

5. In infants it is used to treat celiac disease.

Hyaluronidase

Biological Source

Hyaluronidase for injection is a sterile dry, soluble enzyme product, prepared from mammalian testes (bovine) and semen. It is capable of hydrolyzing mucopolysaccharides, the type of hyaluronic acid.

Description

It is highly soluble in water, insoluble in organic solvents. It is odourless and yellowish to white. Hyaluronidase is a mucolytic enzyme capable of depolymerizing and catalyzing hyaluronic acid and similar hexosamine containing polysaccharide. It is also a spreading and diffusing factor.

Preparation

It is prepared from mammalian (bovine) testes and semen by fractional precipitation of aqueous extracts and further refined by dialysis and sterilization by filtration and lyophilization.

Uses

1. It reduces the viscosity so that tissues become easily permeable to injected fluids.
2. It causes large area of distribution of drugs in the tissue space and facilitated their absorption.
3. It promotes diffusion and faster absorption of subcutaneous infusion.
4. It is used in hypodermoclysis as an aid to subcutaneous administration of large volume parentals.

Rennin

Biological Source

It is partially purified, milk, proteolytic enzyme from glandular layer of the fourth or true digesting stomach of the calf, *Bos taurus*. Family: bovidae

Description

Rennin has peculiar odour and characteristic saline taste. It is available as a scales or powder. It has hygroscopic nature, yellowish -white or grayish -white colour.

Preparation

For the production of rennin, the glandular layers of digesting stomach of calf are minced and macerated in 0.5% sodium chloride solution, followed by filtration. The filtrate is acidified with hydrochloric acid and rennin is precipitated by saturating the filtrate with sodium chloride. Further rennin is separated; dried and powdered. Rennin can also be prepared microbiologically by controlled fermentation of *Endothia parasitica*, *mucor pusillis* and *Bacillus cereus*.

Uses

1. Rennin is used to prepare junkets and cheese.
2. It is used to coagulate milk and hence making the milky easily digestible for weak patients.

Penicillinase**Biological Source**

It is a term that refers to bacterial enzyme elaborated by strains of bacteria. These are *E. coli*, *B. cereus*, and *B. anthracis*. Each bacterium develops its own chemical types of bacteria.

Description

It is thermolabile protein, molecular weight about 50,000.

Preparation

This enzyme produced in industries from culture of *B. cereus*. It obtained by precipitation with acetone and alcohol by fractionation from aqueous solution with ammonium sulphate.

Uses

1. To treat allergic reactions caused by penicillin medication. In past the enzyme was chiefly used to isolate bacteria from blood, body fluids and tissues of patient under penicillin treatment. As well as to determine the sensitivity of penicillin solution.
2. It may be administered as prophylactic in cases of penicillin allergy if administration of drug containing penicillin is intended.

Trypsin**Biological Source**

It is proteolytic enzyme crystallized from an extract of the pancreatic gland of the ox (*Bos taurus*). Family- Bovidae

Description

1. It is a crystalline or amorphous, yellowish white powder without any odour.
2. It is soluble in water but insoluble in alcohol or organic solvents.
3. It is stable in air but the solution should be freshly prepared because of degradation, in the presence of Ca^{2+} . Its stability is increased.

Preparation

It is obtained by alcoholic or aqueous acid extraction of its precursor trypsinogen and further conversion into crystalline trypsin.

Urokinase

Urokinase was originally isolated from human urine, but is present in several physiological locations, such as blood stream and the extracellular matrix. The primary physiological substrate is plasminogen, which is an inactive zymogen form of the serine protease plasmin. It is a lyophilized white powder soluble in water. Urokinase is used clinically as a thrombolytic agent in the treatment of severe or massive deep venous thrombosis, pulmonary embolism, myocardial infarction, and occluded intravenous or dialysis cannulas. It is also administered intrapleurally to improve the drainage of complicated pleural effusions and empyem.

Streptokinase

It is an extracellular metallo-enzyme produced by beta-hemolytic streptococcus and is used as an effective and cheap clot-dissolving medication in some cases of myocardial infarction (heart attack) and pulmonary embolism. It is available as a sterile, friable solid or white powder. It is soluble in water with maximum activity at pH 7. The solution at higher concentrations is stable for 6 hours at 4 °C, otherwise dilute solution are unstable. It belongs to a group of medications known as fibrinolytics, and works by activating plasminogen through cleavage to produce plasmin.

Muramidase

It is a crystalline mucolytic enzyme present in tears, lungs, serum, leucocytes, different tissues and secretion of animals. It contains mainly arginine aspartic acid, tryptophen, and traces of tyrosine. It hydrolyses mucopolysaccharides and is active in transforming insoluble polysaccharides of cell wall to soluble mucopeptides, especially in gram positive bacteria. Due to this activity, it is given intravenously for the treatment of bacterial or viral infections.

L-Asparaginase

This enzyme is obtained from *E. coli*. It is also contains asparaginase without antileuemic activity and it is removed during the purification of enzyme. L-asparaginase is also obtained from plant and animal tissues, fungi, yeast in pure form. It is available as white and crystalline powder, soluble in water. This enzyme interferes with the growth of malignant cells, which are not capable of synthesizing L-asparaginase for their metabolism and hence, it is used in chemotherapy of acute lymphocytic leukemia in sequential combination with other drugs.

Serratiopeptidase

It is a proteolytic enzyme derived from the bacteria belonging to genus serratia, present in the gut of silk worm. Originally, it was discovered in serratia E15 species. Nowadays, it is produced by fermentation biotechnology. Serratiopeptidase is considered as very effective bacterial enzyme and is found to have better effects than trypsin and chymotrypsin, with negligible toxicity and side effects. Serratiopeptidase has a number of therapeutic applications, like:

1. Resolution of inflammation,
2. Sputum liquefaction due to lysis of various proteins in sputum and hence lowering viscosity,

anti-hypertensive effect in experimental animals. It may even be useful in the treatment of AIDS to stop the spread of HIV. It has no major side effects, except for possible allergic reactions.

Food industries: Alcohol & beer industries, Hydrolisation of proteins, Meat processing, Baking industry, Pet food, Health food. Bromelain is also used in Cosmetic industries and Textile industries.

PANCREATIN

Pancreatin is a digestive enzyme extracted from the pancreas of certain animals like hog, *Sus scrofa* (Suidae) or ox, *Bos taurus* (Bovidae) that is used to supplement loss of or low digestive enzymes, often used in people with cystic fibrosis. It is also known as Pancreatinum and Pancreatic Enzymes.

Pancreatin is made up of the pancreatic enzymes trypsin, amylase and lipase. Pancreatin is very similar to another enzyme known as pancrelipase. The primary difference between these two enzymes is that pancrelipase contains more active lipase enzyme than pancreatin. The trypsin found in pancreatin works to hydrolyze proteins to oligopeptides, amylase hydrolyzes starches to oligosaccharides and the disaccharide maltose and lipase hydrolyzes triglycerides to fatty acids and glycerols.

Pancreatin is an effective enzyme supplement for replacing missing pancreatic enzymes used in a number of essential body processes.

Pancreatin enzymes have two important functions in the body: digestion of foods and routine cancer eradication. Pancreatin is a mix of many different enzymes and those involved in the digestion of proteins are also used to help eliminate cancers that occur. Cancer is often a disease of protein metabolism because the pancreatin enzyme cancer defense mechanism can be overwhelmed by consuming protein rich foods at inappropriate times or in excessive amounts. The body needs a time span each day approaching twelve hours or more without protein consumption for its pancreatin cancer defense mechanism to work optimally. Pancreatin enzymes can be made ineffective by contact with acids or alcohols. A diet comprised mostly of refined foods and meats may result in an acidic body chemistry that depletes these enzymes. Cancer, once established, ensures its survival by continuously generating acid as it inefficiently metabolizes food. Consuming alcoholic beverages can also interfere with the defense mechanism. Many popular cosmetics that contain acids or alcohols are a special concern for skin cancer. Mercury leakage from amalgam tooth fillings is also debilitating to many enzyme functions. It has also been claimed to help with food allergies, celiac disease, autoimmune disease, cancer and weight loss.

HELLUCINOGENIC, TERATOGENIC, ALLERGIC AND OTHER TOXIC PLANTS

HALLUCINOGENIC DRUGS

This is category of ^{drugs} which acting on the central nervous system causing mental disturbances, imaginary experiences, coma & even death. These Hallucinogens often derived from plants. Have frequently being used within a religious context. In recent years many drugs like Indian hemp, peyote and Lysergic Acid are acting as Hallucinogens. These hallucinogenic drugs are acting on the neurophysiological transmitter noradrenaline & 5-hydroxytryptamine (serotonin). There are many drugs which acts as Hallucinogenic these are

Fungi

Some of the poisonous fungi when taken orally produce hallucinations.

The Amanitas

Biological Source: It is obtained from the *Amanita muscaria* and *Amanita pantherina*.

Chemical Constituents: This genus is responsible for approx. 95% of the fatalities resulting from mushrooms poisoning, with the death cap accounting for about 50% on its own. The most important toxin present in these mushrooms is alpha amanitin (amatoin).

Amatoxin	Tryptamines e.g. Bufotenine Cyclicpeptide e.g. Phallotoxin, Amatoxins Isoxazole alkaloids e.g. Ibotenic Acid
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Pharmacological Actions: Its action appear within an hour or so of ingestion, with an initial period of excitation followed by muscular twitches, a slowed pulse rate, imopaired breathing, delirium and coma, however, ingestion of the fungus is rarely fatal.

Mexican Mushrooms: It is obtained from of small toadstools particularly species of

1. *Psilocybe (P. maxicana)*
2. *Conocybe (C. cyanopus)*

3. *Stropharia*

Chemical Constituents: The active constituents are the typtamine derivatives. Psilocybin and psilocin components are related to serotonin. These components are also found in similar toadstools (e.g., *Psilocybe* and *Panaeolus* spp.), which produces Hallucination.

Puffballs: It is a member of any of the number of groups of fungus in the division Basidiomycota. It is related to the species *Lycoperda* contain as yet uncharacterized constituents which produces auditory Hallucinogen.

LYSERGIC ACID DERIVATIVES

Lysergic Acid

Lysergic acid also known as D-lysergic acid and (+) - lysergic acid, is a precursors for a wide range of ergot alkaloids that are produced by the ergot fungus and some plants. Amide of lysergic acid, lysergamide are widely used as pharmaceuticals and as Hallucinogenic. It is obtained from dried sclerotium of fungus *Claviceps purpurea*. Family is Clavicipitaceae.

Morning Glory Seeds

Morning glory is a common name for over 9,000 species flowering plants in the family convolvulaceae, belonging to the genera: (1) *Calystegia*, (2) *Convolvulus*, (3) *Ipomoea* (4) *Merremia*, and (5) *Rivea*

The seeds of many species of morning glory contain ergot alkaloids such as the Hallucinogenic ergonovine and ergine (LSA). Seeds of *Ipomoea tricolor* and *Ipomoea corymbosa* are used as Hallucinogens. The seeds can produce similar effect to lysergic acid derivatives when taken in the hundreds. They should not be taken by pregnant woman as they can cause uterine contraction which can lead to miscarriage.

Peyote ^{cactus}

Biological Source: It is obtained from the cactus *Lophophora williamsii*, better known by it's common name is Peyote, but also sometimes called mescal button or the Divine cactus.

Description: The cactus flowers occurs sporadically, producing small pink fruit, which can be delectable and bitter-sweet tasting when eaten. The seeds are small and weak, requiring hot and humid conditions to germinate.

Chemical constituents: Peyote contains a large spectrum of Phenylethylamine alkaloids, the principle of which is mescaline. In 1973 some 36 alkaloids had been characterized from the cactus and these can be classified as:

- Mono, di-, tri- oxygenated phenethylamines and their amides.
- Tetrahydroisoquinolines alkaloids and their amides.
- Phenylethylamine conjugates with kreb's cycle acids.
- Pyrrole derivatives.

Uses: It is mainly used as Hallucinogenic agents. It is also used toothache, pain in child birth, fever, breast pain, skin diseases, rheumatism, diabetes, cold and blindness by native Americans.

Cannabis sativa

Cannabis sativa is an herb that has been used by humans throughout recorded history for its fiber known as hemp, for its psychological and physiological effects and for the nourishment of its oil bearing seeds. Synonym is Indian Hemp.

Biological Source: It consist of the dried flowering plants *Cannabis sativa*, *Cannabis Indica* and *Cannabis ruderalis*. It belongs to Family Cannabaceae.

Hemp Products: Three main types of Narcotic products are produced from hemp. These are:

- The Indian hemp or *Ganja* of the Indian pharmacopoeia (1955) is required to contain not more than 10% of its fruit, large foliage leaves and stem over 3 mm.
- Bhang or Hashish consists of larger leaves and twigs of both male and female plants.
- Charas or Churrus is the crude resin.

Description: This texon includes wild or feral cannabis plants. In the absence of selective breeding these plants have lost many of the traits, they are originally selected for and have acclimatized to their locales. Plants are often short, branchless and early flowering.

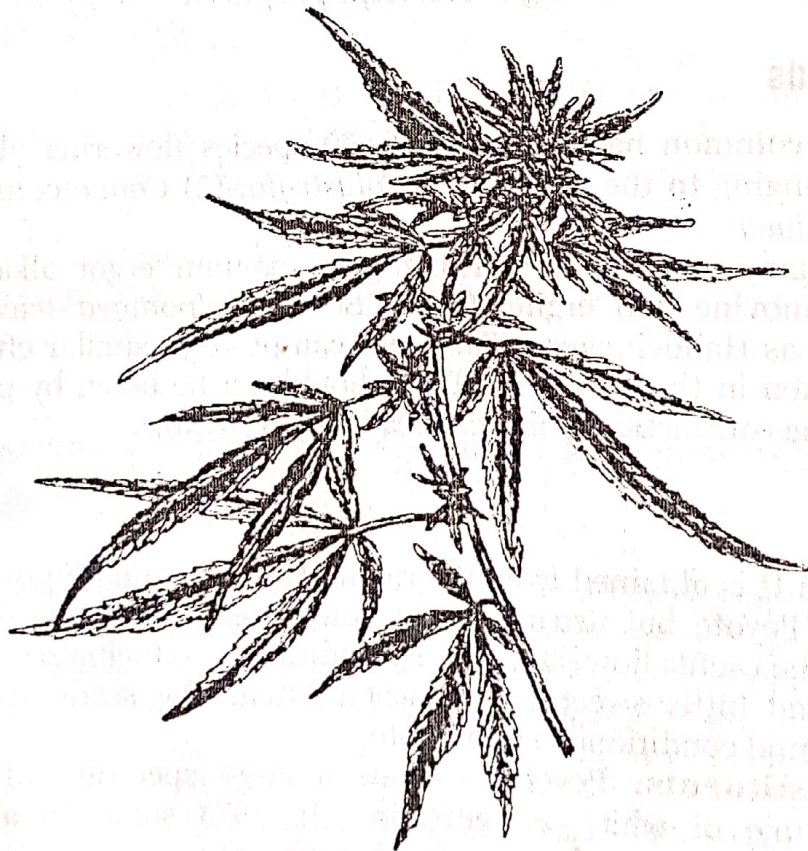


Fig. 12.1: Cannabis herb.

Chemical Constituents: It contains more than 60 compounds (Cannabinoids) all compounds of an aromatic portion (C_{11} or C_{12}), theoretically derivable from six acetate units and an Isoprenoid component (C_{10}). Cannabinol, tetrahydrocannabinol, cannabidiol, cannabigerol and cannabichromene are the main constituents in the plant.

Uses: It is mainly used as psychotropic agents and it is also used as Analgesic, anticonvulsant, antianxiety and antitussive.

Other Plants

Nutmeg and Mace: It is obtained from the species *Myristica fragrans*. Its main chemical constituents are myristin and elemian which produces Hallucinogen and the formal relationship of these compounds with amphetamines.

Virola Species: It is obtained from the *Virola multinervia* family Myristicaceae. It mainly contains tryptamines.

Leguminosae: The beans of *Anadenanthera peregrina* are used in northern-south America for the preparation of snuffs and it contains tryptamine which is responsible for Hallucinogenic activities.

Apocynaceae: Iboga root (*Tabernanthe Iboga*) contains indole alkaloids which produces Hallucinogen.

Labiatae: *Salvia divinorum*

Solanaceae: Tropane alkaloids.

Compositae: Calea Zacatechich

TERATOGENIC DRUGS

Teratogenic drugs are those drugs which causes the production of physical defects in the developing embryo. Teratogenic substances are ingested by the mother and they produce abnormalities in the fetus. Teratogens are harmful for the fetus e.g. thalidomide represents the tragic example of a synthetic drug having undetected properties at the time of its use.

Conium

Synonym: Poison hemlock

Biological Source: Conium is a genus of the species of highly poisonous perennial herbaceous flowering plants in the family Apiaceae, native to Europe and the Mediterranean region (*Conium maculatum*) and to southern Africa (*Conium chaerophylloides*).

Characters: It is a herbaceous biennial plant which grows between 1.5-2.5m tall, with a smooth green stem, usually spotted or streaked with red or purple on the lower half of the stem. The leaves are finely divided and lacy, overall triangular in shape, upto 50 cm long and 40 cm broad. The flowers are small, white clustered in umbels upto 10-15 cm across.

Chemical constituents: It contains the alkaloids coniine, N-methylconiine, conhydrine, pseudoconhydrine and atropine.

Effects: Coniine is a neurotoxin, which disrupts the working of the peripheral nervous system. It causes death by blocking the neuromuscular junction in a manner similar to curare. It produces crooked calf disease and show teratogenicity.

Veratrum

Synonym: False Hellebores.

Biological Source: It is obtained from the plant *Veratrum californicum*; Family is Liliaceae.

Chemical Constituents: Veratrum contains many steroidal alkaloids but cyclopamine and jervine which are important in animal development biology.

Effects: Veratrum species are important source of life saving medications used in modern preparation which lower blood pressure, slow the heart beat, and are used for cancer treatment. Cyclopamine derived from Veratrum species is a potent teratogen that is an

effective treatment from several deadly and malignant cancers but it causes cyclopien and related cephalic malformations in lambs.

Brain

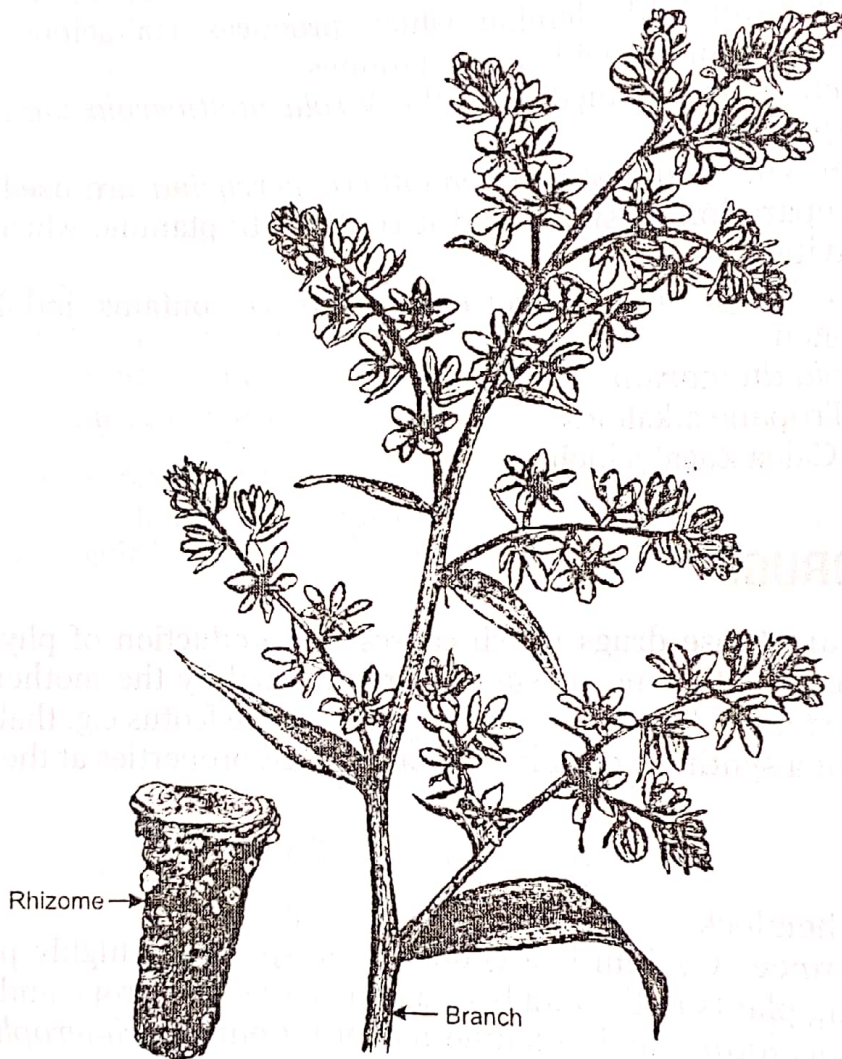


Fig. 12.2: Veratrum.

Indigofera ✓

Biological Source: It is obtained from the herb *Indigofera spicata*. Family is Leguminosae.

Chemical Constituents: The toxicity of the plant is attributed to a non-protein amino acid, indospicine (6-amidino-2-aminohexanoic acid).

Effects: Consumption of plants produces a neurological syndrome known as Birdsville disease. It produces cleft palate and embryo lethality in rats.

Nicotiana ↓

Synonym: Nightshade

Biological Source: It is derived from the plant *Nicotiana tabacum*. Family is Solanaceae.

Chemical Constituents: It mainly contains Nicotine. It is the tropane alkaloids which are often poisonous to human and other animals.

Effects: Tobacco leaves and sometimes stems are commonly used as entheogens and for pleasure. It is also responsible for some skeletal deformation in pigs but effect not positively contributable to alkaloids.

Table 12.1: Teratogenic Plants

Plant Name	Chemical Constituents responsible for Teratogenicity	Teratogenic effects
<i>Indigofera spicata</i> (Leguminosae)	Indospicine	It produces neurological syndrome cleft plate and embryo lethality.
<i>Nicotiana species</i> (Solanaceae)	Pyrdine alkaloids	It produces skeletal deformation in Pigs.
<i>Lobelia Species</i> (Cumpanulaceae)		
<i>Conium maculatum</i> (Apiaceae)	Coniine, N-methylconiine, conhydrine atropine	Crooked calf disease
<i>Veratrum californicum</i> (Liliaceae)	Cyclopamine. Jervine	It causes cycloplan and related cephalic malformation in lambs.
<i>Leucaena leucocephala</i> (Mimosaceae)	Leucenine or leucend and Mimosine	Large quantity toxic to <u>liver stock</u> .
Locoplants e.g. <i>Astragalus lentiginosus</i> (Legiminosae)	-	It contains osteolathyrogens and teratogens characterized by causing excessive flexure of carpal points or contracted tendons.
<i>Lupinus sericeus</i> (Leguminosae)	d-,dl-lupanine, cystisine and anagyryne	Crooked calf disease.

NATURAL ALLERGENS

A large number of plant and animals materials give rise to allergic reactions. In certain individuals, the allergic materials transmitted by direct skin contact, by airborne pollens, smoke and dried plant particles and on the coats of domestic animals.

The term allergy was first defined in 1906 by Von Pirquet in describing changed or altered reactions in the body. When an individual develops an unusual response to a substance or condition that is harmless to others, the individual is said to be allergic.

Allergens are antigenic substances capable of sensitizing the body in such a way that unusual responses occur in hypersensitivity individuals. Almost any substances whether of biologic, chemical or synthetic origin may prove to be allergenic, in addition, numerous other factors are allergy producing such as emotional factors, atmospheric factors, psychosomatic factors and chronic types of infection. The allergen concerned with the patient's symptoms must be antigenic that is, it must be capable of eliciting an antibody response.

Pollens

They are responsible for the seasonal hay fever, which may progress in to chronic asthma. To ascertain whether certain plants are significant in seasonal pollinosis, a series of postulates was devised by authorities in the field of allergy to serve as define criterias:

1. The pollen must contain an excitant hay fever.

2. The pollen must be anemophilous, or windborne, as regards its mode of pollination.
3. The plant producing the pollen must be widely and abundantly distributed.

Some of trees which are allergic for peoples are:

1. *Acer saccharinum* (silver maple)
2. *Acer rubrum* (red maple)
3. *Alnus serrulata* (common alder)
4. *Betula lenta* (sweet birch)
5. *Juglans nigra* (black walnut)
6. *Quercus alba* (white oak)
7. *Quercus rubra* (red oak)

Common grasses are involved as natura allergens are:

1. *Cynodon dactylon* (Bermuda grass)
2. *Dactylis glomerata* (Orchard grass)
3. *Phleum pretense* (Timothy)
4. *Agrostis alba* (redtop)

Other important hay fever weeds are

1. *Ambrosia* species (ragweeds)
2. *Amaranthus retroflexus* (pigweed)
3. *Chenopodium ambrosioides* (Mexican tea)
4. *Artemisia tridentata* (sagebrush)
5. *Iva xanthifolia* (marsh elder)

Spores

Mold allergy is an exceedingly important cause of perennial rhinitis or non seasonal hay fever. Atmospheric determinations conducted in much the same manner as pollen counts have revealed that the most common mold genera are *Alternaria*, *Macrosporium*, *Helminthosporium*, *hormodendrum*, *Aspergillus*, *Penicillin*, *Mucor*, *Rhizopus*, *Syncephalastrum*, *Curvularia*, *brachysporium*, *Pullularia*, *Pleospora* and others.

Rhus Toxicodendron Species (Poison Ivy)

It is composed of the fresh leaflets of *Toxicodendron radicans* (L.) Kuntze, formally known as *Rhus radicans* L. (family Anacardiaceae), a woody vine common throughout the United States. The plant trails over the ground, climbs by means of aerial roots, or remains shrublike. The leaves are 3 foliate and the leaflets are ovate, acuminate, nearly entire, in equilateral, 3 to 20 cm long, and have short stalks. They are inodorous and slightly astringent, saline and acrid in taste. The flowers are green and occur as loose auxiliary panicles. The fruit is a globular, glabrous, grayish drupe.

The active principle of poison ivy, and of other *Toxicodendron* species as well, is known as urushiol. It is not a single compound but instead, a mixture of closely related C₁₅ and C₁₇ catechols, varying from one another by the number and position of double bonds in their side chain.

Toxicodendron vernix (L.) Kuntze, commonly known as poison sumac, poison elder, or poison dogwood, is allergenic, like *Toxicodendron radicans* and contains similar active principle. Other species of toxicodendron are also poisonous, as the **western poison**

Oak (*T. diversilobum*) of the Pacific coast, and the **Japanese lacquer** or **varnish tree** (*T. verniciferum*). Similar compounds to the above have been isolated from the fruit pulp of *Ginkgo biloba* and from the glandular trichomes of annual *Phacelia* species (*Hydrophyllaceae*) of the Californian Mojave Desert.

Sesquiterpenes Lactones

These compounds, obtained from members of the Compositae, Lauraceae, and Magnoliaceae and from the liverwort *Frullania* (*Jubulaceae*), are a major class of substances causing allergic contact dermatitis in man. Two other plant species which can give rise to allergic reactions are the common rue (*Ruta graveolens*) and the indoor ornamental Dumb cane (*Dieffenbachia seguine*, *Araceae*).

OTHER TOXIC PLANTS

Toxic plants are generally of local importance, and it is desirable that the pharmacist should have some knowledge of those found in his own locality, be familiar with those characters by which the plant can be identified and be aware of the antidotes required for the treatment of poisoning. Cases of poisoning of humans by higher plants is most likely to occur with children and to involve those plants that produce attractive berries (e.g. belladonna, cotoneaster) seeds (e.g. laburnum) eaten for green peas and those which may be introduced into the mouth for other reasons (e.g. the hollow stem of hemlock used as a pea shooter). Some toxic plants are described here, these are following:

Mycotoxin

Mycotoxin is a toxin produced by an organism of the fungus kingdom, which includes mushrooms, molds and yeasts. Most fungi are aerobic (use oxygen). Fungi are found almost everywhere in extremely small quantities because of their spores, and are most commonly microscopically small.

Aflatoxins

Aflatoxins are naturally occurring mycotoxins that are produced by many species of *Aspergillus*, a fungus, most notably *Aspergillus flavus* and *Aspergillus parasiticus*. Aflatoxins are toxic and one of the most carcinogenic substances known. After entering the body, aflatoxins are metabolized by the liver to a reactive intermediate, aflatoxin M₁, an epoxide. Aflatoxin is frequently misspelled as aflotoxin and aflatoxin, which could be confused with alpha toxin. The toxin can also be found in the milk of animals which are fed contaminated feed. Virtually all sources of commercial peanut butter contain minute quantities of aflatoxin, but it is usually far below the US Food and Drug Administration's (FDA) recommended safe level.

Aflatoxin G1

Aflatoxin G1 is a mycotoxin, which may be produced by mold species of the genus *Aspergillus* in areas of the world with hot and humid climate. Aflatoxins are potent liver carcinogens and DNA-damaging agents from natural sources. The carcinogenicity and mutagenicity of AFG1 is considered to arise as the result of the formation of a reactive epoxide at the 8, 9 positions of the terminal furan ring and its subsequent covalent binding to

nucleic acid. Aflatoxicosis is poisoning that result from ingestion of aflatoxins in contaminated food or feed. AFG1 is a light sensitive mycotoxin, which should be stored in a freezer in amber glass vials. Do not transfer crystalline AFG1 for weighing or other purposes unless facilities are available to prevent dissemination of mycotoxin to surroundings because of electrostatic charge on particles.

Ochratoxin A

Ochratoxin A is produced by *Penicillium verrucosum*, which is generally associated with temperate climates, and *Aspergillus* species which grow in warm humid conditions. *Aspergillus ochraceus* is found as a contaminant of a wide range of commodities including cereals and their products, fruit and a wide range of beverages and spices. *Aspergillus carbonarius* is the other main species associated in warm humid conditions found mainly on vine fruit and dried vine products particularly in the Mediterranean basin. It causes kidney damage in humans and is a potential carcinogen.

Patulin

Patulin is associated with a range of fungal species and is found in moldy fruits, vegetables, cereals and other foods. It may be carcinogenic and is reported to damage the immune system and nervous system in animals.

Fusarium

Fusarium toxins are produced by several species of the genus *Fusarium* which infect the grain of developing cereals such as wheat and maize. They include a range of mycotoxins including the fumonisins, which affect the nervous systems of horses and cause cancer in rodents; and the trichothecenes, including deoxynivalenol, and zearalenone, the last two of which are very stable and can survive cooking. The trichothecenes are acutely toxic to humans, causing sickness and diarrhea and potentially death.