and leaves which capture sunlight and produce food. The leaves grow in many shapes, sizes, and in different arrangements on the stem. The leaves of conifers are usually needlelike and adapted for drought. The Angiosperms have much larger structures to absorb sunlight with many variations in size and shape.

The stem of the plant holds the leaves and flowers up and out to capture sunlight and the wind for pollinating. The stems of *Arboreal* plants are supported by a solid column of wood while *Herbaceous* plants have slender stems with no woody tissues. They maintain a rigid stem by keeping the stem cells full of watery sap.

Roots take in water and minerals from the soil through root hairs. The plants typically lose 90% of their water through evaporation from the leaves and it must continually be replaced.

Plants take many shapes and forms. Three trees, the Fir, the Oak, and the Date Palm have all developed different specialized architecture. The fir tree is a conifer with a symmetrical cone shape. Its branches come out at regular angles from the trunk and have small stiff twigs along their lengths. The broad leafed Oak has branches dividing multiple times into many successively smaller branches and finally into twigs with leaves and flowers. The trunk of the date palm does not branch and carries many divided leaves in a bunch at the top.

The flowering plants (angiosperms) are divided into the monocotyledons which generally have narrow leaves with veins that run lengthwise and often grow from the base of the stem rather than the tip of the shoot. The embryo in the seed only has one shoot or seed leaf. The dicotyledons are a much larger group with their leaves coming in many shapes and the veins forming a network through the leaf. The plants grow in a branching fashion with growth occurring at the tips of the shoots. The embryo has two seed shoots. Most of the well known flowers and vegetables (and poisonous plants) are dicotyledons.

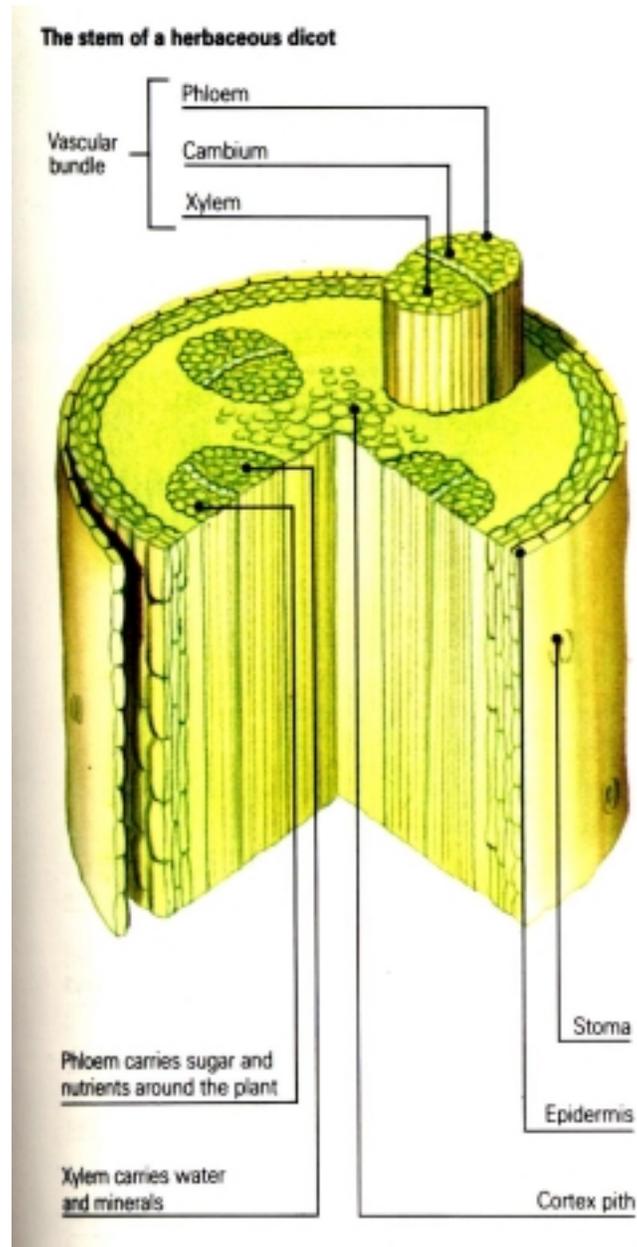
The flowers carry the reproductive structures and attract pollinators. The bright colors are produced by pigments in the cells and most produce attractive fragrances.

Parts to know include-

1. The kind of fruit it produces
2. Size, color, texture of the fruit
3. Number of stones or pits in the fruit
4. Arrangement of the fruit on the plant
5. Appearance (low herb, shrub, tree, etc.)
6. Size shape and arrangement of the leaves

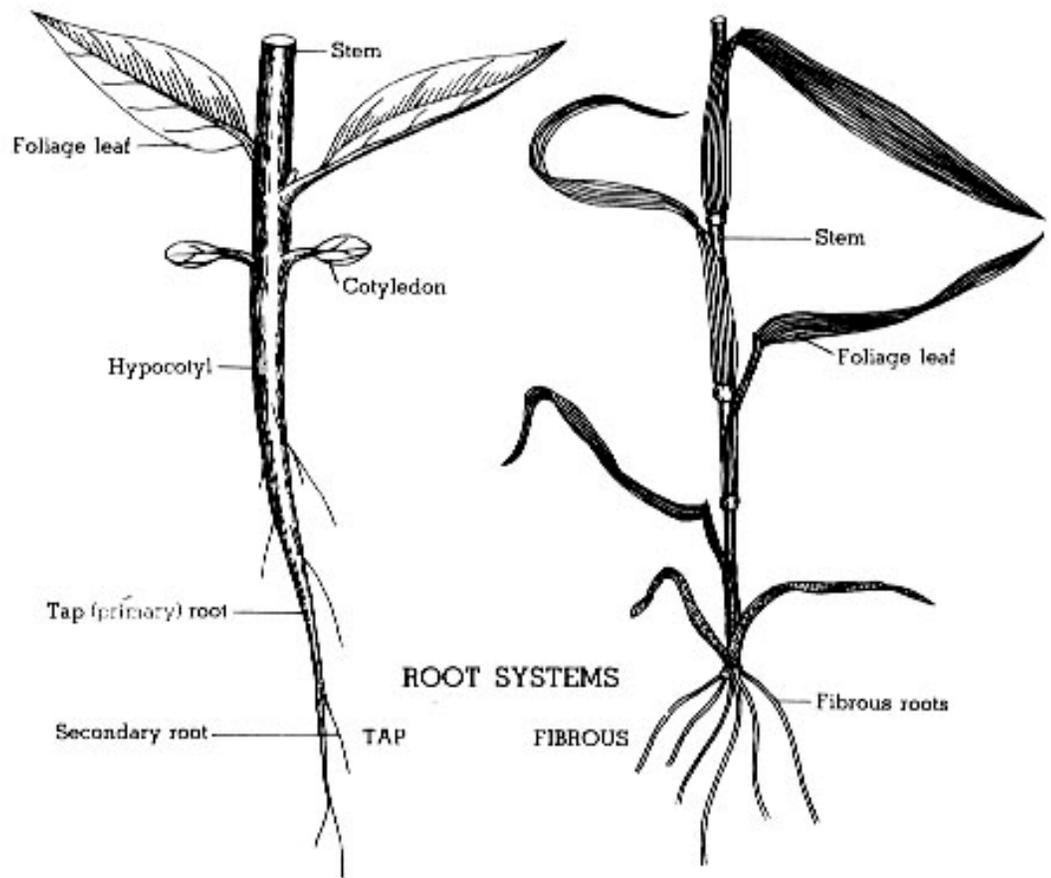
These features will be described in more detail now.

## 2. Roots, Stems and Buds



Stems and trunks of plants have the same basic structures to support leaves and flower's and move water around the plant. Woody plants develop a tough protective bark.

Tap and fibrous roots shown in seedlings of an amaranth and love grass (right).

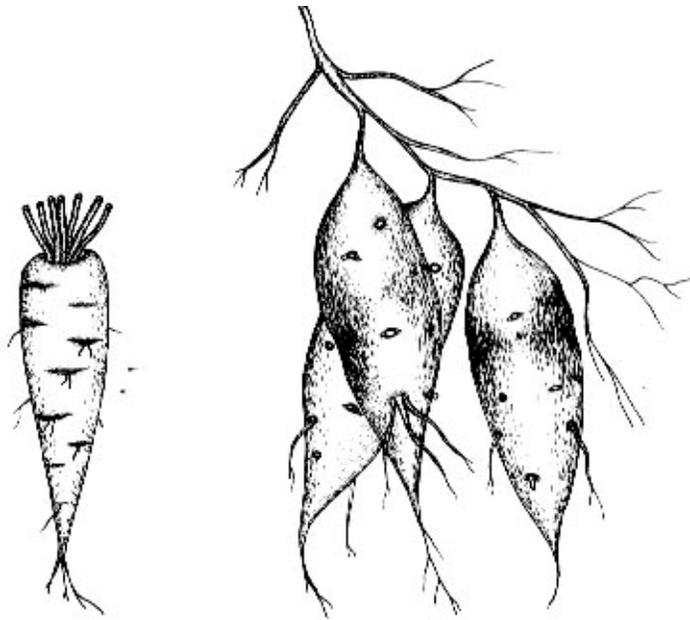


The tap root of dicotyledons are usually much larger than the secondary roots. In monocotyledons, several or secondary roots will be as large as the primary root. Sometimes in dicotyledons, the primary root may degenerate and be replaced by a fibrous root system like the one shown above.

Above ground branches of many plants can produce roots if they are kept moist if lying in mud or if cut branches (cuttings) are placed in moist sand or soil by man. Branch roots normally form by rapidly dividing cells which are similar to the ones from which they are formed. If they are not formed this way, as in cuttings, they are called *adventitious* roots. The ability to form roots from leaves, stems or other parts different from the main root is a helpful characteristic in identifying and classifying plants. Some help support the plant such as the prop roots of sugar cane, corn, and the banyan tree.

Some plants produce aerial root systems such as Poison Ivy, Poison Oak, Trumpet Vines and many species living in the upper levels of rain forests or on other trees (such as orchids).

Many plants store energy in roots in the form of fleshy bodies that are familiar to most of us. Pictured here are carrot and sweet potato tap roots.



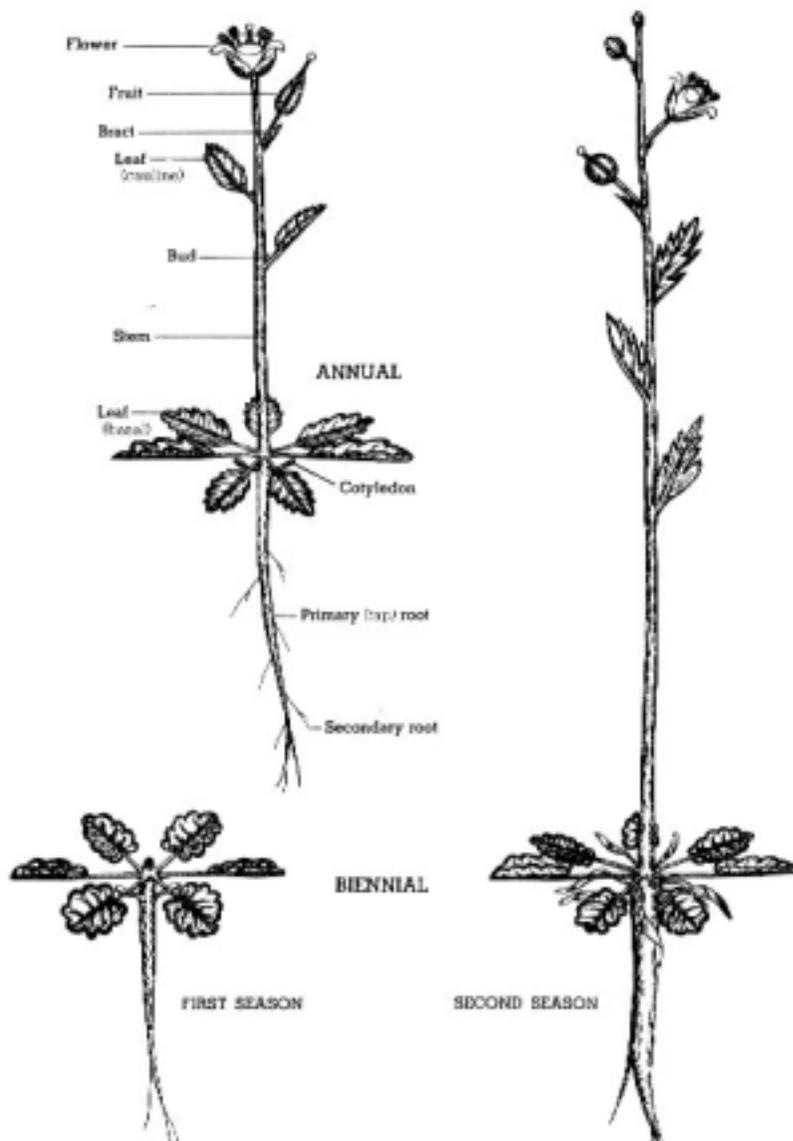
The roots become greatly enlarged because of the development of internal storage tissue. They can have spheroidal shape as in some beets, top shaped or turbinate as in a turnip or obconical as in carrots and parsnips. The sweet potato above is considered spindle shaped or fusiform.

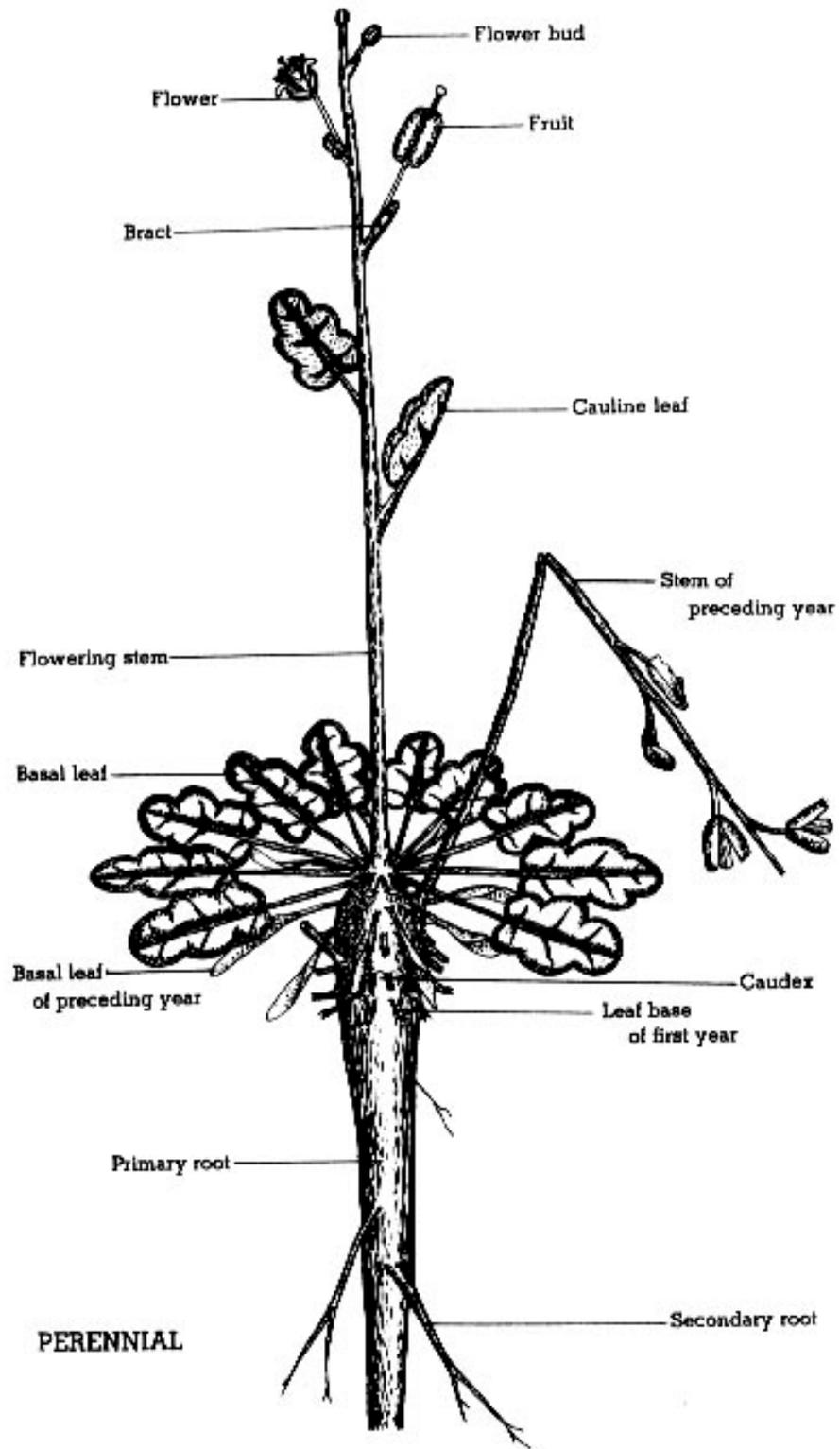
Stems are classified as herbs, shrubs, or trees. A herb is a plant with a soft stem that does not live over from year to year. If it has a cambium it does not become very active. Shrubs and trees are woody plants with stems and branches that live from year to year producing a growth ring and becoming thicker with each season as the cambium adds new layers of phloem and xylem. A shrub is distinguished from a tree because it has no main trunk and instead has a number of major branches rising above the ground. There are a number of plants that fall in between these categories and are distinguished by the overlaps.

There are special types of stems that plants produce. In the strawberry, runners and similar branches grow along the ground and are called stolons. They develop adventitious roots when they touch the ground, usually at the nodes. Over time the internodes die and separate plants develop the following season.

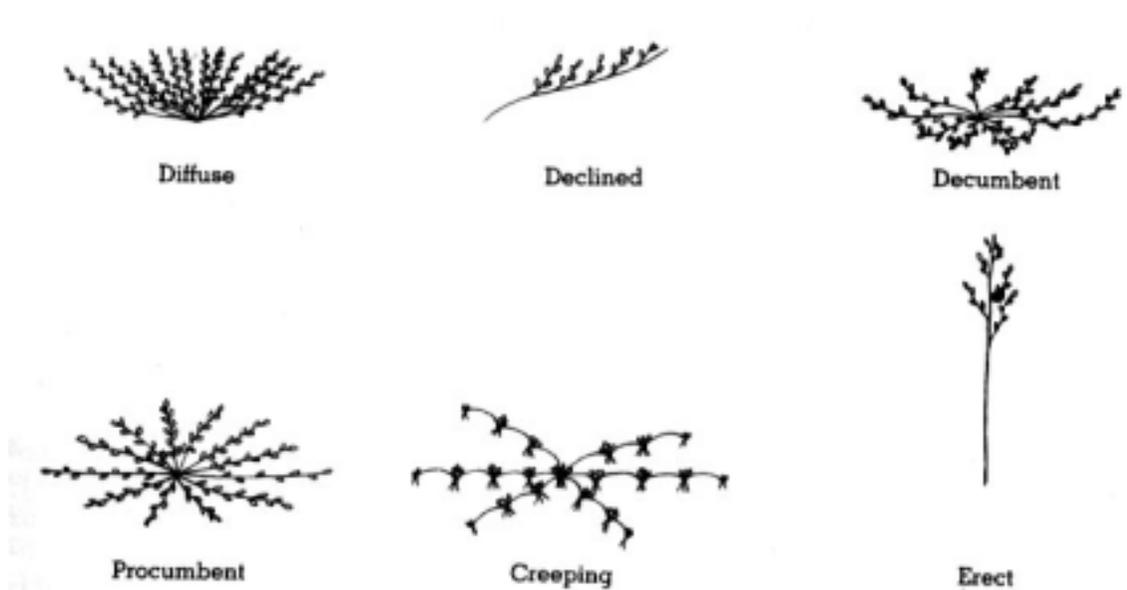
An underground horizontal root system is called rootstock or a *Rhizome*. These are seen in most ferns and many flowering plants. They can be elongated or slender as in Bermuda Grass or thickened with *tubers* as seen in the white potato. Fragmentation of rhizomes is a common form of asexual reproduction by plants.

Herbs are classified into three categories according to how long they live. **Annuals** live through the winter or dry season as seeds coming up annually as seedlings. They flower, fruit and die. **Biennials** produce basal leaves the first season. Flowers, stems, leaves, and fruits in the second season and then they die. **Perennials** survive winter and drought by seeds and by persistent underground parts. Their roots often have thickened structures, woody crowns just below the ground, or may have many dead stems from preceding seasons. Some plants have mixed characteristics. The annual castor bean (where we find Ricin) which is a herb, becomes a tree in the mild winter of California and can grow to 30 feet tall with a trunk a foot thick.





Their direction or method of growth distinguishes stems.



**Diffuse**, spreading in all directions

**Declined**, bending over in one direction

**Decumbent**, resting on the ground, without strength to stand erect

**Procumbent**, flat on the ground

**Creeping**, lying on the ground and producing adventitious roots at the nodes (lawn grasses)

**Ascending**, rising upward at an oblique angle

**Erect**, standing upright

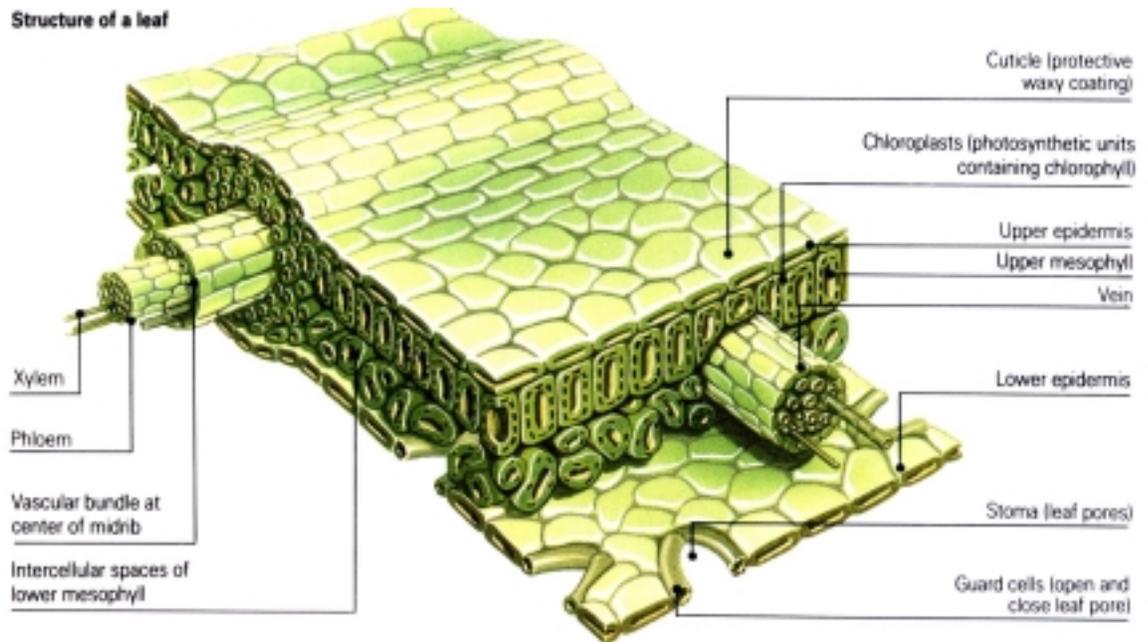
**Climbing**, supported by clinging with twinning stems, special roots, or tendrils from branches, or from leaflets

Some stems form bulb-like structures underground. These tuberous enlargements are called corms or solid bulbs. A true bulb is a short thickened stem with many fleshy or scale-like leaves. It is really an underground bud. When they fall to the ground they develop roots and grow into new plants.

Many plants, and most shrubs have **thorns** which are sharp, pointed woody branches. Some form from the tissues of the stem instead of branches and are called **prickles** (Rose prickles). **Spines** are sharp structures formed from parts of the leaf.

The cells at the apex of a stem or branch can divide and grow into leaves, branches, or flowers. These are called **buds**. Buds can be protected by many layers of leaves as in lettuce and cabbage. In warm regions they may fail to form heads because the temperature is too high and the stem elongates instead of forming an enlarged bud.

### 3. Leaves



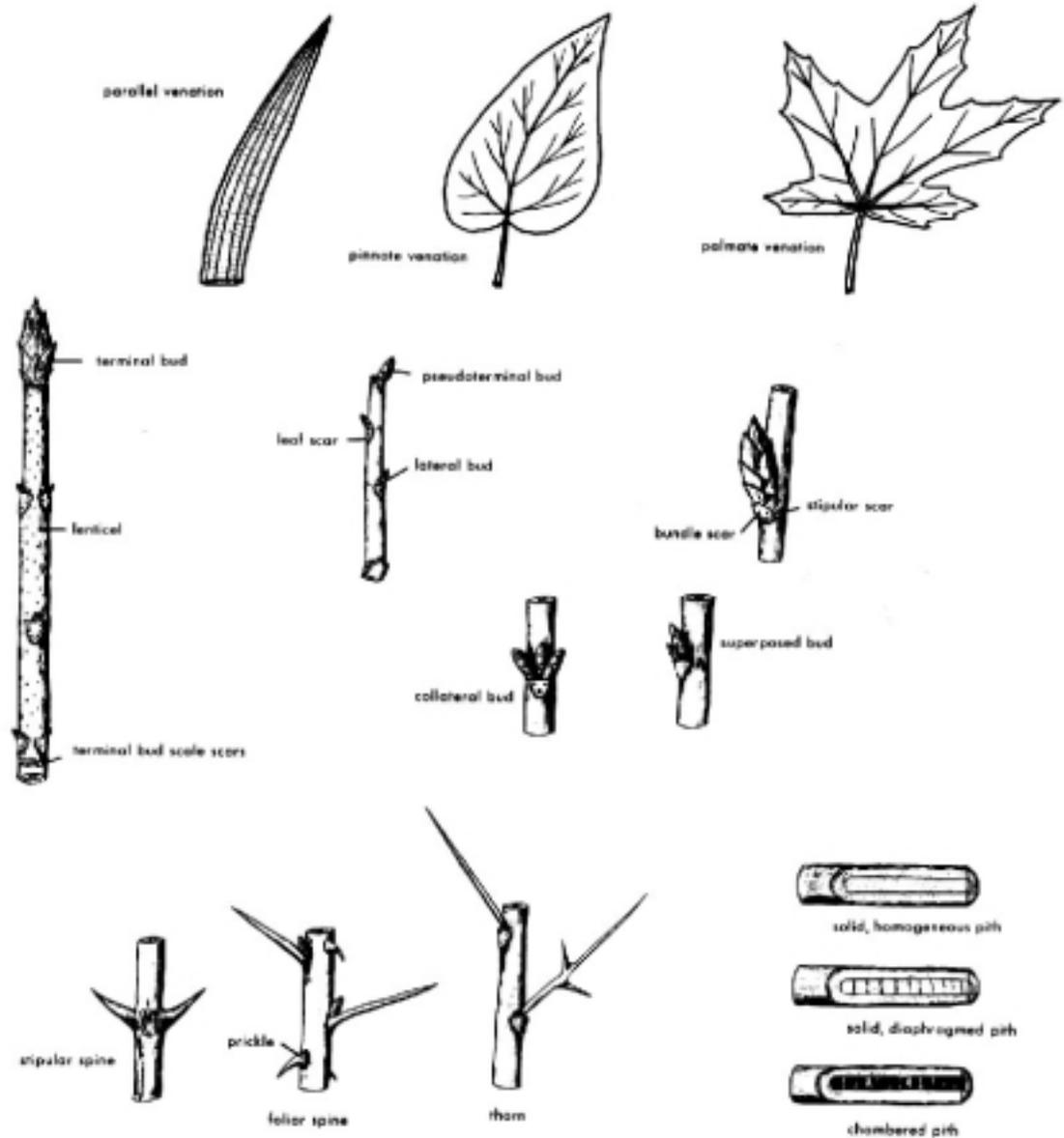
Leaves are a primary identification characteristic of plants and many are recognized from their leaves alone. We will cover the following descriptions-

- a. Twig and leaf arrangement
- b. Leaf Forms
- c. Leaf Shapes
- d. Leaf Margins
- e. Leaf Apices and Bases
- f. Leaf Lobing

#### a. Twig & Leaf Arrangement

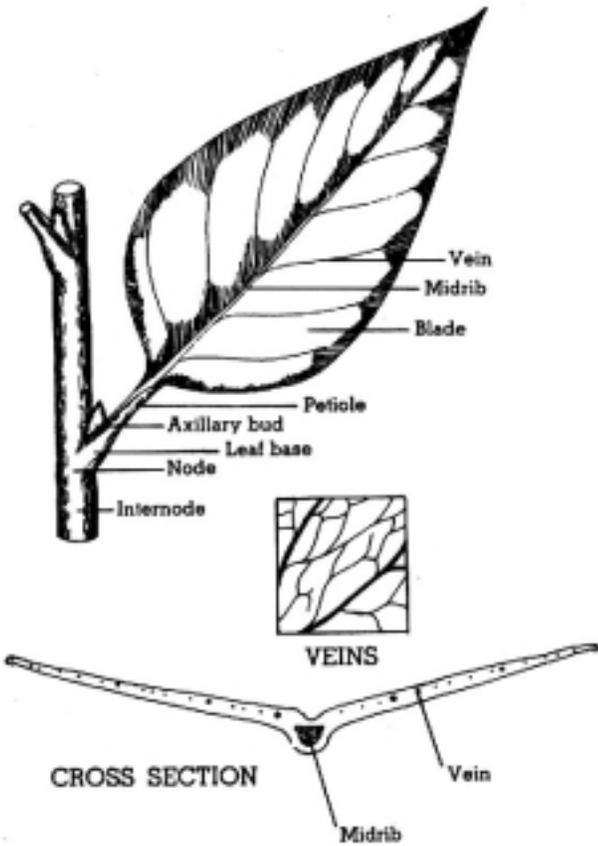
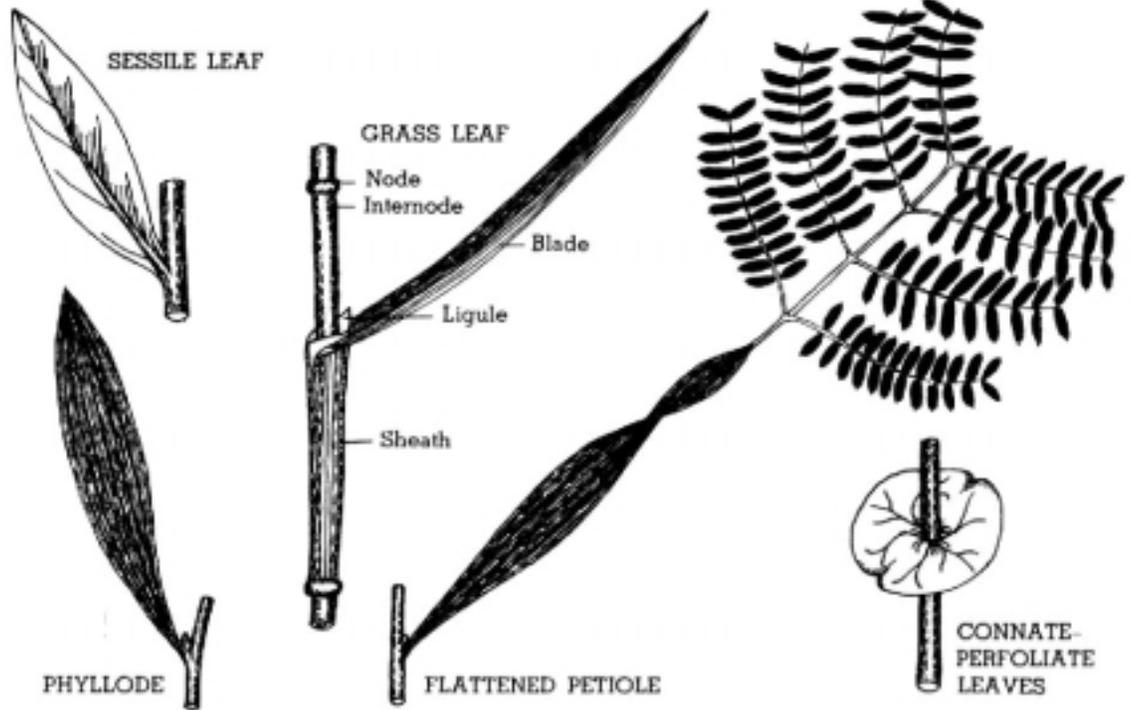


Three or more leaves at a node are called "whorled"



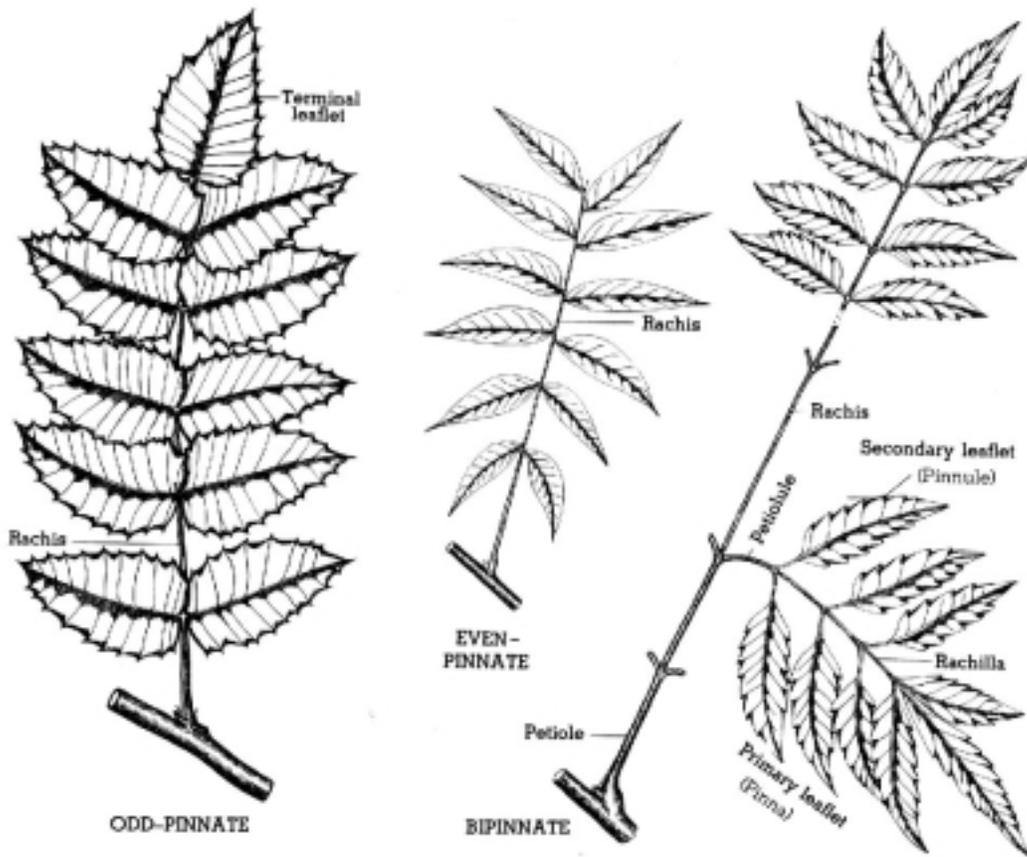
Some of the twig and leaf terms are shown above.

Most leaf blades are supported by a *Petiole*. Most grasses have a *Sheath* instead of a petiole. Where the blade attaches to a sheath there is a small scale called a *ligule*. Some structures develop by broadening the petiole and are known as *Phyllode's*. Where the base of a sessile leaf encircles the stem it is called *Perfoliate*. When leaves are grown together from the same node they are called *Connate*.

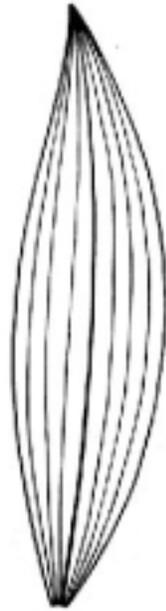


A leaf with the blade in a single segment is called *Simple*. If the blade is divided into leaflets or sections it is called *Compound*. A compound leaf can have the appearance of a human hand where all the leaflets rise from one point at the end of the petiole. This leaf is called *Palmate*. If the leaflets are arranged along both sides of a compound leaf it is called *Pinnate*. If leaves are in opposite pairs along the axis they are called *Rachis*.

When an odd number of leaflets occur on the leaf and terminate in a single leaflet they are *odd-pinnate*. If they have no terminal leaflet the number is even and it is called *even-pinnate*.



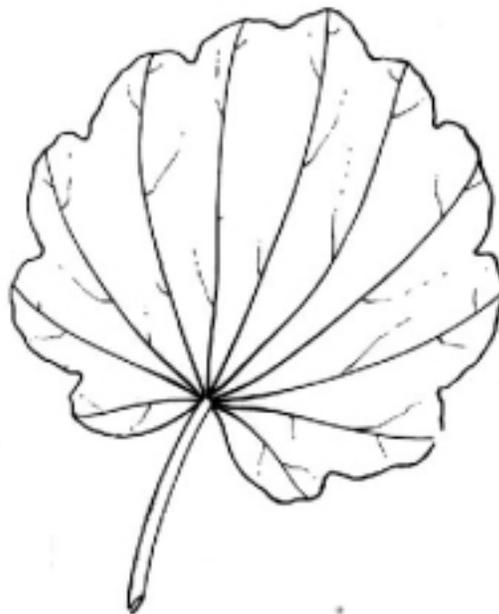
Veins in the leaf can be parallel, pinnate, or palmate.



**Parallel venation**



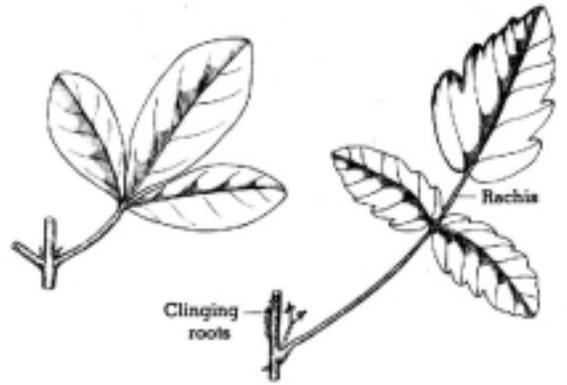
**Pinnate venation**



**Palmate venation**



PALMATE



PALMATELY TRIFOLIATE

PINNATELY TRIFOLIATE

A structure at the base of the leaf may appear and is called a **Stipule**. They can be absent, scale-like, glandular, spinose (spines), foliar (leaflets), sheathing and protective.



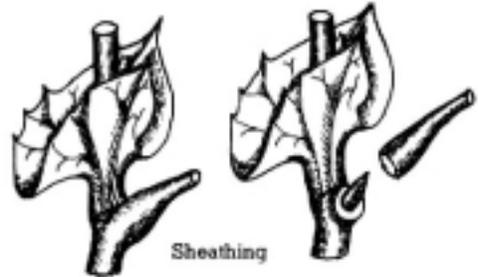
Absent



Scalelike



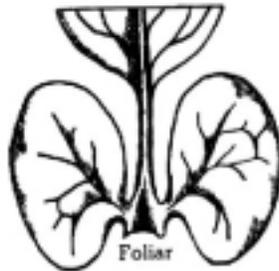
Glandular



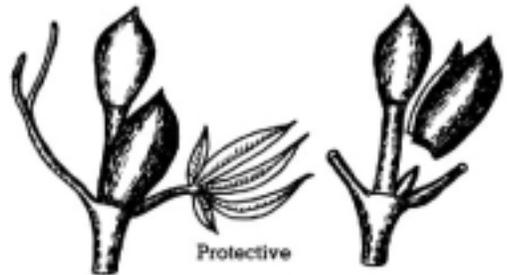
Sheathing



Spinose



Foliar



Protective

### C. Leaf Shapes

- Orbiculate** circular in its outline with the petiole attached on the edge
- Peltate** Shieldlike with the petiole attached in the center of the leaf blade, Similar to a mushroom or umbrella
- Elliptic** elliptical in shape. Twice as long as broad with curved sides and ends. The petiole is attached at one end
- Oval** is broadly elliptic, width more than half the length
- Ovate** shaped like a hens egg. One and a half times as long as broad The widest point is offset and not in the middle
- Ovoid** is the same in three dimensions instead of flat
- Lanceolate** in the shape of a lance, length is four to six times width with curved sides and pointed ends. Petiole attached at the broad end
- Ob lanceolate** same as lanceolate with the petiole attached at the narrow end
- Oblong** nearly rectangular with three rounded corners, 2-3 times as long as broad. The petiole is attached to a narrow end
- Linear** an elongated rectangle with parallel long sides, length is eight or more times width
- Rhombic** diamond shaped with the petiole attached to one of the sharper ends
- Cordate** heart shaped with the petiole attached to the indentation at the base
- Obcordate** like cordate with the petiole attached to the point of the heart
- Reniform** kidney shaped or bean shaped with a rounded apex and width greater than length. Petiole is attached in the broad basal indentation of the blade
- Sagittate** arrowhead shaped, a narrow isosceles triangle with an angular indentation in the short side. Petiole is attached in the indentation
- Hastate** in the form of an arrowhead with basal divergent lobes
- Subulate** slender and tapering from the base, awl shaped
- Cuneate** or cuneiform, wedge shaped as a narrow isosceles triangle with the distal corners rounded off. Petiole attached to the sharp angle
- Deltoid** in the shape of the Greek letter delta (a triangle). The petiole is attached to the middle of one side
- Obdeltoid** deltoid with the petiole attached at one of the angles
- Spathulate** similar to a spatula, rounded at the top and tapering into an elongated, narrow, gradually diminishing lower portion



Orbiculate



Peltate



Elliptic



Ovate



Obovate



Lanceolate



Oblanceolate



Oblong



Linear



Rhombic



Cordate



Obcordate



Reniform



Sagittate



Hastate



Subulate



Cuneate



Deltoid



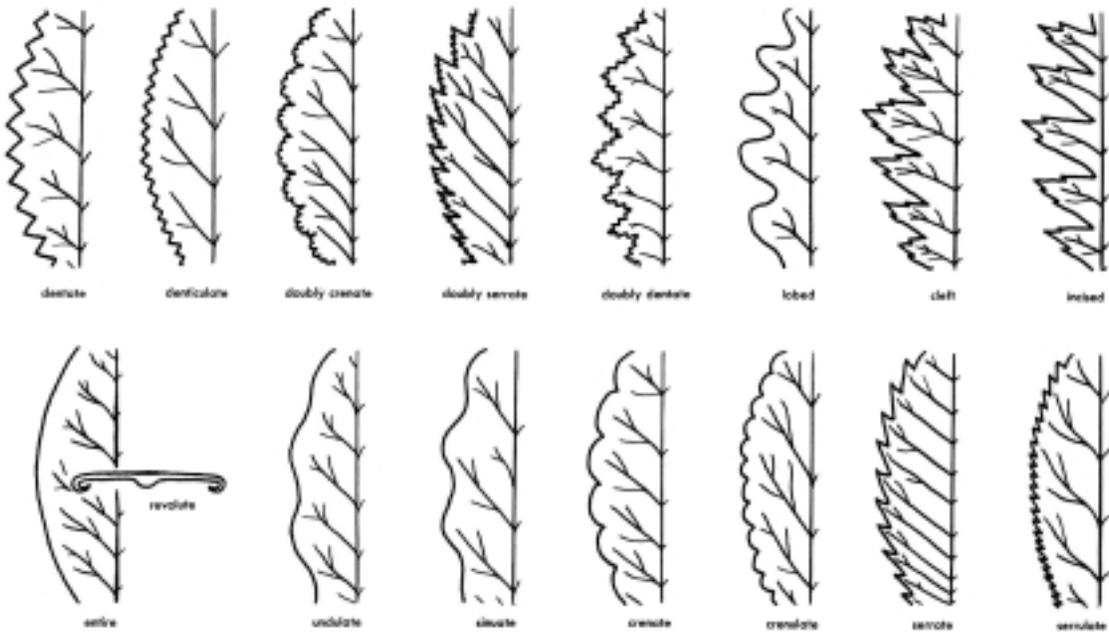
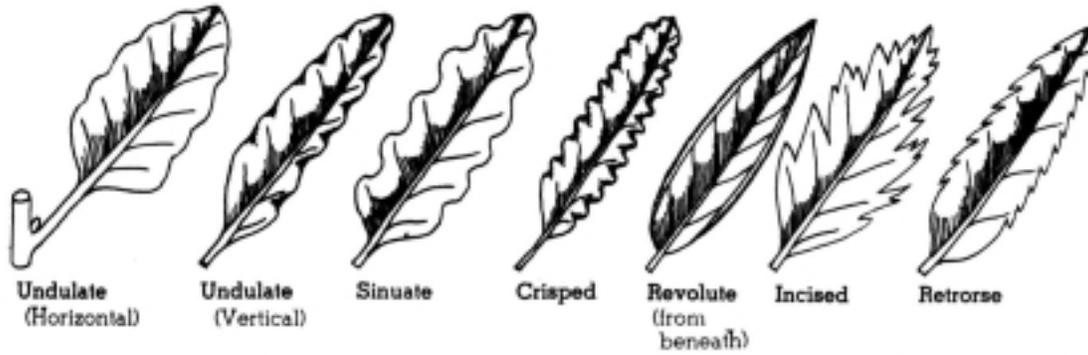
Obdeltoid



Spathulate

### D. Leaf Margins (Indentations on the edges)

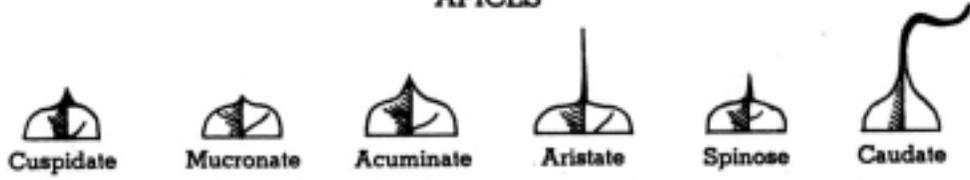
The following charts illustrate and name the different type of leaf edges. Leaves can be entire, toothed or lobed depending on the size of the indentations.



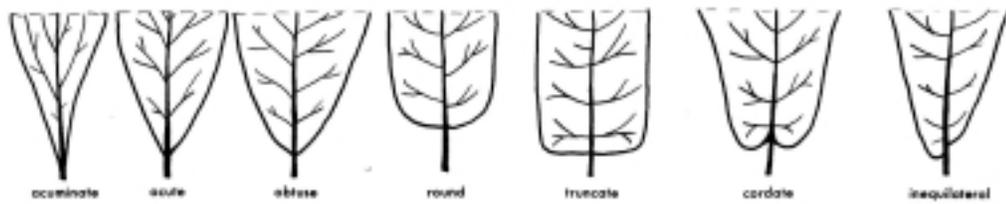
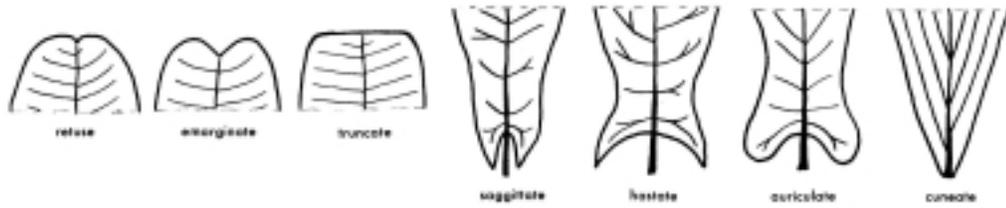
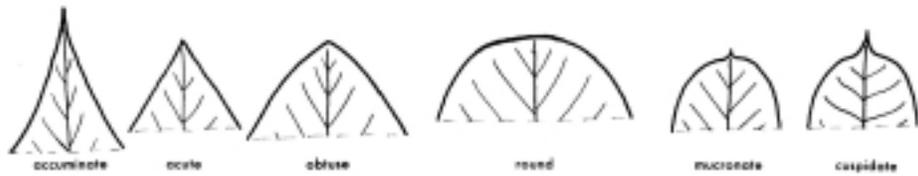
### E. Leaf Apices and Bases



#### APICES



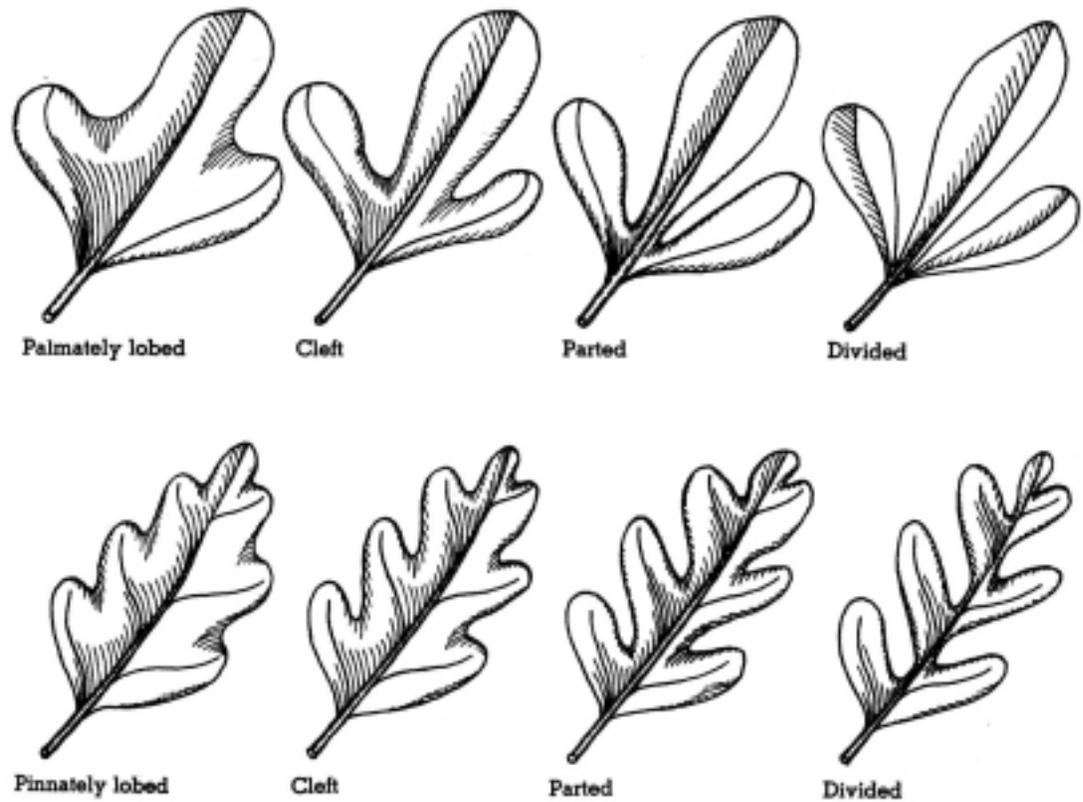
#### BASES



## E. Leaf Lobing

Leaves have edges with varying degrees of lobing or curves and protrusions. The depth of indentations can be palmate or pinnate depending on the direction of the spaces between the lobes. Palmately lobed leaves have the indentation towards the base. Pinnately lobed leaves have the indentations toward the midrib. Lobing is **cleft** with the indentations running halfway or more than halfway. They are **parted** if the indentations run more than halfway to nearly all the way. They are **divided** when the indentations run all the way.

The degrees of lobing are illustrated here.



#### **4. Surface Features and Colors**

Chlorophyll is the green pigment that gives plants its characteristic color. In its presence living green cells can absorb energy from light. This energy is converted to sucrose, then a simple sugar, and finally into carbohydrates. Since most plants contain chlorophyll most of their parts are green in the surfaces exposed to the sun. Different types of chlorophyll and related pigments produce blue-green and yellow-green colors. A few produced by certain plants can produce other colors. These pigments are water insoluble and remain in solid bodies called plastids inside the cells instead of in the cell sap.

Many plant produced pigments are water soluble and become dissolved in the cell sap. The most common ones are called **Anthocyanins**. Their color changes according to the acidity inside the cells and they react like litmus paper. In acid they tend to turn shades of red while in alkaline they shift to blue. The anthocyanin molecules contain sugar and are formed only when sugar is present. They also form in greater abundance in low temperature and greater light. These can give plant parts varying shades of colors.

In fall, chlorophyll disintegrates leaving a characteristic carotene (yellow) color with many brilliant variations. Bright cool days also foster the accumulation of sugar in leaves which promotes formation of anthocyanins, acid pH and a red color.

Common terms used to describe the physical surfaces of the leaves, stems and other appendages are listed here-

**Smooth**, not roughened

**Glabrous**, without hair

**Glabrate**, with hair at the beginning and then falling away

**Subglabrous**, with few hairs or nearly glabrous

**Farinose**, mealy, with small granules on the surface

**Glaucous**, covered with a bloom of finely divided particles of wax. The bloom is bluish on a plum or prune or can be white. It can be easily rubbed off of many fruits and leaves.

**Glaucouscent**, slightly glaucous, or blue-gray

**Scurfy**, covered with dandruff-like scales, scale-like hairs (found in the oleaster family)

**Scabrous**, with tiny rough projections making them rough to the touch

**Pubescent**, hairy or downy usually with fine soft hairs.

The type of hairiness can be described as follows –

**Canescent**, grayish white or hoary with the dense covering of the surface with fine short white hairs

**Ciliate**, with hairs along the margin of the structure like human eyelashes

**Fimbriate**, with a fringe along the margin like fringe on early American buckskin shirts.

**Hirsute**, hairy with more or less stiff hairs

**Hirsutulous**, slightly hirsute

**Hirtellous**, minutely hirsute

**Hispid**, bristly, covered with markedly stiff hairs

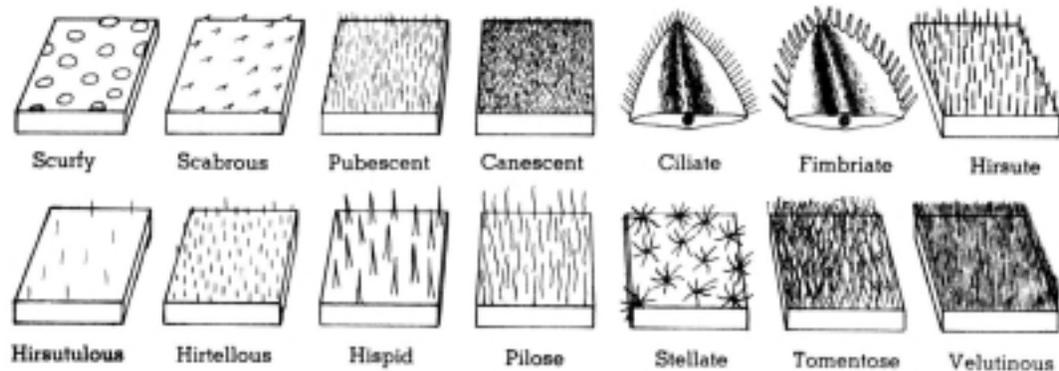
**Pilose**, with soft elongated slender hairs

**Pubescent**, hairy or downy with fine soft hairs

**Stellate**, hairs branched so that each one appears like a small star

**Tomentose**, covered with matted wooly hairs forming a **tomentum**

**Velutinous**, velvety with a pile like velvet



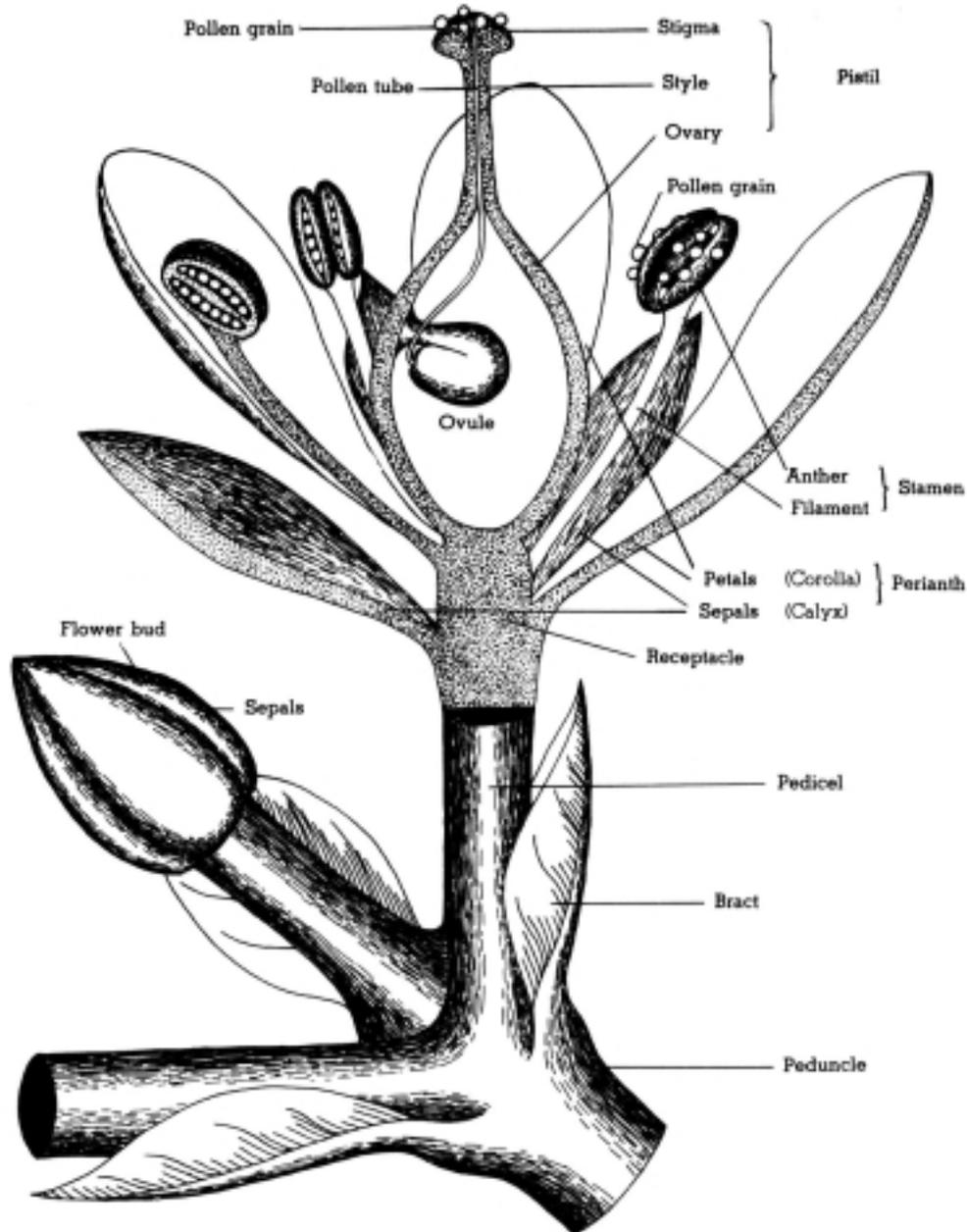
## 5. Flower Parts and Inflorescences (Clusters)

A flower is a branch with specialized appendages. The part which supports the flower parts and connects it to the branch is called the receptacle. A flower has four commonly known parts or appendages used in identification. These are –

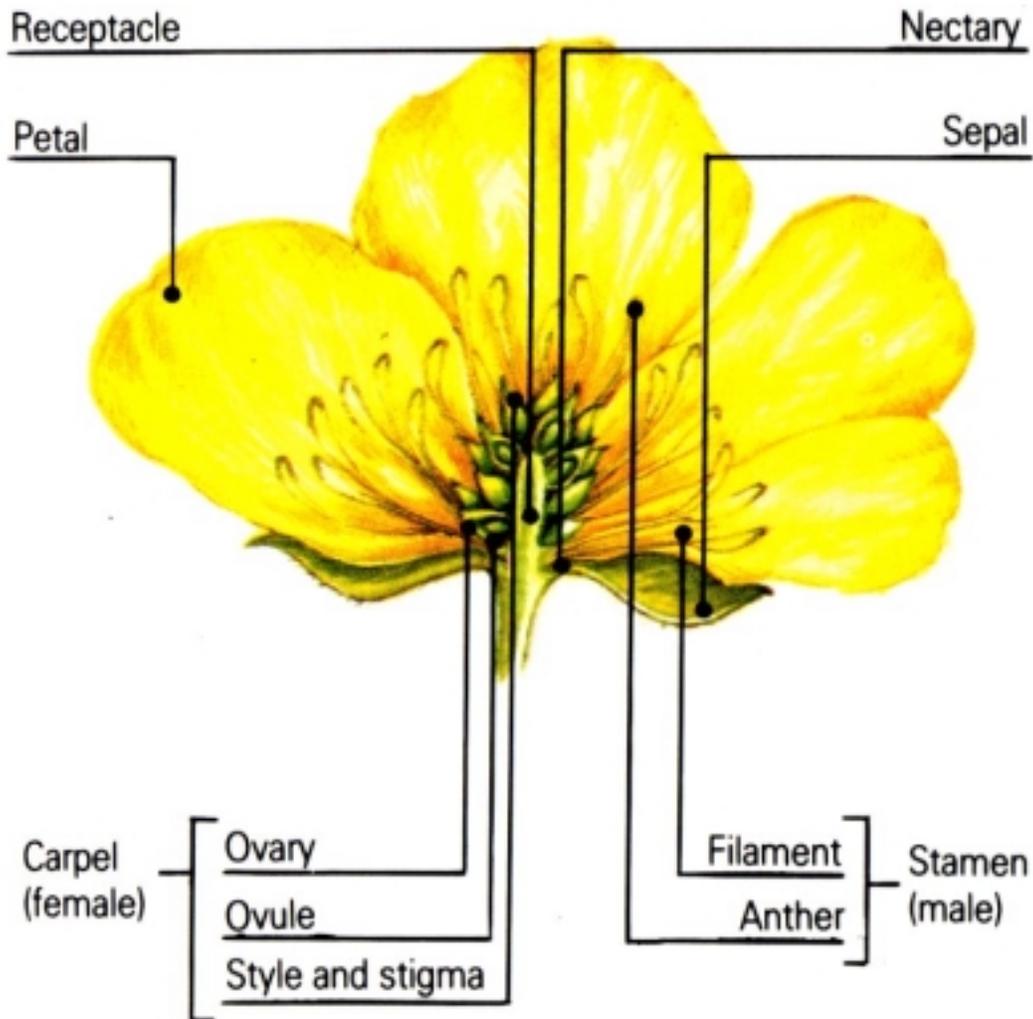
1. The **Sepals** known collectively as the **calyx** usually have the same structure as the leaves and in most cases are green. They usually act as a cover for the inner parts to prevent evaporation. When the sepals are colored they can assist the petals in attracting insects.
2. The **Petals** are known collectively as the **Corona** and are colored or white and are used to attract insects to nectar glands near or at their base. The insects normally carry pollen and *pollinate* the flower.
3. The **Stamens** are known collectively as the **androecium**. Each stamen has an **Anther** which carries the pollen and a filament or stalk. The anther usually contains four spore cases (microsporangia) or pollen sacs (chambers). Insects, or the wind carry the pollen to the **stigma**.

The male sex cells are developed in the pollen grains and these develop in the anthers which is why the stamens are the male organs of the flower.

4. The **Carpals** are known collectively as the **gynoecium**, or if there is only one it is called the **pistil**. The pistil consists of a basal **ovary**, a median **style**, and a terminal **stigma**. The ovary contains the ovules, the female sex cells, which after fertilization develop into seeds. The stigma acts as a collector of pollen.



## Parts of a flower



A specialized leaf which forms either all, or part of the pistil is the **Carpal**. A pea pod is a pistil formed from a single carpal. In some plants there is more than one pistil and each pistil is formed from one carpal. In some, like the orange several carpals are united into a single pistil.

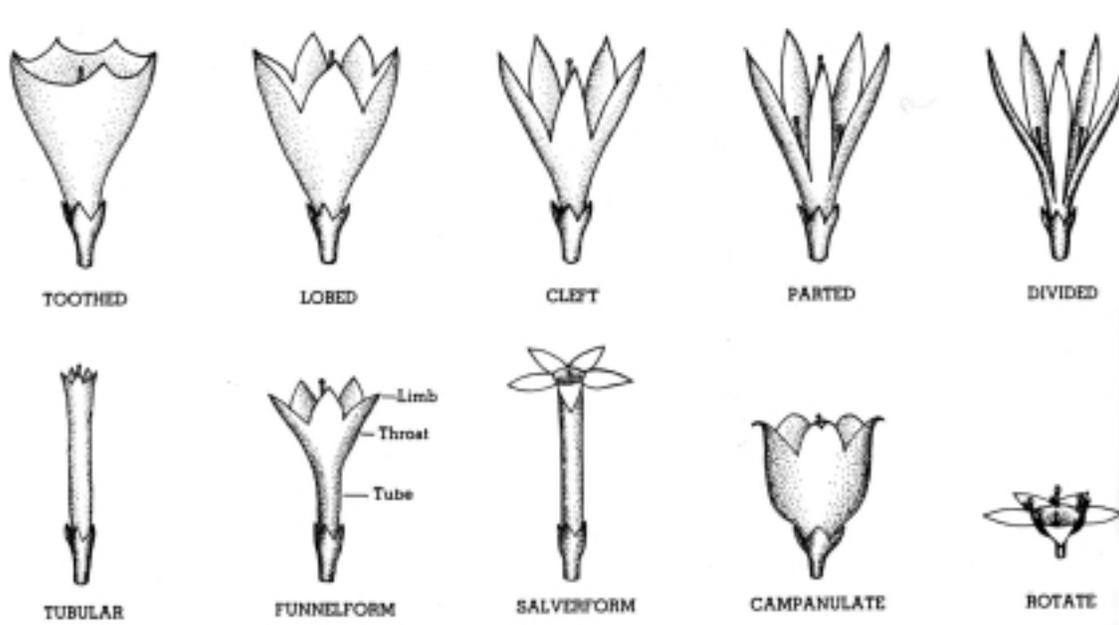
A flowering plant pollen grain has two cells. A generative cell inside of a tube cell. When the grain contacts the correct sugar which is on the exudate of the stigma, the tube cell rapidly grows into a long tube. The pollen tube can grow only a tiny length like wheat or several inches like corn which has long and flexible styles (silk).

## Variation in Flower Structures

The flower parts described to now with the four main groups are considered complete when they appear together. Many flowers are incomplete and may lack all or part of the perianth (willows) or either stamens or pistils. Flowers lacking petals include grasses, willows, poplars, cottonwoods, walnuts, oaks, elms, mistletoe and mulberries.

In some flowers, parts of the petal are united with each other and are called **coalescent**. If members of one series is united with another the two series are **adnate**.

If the petals are **coalescent** the corolla is **sympetalous** and the structure is called a corolla.

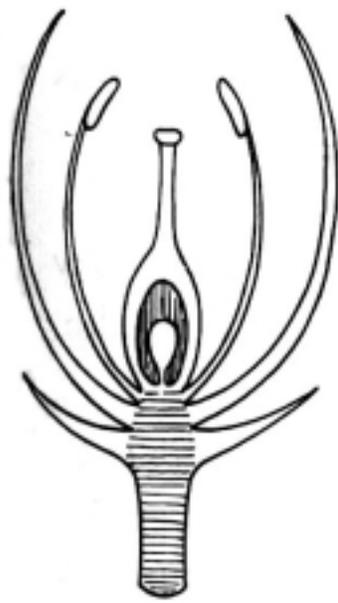


The top row shows degree of lobing and the bottom row describes shapes.

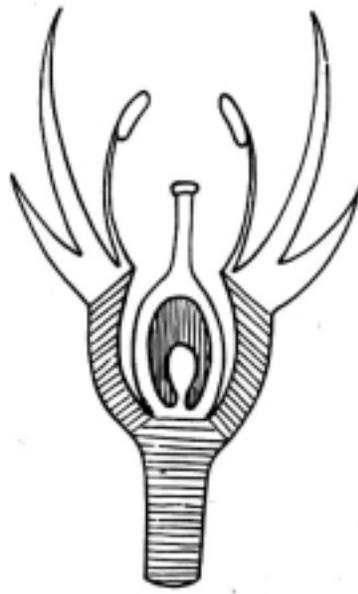
The basal enlarged part of the carpel is the ovary which contains the ovaries.

Ovaries can be

1. Superior, with the carpals above the level of all the other floral parts and the flower is called *hypogynous*.
2. Semi-Inferior, where the carpels appear at the same level as the other floral parts and the flower is *perigynous*.
3. Inferior where the carpals are inserted below the other floral parts  
In which case it is *epigynous*



Superior



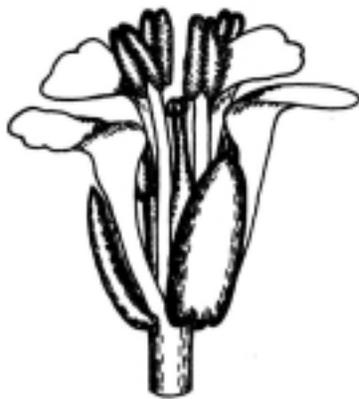
Semi-inferior



Inferior

Flowers with separate petals are **Chloripetalous**. These include mustards, radishes, roses, buttercups, apples and cherries.

Flowers without petals are **Apetalous**, and those with coalescent petals are **Sympetalous**.



CHORIPETALOUS

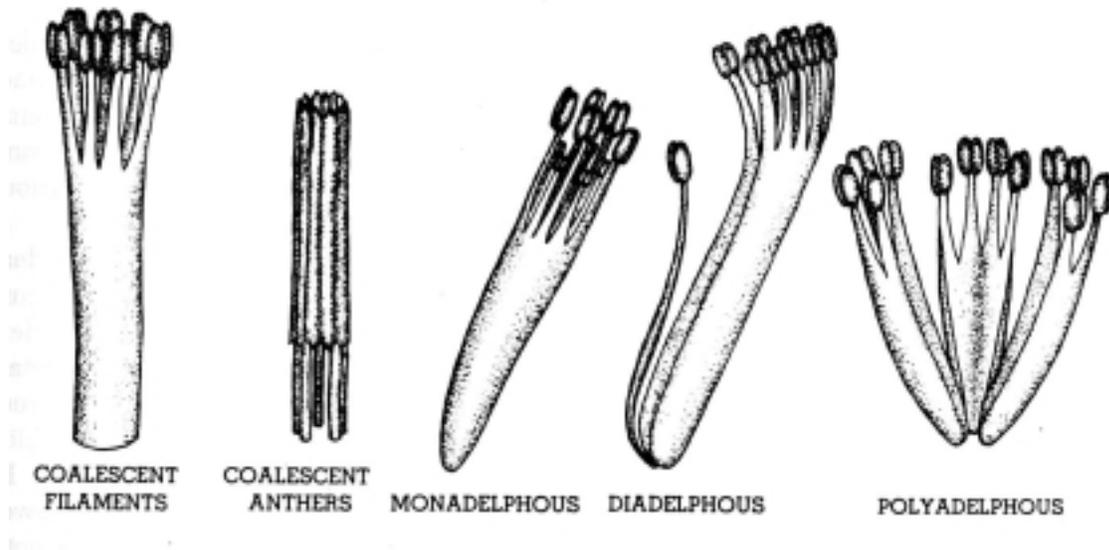


APETALOUS



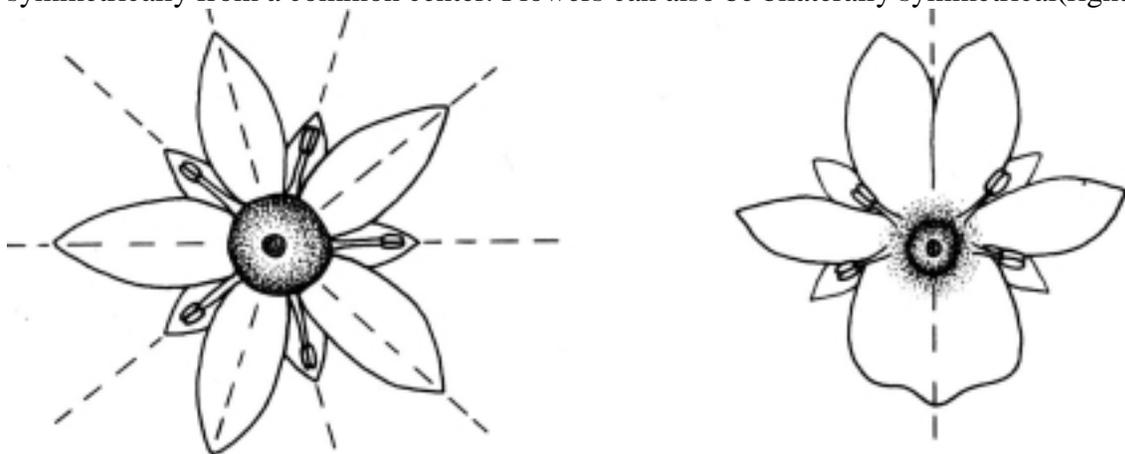
SYMPETALOUS

If the stamens of a flower are coalescent by their filaments into a common tube they are called **monadelphous**. If they are coalescent into two groups they are **diadelphous**, and if they form several groups they are **polyadelphous**. If only 9 of 10 stamens are coalescent like many members of the pea family they are called **diadelphous**, and if they may have **coalescent anthers** like the sunflower.



Most flowers parts are built on plans of multiples. If the flower has 5 sepals, 5 petals, and one or more series of 5 stamens and 5 carpels it is called **pentamerous**. This type of numerical arrangement occurs in series of 2,3,4,and 5-merous flowers. There are occasionally larger series than five but are rare.

Flowers are ordinarily radially symmetrical (left), meaning their parts radiate symmetrically from a common center. Flowers can also be bilaterally symmetrical(right).



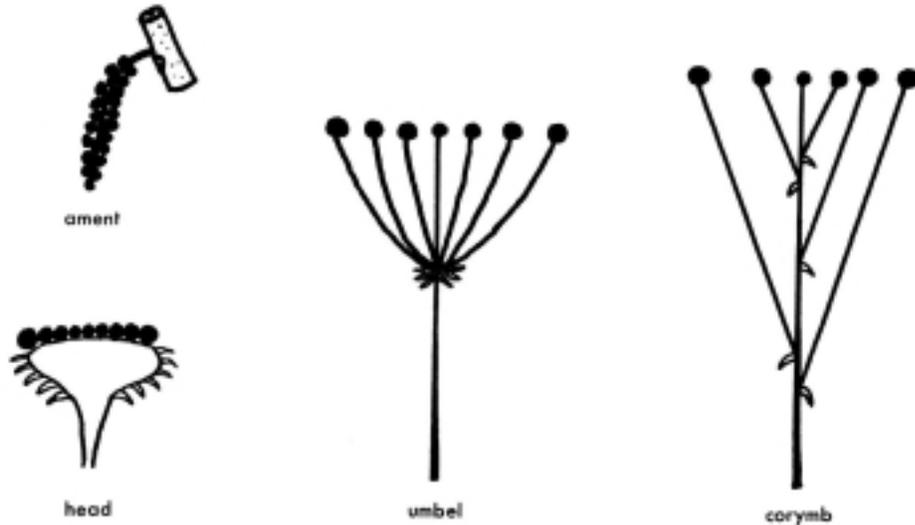
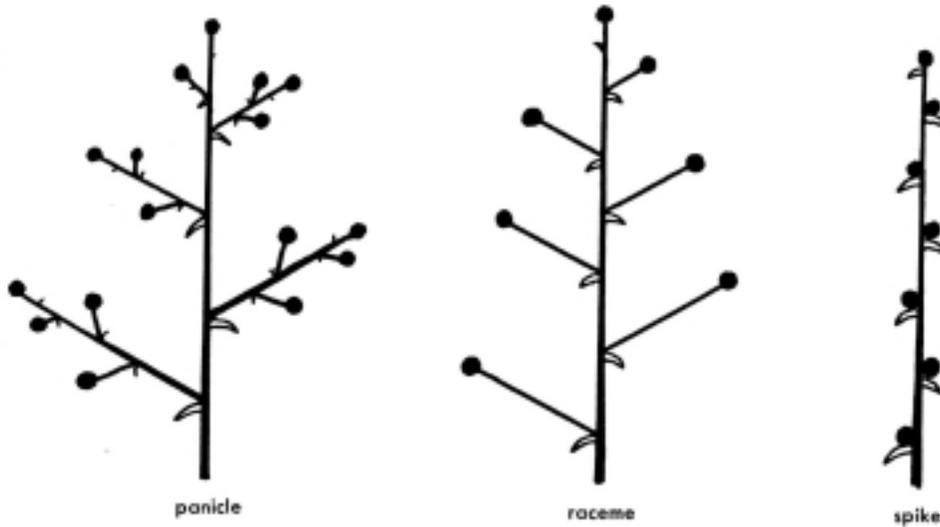
Flowers can be physically arranged on the plant as an **indeterminate inflorescence** where the apical bud can grow for an indefinite period. There are four types-

**Raceme** which has an elongated axis with pedicelled flowers along it. There is a constant supply of new flower buds at the tip (which is why it is indeterminate) and the oldest flowers and fruits are at the bottom.

**Spike** has flowers that are **sessile** (without pedicels/stems) and are similar to raceme.

**Corymb** have a gradation in the lengths of the pedicel with the lower flowers longer than the upper ones. This usually produces a flat topped cluster of buds.

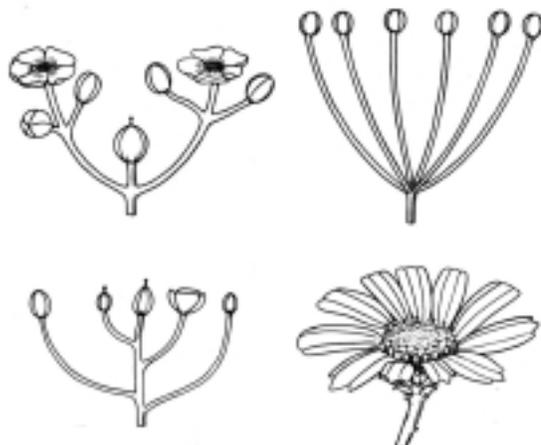
**Panicle** is a compound inflorescence which forms a cluster of associated racemes, spikes, and other complex clusters





Above are examples of indeterminate inflorescence's.

Determinate Inflorescences are called **Cymes**. In cymes the terminal bud becomes a flower and no further elongation occurs which theoretically predetermines the growth. Cymes can have alternate or opposite branching. An **Umbel** is an inflorescence without a central axis and is usually a flat topped cluster of flowers. A **head** is an umbel where the flowers have no pedical (stems). These forms are shown below.



## 6. Seed Producing Parts

In most flowering plants the most easily identified feature is its pistil which carries the ovules in its ovary walls. After flowering, the ovary grows, its texture changes as becomes hard, leathery, fleshy, etc. The ovules mature into seeds and become a fruit (grain, seed and other terms are used interchangeably).

In most cases the receptacle grows very little but in some cases, like the strawberry it expands greatly and becomes fleshy. There are two main kinds of fruits, dry and fleshy.

In fleshy fruits the ovary wall is usually juicy and edible but it can be leathery like a pumpkin or orange or become a leathery husk like the almond. There are two kinds of fleshy fruits.

1. **Berries** which have pulpy interiors, no stony layer and usually several to many seeds.
2. **Drupes** have a stony interior layer and most often have only one seed. Sometimes there are many drupes formed on one flower such as blackberries, and raspberries.

Dry fruits are divided into groups according to the number of seeds they produce.

1. An **Achene** is a one seeded dry fruit with a firm close fitting pericarp (ovary wall) which does not split open. True fruits of strawberries and sunflowers are achenes. A nut is similar to an achene but is usually much larger. A *samara* is considered part of the one seed category and is recognized by its wing structure. Examples are ash and elm and in the maple the samara is double.
3. **Dehiscent** is several to many-seeded dry fruits. They are classified according to the number of carpals entering into them.

Seeds vary in many ways besides those listed above. The seed coat surface can be smooth or sculptured. It can form a thin flat wing and is sometimes covered in hair (like the cotton). It can have tufts of hair at one end like the milkweed or at each end like the dogbane.

## **7. Plant Growth Habits, Habitats, and Size**

All plants have areas where they are found in nature. Modern field guides and textbooks describe and usually illustrate on a map where the pictured species are found. We will describe these areas later in the book with species descriptions and photos. Many species can be found in homes and gardens outside their natural habitats. You can also purchase seeds from private companies for almost any plant known. [Especially today with the Internet].

Plants have growth habits which make them suitable for deserts, forests, indoors, outdoors, and various climates. These too will be described with each species. The different plants are also often distinguished by size of various parts and these too will be stated.

## **8. Glossary of Terms**

- Achene: A small, dry indehiscent one seeded fruit.  
Actinomorphic: star shaped, radially symmetrical  
Adaxial: Nearest to the axis  
Alkaloid: A nitrogenous organic base found in plants and used in medicine  
Alternate: neither opposite nor in whorls. Leaf arrangement where only one leaf is at any one level on the stem  
Androecium: the male structure in the flower  
Anemophily: pollination by the wind  
Annual: A plant completing its life cycle in one growing season and dying in winter  
Anther: a pollen sac on the stamen of the flower  
Antheridium: male organ found on a *prothallus* producing a large number of *Sperm*  
Antipodal Cells: three cells in the embryo sac at the end opposite the micropyle and representing the prothallus in Angiosperms  
Archegonium: female organs formed on a prothallus producing a single egg only  
Aril: a fleshy or pulpy outer covering of a seed or an appendage of a seed formed from the stalk or from near the micropyle  
Axil: the angle between the leaf and stem  
Axile placentation: ovules attached to the central axis of an ovary  
Axis: the line passing through the middle of any organ  
Berry: a type of fruit that is usually fleshy throughout  
Biennial: a plant which takes two years to finish its life cycle  
Bisexual: having both male and female parts  
Bract: small scale-like leaves subtending an inflorescence or flower  
Bracteole: small bract

Bulb: organ with swollen leaf bases and buds  
 Bulbil: a small serial bulb growing in a leaf axil  
 Calyx: outermost whorl of a flower, collective terms for all the sepals  
 Cambium: undifferentiation, actively dividing cells, which give rise to xylem and phloem  
 Cap: the expanded top of a mushroom  
 Capsule: a type of dry fruit which has more than one row of seeds and splits along two or more lines  
 Carpel: the ovule bearing structure which forms the gynoecium of the flower  
 Catkin: a specialized inflorescence which has sessile flowers around a common stalk and is usually all male or female  
 Cilium: a hairlike lash produced by a cell  
 Circinate: rolled inwards from the tip of the base  
 Coma: a condition of insensibility  
 Convulsion: a violent, uncontrolled series of muscular contractions  
 Corm: swollen, short underground stem  
 Corolla: the petals or second whorl of a flower  
 Cotyledon: seed leaf  
 Cross Pollination: movement of pollen from the anther of one flower to the stigma of another flower  
 Cyme: an inflorescence which repeatedly branches where the main axis ends in a flower  
 Deciduous: falling off like the leaves in autumn  
 Dehiscent: spontaneously opening at maturity  
 Delirium: a state of frenzied excitement  
 Diarrhea: unusual and frequent discharge of liquid stools from the bowel  
 Dilation of Pupils: enlargement of the pupils in the eyes  
 Dimerous: arranged in twos  
 Dioecious: having male and female flowers on different plants  
 Diploid: with twice the base number of chromosomes in the nucleus, a common condition in higher plants  
 Distal: at the outer end  
 Dorsal: turned away from the axis  
 Drupe: a fruit type with a stony pit enclosing the seed and a fleshy exterior  
 Emetic: a substance that causes vomiting like ipecac, soapy water or table salt  
 Endosperm: nutrient tissue in the seed  
 Entomophily: insect pollination  
 Embryo Sac: tissue in which the embryo develops  
 Epicalyx: having an extra calyx, usually of bracts around the true calyx  
 Epidermis: the outermost layer of skin  
 Epiphytic: a non parasite which is supported by or grows on another plant  
 Fertilization: the fusion of sperm and egg  
 Filament: the stalk of a stamen  
 Follicle: a dry fruit which opens only along one side  
 Free: separate to the base

Free-Central Placentation: ovules on the placenta surface which rise like a column from the ovary base but falls just short of the roof

Fruit: after fertilization, a structure develops from the ovary of angiosperms

The many types of fruit include-

*Achene*: the dry indehiscent one sided fruit formed from a single carpel with the seed distinct from the fruit wall (buttercup)

*Aggregate Fruit*: a fleshy structure developed by the receptacle of a single flower which bears many true fruits each from a separate carpel (strawberry, blackberry)

*Berry*: fleshy fruit without a stone, usually contains many seeds in its pulp (gooseberry)

*Capsule*: dry, dehiscent fruit from a compound ovary where each carpel splits longitudinally along the carpellary or in the middle of the carpels or by pores toward the top of each carpel to release several seeds

*Drupe*: succulent fruit formed from a superior ovary, mostly one seeded with an exterior layer or pericarp of fleshy tissue. Below it is a heavy stony layer or endocarp which encloses the seed

*Follicle*: dry fruit formed from a single carpel usually with several seeds and similar to a legume but splits only along the ventral suture

*Legume*: fruit formed from a single carpel splitting along the dorsal and ventral sutures and usually contains a row of seeds on the inner side of the central suture

*Nut*: a dry hard indehiscent fruit formed from a compound ovary and usually having a single seed

*Pome*: fleshy fruit with a number of seeds inside a papery core formed from the inner walls of the united carpels

*Samara*: a hard winged fruit that does not split open to spread seeds (elm)

*Siliqua*: a capsule developed in a bicarpellate ovary where two carpels separate from the central partition at maturity (mustard)

Funicle: a thin stalk connecting the ovule to the ovary

Gamete: the sexual reproductive cell-the female gamete is the egg and the male gamete is the sperm

Gametophyte: sexual generation of a plant or the gamete child

Gills: platelike structures on the bottom of a mushroom cap which contains the Spores

Glabrous: not hairy

Globose: round or spherical

Glycosides: abundant combined sugars found in nature (sucrose, starch)

Halophyte: a plant that can live in soil with high inorganic salt content

Haploid: the basic number of chromosomes in a cell nucleus (sperm or egg)

Head: a dense inflorescence of small crowded, normally sessile flowers

Hermaphrodite: bisexual

Hybrid: a plant cross from two different species

Indehiscent: does not open when ripe

Inflorescence: arrangement or grouping of flowers in a branch system or a cluster of flowers  
 Infructescence: inflorescence after the flowers have fallen and fruits form  
 Integument: the protective layer around an ovule  
 Internode: the length of stem between two nodes  
 Involucre: a whorl of bracts surrounding or underneath flower(s)  
 Lanceolate: narrow with the widest point near the base and tapering at the apex  
 Latex: milky sap  
 Leaf: growth from a plant stem  
 Leaflet: the blade-like part of a divided (compound) leaf  
 Leaf Blade Margin: edge of the leaf blade  
 Leaf Blade Venation: the arrangement of veins in the blade  
 Legume: any dry fruit splitting along two lines and having one row of seeds  
 Lignified: thickened with lignin  
 Lignin: organic tissue produced for plant cell walls  
 Loculus: a compartment in the anther or ovary  
 Meiosis: cell division which reduces the chromosomes in half (egg & sperm formation)  
 Micropyle: a tiny opening in the integument at the apex of the ovule  
 Mitosis: cell division producing two twin daughter cells  
 Morphology: the study of plant anatomy and structure  
 Narcotic: a drug where moderate doses cause insensibility and relieves pain and produces stupor and convulsions in large doses  
 Nausea: stomach uneasiness with a desire to vomit  
 Nectar: sugary secretion from nectary used to attract insects  
 Node: point where leaves attach to stems  
 Oospore: diploid product of a fertilized egg cell in ferns, cyads, etc.  
 Opposite: two leaves opposing each other at any one level on a stem, two leaves at a node  
 Ovary: enlarged part of a carpel in the lower portion of the pistil which holds the ovule(s)  
 Ovate: wide and broadest near the base  
 Ovoid: egg-shaped with the largest diameter near the base  
 Ovule: organ that contains the egg and develops into the seed after fertilization  
 Palmate: veins radiating from a common point in a leaf  
 Panicle: a broad and many branched inflorescence, a branched raceme  
 Papilla: a tiny conical structure on the surface of a petal  
 Peduncle: the main stalk(s) of an inflorescence  
 Pentamerous: having five members in a whorl  
 Perennial: plants that live more than two years  
 Perianth: the sepals and petals of a flower, the calyx and corolla  
 Petal: a leaf-like part of a flower on the inner whorl, usually colorful and showy  
 Petiole: stalk of the leaf  
 Phylloclade: a shoot with the form and function of a leaf  
 Phloem: tissues which move food and water through a plant

Phylogeny: tracing the ancestry of plant(s)  
Pinnate: arranged along a central axis  
Pistil: the ovary, style and stigma. The central structure which develops into fruit after fertilization  
Pith: the spongy, soft central cylinder of most stems  
Pollen: the fertilizing grains produced in the anthers of a flower  
Pollination: moving pollen from the stigma to the ovary  
Polyploid: having more than 3 times the base (haploid) number of genes in the nucleus  
Pome: fleshy fruit with a papery core (apple)  
Procumbent: a stem lying on the ground for most of its length  
Protandrous: having stamens that ripen before the ovary  
Prothallus: a small plate of tissue formed with spore germination that bear antheridia and archegonia  
Protogynous: with an ovary that ripens before the stamens  
Raceme: a conical growth where the growing point is unbranched and does not terminate in a flower  
Receptacle: the enlarged end of a stem with a flower or an inflorescence  
Rhizome: an underground stem lasting more than one season, usually running horizontal  
Ring: thin loose tissue around the stalk of a mushroom often called the veil  
Rootstock: a general term for any root system  
Rosette: a group of leaves close to the ground and radiating from the apex of a short stem  
Runner: creeping stem rooting at the end and forming a new plant  
Salivation: excessive discharge of saliva from the mouth  
Saprophyte: a plant which derives its fruit from decaying plant and animal tissue  
Seed: a ripened ovule after fertilization of the egg, embryonic plant with a protective coat  
Sepal: one of the parts of the calyx, a leaflike part on the outer whorl of the flower  
Septum: partition  
Sessile: having no stalk  
Simple: a leaf blade which is not divided into leaflets  
Spasm: uncontrolled and unnatural muscular contraction  
Spike: unbranched long and slender inflorescence with sessile flowers  
Sporangium: the sac where spores are produced  
Spore: a tiny reproductive structure (not a seed) which can develop into a new individual  
Sporophyll: a leaf bearing a sporangium  
Sporophyte: the asexual or spore bearing generation of a plant  
Stamen: male organ of the flower that produces pollen  
Staminode: an infertile stamen  
Stalk: stemlike structure at the base of the flower or leaf  
Starch: a carbohydrate food reserve of the plant  
Stigma: tip of the style which receives the pollen

Stipule: one of two small bracts (outgrowths) at the base of a leaf  
Stolon: a creeping stem which yields aerial shoots and roots  
Strobilus: a cone  
Stupor: partial or complete unconsciousness  
Style: portion of the carpel between the ovary and the stigma, often elongated and threadlike  
Sucker: a shoot produced by a root  
Symbiosis: mutually beneficial partnership of two organisms  
Sympetalous: having petals joined  
Syncarpous: a gynoecium with two or more united carpels  
Synergid: either of two cells in the embryo sac which guide the pollen tube  
Tendrils: a threadlike climbing organ formed from a stem or leaf petiole  
Tepal: perianth segment undifferentiated into calyx or corolla  
Tetramerous: arranged in four  
Tracheid: a single water conducting element in the xylem. A long and tube like cell, closed at both ends  
Tremor: an involuntary trembling, shivering, or shaking  
Trimerous: arranged in threes  
Triploid: with three times the base (haploid) number of chromosomes  
Tuber: a swollen and fleshy underground stem part (potato)  
Umbel: a branched flat topped cluster (umbrella shaped) of small flowers  
Valve: portion of fruit that releases the seed  
Variety: a subdivision of species  
Vascular Bundle: a strand of connecting tissue of xylem, phloem and cambium  
Vegetative Reproduction: formation of new plants from vegetative parts  
Vein: a vascular bundle forming a rib in a leaf  
Vessel: a very long water conducting organ in the xylem, not closed on both ends  
Xerophyte: a plant that can inhabit dry habitats  
Xylem: water conducting woody tissue of a plant composed of vessels and tracheids  
Zygomorphic: bilaterally symmetrical  
Zygote: the child cell of two gametes

# Chapter 3

## Plant Toxins

Plants produce a huge array of chemical compounds but only a few groups of these are responsible for almost all toxicity. The categories of toxins include –

1. Alkaloids
2. Glycosides and glucosides
3. Oxalates
4. Proteins and Amino Acids
5. Carbohydrates, Lipids and Conjugates
6. Tannins and Polyphenolic Compounds
7. Other Plant Toxins

### **1. Alkaloids**

Alkaloids are by far the most common type of toxin found in plants. They are a large and varied group of nitrogen containing compounds that are chemically complex, and usually alkaline in pH and basic in nature (which is why they are called alkaloids). They react with acids to form soluble salts which are often used in medicine or can be used as poisons. Nicotine and caffeine from tobacco and coffee are among the well known alkaloids. They almost always have a bitter taste, are poisonous and are insoluble in water. Water insolubility allows for their extraction with other substances such as alcohol, acetone and other solvents. Then purification using water to remove other compounds.

Organic solvents are usually used to extract them from plants. Most of the alkaloids are crystalline solids when purified and dried but a few are liquids.

About 15-20% of all vascular plants produce some type of alkaloid. Most of the alkaloids are derived from amino acids where plants convert them to amines, then to aldehydes and finally to alkaloids. They are believed to function as metabolic by products but in some instances seem serve as insect and animal repellents due to their bitter taste.

More than 5,000 alkaloids have been isolated and described. Most produce a very strong physiological reaction on the nervous system but a few produce no effect. Some types cause only liver damage (the pyrrolizidine alkaloids).

The alkaloid content of the plant usually does not vary much with growing season, availability of water or climate. The alkaloids are most often completely distributed throughout the plant and any part can contain extractable toxin.

Alkaloids are chemically classified as –

- A. Pyrrolizidine alkaloids which are present in tansy ragwort and common groundsel (*Senecio* species). They cause irreversible liver damage and the most common toxins in this class are monocrotaline, heliotrine, lasiocarpine, and senecionine. In some countries grain has been contaminated with ragwort causing many accidental fatalities from bread made with seeds and flowers of ragwort harvested with wheat. Herbal tea has also been associated with this type of poisoning and may also be carcinogenic in small amounts.

Another plant with this alkaloid (*Crotalaria sagittalis*), a broad leaf weed which is widespread in the US and causes walking disease in horses. It killed hundreds of people in India and Afghanistan in the early 1970's with veno-occlusive disease as a result of grain contamination. Spraying grain fields for broad leaves has eliminated this problem in the US.

*Amnisiackia intermedia* (known as tarweed or fiddleneck) is an annual broadleaf weed found in waste areas and grain fields of California and the Pacific Northwest. It includes several PA's such as intermedine, lycopsamine, echiumine, and sincamidine. It causes walking disease in horses and hard liver disease in swine and cattle which ate the weed seeds in grain.

Comfrey (Russian Comfrey) is a deep rooted perennial herb widely used for medicinal properties. It contains at least eight PA's which cause liver cancer and mortality. When fed to rats with grain and plant parts of .5% root and 8% leaves they produced hepatomas in rats. It is commonly sold in health food stores and seeds are widely available. The effects of these PA's are believed to be accumulative.

Hounds Tongue (*Cynoglossum officinale*) is a native of Europe and has become naturalized in the US and Canada. It has a distinct unpleasant odor, is found in hay fields and contains .6-2.1% PA's as part of its total dry matter.

About 150 PA's are known and most kill rats in lab tests at 50-300 ppm of their diets. Their toxicity usually occurs from conversion to toxic metabolites in the liver called pyrroles. These are powerful alkylating agents and react with many tissue components causing a large range of potential damage and symptoms.

- B. Piperadine alkaloids which are found in poison hemlock (*Conium maculatum*), the main toxin being coniine with a mix of other related alkaloids. These alkaloids affect the nervous system and are also teratogenic producing many types of birth defects.

Poison hemlock is native to Europe and is widely distributed throughout the northern US. It has an unpleasant mousy odor near it or when a stem or leaf is crushed. The alkaloids are so toxic that they have produced symptoms when inhaled as tiny dust particles from plant matter. It was these alkaloids that killed Socrates. Symptoms in order of appearance include nervousness,

trembling, incoordination, dilation of the pupils, weakened heartbeat, coldness of the extremities, coma and death through respiratory failure. The primary alkaloid is coniine which produces toxicity at 3-20 mg per kg body weight. It is absorbed through the digestive tract and is more lethal when injected. Concentration of the alkaloids is greatest in the seeds which are responsible for many grain related poisonings in the early 1900's.

One gram of the seed per kg of body weight or 8.8 grams of total fresh plant per kg of body weight are considered lethal. At low doses they can have a dependence effect and produce birth defects at very low doses. When the plant is fresh only a small part (<2%) of the alkaloid is coniine. After drying this increases to over 30%. Poison preparations in early history used the dried plant material for this reason.

C. Pyridine alkaloids which include *nicotine* from cultivated and wild tobaccos.

Tobacco is widespread as a plant and can be purchased in any convenience store. The amount of nicotine in a single cigarette contains 1-2 lethal doses. Dogs have died from ingestion of cigarettes and horses from consuming tobacco leaves. Large doses cause a descending paralysis of the nervous system and ends in suffocation due to paralysis of the lungs. A different alkaloid in tobacco (anabasine) has significant teratogenic properties and causes significant numbers of birth defects at very low doses.

Nicotine is a colorless to pale yellow, oily, volatile liquid which turns brown when exposed to air. It is hygroscopic and forms alkaline solutions. It is soluble in many organic solvents such as alcohol, chloroform, ether, kerosene and various oils. It forms salts with almost any acid and has an acrid burning taste. It smells like pyridine. Its boiling point is 247 C. Dried tobacco leaves contain .5-8% nicotine and certain strains developed by tobacco companies contain much more. All parts of the plant contain the alkaloid including the seeds.

The LD50 for most species typically run from 1-50 mg/kg of body weight when given as a single dose as IV or subcutaneous. It kills worms at very low levels and has been used as a wormer in livestock. A significant portion of nicotine is absorbed in the digestion tract and the oral LD50 for humans has been established at 60 mg for a single dose. 1-2 mg can produce non-fatal toxic symptoms. Daily application of 3 mg per day on the skin is considered dangerous.

Nicotine is rapidly absorbed and given a large dose, death can occur in minutes. Tobacco in cigarettes contain factors which slow the digestive absorption and this often induces vomiting and saves lives in accidental ingestion cases.

D. Indole alkaloids which are derived from the amino acid tryptophan. These include “ergot” alkaloids such as perloine found in tall fescue and 3-methylindole which causes pulmonary emphysema. Ergot comes from a fungus which parasitizes the seed heads of many grasses and grains. The most notable is rye and triticale infection. Many epidemics in human history have resulted from grain infected with ergot, especially in France from the 9<sup>th</sup> to 14<sup>th</sup> centuries. The infections are most common in modern agriculture around the edge of fields where wild grasses in the ditches harbor spores and infect the grain.

Ergot can cause many behavioral and reproductive effects and even cause gangrene in the extremities. It is considered by chemists and drug companies to be a treasure house of drugs due to the enormous number of active constituents and their wide range of properties.

The fungus infects the seed head and sends filaments into the ovary tissue. Spores form at the tips of the filaments and are spread by the wind and insects. The filaments then harden into a pink or purple structure seen on the grain heads. This hard structure contains the poisonous alkaloids. [The fungus can also be grown on artificial media which will be covered in the next book. It is significant as a plant poison because it can be mass produced on cereal grains and have historically already destroyed armies demonstrating their military potential].

Ergot alkaloids have a direct stimulatory effect on smooth muscle causing vasoconstriction and elevated blood pressure. The two main forms are convulsive and gangrenous where this vasoconstriction cuts off the blood supplies. Levels as low as .1% in feed grains produce these effects in livestock and are comparable to the levels believed to have occurred in the historical epidemics.

Lysergic acid is the basis for all drugs produced from the ergot alkaloids, including LSD. Ergot has been used for over 400 years for its oxytocin properties in livestock to start uterine contractions and cause abortions. Because of the many compounds produced and consumed under varied conditions, the potential physical and psychological effects on humans could fill an encyclopedia. The primary toxic effects seen include vasoconstriction to the point of causing gangrene, convulsions, and neurological disturbances.

Strychnine is considered in most textbooks as an indole alkaloid. It was first isolated in crystalline form from the beans of *Strychnos ignatii* and *Strychnos nux-vomica*. It is commercially available in a variety of salts. The amino acid glycine is a precursor of strychnine. Strychnine will react with acids to produce salts such as hydrochloric acid to yield strychnine hydrochloride. It is readily soluble in water. Other related alkaloids in the plants are sparingly soluble in water and have strong toxic properties as well. Strychnine is well known as a spinal and central nervous system convulsant.

- E. Quinolizidine alkaloids which occur in lupines (scotch broom and golden chain trees) and cause birth defects and acute poisoning. The lupine seed contains 35-40% protein and has been used as a protein supplement for both livestock and humans. They have been produced on occasion as a soybean substitute in the US. The crop varieties have been selected because of their low alkaloid content.

Two of the alkaloids found in the lupines (lupanine and sparteine) are the most bitter of all the alkaloids. The concentration of these is much higher in wild varieties than the cultivated "sweet" varieties. Their pharmacological effects include nausea, ataxia, respiratory and visual disturbances, progressive weakness, coma and death from respiratory paralysis.

The greatest concentration of the alkaloids is in the seeds and lowest in the leaves of the preflowering plant. Lethal dose for the wild seeds is app. .25-.5% of body weight for seeds and 1.5% for the pods and seeds without any extraction or concentration of the toxins. Birth defects have also been noted in pets, livestock, and humans fed milk from animals consuming small doses of lupines.

- F. Steroid alkaloids Type 1-(Solanum) found in green potatoes, tomatoes and nightshade. These are the natural nerve agents acting on the central nervous system and are cholinesterase inhibitors. Type 2-Veratrum) are found in false hellebore and produce birth defects and prolonged gestation. It is also found in the death camas in the western US.

The Solanum species include nightshades, potatoes, Jerusalem Cherry (a Christmas ornamental), as well as the close relative, the tomato. The glycoalkaloid Solanine was first discovered and isolated in 1862 from potatoes. It is a glycoside with a side chain of alkaloids making it a glycoalkaloid. In 1954, a second glycoalkaloid called chaconine was discovered in potatoes. The two main effects of solanum alkaloid poisoning are gastrointestinal tract irritation and impairment of the nervous system. These toxins are far deadlier when injected into the blood because they have a slow absorption rate in the intestinal tract. Symptoms include apathy, drowsiness, salivation, difficult breathing, trembling, weakness, paralysis, and unconsciousness.

These alkaloids are cholinesterase inhibitors and act like nerve gas once in the bloodstream. They are found in highest concentration in green sprouts and green skins (potato peels). The greening occurs when the tubers are exposed to light during growth or after harvest. The green pigment is chlorophyll which is promoted under identical conditions as the alkaloid. History is full of examples of humans dying from eating green potatoes even though the toxin is weakly absorbed.

Livestock have died from being fed the green sprouts, peelings and sunburned potatoes. Green potato vines also produce the toxins. Any green parts of the plant contains high levels of the alkaloids. They are not destroyed by boiling, baking, frying or other forms of heat or drying.

There are three reasons that far more people are not killed by potato greens ingestion. These are –

1. Solanine is poorly absorbed by ingestion
2. It is hydrolyzed to a less toxic form in the gut
3. It is rapidly excreted via the urinary and intestinal tracts

Solanine produces a burning sensation in the mouth and throat when eaten at levels above 14mg/kg. It can be absorbed as a dust.

Black Nightshade is a common annual garden weed that produces white flowers and shiny black berries. It also invades pastures and various crops. Berries and leaves have caused human and animal mortality. Climbing nightshade is a climbing perennial with blue or purple flowers followed by large berries. The garden huckleberry is also a domesticated form of black nightshade but its berries are non-toxic. All these also produce solanine.

Tomatoes contain “tomatine” alkaloid first identified in 1948. The mature fruit is low in alkaloid but green tomatoes and vines can contain higher quantities. The vines have killed cattle and pigs. Tomatine is also a cholinesterase inhibitor.

Type 2-Veratrum alkaloids are found in *Veratrum californicum*, and in other veratrum species. The species as a group contain more than 50 individual steroid alkaloids of which veratramine is usually found in high concentrations. They contain compounds that cause tetragenicity in livestock. The plants lose their toxicity after being killed (by frost).

The alkaloids lower blood pressure by dilation of arterioles and simultaneously constricting venous vascular beds and slowing the heart rate.

Death camas also contains veratrum type alkaloids. It looks like a wild onion with a small bulb and grasslike leaves. All its plant parts contain toxin and the lethal dose varies from .6-6% of body weight. Several steroid alkaloids are found in death camas including zygacine.

- G. Polycyclic Diterpene Alkaloids are complex and found in larkspurs and *Aconitium* species which include aconite and monkshood. Larkspurs cause annual livestock deaths of 1-4% of entire herds in the western US for the entire 20<sup>th</sup> century. They acutely affect the central nervous system acting rapidly and rarely producing visible symptoms in livestock. In experimental poisoning, death occurs from respiratory paralysis following doses of .5% of body weight of the raw plant. Studies of one alkaloid from *Delphinium brownii*, methylaconitine, found it acts as a potent neuromuscular blocking agent. The alkaloids are most heavily concentrated in early plant growth, in growing tips and new leaf growth. They are most toxic in spring and lose toxicity as the season passes, especially after flowering.
- H. Indolizidine alkaloids are found in locoweed (*Astragalus*-350+ species in the US) in the US. They act to inhibit alpha mannosidase which causes mannose deposits to accumulate in the lysosomes of nerve cells. This makes them cumulative toxins. They also become addictive. The alkaloids also cause birth defects in addition to attacking the immune system. It takes about 30% of body weight to cause a lethal dose over time in livestock. Early stages are reversible while later stages and advances symptoms are irreversible. The alkaloids are also associated with congestive heart failure.

A fungus on red or white clover and hay produces Slaframine which causes profuse salivation (slobbers) in cattle. It develops rapidly in rainy weather and high humidity and produces black patches on the clover. The toxin slowly degrades over time and in storage. It is extremely toxic with oral LD 50's in guinea pigs of less than 1 mg per kg of body weight. Atropine acts as an antidote in poisoning of this type. The toxin is activated by enzymes in the liver and acts afterward like nerve agents.

- I. Tryptamine alkaloids are found in reed canary grass. They cause acute neurological problems and chronic muscular incoordination. They can cause sudden death syndrome in livestock as well as acute and chronic poisoning. The alkaloids act on the nervous system and heart and are similar in structure to serotonin. They affect brain metabolism and cause sudden death via acute heart failure. Doses of the pure alkaloid produce acute symptoms at .01-.1 mg per kg of body weight while 1.5-2mg per kg produces heart failure and death.

Reed canarygrass is found in poorly drained and flooded soils in Canada and the northern US. It contains at least 8 alkaloids.

- J. Tropane alkaloids which include atropine are found in Jimsonweed (*Datura*) which is a common inhabitant of waste area, barnyards and field ditches. It has pronounced effects on the central nervous system. The fruit contains the alkaloids which affect the nervous system and is generally unpalatable. All plant parts contain some alkaloid poisons however.

Symptoms in both humans and animals include intense thirst, disturbed vision, delirium and violent behavior. Poisoning have occurred in humans from sucking on the nectar of the flowers or consuming the seeds. The whole seed passes through the gut without absorption but is readily absorbed if the seeds are broken.

Jimsonweed contains .26% atropine and .55% scopolamine. The toxic doses for each are 2.49 mg or .5 mg respectively per kg of body weight.

Atropine is one of the oldest known poisons with reference to its extraction from plants dating back to 1550 BC. Its name comes from the plant *Atropa belladonna* or deadly nightshade and Henbane. It has a long history of use as a poison and has been referred to by authors from Pliny to Shakespeare in this regard. It was used by women in tiny doses up to the 19<sup>th</sup> century to dilate the pupils and “enhance” their beauty which is where the name belladonna (beautiful woman) comes from.

Oral LD50's for atropine are high requiring 56 grams to kill a 150# man. The ancient poisoners used chronic smaller doses over time to kill without detection. Eyedrops have caused toxic effects in a few days at .75 mg in some individuals. It has also caused psychosis when used in treatment of myocardial infarction at 4 mg per day.

- K. Fescue alkaloids occur in tall fescue, a perennial grass which grows in pronounced clumps. It contains two principal alkaloids, perloline and perlolidine. Perloline is a yellowish green fluorescent alkaloid first isolated in 1943. Its content in fescue increases from early spring to the end of July and rises sharply in August. The alkaloids are concentrated highest in the seeds and produce a variety of respiratory symptoms. They also appear to cause a gangrenous condition in the extremities.
- L. Quaternary Ammonium Compounds. The active principles of Curare belong to this group. The name and its synonyms come from the Indians of the Amazon and Orinoco valleys and the Guianas who have used them for centuries as arrow poisons. The tips are coated with a brownish layer of “flying death” resulting in rapid paralysis and death of animals and humans who are struck. Meat from rapidly killed animals is safe to eat because the poison is not absorbed from the digestive tract.

The arrow poison is prepared from a number of plant species belonging to the families *Menispermaceae* and *Loganiaceae*. The toxins are called curarines and toxiferines and are the alkaloids responsible for the biological activity. The main source for curare in the Amazon valley are the climbing vines of the genus *strychnos* of which *S. toxifera* is the most active. The seeds of plants of the genus *Erythrina* also possess curare type alkaloids.

The first curare compound called dTC was purified in 1943 from a crude extract from *C. tomentosum*. It is a white odorless powder and its solubility in water ranges from 25-50 mg/ml. It crystallizes into hexagonal and pentagonal microplates from water as it dries.

The most potent curare alkaloids are those isolated from calabash curare extracted from *Strychnos toxifera*. There are 30 similar and 12 different alkaloids in this curare preparation and one of these (toxiferene 1) is 15-30 times as potent as dTC.

In humans, the usual clinical paralyzing dose of dTC is 10-15 mg by IV. In 30 seconds nervous system effects are observed and by 2 minutes, paralysis of the neck and facial muscles sets in and spreads. At 3 minutes, breathing becomes difficult and artificial respiration becomes necessary. Recuperation begins at 20-30 minutes with complete recovery at 60 minutes

## **2) Glycosides and Glucosides**

Glycosides include –

- A) Cyanogens
- B) Glucosinolates
- C) Coumarin
- D) Steroids and Triterpenoids
- E) Nitro Containing Glycosides
- F) Vicine (Favism)
- G) Calcinogenic Glycosides
- H) Azoxyglycosides
- I) Carboxyatractyloside
- J) Isoflavones and Coumestans
- K) Jojoba Glycosides
- L) Ranunculin

Purified glycosides are usually bitter, colorless, crystalline solids. They yield one or more sugars when hydrolyzed in dilute mineral acids or enzymes. They are much more widely distributed in the plant kingdom than are alkaloids. Many are not toxic. The amount found in the plant depends on genetics, plant part, age, sex, climate, moisture supply and soil fertility.

A) Cyanogens are glycosides of a sugar or sugars (usually glucose) and a cyanide containing aglycone. More than 1,000 species of plants produce the 21 cyanogenic glycosides. Enzymes can hydrolyze these and produce prussic acid/hydrogen cyanide as a by product. This form of cyanide is a potent toxin which affects the respiratory system.

The major cyanogens include –

1. Laetrile which is found in chokecherries, wild cherries mountain mahogany, and the kernels of almonds, apricots, peaches and apples.
2. Dhurrin occurs in grain sorghums, forage sorghums, and Johnson Grass.
3. Linamarin found in white clover, linseed (flax), lima beans and cassava.

Plant enzymes hydrolyze these and other cyanogens into hydrogen cyanide in two steps. The glycosides occur in the vacuoles while the enzymes are found in the cytosol. Damage to the plant from frost, mechanical crushing and bruising, and so on brings these two components together.

Hydrogen Cyanide, once formed is readily absorbed into the bloodstream via ingestion, inhalation and through the skin. There it enters individual cells and inhibits electron transport. This rapidly produces death. Symptoms include labored breathing, gasping, excitement, staggering, paralysis, convulsions, coma and death. Cyanide is readily and continuously detoxified in living tissue so death only occurs if the dose exceeds the detoxification reaction rate. Liver, kidney and thyroid tissue all contain an enzyme which converts cyanide to thiocyanate which is excreted in the urine.

Toxic dose of pure HCN (hydrogen cyanide) is app. 2 mg per pound of animal per hour.

Cyanide poisoning occurs almost immediately and quick deaths have resulted from consumption of apple seeds, apricot seeds and bitter almonds. Animals have died from sorghums and chokecherries. Sudan grass can produce high HCN (hydrogen cyanide) levels after being stressed by drought or frost. Very dark green plant growth also tends to be higher in HCN.

Chokecherries are highest in cyanide in the spring and early summer. Animals which drink water and then eat the cherries and even the leaves by themselves often die quickly because water is used in glycoside hydrolysis and the water rapidly aids the reactions. [A hint for extraction, processing and weapons design].

Bracken Fern contains cyanogens and a number of other toxins including thiaminase and carcinogens.

The tropical tuber cassava (manioc, tapioca) is usually grated and soaked in water. This activates the conversion of the cyanogen which is then washed or leached out. Cooking also destroys the enzymes which convert the cyanogens. Sub lethal doses occur with symptoms from the repeated consumption of small amounts of the cyanide in cassava. Lesions occur on the optic, auditory, and peripheral nerves. Goiters and neurological problems have also been observed.

The lethal dose of cyanide is .5-3 mg/kg of body weight. The following plants contain cyanide in the amounts listed –

|                | <u>Mg CN/100 g Plant tissue</u> |
|----------------|---------------------------------|
| Sorghum forage | 250                             |
| Wild Cherries  | 140-370                         |
| Arrow Grass    | 77                              |
| Bitter almonds | 10-300                          |
| Bamboo Tips    | 800                             |
| Linseed Meal   | 53                              |

Wild cherry leaves at 200 mg in 100 g of leaves easily contain a lethal dose for a 100 # human (or animal). The leaves crushed and soaked will then contain the dose for a short period in the water.

- B) Glucosinolates occur widely in cultivated plants, especially those that belong to the *Brassica* genus and include cabbage, broccoli, rapeseed, mustard, and turnips. Glucosinolates yield compounds with a hot “biting” taste used in mustards and horseradish. These compounds are hydrolyzed in a manner similar to the cyanogens covered in the last section. The enzyme occurs in the plant and is released when the tissue is crushed. The hydrolysis products affect the thyroid gland in several ways yielding goiters and other thyroid damage which has been observed in large consumption of cabbage.
- C) Coumarin occurs in sweet clover and as Furocoumarins in many other plants. It is metabolized by various molds yielding a product that inhibits vitamin K. This can produce internal hemorrhaging because lack of vitamin K inhibits blood clotting. The sweet clover produce the byproducts when it becomes moldy. Hay which is allowed to mold when wet can also yield coumarin. An associated chemical called warfarin (used in rat poisons) was also developed from studies of coumarin.

The hemorrhaging can be internal or external and results in pooling of blood. The mucous membranes become pale and the affected individual becomes weaker and dies without a struggle.

The furocoumarins are photosensitizing agents and have been used for thousands of years in India and Egypt to treat skin depigmentation. They occur in many plants but when these plants become infected with mold, they yield phytoalexins (Celery, Bishops Weed, and Parsnips).

These substances are primary photodynamic agents and absorb long wave ultraviolet light. This causes them to react with light in cells near the skin surface and cause cellular damage.

This damage can include severe blistering, clouding of the cornea, blindness, erythema, and in long term cases, cancer. The whole plant fed to livestock at 9-12 g/kg of body weight induced photosensitization symptoms. Celery dermatitis was named for the condition which occurs in workers handling the plant with erythema and blistering on the hands and forearms.

D) Steroids and Triterpenoids take several forms.

*Cardiac Glycosides* occur in the common garden foxglove (*Digitalis purpurea*). A native of Europe and naturalized to the US and Canada, it is widely distributed. Foxglove contains several cardiac glycosides or digitalis drugs that are used in human medicine. Because they affect the heart by strengthening the force of contraction, and prolonging the diastolic phase, they have been involved in a number of accidental poisonings. Fresh foxglove leaves have lethal doses of the glycosides at only a few hundredths of a percent of body weight without any concentration.

Oleander, an ornamental shrub widely grown in California also contains several cardiac glycosides similar in action to those in foxglove. All plant parts are lethal, green or dry. A single leaf carries a lethal dose for most humans and deaths have been reported from hot dogs being skewered on oleander branches. An intake of only .005% of body weight produces 100% mortality in cattle and horses. [No human studies have been completed].

*Cardenolides* are found in various species of milkweed throughout North America. As little as 10-20 mg of milkweed tissue can kill sheep. symptoms include profuse depression, staggering, collapse, dilation of the pupils, and congestion of the lungs. Monarch butterflies feed on milkweed and accumulate the cardenolides and when the level is high enough it causes birds which consume the caterpillar, adult or pupa to vomit.

*Bufadienolides* are similar to cardenolides chemically. Found primarily in plants in South Africa, a dose as small as a single leaf can kill.

*Saponins* are widely distributed among cash crops and other species of the world. They have a wide range of biological effects that are positive and negative. Saponins are characterized by a bitter taste, and the honeycomb foam they produce in water. They are used in soft drinks, shampoo, soap, fire extinguishers and synthesizing steroid hormones (birth control pills).

They also tend to have strong detergent properties. Some of the saponins are highly toxic with various symptoms and some of these are present in such high levels (up to 3%) in tissues that they can be lethal in small ingested amounts.

Saponins however are not easily absorbed through the uninjured digestive tract. To be dangerous during plant consumption, the plant must usually have a substance that injures the intestinal wall and permit absorption. By injection they are fatal in small amounts.

#### E) Nitrogen Containing Glycosides

There are more than 370 *Astragalus* species (milk vetch) in North America, and more than 260 of them are poisonous due to nitrogen containing glycosides. Thirteen of them cause *locoism*. Acute poisoning results in weakness, convulsions, frequent urination, rapid heart beating, labored breathing, coma and death.

The compounds concentrate in the leaves and reach their peak during pod formation. These levels drop rapidly when the leaves begin to dry. Herbicides also cause the leaves to bleach and lose toxicity. The toxins are stable in dried green specimens and have been measured in 100 year old samples. About 20 grams of green leaves is all that is required for a toxic dose. Bees have been poisoned from foraging on *Astragalus*.

#### F) Vicine (Favism)

The fava bean (horse bean, broad bean) is grown extensively in Europe for human consumption. Eating the unprocessed bean or inhaling its pollen sometimes causes a condition called *Favism*. It is characterized by acute hemolytic anemia with symptoms of headache, nausea, dizziness, yawning, vomiting, abdominal pain and fever. These can occur in minutes with children most effected and mortality rates of 6-8% reported in the past. Blood transfusion therapy has since reduced this rate. The most potent toxin accumulation occurs when the plant first blooms and in fresh beans. [The mathematician Pythagoras died at the hand of Greek soldiers rather than cross a field of fava beans.]

Over 100 million people are susceptible to favism due to a genetic deficiency of a red blood cell enzyme. Racial groups such as Oriental Jews, Blacks, and Mediterranean Europeans, Arabs and Asians have a high incidence of susceptibility.

- G) Calcinogenic Glycosides are the active metabolite of Vitamin D and when they are consumed in foods they cause the deposition of calcium in the soft tissues which is called Vitamin D toxicity. The plants containing these are found in South America and Europe and are primarily of academic value.
- H) Azoglycosides cause hepatic and gastrointestinal disease and are carcinogenic. They are found in the roots, seeds, stems and leaves of Cycads, a tropical plant that was distributed worldwide during the Mesozoic era. Human processing methods seem to destroy its cancer causing properties making it safe for human consumption. Unprocessed, the plant parts have been long known to be toxic. When Captain Crooks ship ran aground at Cooktown, Australia, the crew consumed seeds of *Cycas media*. In his diary he wrote that “the sailors were violently ill, both upwards and downwards”.
- I) Carboxyatractyloside is found in the coarse annual weed cocklebur (*Xanthium* species). Its fruit contains two seeds surrounded by a spiny capsule. One seed germinates the first year and the second in the following year. It often grows underwater and then as the area dries out it continues to grow. Only the seedlings of the cotyledon stage are poisonous and as its first true leaves develop the toxicity rapidly disappears.

Symptoms include depression, reluctance to move, hunched posture, nausea, vomiting, weakness, dyspnea, convulsions, coma and death. Severe hypoglycemia occurs with gross lesions from vascular permeability. Edema of the gallbladder wall, ascites of the peritoneal cavity and liver necrosis occurs.

The cocklebur also contains hydroquinone although the principal causes the above symptoms.

- J) Isoflavones and Coumestans. Isoflavones are plant produced substances that have estrogen activity that decrease fertility and increase uterine weight. They are called phytoestrogens and are water soluble. Coumestans inhibit ovulation and menstrual cycles. Both substances are found in subterranean clover (and other clovers) reaching as much as 5% of the plant dry weight and coumestans are also in found alfalfa. The biological effects can be wide ranging and varied in humans.
- H) Jojoba Glycosides are found in the Jojoba, a native to the US southwest desert areas. Its seeds contain a liquid wax similar to that of sperm whale oil that is widely used in cosmetics manufacture. The mealy part of the seed left over after the oil is extracted contains a glycoside called *simmondsin*.

- I) Ranunculin occur in Buttercups, a common pasture weed in North America. They are usually grown in marshy areas and wet acid soils with poor fertilization. When their plant tissue is crushed, the glycoside is enzymatically converted into a yellow volatile oil called Protoanemonin. It is unstable and polymerizes or volatilizes so it cannot be stored in a dry plant like hay. It is an irritant that can cause blisters on the lips, mouth throat and intestinal tract. LD50 (lethal dose for 50% of animals tested) is estimated at 10-12 grams of the fruit per Kg of body weight.

### **3) Oxalates**

Oxalic acid is a highly toxic substance that is found in plants as a salt such as sap soluble potassium oxalate in low sap pH, and as sodium, and sap insoluble calcium and magnesium oxalate. It is the highly toxic material found in rhubarb leaves and the popular houseplant *Dieffenbachia seguine* (dumb cane). In the latter, it is found as crystals of calcium oxalate that burn the throat and mouth. The plant is a native of the West Indies where it was used in torturing slaves and was considered by Hitler for inflicting additional pain on the concentration camp Jews. The oxalates are found in plant cells called idioblasts which store the crystals in a gelatinous substance. When the cell wall is broken, juice from the plant or salive enters the cell and causes the gelatinous material to swell. This causes it to mechanically expel the tiny crystals like bullets fired from a gun. This process can be seen under the microscope.

Dieffenbachia also contains a toxic protein that causes the throat and mouth to swell. When the sap enters the eye, the water initiates the effects and permanent and nearly immediate opacification (partial blindness) occurs.

A plant called Halogeton is native to Russia and was accidentally introduced into the US as a contaminant of agricultural products. Since then it has spread over more than 10 million acres of rangeland in the west, particularly Nevada, Idaho and Utah. The plant concentrates the oxalate to its highest point in fall and winter and at times can have as much as 10% of its dry matter as calcium oxalate. Numerous cases have been documented since the 1940's in which hundreds of sheep have died in a single day from eating the plant. Hundreds of sheep died on an army base in the 1970's and the initial belief was that they had died from nerve gas poisoning. The sheep mortality was later determined to have been caused by halogeton ingestion.

#### **4 Proteins and Amino Acids**

A number of proteins produced by plants have toxic and other properties useful in weapons. These include –

- A) Trypsin Inhibitors
- B) Amylase Inhibitors
- C) Carboxypeptidase Inhibitors
- D) Allergenic Proteins
- E) Hemagglutinins (Lectins)
- F) Enzymes
- G) Mimosine
- H) Tryptophan
- I) Selenoamino Acids
- J) Lathyragens
- K) Linatine
- L) Indospecine
- M) Canavanine
- N) Brassica Anemia Factor
- O) Hypoglycin
- P) Biogenic Amines

A) Trypsin Inhibitors are proteins that inhibit digestion in the digestive tract of animals and man. The inhibitors of soybeans are the most well known and studied. Most types of beans, potatoes, rye, triticale, barley and alfalfa also contain trypsin inhibitors. The term protease inhibitor is a better term to describe these substances since they inhibit enzymes other than trypsin as well. They are complex proteins with 180+ amino acids. The chemical reaction is instantaneous and the complex that is formed binding the protease is a very tight one that is not easily broken.

Trypsin inhibitors occur mainly in seeds and are occasionally found in the leaves. Most lima, navy, pinto, and garden beans, peas, and peanuts all have these inhibitors. Cereal grains also contain them but in insignificant amounts. Many plant leaves accumulate inhibitors at the wound sites caused by insects or bacteria.

Trypsin inhibitors cause slow growth in animals in addition to inhibiting protease enzymes through other biological action. This is observed in the feeding of raw and unprocessed soybean and other related plant seeds. The inhibitors are destroyed by heat processing with 95% of the activity gone in 15 minutes at 100 C.

- B) Amylase Inhibitors are found in wheat, oats, rye, beans and potatoes. They function as starch blockers and produce digestive upsets and are of only academic importance here.
- C) Carboxypeptidase Inhibitors are a group of pancreatic enzymes found in potatoes at .03% which is insufficient as eaten to affect digestion.
- D) Allergenic Proteins are produced in many foods and entire books are written on those that produce allergic reactions in humans. These include soybean based milk substitute. Usually heat treatment destroys these substances.
- E) Hemagglutinins (Lectins) cause the clumping of red blood cells and were first isolated from castor beans in the form that is called "Ricin". They are proteins that like to bind to sugars and have sometimes been classified as glycoproteins. They have also been classified as phytotoxins or toxalbumins in some literature. They are also found in many field beans but those found in soybeans are considered nontoxic to humans. The lectins in raw kidney beans will kill them directly. The hemagglutinins in crops cause reduced growth in animals and humans, decrease nutrient absorption, and increase bacterial infections by affecting gut permeability. They can also impair the immune system. Lectins are destroyed by moist heat but are resistant to dry heat which is why beans are soaked before cooking.

The rosary pea contains one of the deadliest toxins known. It is a lectin called *Abrin* which is concentrated in the seed or pea. A single seed can produce a fatal dose. The rosary pea occurs as a tropical vine and a weed of fence rows. The seeds, when eaten, produce stomach irritation and violent vomiting, coma and death.

The Castor Bean produces Ricin, one of the most well known poisons in the world. It has been made into a significant name in the spy and assassination trade because of its documented use as an injected poison by the Soviet KGB. In well publicized instances, the agents used a needle in the tip of an umbrella to jab and inject small steel capsules containing Ricin into the bodies of the targeted defectors. One died while the capsule in the other was located by x-rays and removed before sufficient poison was absorbed.

The ricin is present in the seed, press cake, and foliage of the castor bean at a concentration of .5-1%. The castor oil is non toxic and has been widely used commercially. Ricin is one of the most toxic substances known with a minimum lethal dose of .00000001 % of body weight by injection. By ingestion, the lethal dose is several hundred times higher at app .0001% of body weight. This makes it about 1,000 times as toxic as any other lectin except abrin. Ricin is destroyed by moderate heat.

Ricin and abrin are water soluble and can be extracted with water from the plant tissues. The cells must be physically crushed to release the toxin from the plant tissue. It is then leached out in water although solvents such as hexane or acetone are generally used to help penetrate the cell walls. A 10% solution of added salt will precipitate the lectins out with other similar weight substances once they are in solution

The patent for recovery of ricin describes the procedures of using 5% acetic acid (full strength vinegar) as the extractant to reach the ideal pH of 3.8-4. The oil is usually removed first and then the beans are solvent extracted at 4 degrees C. The solids are separated from the liquid by filtering, centrifuging or other methods. Ammonium sulfate is added to precipitate the ricin. The patent states that 70 grams per 100 ml is used. The ricin settles to the bottom at the low refrigerator temperature with other materials but is strongly concentrated. The next purification step involves taking the solid extract and mixing it into 30 times its weight in distilled water. Dropwise, with strong stirring, a solution of 5% sulfuric acid is added. This is filtered cold. To the filtrate solution is added 12% baking soda solution until a pH of 7 is reached. A mix of two pounds of sodium sulfate is mixed into 10 # of distilled water and then this is added at a total of 20% of the ricin bearing solution by weight. The solution is left cold for an hour or more and the solution is filtered. The solid cake left over contains an estimated 50% ricin and 50% sodium sulfate.

The black locust contains a lectin called *robin*. It causes anorexia, lassitude, weakness, paralysis, nausea, dilation of the pupils, weak irregular pulse, diarrhea, dyspnea and death. It has caused poisonings from ingestion of the bark and sprouts. The leaf is used as a dietary substance in some parts of the world.

- F) Enzymes. Thiaminase splits thiamine rendering it inactive. It is found in bracken fern, horsetail and nardoo. The destruction of this B vitamin produces symptoms of severe hematological disturbances, bone marrow damage, anorexia, ataxia, convulsions and death, mostly from thiamine deficiency. The thiaminase is rendered inactive by cooking.

Lipoxidases are enzymes that catalyze the oxidation of lipids. These occur in grains, soybeans and alfalfa and destroy carotene and xanthophylls which reduce vitamin A activity in the feeds. It is used in the baking industry to bleach carotene in bread dough. The ebony flavor of beans is due to the action of lipoxidases on free fatty acids in the seeds. These give rise to ketones that have undesirable flavors. The enzyme is destroyed by heat at 80 degrees C.

- G) Mimosine is found in a tropical legume called kao haole (Hawaii). It can cause hair loss, eye cataracts and reproductive problems. It is an amino acid antagonist and binds with copper and zinc. It is also a teratogenic agent.
- H) Tryptophan yields metabolites that are poisonous to cattle feeding on lush pastures and occasionally to humans from moldy sweet potato and purple mint (a herb). It has caused pulmonary emphysema and fatalities in humans.
- I) Selenoamino acids. Some plants live in soils that are high in selenium, a trace mineral required in very tiny amounts by all living things. In tiny doses larger than those that are needed the selenium is toxic and can kill. Some plants accumulate highly toxic levels of selenium and are found in the US from the Mississippi river to the Rockies. Only a few hundred parts per million in the plant produces staggers and alkali disease followed by death in grazing animals. Symptoms include staggering, diarrhea, prostration, hemorrhage of internal organs and abdominal pain. Humans are susceptible as well.

Selenium accumulator plants can contain up to 10,000 ppm on a dry weight basis. The plants usually have offensive odors from the selenium compounds. About 25 species of *Astragalus* and *Xylorhiza* (the woody astors) are called selenium indicators because they mainly grow in high selenium soils and accumulate selenium into a variety of amino acids. Other plants on the same soil can accumulate up to 200 ppm in their tissues.

Chronic toxicity symptoms include loss of hair, sore feet, deformities and death.

- J) Lathrogens cause a crippling disease in humans caused mainly by consumption of the chick pea. It is a major public health problem in India because of its use as a food crop. Its seeds are used in making flour for bread and as a vegetable. At one time it was even used as currency with landlords and tenants. Because of the health problems several Indian states have banned the sale of seeds but it is still widely grown.

Epidemics of its toxic symptoms have occurred in 1958 and 1974. The symptoms include skeletal deformities, aortic rupture and nervous system disorders such as paralysis of the leg muscles. The toxins have different effects and are found in sweet peas as well.

Steeping and boiling the seeds in hot water removes most of the toxins but in raw form the toxin is retained. Different Vetch species also contain lathyragens.

- K) Linatine is found in flax and linseed meal. It is an antagonist for the vitamin pyridoxine and results in anorexia, poor growth and convulsions.
- L) Indospecine occurs in *Indigofera spicata* or creeping indigo. It is a tropical legume and contains the toxic amino acid which is a structural antagonist of arginine. This results in liver damage and nodular cirrhosis.
- M) Canavanine is also an analog of arginine. It occurs in concentrations of up to 5% in jack bean seeds and in other legumes. Alfalfa sprouts contain up to 1.5% canavanine and when fed to monkeys directly, produced severe lupus erythematosus.
- N) Brassica Anemia Factor occurs when plants like kale, rape, cabbage, cauliflower and turnips are grown for grazing animals. They develop a severe hemolytic anemia in 3-4 weeks. Liver, kidney and spleen damage slowly results. The cause is glucosinolates and an amino acid called SMCO. It is rare but is found in brassica species in levels as high as 4-6% of dry matter. It increases with plant maturity and peaks in the winter.

Raw onions, and the leaves and bark of the red maple can also cause anemia conditions.

- O) Hypoglycin. Captain Bligh brought a plant with him to the West Indies on his second voyage after surviving the mutiny on the bounty. It is named after him and is called *Blighia sapida*. It is a small native tree of Africa that is cultivated in southern Florida. Its ripe fruit is edible but has a high level of a toxic amino acid when unripe called hypoglycin A. A second "B" form has also been identified in other plants. It causes vomiting sickness in humans followed by convulsions, coma and death. The first clinical sign is severe hypoglycemia.
- P) Biogenic Amines are compounds found in common foods such as pineapples, bananas, avocados, cheese, fish and chocolate. They are potent vasoconstrictors and cause elevated blood pressure. They are detoxified by the enzyme monoamine oxidase (MOA). Some humans have low tissue levels of MAO and are sensitive to these foods. Various antidepressants and amphetamines contain MAO inhibitors which can also sensitize the user.

One of the biogenic amines, serotonin is present in high levels in bananas and high levels of consumption on banana plantations in Africa have led to carcinoid heart disease.

### **5) Carbohydrates, Lipids and Conjugates**

There are only a few carbohydrates that are toxic. One of the simple sugars, xylose is toxic. It is generally not a problem in humans because it is most commonly found in wood molasses and other livestock feed roughages. It can cause eye cataracts and depressed appetite.

The sugar sucrose has been implicated as a cause of myocardial infarction and peripheral arterial disease in man and growing pigs. It raises serum cholesterol but the amounts required to cause serious problems is so high that it is mostly of academic interest.

Annual Ryegrass seedheads contain a group of highly toxic glycolipids called corynetoxins. They affect the nervous system causing convulsions and spasms and can be fatal. The cause is a nematode that infects the seedhead shortly after germination. When the grass begins to flower, the larvae burrow into the developing flower where they mature and lay eggs in the seed forming a gall instead. This process is not toxic unless the nematode carries a *Corynebacterium rathayi*. This bacteria in the presence of ryegrass triggers the formation of the toxins. The bacteria produce a yellow slime oozing from the seedhead which makes it easy to recover and cultivate for weapons production. This also has potential as an agricultural weapon.

### **6) Tannins and Polyphenolic Substances**

Phenolics are water soluble compounds in plants that contain one or more phenol groups. Those substances with many phenolics are called polyphenolic compounds. Tannins are polyphenolic compounds that bind with and precipitate proteins from water solutions. The term “tannin” comes from its extraction from plants and its use to tan leather. Hides and skins that soaked in tannins become much more resistant to bacteria, abrasion, and heat.

Tannins have a bad taste which makes certain plant foods such as green persimmon or walnut less palatable. They also interfere with the action of trypsin and amylase in the digestive tract and elevated levels can also damage the digestive tract.

Oak buds, leaves and twigs in the spring and acorns in the fall have caused livestock and human poisonings. Tannin in the form of tannic acid and its phenolic acid constituent, gallic acid are the cause.

St.-Johns Wort is an erect perennial herb that has leaves that contain numerous small dots barely visible to the eye. These are translucent pigment granules. The principal substance in the granules is called hypericin and is a potent photosensitization agent. When the leaves are ingested by animals (or humans) the hypericin reacts with light at the surface of the skin and fluoresce when hit by a molecule of light. This results in an unstable energized molecule that collide with surrounding cell constituents and create free radicals. These cause cell breakdown and results in erythema, serious oozing and skin necrosis. Infection may set in as well as photophobia. The condition also leads to various forms of skin cancers.

### **8) Other Plant Toxins and Poisonous Plants**

There are hundreds of toxins and poisonous plants that will be covered at the end of Chapter 5 in a book on poisonous plants of the world. A few of the noteworthy plants and toxins that do not fall in the previous categories will be mentioned here. Some plants contain substances of a unique type and we will cover a few here.

Sleepy Grass contains a substance called diacetone alcohol which has narcotic effects similar to acetone (a depressant). The grass forms erect clumps and is found in Colorado, Arizona, New Mexico and Texas. Small amounts of the grass produce stupor with moderate amounts inducing catatonia in livestock. The effects are believed to be similar in humans due to the release of acetone in the digestive tract. It is a potent and potentially deadly sedative.

A variety of plant on the US rangelands contain toxicants called sesquiterpene lactones. These plants include bitter rubberweed, sneezeweeds, and bitterweeds. The substances are highly irritating to the eyes, nose and throat. Sneezewood poisoning is called spewing sickness because of the vomiting it induces in livestock. Vomited material is often inhaled into the lungs causing death from inhalation pneumonia or permanent lung damage. Liver and kidney congestion and pulmonary damage is also observed.

The oral LD50 in sheep of dried bitterweed is 2.9-8.5 g/kg of body weight making it very toxic without concentration. Its symptoms make the lactones a poor mans super tear gas.

A group of toxins are sometimes classified as resins or resinoids. On extraction, they usually are solid or semisolids at room temperature. They are brittle and easily melted or burned. They are usually insoluble in water, contain nitrogen, and are soluble in organic solvents. Marihuana, milkweeds, water hemlock, laurel and labrador tea are considered to have these types of toxins.

Water Hemlock is found in wet and swampy areas in the US. It grows 5-10 feet tall with a jointed hollow stem. It has a thickened storage organ at the base of the stem and roots which is divided into chambers. These chambers contain the yellowish oily liquid with the pungent odor of raw parsnip. The liquid is also found in the lower portions of the stem and is the main toxic material called cicutoxin. It is a highly unsaturated higher alcohol which has been responsible for main human poisonings and fatalities. Cicutoxin acts directly on the nervous system and is a violent convulsant.

Garden carrots and celery contain small amounts of a similar acetylinic alcohol called carotoxin which is much less toxic.

White Snakeroot is a showy herbaceous perennial that grows over much of eastern North America. Cattle would forage on the plant in through American history and ingest a toxin in its leaves and flowers called tremetone or tremetol. The milk cows would then pass on the toxin in the milk to humans creating a condition called milk sickness. Symptoms included weakness, nausea, prostration, ketosis, delirium, coma and death. In early pioneer days it sometimes reached epidemic proportions and entire villages were abandoned. It is believed to be the cause of death of Abraham Lincoln's mother. Milk sickness gradually disappeared with the practice of pooling milk from many farms during processing which greatly diluted the toxin. Rayless goldenrod or jimmyweed also contains tremetol. App. 1-1.5% of the animals weight consumed as green plant causes toxicity.

Pine needles are known to contain a substance that causes abortion in a wide range of animals. The toxin is extracted with water and/or acetone and in mice produce a high degree of embryonic mortality. Extracts with acetone and chloroform have antiestrogenic properties as detected by reduced uterine weights in mice. Hexane extracts also cause reproductive failure in mice and livestock. It is believed the causative agent is a mixture of diterpene resin acids.

Sodium Monofluoroacetate, also called compound 80 is a poison that has been used to kill coyotes for years. It is also used to kill other pests. Certain plants contain 1080 which is a very potent toxin that brings cellular respiration to a standstill. Australian plants of the family Leguminosae including the species Acacia, Gastrolobium, and oxylobium contain 1080 and only a few leaves are required to produce mortality in a 100# animal. The oral LD50 is .3-1.75 mg of the pure compound per Kg of body weight.

Bracken Ferns, mentioned earlier produce other toxins than those already mentioned. When bracken "fiddleheads" green fronds are emerging they are five times as toxic as the mature fronds and the rhizomes are also highly toxic. The poison causes severe damage to the bone marrow which resembles radiation poisoning (a poor mans plutonium?). There is a subsequent loss of cellular blood components and hemorrhaging also occurs with blood in the feces, and bleeding from the nose, vagina, mouth and eyes.

A high fever develops in the terminal stages. Bracken Fern also causes cancer in cattle when consumed in low amounts over time. Tumors in the form of small nodules or polyps develop in the mucosa of the urinary bladder. Bleeding from these polyps cause anemia and death or spread to other tissues with 100% mortality. When fed to laboratory animals, the fern also causes a variety of cancers.

About 30 unique substances are found in bracken extracts that produce the symptoms in livestock and lab animals. The young bracken fronds are served as a delicacy in Japan and appear to be responsible for a high incidence of stomach cancer there. Transfer of the carcinogen(s) from cows milk has been documented in England.

Blind Grass (*Stypantra imbricata*) contains an unidentified substance that affects the nervous system and causes neurological disturbances that are often fatal or result in permanent blindness with vacuolation of myelin in the brain and spinal cord. The optic nerves gradually disintegrate until they become only small strands of scar tissue.

Blue Green algae produce toxins called cyclopeptides. When the algae blooms in rivers, lakes, water tanks and in the ocean, they kill many animals which live in or drink the water. The toxin is potent and causes major liver damage. Its LD50 for purified toxin extracts in mice is .056 mg/kg of body weight. In sheep, feeding a single dose of dried blue green algae at 730-950 mg caused no lesions, while 990-1040 caused mild sublethal changes. Doses in excess of 1040 mg were lethal. (that is only slightly more than one gram). The algae blooms are most toxic when the cells are rapidly proliferating or disintegrating.

A group of dermatitis causing substances are produced by Poison Ivy, Poison Oak and Poison Sumac. Although not considered a poison or directly toxic, the substances have enhancing value when combined with other materials. The principal compounds in these species affect almost all human beings at very tiny doses. The substances are generally insoluble in water, but soluble in alcohol, acetone and other solvents. They are not volatile and are extracted as liquid drops. The four principal substances characterized so far are –

|                       |  |
|-----------------------|--|
| Pentadecylresorcinols | Cashew Nut Oil                             |
| Pentadecylcatechols   | Poison Ivy, Poison Sumac, Poison Wood Tree |
| Heptadecylcatechols   | Western Poison Oak                         |
| Pentadecylphenol      | Cashew Nut Oil                             |

The active principals (above) from these species of the Genus *Toxicodendron* is called urushiol which is a group of closely related substances. Chemically they belong to a class of substances known as alkylcatechols. When administered orally or dermally, they are rapidly absorbed, and even when the skin is excised the dermatitis reactions still occur.

The reaction usually takes place at 1-2 days after exposure if the previous exposure to poison ivy (sumac or oak) took place in the last five years. The reaction occurs in 5-7 days if the last exposure was 6-20 years. The reactions occur from exposure to 2-2.5 micrograms of pure urushiol which is the approximate amount present on the surface of a leaf. About 35% of the population are subclinically sensitive and require and will react only to doses of 5-100 micrograms.

The effects of these substances can be so drastic that they can cause disability and hospitalization. In California it is responsible for over 50% of workers compensation claims. The severity of the response varies greatly among individuals and with dose. If the dose is sufficiently large (one gram or more) the reaction can occur very quickly in most individuals. Erythema develops and edematous swelling begins. The rash may be limited to the area of contact or spread over the entire body. Previous reaction sites may flare up again. In the next 24 hours, blisters form and exudation may be marked. Intense itching is a prominent and consistent effect. Crusting and scaling occurs over the following days and is usually over by day 10. Topical steroids are usually used to treat the worst areas.

The leaves are the main source of contact in nature and often leave tiny scratches at the point of contact. The compounds are present in the sap in volume but can be found in varying amounts in the roots, stems, leaves, pollen, flowers, and fruit. The summer is the peak time for sap production.

The character of producing itching and scratching make these substances highly effective when combined with infective bacteria, viruses, toxic chemicals and other weapons materials (including plant substances such as the oxalates described earlier). The scratching creates a self inoculating method of distributing effective weapons in environments where gas masks are used. The target individuals do not know they have been exposed until the itching begins. They scratch the primary weapon into and under their skin.

# Chapter 4

## Toxin Extraction & Concentration

There are several steps in acquiring plant toxins for use in weapons. These are –

1. Acquiring the plant or plant parts. This can be accomplished by learning what the plant looks like and finding in the field. It can also be done through direct purchase of the plant from garden and other related shops. With the advent of the internet, you can find the seeds for almost any species on earth as well as instructions on how to grow them yourselves. This book serves only as a beginners guide for plant recognition and growth.
2. Plant preparation. Once the plant and/or parts have been acquired, they must be prepared for toxin extraction. The toxin may be in the sap, in the bark or stem tissues, or may be encased inside of individual and very tough cell walls within the seeds. You need to know the general location so you have the right part and then generally what is necessary for its extraction.

The plant tissues that contain the toxin is a mix of various materials that include liquid sap, individual cells, vascular tissues and other substances that are built out of cellulose and related chemical structures. To liberate the toxins so that they are free in a liquid that you add to extract them you can do one or more of the following –

- a. Grind the material into tiny particles, This physically breaks down the tissues into their smallest components and often shatters individual cell walls liberating the internal contents. This can be done with a kitchen blender over a few minutes to as long as an hour depending on the material being extracted. It can also be done with commercial dry grinders.
- b. Soak and mix the material in a mild acid, alkali, water or organic solvent. If the toxin is not generally encased in a tough cell wall, the above liquids can solubilize the toxin and pass it through and around tissues so it is liberated into the liquid overall fraction.
- c. Heat or burn the solids. Some toxins are heat resistant and the use of heat can soften, weaken or destroy the bonds holding plant tissues together. Sometimes the toxins can be liberated in this manner.
- d. Enzyme attack. Some enzymes such as cellulase enzymatically attack and destroy the bonds holding plant tissues together. These generally do not affect other types of substances and can be used to liberate toxins.

- e. Crushing. Sometimes an extruder can be used to crush the individual cells rapidly. The cells burst under the pressure liberating their contents which can then be mixed into a liquid and extracted.
3. Toxin dissolving. There are generally two ways that toxins are separated from the surrounding tissues and substances. First, the toxin can be dissolved into a solvent that it is soluble in. Once in solution, the excess liquid containing the toxin can be decanted or filtered off. Usually, there are other materials that are also soluble in the extracting fluid. Second, the plant tissues can be dissolved in a liquid that the toxin is insoluble in. This allows you to pour away the plant and leave the toxin behind.

The science behind this is best explained as follows. Almost any type of plant material will go into a liquid solution and dissolve into it. When you add 1 # of table salt to 10# of water and stir it at room temperature it will dissolve into it. Each molecule of salt floats around in the water separate from the other salt molecules because it is soluble and the water has enough energy to hold all the salt up in between its own molecules. If you keep adding salt up to 10# or more, the water can no longer hold it all between its own molecules so some of it precipitates, or rains out onto the bottom of the jar as a solid layer of material. If you heat the water, you add more energy to it and with this extra heat energy, the water can now hold up more salt in solution and you will see all the salt dissolve into it. As you cool the water, the salt will “salt out” or rain out as a solid. As you approach freezing, the water loses so much energy that most of the salt drops out. This is one of the most basic principles of separating substances.

Some plant materials are soluble in water but most are not because they are made up of woody tissues that are held together too strongly. If the toxin is water soluble and most of the plant is not, you can extract the poison using the simple method that most of the ancients did. Simply soak the plant in water and mix it so the toxin is well dissolved and distributed into the water. If you have 20 parts of water and one part plant, then after soaking for an hour or a day, you can simply pour off the water leaving all the solids behind in the jar. This is called decanting. If the sample was ground to a mush, then the water can be stirred until all the poison is in the water fraction and then the sample is left to settle. If the jar is 10 inches high and full, and the mush is 1 inch high settled on the bottom, then you can obtain up to 90% of a water soluble poison simply by pouring it off into another container leaving the plant mush behind. If you want to extract the last little bit of toxin, you can add another 9 inches of water, remix the sample, resettle it and pour it off again to remove 90% of the remaining liquid fraction with 90% of the water soluble toxin.

Some toxins are not soluble in water but are soluble in other materials. They can be organic solvents like the isopropyl alcohol in the health and beauty section of the Wal-Mart stores. You can also use kerosene, acetone, ethanol and other similar liquids.

Some materials are soluble in a solution at a low or high pH and not soluble at other pH levels. By adding baking soda or vinegar, you can increase or decrease the pH and separate the toxin from other materials.

4. Toxin Separation and Concentration. After toxins are extracted and in solution, you can simply let the solution dry with the toxin mixed in with the other materials like the Amazon Indians did in preparing their poison arrows. You can sun dry the solvent or water until you have a pasty or dry material. You can also put it in the oven or microwave at low temperatures to speed up the drying. You can also put the liquid and toxin in a pressure cooker and add a hose and fitting to the steam release valve. Attach the hose to a vacuum pump that sucks the air out and the water will evaporate off very quickly at room temperature and even close to freezing. This works well with heat sensitive toxins. At this point you have a poison diluted in other materials. Sometimes this can be highly diluted.

There are several methods of further separating the toxins from these other materials. You see long lists of direction in patents for separating the parts so you can get a completely purified material. For use in effective weapons, this is completely unnecessary and too complicated. We gave the example of the patent methods for extracting Ricin earlier. The multiple steps for extracting the last ounce of water soluble Ricin using filtering and other methods listed in the patent can be ignored. If the plant material is broken down and then mixed into the water, the Ricin dissolves into the water. By simply mixing and adding more water and then letting it settle, you can pour off (decant) and recover most of the Ricin in the water without difficulty.

Once the sample is dry, you can then mix another, different kind of solvent to the dry materials. If you used water the first time you can now mix the dried solids into kerosene or isopropyl alcohol. Ethanol or methanol can also be used. Some of the solids will dissolve into the new liquid and some will remain solid. By pouring off and drying both parts again, you now have two separate fractions. One will contain most or all of the poison and the other will not. You can feed small samples of the fractions to pet mice and observe the reactions. Most poisons will act on mice in high doses as they do on humans and this will be a quick way of telling which fraction contains the largest poison dose quickly.

A third way of separating and purifying is adding another special solid to the liquid. Most chemists use ammonium sulfate (a common fertilizer and best choice), sodium sulfate (also called glauber salts and is both a livestock feed and fertilizer), or ordinary table salt.

The choice of salt is made. Instead of letting the liquid dry, you now add 10% ammonium sulfate, or your choice of salt to the mix. The liquid has enough energy to hold up only so much of the mix of substances. When the salt is added, it displaces some of the mix. The water or solvent cannot hold up everything so it drops the heaviest (usually) molecules that are in solution. At 10%, only a small fraction of the mix “salts out” or precipitates. The toxin might salt out or might still be in solution. The liquid is filtered off and the solids on the filter are tested in the pet mice. Another 10% ammonium sulfate is added to the liquid which now displaces more of the solids. The solids are allowed to settle out, usually overnight and then these are filtered off. This process is repeated up to 50 or 60% which by then drops everything else but the salt out (usually).

The entire process above is called fractionation. This allows you to separate all the solids in a liquid solution into fractions. One fraction will contain most of the toxin and now you have a strong concentrate.

When scientists work to completely purify a substance, they will add pH adjusters like vinegar and baking soda to create more fractions. They can also chill the liquid which causes it to lose energy. If it is holding a mix of substances, slow cooling will drop out materials, usually one layer or substance at a time and you can even see the different layers on the bottom of the jar. Separations are sometimes done in the cold to prevent some materials from reacting with each other when they become very concentrated.

There is little need to completely purify most poisons. Some poisons kill at as little as 1 microgram. This amount is  $1/1000^{\text{th}}$  of a milligram which is  $1/1000^{\text{th}}$  of a gram. There are over 25 grams in an ounce. A substance that can kill at one microgram is a very nearly invisible, tiny speck of dust.

Mixtures of these substances can be used in combinations weapons. One of the weapons ideas already described was the mixture of poison ivy extract with Anthrax. The basic idea was to be able to coat the material onto a post card or outside of an envelope. Once the recipient handled the card, and would even throw it away, they would have a small amount of it on their hands and skin. After a while, the itching would begin and the target would scratch the infecting anthrax into their skin where it would germinate and grow.

[I considered applying for a patent for the above method of producing self inoculating weapons. One of the patent claims would have been for “a method of removing dishonest governmental institutions and their personnel from power and use as my example, the employees of the US patent office. Since the patent examiners are supposed to find a similar claim that has been previously filed as the basis for rejection, I was curious to see how they would have handled this one.]

Perhaps the most important properties of these types of weapons is that-

1. They can be grown by anyone
2. The possession of most of the plants and or seeds are legal for anyone to have
3. The final toxin amounts are so small that they can be applied to a piece of tape and taped to the page of a book for later use. They can be solidified into material resembling dirt and be carried under or on the floormat of a car or even the inside of a shoe.
4. They can be mixed into plastics for dissolving and use later. In some cases, jello and similar foods can be used as disguise.
5. You can even carry some of them under a fingernail where a single scratch can be fatal.
6. You can apply the toxin to one side of a knife and butter the targets bread for them. You can turn the knife over and use the clean side for your own bread which would allow for a clean assassination in front of many witnesses and guards without arousing suspicion since you ate from the same butter, knife and bread as well.
7. You can even grow your own nerve agents (VX as a powder) which does give you a small military scale weapon that you can safely carry.

The ability to use these types of weapons is limited only by the imagination. The ability to grow, extract and concentrate them is limited only by ones knowledge of plant life and basic laboratory methods. Knowledge is indeed power. Especially in a world where the governments control military and police state institutions and often do what they wish to unarmed populations. Anyone can arm themselves as long as knowledge is legal or available. The most important weapon is not the gun. It is the know how that cannot be searched for and seized. It is the invisible knowledge carried in a persons head, and the invisible seeds growing underground, on jello or even on a persons shirt under a fingernail that give people power that governments cannot take away. The knowledge in this book will long outlive its author and will hopefully help future generations keep the power of government in their own hands rather than the hands of government employees, so intoxicated with their own self importance and power that they think they can do anything to anybody.

# **Chapter 5**

## **Poisonous Plant Description and Identification**

This chapter will illustrate and give descriptions for most of the plants and the toxins already mentioned in the book. Many more plant will be described in the supplement to this book. It is a 980 page work on Poisonous Plants of the World. It was written in the early 1900's and is one of the best early works on the subject that this author has ever seen. Its copyright has expired and it will be included with this volume.

The plants will be presented according to the main toxin bearing group they were described with. At the end of the group sections, various other toxin producing plants will be illustrated that are not categorized.

1. Alkaloid Producing Plants
2. Glycoside Producing Plants
3. Oxalates
4. Protein & Amino Acid Producers
5. Tannins
6. Unclassified

## Ragwort (*Senecio jacobaea*)



There are several related *Senecio* species. Ragwort pictured above, *S. longgilobus* also known as Threaded Groundsel, and *S. vulgaris* or Common Groundsel. Ragwort is biennial or perennial growing to 4 feet tall. Its yellow flowers form a showy cluster (corymb) at the end of the stem. The branches are variably “cottony”. It has erect angular grooved stems branching above halfway with the branches pointing upwards. Basal leaves are light green, lyrate pinnatifid and usually dead before flowering. Middle leaves eared and pinnatifid. Fruits indistinctly longitudinally grooved.

The species are found throughout the United States but mostly in the northern states, especially the northwest. It is seen in sparse woods and at the edge of woods, mostly in the lowlands. Of the 3,000 *Senecio* species, most produce high levels of at least six pyrrolizidine alkaloids of which jacobine is the primary toxin. The entire plant is poisonous and milk from grazing animals and honey made from nectar have also contained the alkaloids.

**Rattlebox**  
***Crotolaria sagittalis***



Rattlebox is a bushy short lived perennial or annual. It has downward pointing arrowlike stipules. The leaves alternate, are simple, lance shaped to elliptical. Flowers form 1-4 or 2-4 racemes, are yellow and fade to white. Its black pods rattle when dry which is why it is called rattlebox.

It is found in dry rocky prairies and fields of the eastern US to the East Great Plains southward. Related species are cultivated in Florida (*C. retusa*). Other species are found throughout the US. It is believed to be the source of bottoms disease which killed many horses in the 19<sup>th</sup> century.

The entire plant contains pyrrolizidine alkaloids that cause liver disease.

**Poison Hemlock**  
**(Conium maculatum)**



Hemlock is a tall annual or biennial 4-8 feet tall with a purple streaked or spotted stem (higher up) that is finely grooved, and round. Leaves are intense green, carrot or fernlike, lacy and delicate in an equilateral triangle with 2-4 pinnate and glabrous. Its flowers are white, umbels with bracts and its fruit is ovoid, glabrous, with wavy ridges. It has an unpleasant mouse odor that is stronger when it is crushed due to the alkaloid coniine. The young plant resembles a wild carrot.

Hemlock is native to Europe and is found throughout the US, mostly in waste ground, and is not found in deserts.

Alkaloids are found in all plant parts and accumulate up to 3.5% in the fruit, mostly in the inner wall called the coniine layer and in the roots. It has a curare like action and is the poison whose symptoms that Plato described in detail while watching Socrates die from it

## **Tobacco** **(*Nicotiana* species)**



Nicotiana can be annuals or perennials as large shrubs or small trees 3-9' tall. Its flowers are tubular with five flared trumpets, and can be red, white, yellow or greenish yellow. Leaves are simple and opposite with smooth edges and are often broad, hairy and sticky. The fruit is a capsule with numerous tiny seeds.

The entire plant is poisonous with tobacco cultivated for use in cigarettes. The alkaloid nicotine is fatal if ingested in small amounts with a single leaf producing a fatal dose. It is rapidly absorbed through the skin, lungs and mucous membranes. Smoking with injuries in the mouth has caused fatalities.

The *Nicotiana tabacum* is mass produced in the southeastern US and in many other countries. Various species are naturalized and widespread throughout the entire US.

## **Strychnos Nux Vomica (Loganiaceae Family)**



Strychnos is a small tree with yellowish-white tubular flowers growing in terminal clusters. The leaves are ovate about 2 x 3.5 inches in size. The fruit is hard shelled and its color varies from yellow to orange and resembles a small grapefruit. The fruit has several velvety seeds that resemble buttons about the size of a dime.

The plant is grown in Hawaii and is native to India and Sri Lanka where Indians extracted strychnine for medicinal and poisonous purposes.

The entire plant is toxic, particularly the seeds and it contains a mix of alkaloids, primarily strychnine.

## **Golden Chain (*Laburnum anagyroides*)**



Golden Chain is a showy small tree or shrub that can reach 30' in height and produces golden yellow sweetpea shaped flowers in masses to  $\frac{3}{4}$  inch long. As many as 10-20 flowers occur in showy hanging racemes that reach 18 inches in length. Branches are wide spreading and drooping. Alternate leaves divided into three leaflets on long stalks. The underside of the elliptical leaflets has light gray down. Its seeds are flat, dark brown and contained in flattened pods which are silky, persistent, 2" long.

Laburnum species are widely cultivated in the southern US and are often seen in gardens and parks. They are native to Europe.

All plant parts are poisonous, especially the seed and flowers. The primary alkaloid is cytisine which is related to nicotine. It is responsible for more poisonings in Great Britain than any other shrub except the Yew, mainly due to children playing with the pea like pod and seeds and swallowing them. Vomiting usually prevents ingestion of fatal doses.

## Jerusalem Cherry (*Solanum pseudocapsicum*)



This is representative of the *Solanum* which is a very large genus containing more than 1,700 species. The plants are mostly herbs (sometimes climbing) or shrubs. They can have stinging hairs and are often spiny. Its flowers are usually five toothed and showy, and white or blue in color. The berries can be black, orange, red or yellow.

The species pictured above has escaped from cultivation in Hawaii and the Gulf Coast states. It is also a decorative pot plant.

In most cases the poison is ingested from the fruit but other plant parts are poisonous as well. The entire plant contains a mixture of Solanine glycoalkaloids.

## **Deadly Nightshade (*Atropa belladonna*)**



Known by many names such as deadly nightshade, climbing nightshade, black nightshade, sleeping nightshade and others. These are perennial plants about three feet tall with many branched stems. The leaves are 6" ovate and are paired with one larger leaf always with a smaller leaf.

Its flowers about 1" long, are single and emerge from the leaf joint. They are purple-blue to dull red, are drooping, and are bell shaped. The seed pictured above is nearly globular, about ½ inch across and is shiny or glossy black or purple when mature. They are seated on a star shaped calyx. Its roots are a thick rhizome and its sap is reddish.

*Atropa* is native to Eurasia and North Africa. It is usually found in cultivation only in the US but is sometimes seen as a specimen plant in gardens. The name *belladonna* comes from the use of its juice by Italian women as a cosmetic aid to dilate the eyes.

The entire plant contains toxic alkaloids including atropine, scopolamine and L-hyoscyamine. It is one of the earliest known poisons and is well established in historical works as a narcotic stimulant and assassination tool. Plants grown in higher altitudes and on heavy soils produce greater concentrations of the alkaloids. The unripe fruits and seed contain mostly L-hyoscyamine but the ripe fruit contains atropine almost exclusively.

**Death Camas**  
**(*Zigadenus venenosus*)**



Death Camas grows 4-15" high and is slender to stout. Its leaves are grass like and are up to 12" long. Its flowers are numerous in a thick spike along the top of the central stalk. They are usually yellow or whitish green. Its stamens exceed the number of petals. The petals are obtuse and its bulb is globe shaped (onion-like).

*Zigadenus* species are found throughout the US except in the extreme southeast and Hawaii. It is also found throughout Alaska and Canada.

All plant parts contain the toxic alkaloids Zygadenine, zygacine, iso- and neogermidine and protoveratridine.

## **Monkshood, Wolfsbane, Larkspurs (Aconitium species)**



Aconitium species are perennial plants that are usually erect, have stout stems, sometimes branched and stand 2-6' in height. They have tuberous fleshy roots and physically resemble delphiniums (which are also known as Larkspurs). They have characteristic helmet shaped sepals with visorlike beaks to 1" tall. The flowers grow in a dense raceme at the top of the stalk and appear in summer or fall. The flowers are normally blue but can be flesh-toned, pink or white. The dried seed pods contain many tiny shiny black, triangular seeds, winged at the angles. The leaves have 5-7 segments, are deeply divided, dark green, and become smaller toward the top. It is a highly polymorphic species.

All monkshood species are native to the northern temperate zone and are found in Alaska and Canada. It is native to the Alps and other mountainous regions of Europe as well as England and Portugal. The species are cultivated throughout the US except in the hottest areas. They are also found in many flower gardens. They grow best in wet, well manured soil.

The entire plant is poisonous, with the leaves and roots as the most toxic parts. The plant contains Aconitine and many other related alkaloids. It is one of the most widely used medicinal and poisonous plants of European history.

## **Jimson Weed, Thorn Apple (*Datura stramonium*)**



Jimson weed is an annual with a smooth, stout stem that is hollow, upright, simple or branched (forked) and grows 3-5' tall. The leaves have a long stem and are 6-8", lobed, petiole, ovate, jagged toothed, angled, dull green and smell bad. The white to pale violet flowers are funnel or trumpet shaped, single, are showy and large (3-5") and point upward. The prickly fruits are large green capsules app. 2" across which split open along four seams exposing many small kidney shaped, reniform, brownish (unripe) to black seeds when they are mature and ripe. They are sharp spined (above) turning distinctly brown at maturity.

*Datura* is a weed found in all parts of the US, Canada, and the West Indies, but not Alaska. Usually found in ditches, pastures and waste ground. It prefers sandy nutrient rich soils and loam.

The entire plant contains toxic tropane alkaloids including the nectar. The seeds and dried leaves are used to induce deliberate intoxications. Young plants contain mostly scopolamine and older plants mainly hyoscyamine. It causes severe hallucinations and its name comes from the Jamestown epidemic. In the early west, horse dealers would tell prospects "even the most miserable worn out nag will become as frisky as a thoroughbred when you stick a couple of rolled up leaves up its rectum". The dried leaves have long been used as a fumigant for bronchial asthma.

## Henbane (*Hyoscyamus niger*)



Henbane is a fairly, erect, annual or biennial weed up to 2 ½ feet tall. It has large (up to 8”) leaves that are oval, oblong, wavy, coarse and irregularly toothed. Lower leaves are short stalked and the upper ones clasping. The flowers emerge singly just above the leaves from the main stem. They are yellowish-white to a dirty greenish-yellow with a purple throat and veins. The seeds are contained in a globular capsule or pod with flared, persistent calyx and up to 200 black seeds. It has an unpleasant smell and is sticky.

It is native to Europe and was introduced into the US and can be found occasionally in almost all of North America. It is mostly seen in waste areas of the northeastern US and in all of Canada’s provinces, usually in nutrient rich sandy soils and loam.

Also called by various “Nightshade” names, insane root, poison tobacco and others, it is one of the famous poisons of antiquity. It contains tropane alkaloids that produce intoxication, hallucinations and death. They include atropine, hyoscyamine, and scopolamine. 17<sup>th</sup> Century breweries added seed extracts to strengthen weak beers and grew the Henbane on plantations for this purpose.

## Plants Producing Glycosides

### **Chokecherry (Prunus species)**



Prunus species are trees and shrubs growing 12-60' tall, usually with oval, deciduous leaves that alternate and are mostly serrate. The flowers are white or pink in a thick raceme with five petals and sepals. The fruit is a drupe with a fleshy outer layer over a stone or pit. It is round and lustrous scarlet to blackish red.

Prunus are widely cultivated in the northern temperate zone. Their trivial names include apricots, peach, plums, almonds and sloe. There are a number of native species and fruit varieties available commercially.

The kernel in the pit is poisonous. Most fatalities come from ingestion of the pits. The cyanogenic glycosides produce hydrocyanic acid on hydrolysis so soaking the ground pits produce the cyanide toxin which has an almond odor. Seeds, fresh and dried leaves, twigs and bark can also contain the toxins. Children have been poisoned chewing on the twigs.

**Bracken Fern**  
**(*Pteridium aquilinum*)**



A most common fern, 3-6' tall forming large colonies. Leaves (fronds) are triangular in outline and divided into three parts. Its leaflets are blunt tipped, the upper ones not cut to midrib. The underside is mostly woolly and the top is nearly smooth.

Bracken Fern is widely distributed throughout North America. It is found in barren soils and in many plant communities. It is rarely seen in the plains.

It produces thiaminase enzyme that disturbs thiamine metabolism. It is also well known for water soluble cancer causing compounds that can be passed on through the milk of mothers and grazing dairy cows. Fern properties were well known to the doctors of antiquity who prepared doses of it to kill worms in livestock and humans.

**Cassava, Tapioca, Manioc, Sweet Potato  
(*Manihot esculenta* Crantz)**



Cassava is a bushy shrub that grows up to 9' tall. It has alternate leaves that are deeply parted into three to seven lobes. It has milky juice. Its roots are long and tuberous.

Cassava is cultivated in Hawaii, the gulf coast states, Guam, the West Indies and Florida. The large swollen tuberous roots are peeled, boiled and mashed to detoxify and prepare them as a food crop. Tapioca is a refined product of the plant.

The roots are poisonous containing as much as .4% of linamarin and the leaves contain variable amounts of the toxin. The glycosides react to form hydrocyanic acid. Ingestion after some time period can be fatal.

## Common Garden Foxglove (*Digitalis purpurea*)



Foxglove is a rough, felt-like biennial herb that grows 2-4'. The rosette of leaves are oval to lance shaped up to 1' long, crenate, round toothed in basal rosette the first year. The lower leaves are long-petiolate and broad. The upper ones are short-petiolate or sessile and narrower. It has an erect unbranched stem the second year. The flowers are spotted thimbles up to 1 1/4 inches long on showy spikes in the second year. They are terminal in often one sided racemes. The corolla is cylindrical campanulate, purple, rarely white, with red spots on the inside. The fruits are ovoid green capsules, dehiscent on two sides with many small seeds.

Native to western Europe it has been widely cultivated and escaped. It is found in open areas of forests and in felled vegetation on sandy loam. It avoids alkali (chalk) soils. It is often planted in gardens.

Foxglove contains cardiac glycosides (*Digitalis*) used in medicine and the entire plant is considered poisonous. The leaves are very bitter, and this discourages consumption. The digitalis also encourages vomiting. Two to three dried leaves can produce a fatal dose.

## Oleander (*Nerium oleander*)



Oleander is a shrub 3-20' tall. It has dull, long, narrow, dark green leaves in whorls of three that grow about the stem. Or they can be opposite, lance shaped, without teeth that grow to 10". Flowers are 1-2", are trumpets, five parted in small showy clusters and can be purple, white, yellow, red or pink. Fluffy winged seeds develop in long narrow capsules which are 3/8 x 5" long and are released into the wind. Fruiting is rare in cultivated plants.

A native to Europe and the Mediterranean, it has been widely naturalized and cultivated as a container plant outdoors in warm climates in the US. It is also used as a tub plant.

The entire plant contains a cardiac glycoside called oleandrin which is similar to digitalis. Smoke from burning branches has caused poisonings but the ingested plant parts often cause vomiting before the toxin is absorbed. The water that the plant is placed in has also become poisonous.

## **Green Milkweed (*Asclepias viridiflora*)**



Green milkweed produces flowers that are greenish in broad, somewhat flat clusters. All milkweeds are perennials that generally have stout and densely hairy stalks. They produce a milky sap and flowers in showy globe shaped clusters. The flowers can occur in small umbels and varying colors. Leaves are usually opposite, broad at the base, soft and hairy underneath. Some produce warty “milkweed” pods.

The milkweed above flowers in May through September.

There are over 20 species of milkweed broadly distributed throughout North America. They are common to roadsides and pastures.

The milkweed roots have long been used in folk medicine. The entire plant contains cardiac glycosides that have often caused livestock fatalities when mixed into hay or grazed.

## Buttercup Family (Ranunculaceae)



Seen above is a field of buttercups in a meadow mixed with other flowering plants. The buttercup family (300+ species) consists mostly of annual or perennial herbs found largely outside the tropics in the northern hemisphere. It includes many ornamentals as well as toxic species of hellebore, monkshood and delphinium. It is found along roadsides, in undergrowth and in abundance in meadows.

The meadow buttercup seen above grows 1-3 feet tall with erect sparsely branched stems. Its lower leaves are palmate, 5-7 main segments divided into narrow toothed lobes, initially pubescent. The upper ones are short petiolate or sessile and simpler. The flowers are conspicuous golden yellow on terite pedicals. They contain 5 to as many as 20 petals. Fruits are numerous on a glabrous cluster (one seeded achenes) and small.

All buttercups contain an acrid skin irritant that causes blisters. The celery leaved buttercup is the most toxic along with the meadow and bulbous buttercups, and crowfoot. The dried plant is not toxic. The sap in the fresh plant contains the glycoside protoanemonin. It is very irritating to the skin with blistering and ulceration. (An ideal component of combination bacteria weapons). The plants acrid taste prevent's ingestion. At one time, beggars in Europe applied the sap to their feet to induce greater sympathies.

## Plants Producing Oxalates

### **Dumbcane (Dieffenbachia species)**



Dumbcane are tall, highly variable, large, smooth, erect unbranched perennials with large oblong to oval leaves up to 15” long, and is splotted with ivory markings. Leaves are mottled with shades of green to yellow, Stems are usually sheathed up to half their length. The flower is a greenish spathe.

Dieffenbachia species are cultivated outdoors in Hawaii and Florida and it is a very popular greenhouse plant. Its popularity as a decorative plant for offices, waiting rooms and lobbies is second only to *Philodendron*.

The leaf contains the calcium oxalate and other toxins. Chewing on the leaf produces immediate intense pain and various injuries already described in the toxin chapter. Severe cases have caused speech to become slurred, hence the nickname “dumbcane”. They also produce contact dermatitis.

## Rhubarb (*Rheum rhabarbarum*)



Also known as the wine plant, it is a perennial with stalks that grow to up to eight feet long, are grooved, and turn red at maturity. It has large ovate leaves with wavy margins and wrinkles. Its flowers are small and whitish on large conspicuous branching panicles.

Rhubarb is native to Europe and is widely cultivated in the US (except for the south) for its edible stalk. It is seen in the wild in old gardens and farm sites.

The leaves contain oxalate salts that can cause intense pain if chewed and anthraquinone glycosides. They are toxic in very modest amounts burning the mouth, inducing vomiting and causing internal bleeding.

## Plants Prouding Toxic Proteins

### **Castor Beans (*Ricinus communis* L.)**



Known as the castor oil plant, it is a bushy annual or perennial that grows up to 15' tall and higher in the tropics. Its stems can be green, red or purple and 3-15' long. It has large leaves, palmate, with 5-11 oval to lance shaped lobes up to 3' across. It has female flowers in burr-like clusters above and male flowers underneath. Spiny seed pods form from these clusters along spikes. Its pods contain three oval, plump seeds called "castor beans". They can be brown on white or mottled black in color.

The castor beans have been cultivated for centuries for the oil from the bean and the oil has been found in Egyptian graves dating to 4000 BC. It grows wild throughout the West Indies and is a naturalized weed along the gulf coast from Florida to Texas. It can also be found in New Jersey, southern California, and Hawaii as well as tropical Africa.

The seeds of the plant produce castor oil and are poisonous. They have been used to make necklaces. The seed cake contains the toxin Ricin (a plant lectin-toxalbumin). A single seed can kill an adult (1 mg dose). The leaves are less toxic and can cause dermatitis.

## Rosary Pea (*Albus precatorius*)



A member of the pea family, it is a twining vine that grows up to 10'. Its leaves are pinnate, compound with 16-30 small leaflets. The flowers are small in racemes in leaf axils and are red to violet in color. Its seeds are glossy with  $\frac{3}{4}$  scarlet and  $\frac{1}{4}$  black.

It is common in South Florida and is cultivated elsewhere. It also is found in the wild (escaped). Its attractive seeds are used to make necklaces.

The seeds contain a phytotoxin that is toxic enough for a single one to often be fatal if it is chewed. If it is not chewed, it passes through the digestive tract without harm.

**Black Locust**  
**(*Robinia pseudoacacia*)**



The tree grows to 80' tall with glabrous spreading branches. Its compound leaves have 7-19 ovate-elliptical imparipinnate leaflets about 1 inch in length and stipules in the lower part of the crown spinose. A pair of woody thorns 1" long occur at the base of the leaf stem. It has up to 15-25 white fragrant pealike flowers, initially erect, later pendant, in racemes in May-June. The fruit is a reddish brown pod that is flat, leathery and parchment like and is 4" long. It persists through the winter.

The Black Locust is native to the Smoky and the Ozark Mountains and is widely planted in the northern US and southern Canada. It is also naturalized in Europe.

The bark especially, seeds and leaves contain plant lectins similar to ricin called "Robin and phasin" as well as a glycoside. Tea prepared from the berries has been fatal.

**Akee**  
**(*Blighia sapida*)**



The akee is a tree that reaches 30-40' in height. Its compound leaves have five pairs of leaflets that can be up to 6" long. Its flowers are small and greenish white and it bears a bright reddish fruit pod that splits at maturity. The pod produces three shiny black seeds inside a snowy white waxy aril.

*Blighia* is found in the West Indies, Hawaii and Florida. It was named after Captain Bligh who noted the toxic effects on his crew in his diary.

The toxin is an amino acid called hypoglycin A. It is concentrated in the arils in the immature fruit and in the pink raphe attached to the aril. Poisoning from the fruit reaches epidemic levels in Jamaica in the winter and is known as vomiting sickness.

## Plants Not Previously Classified

### Water Hemlock (*Cicuta* species)



Most species of *Cicuta* are biennial and grow up to 6' tall. They are stout, smooth, purple streaked or spotted and rank smelling. The leaves are multiply compound, divided into two to three segments. The leaflets are lance shaped and coarsely toothed. They produce small, whitish, heavily scented flowers that occur in loose, flat umbels in May-September. The mature plant produces a bundle of chambered, tuberous roots.

The *cicuta* are found throughout North America and are the most toxic plant to be found in Alaska. They are found only on wet or swampy ground.

If the stem is cut, an oily yellow sap emerges and smells like raw parsnip. The sap contains cicutoxin which can be fatal in very small doses. It is one of the poisons of antiquity. The toxin is most concentrated in the chambers of the root where a single bite, mistaken for wild parsnip, can be fatal. Mortality for children in accidental ingestion's has exceeded 30%.

**Dogbane**  
**(*Apocynum androsaemifolium*)**



A member of the same family as the Oleander, Dogbane is a perennial standing to 4' tall. It has stems that are reddish with milky juice. Its leaves are dark green, smooth on top and oval. The flowers are drooping pink bells with red stripes inside, and occur in leaf axils and terminal during June-August.

It is found throughout North America except for Kansas and parts of the southeast, usually in dry thickets.

Contains the cardiac glycoside apocyanamarin in the stem and leaves. A dose of ½ ounce of dried leaves has killed farm animals. The milky juice is very bitter which discourages accidental ingestion.

## Poison Ivy (*Toxicodendron radicans*)



Ivy is a variable trailing vine that climbs using aerial roots. Its leaves are shiny and alternate with three pointed tipped, irregularly toothed leaflets and smooth on top, hairy underneath. The middle leaflet has the longest stalk. Its flowers are pendant in small axillary clusters. The male and female are on separate plants and flower in June to July. All toxicodendron species have smooth or hairy white fruit in pendulous clusters from leaf axils that emerge in August-November.

It is found throughout North America, mostly the eastern half in woods and marginal areas, thickets and slopes.

Most of the US population are allergic to this plant group. All plant parts contain the sap which has irritant, non volatile phenolics known as urushiol. The oily mixture is released by the plant, with the slightest injury and binds to skin proteins. Those molecules already bound cannot be washed off.

## English Yew (*Taxus baccata*)



All yews are evergreen trees and shrubs that grow to 50' tall and have alternate, horizontal or downwards pointing branches. They have an oblong, pyramidal or irregular crown. The bark is reddish brown, thin and scaled. They produce flat, needle-like leaves to 1" long that grow in opposite pairs along the twigs. The upper side is dark green and glossy, the lower side is light green, matt, and shortly mucronate without veins. They have walled in stomata on the lower side. Its flowers are well separated, dioecious, the male ones in leaf axils of younger twigs. The hard seeds are black to green and partly exposed in a fleshy red cuplike aril (above) on the underside of the branches in June to September.

The English Yew is cultivated in the southern United States while other yews are found throughout North America. They are among the most widely planted ornamentals groups and are used extensively in landscaping with over 250 cultivars of the English Yew alone. The Japanese Yew was introduced to the US in 1862 and is also widely planted and is toxic. It prefers calcareous soils.

All yews are poisonous. All of the plant except the red aril (which is edible) contains taxine alkaloids that are extremely toxic. The symptoms include dilated pupils, dizziness, dry mouth cramping, coma and death. Chewing or ingesting the leaves can be fatal. It is a famous poison used for murder and suicide since antiquity. Julius Caesar wrote of one of the kings of the Eburones drinking a yew extract for the freedom of death over being taken prisoner.

## **Christmas Rose, Hellebore (Helleborus niger)**



The Christmas rose is a perennial standing 1-2' tall with a stout rhizome having one or more stems. The leaves are long petiolate, leathery, pedate, divided with 7-9 segments emerging from horseshoe shaped base leaflets which are oval to lance shaped and toothed at the apex.. They survive the winter. The flowers are white to pink, terminal on thick erect pedicels, five parted, 2-3" across with 1-3 scale like bracts that are green. The fruits are small black capsules of many seeded follicles on short stalks.

It prefers calcareous soils and on stony slopes. It is often seen in gardens and as an escaped plant. Native to the southern and eastern limestone woodlands of the alps, it is cultivated widely.

This plant was used as one of the first known chemical weapons used in warfare. In a well known classical account, its roots were used to saturate the diverted water of the river Pleistus, supplying an ancient city, causing the ancient Cirrhaeans to become ill and desert their posts. The city was then captured by Solon in 600 BC. The entire plant is considered poisonous.

## Opium Poppy (*Papaver somniferum*)



The poppies are tall herbaceous annuals with single erect, usually glabrous, smooth, green blue glaucous stems. The leaves are oblong, irregularly toothed, the lower ones undulate and the upper ones entire. The flowers are single, pedicel, long with spreading hairs, and showy pink, violet or white colors emerging in May to August. The fruits are the urn shaped capsules shown above. It contains many reniform seeds with a reticulated wrinkled surface.

The poppy is believed to have originated in the Mediterranean and is known only in cultivation or rarely as an escaped plant. It has been known as a medicinal plant for over 2000 years and there are more than 100 species identified today. Some of the poppies are grown for their flowers and these are seen frequently in the wild.

Dried latex from the unripe pods are the crude opium. Addictive alkaloids and the derived heroin are contained in this latex. These include morphine and codeine and have caused great pain relief and suffering. Their addiction alone is an effective weapon.