

# Understanding Plant Toxicity



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# The University of Florida Herbarium (FLAS)

- Established 1891 at Florida Agricultural College in Lake City
- Approx. 500,000 specimens
- The oldest, largest, and most comprehensive botanical collection in Florida
- In 1981 became part of the Florida Museum, but partially funded by UF/IFAS
- Used for research, education, and extension
- Constantly growing (~6500 specimens/year)



# The UF/IFAS Plant Identification and Information Service



- A diagnostic, outreach, and education service of the UF Herbarium
- Provides authoritative identifications on vascular plants
- Responds to requests for information on plant nomenclature, distribution, invasiveness, uses, cultivation, and other questions, such as...

***Is this plant poisonous?***

# What do we mean by poisonous or toxic?

## **POISON**

from the Latin *potio*  
“potion”

A substance that causes injury or death when exposed to a living organism

## **TOXIC**

from the Greek *toxikon*  
“poison used on arrows”  
Poisonous, harmful

## **PHYTOTOXIN**

A toxic compound derived from a plant



## **TOXICOLOGY**

The study of the adverse effects of chemical and physical agents on living organisms



# Why do plants contain toxic compounds?



- To **deter** plant-eating critters (especially insects)
- To **protect** themselves from microbial infections
- To provide a **barrier** between injured and healthy tissues
- To give them a **competitive advantage** over nearby plants (allelopathy)
- As **by-products** of routine metabolic processes

# *Sola Dosis Facit Venenum* The Dose Makes the Poison!

- It is a false dichotomy to label some plants as “toxic” and others as “safe”
- In fact, **all chemical compounds have the potential to cause adverse affects at a high enough dose**
- This idea dates back to the Renaissance physician Paracelsus, who argued that **it is not the substance that is toxic but the amount:**

*“all substances are poisonous; there is none which is not a poison. The right dose differentiates a poison from a remedy”*



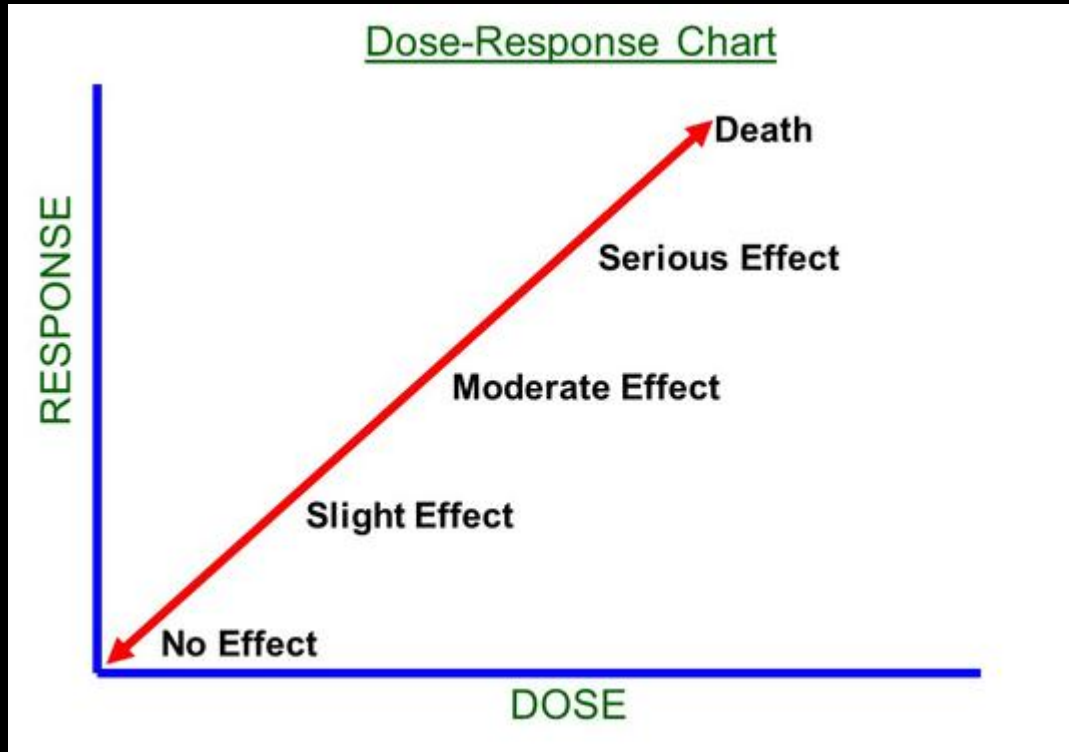
Theophrastus Paracelsus  
Swiss physician & alchemist  
1493-1541

# Is water a poison?

- Most of us would never consider water to be poisonous, but consumption of 6 liters of water in a restricted period of time can kill a 165 lb. person!
- Water toxicity (aka water toxemia) can lead to dizziness, confusion, nausea, and even death
- Remember: it's all about the **dose**



# The Dose-Response Relationship



- Depending on the dose, the effects of a particular compound on the body may range from **benign** to **therapeutic** to **harmful** to **fatal**
- Many of the plants that we think of as poisonous or unsafe are actually therapeutic when administered at an appropriate and controlled dose
- In addition to dose, there are a number of other factors that influence toxicity



# Other factors affecting plant toxicity: frequency and duration of exposure

In 1994 in Taiwan and in 2005 in Japan, there was an outbreak of severe respiratory disease due to prolonged and frequent consumption of large quantities of katuk leaves--a plant reputed to help with weight loss; this obstructive pulmonary disease was caused by the alkaloid **papaverine**



*Sauropus androgynus* (sweet leaf or katuk)  
in the Phyllanthaceae (leafyflower/chamber bitter family)  
© 2009 Jee & Rani Nature Photography (License: [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/))

# Other factors affecting plant toxicity:

## route of exposure

- Skin exposure
- Inhalation
- Injection beneath the skin or into the bloodstream
- Ingestion

Poisoning has never been documented from touching angel's trumpet plants or smelling the flowers, but all parts contain a variety of alkaloids (including **scopolamine** and **hyosciamine**), which when **consumed** or **smoked** can cause delirium, seizures, and even respiratory failure



*Brugmansia* 'Cypress Gardens' (angel's trumpet)  
in the Solanaceae (nightshade family)



# Other factors affecting plant toxicity: which part of the plant



*Rheum × rhabarbarum* (rhubarb)  
in the Polygonaceae (buckwheat/knotweed family)  
© 2006 Dieter Weber (License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/))

Rhubarb petioles (leaf stalks) are edible but the leaf blades contain high levels of **oxalic acid**, which has a corrosive effect on the digestive system, leading to severe cramps, vomiting, and potential kidney damage

# Other factors affecting plant toxicity: maturity of plant or plant organ, time of year, and environmental conditions

In ackee, the fleshy aril around the seeds is edible only when at the right stage of ripeness; immature and overripe fruit contain dangerous levels of the amino acid **Hypoglycin A**, which can cause severe hypoglycemia (low blood sugar)



*Blighia sapida* (ackee) in the Sapindaceae (soapberry family)  
© 2005 Michael Hermann, <http://cropsforthefuture.org>  
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# Other factors affecting plant toxicity: species differences in sensitivity



*Persea americana* (avocado)  
in the Lauraceae (laurel/bay family)  
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- Avocado fruit are **relished by humans**, a cooking oil is extracted from the seeds, and the leaves are used in Mexican cooking
- But all parts contain the antifungal polyketide **persin**, which is **toxic to birds, mice, rats, rabbits, goats, cattle, and horses**

# Other factors affecting plant toxicity: individual differences in sensitivity due to body mass, age, health status, & allergies

Individuals with **smaller bodies** (including children and other young animals), **compromised immune systems**, health problems affecting a **particular organ system**, or **allergies** are often more vulnerable when exposed to potentially toxic compounds



Sparky, an 11 week old Golden Retriever from Pinellas County, ate cherry laurel fruit and air potato bulbils. He became very ill, but fortunately recovered with good veterinary care.

# Other factors affecting plant toxicity: individual differences in sensitivity due to body mass, age, health status, & allergies

Plants in the Oxalidaceae (starfruit/wood sorrel family), Polygonaceae (buckwheat/knotweed family), Portulacaceae (purslane family), Amaranthaceae (amaranth/spinach/beet family) and Brassicaceae (mustard family) often contain **oxalic acids**

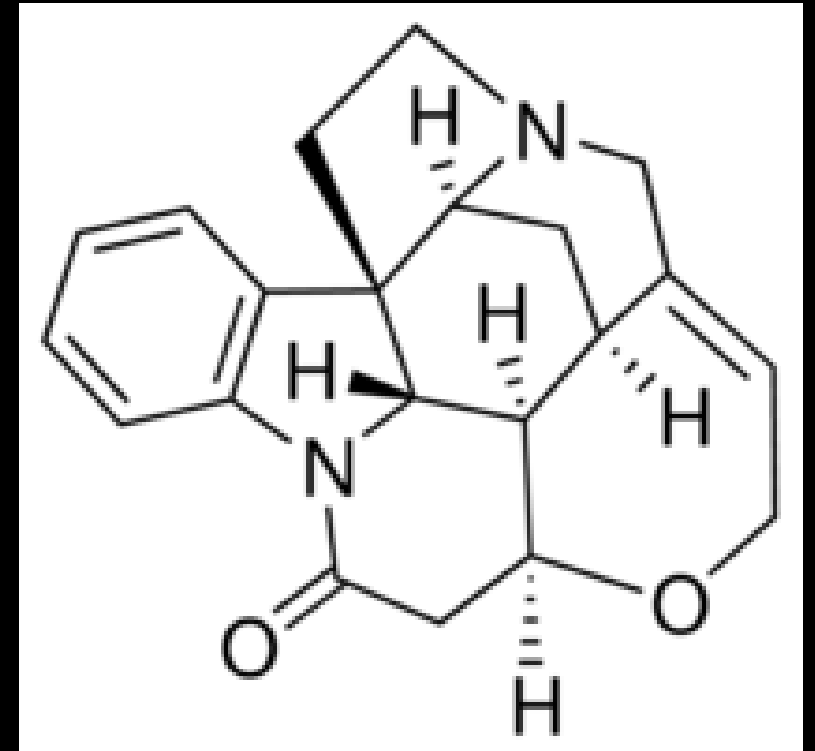
For most of us, occasional consumption of vegetables/fruits in these families poses no problem

But for individuals with kidney disease or prone to kidney stones, eating these plants can have serious health consequences



# How are phytotoxins classified?

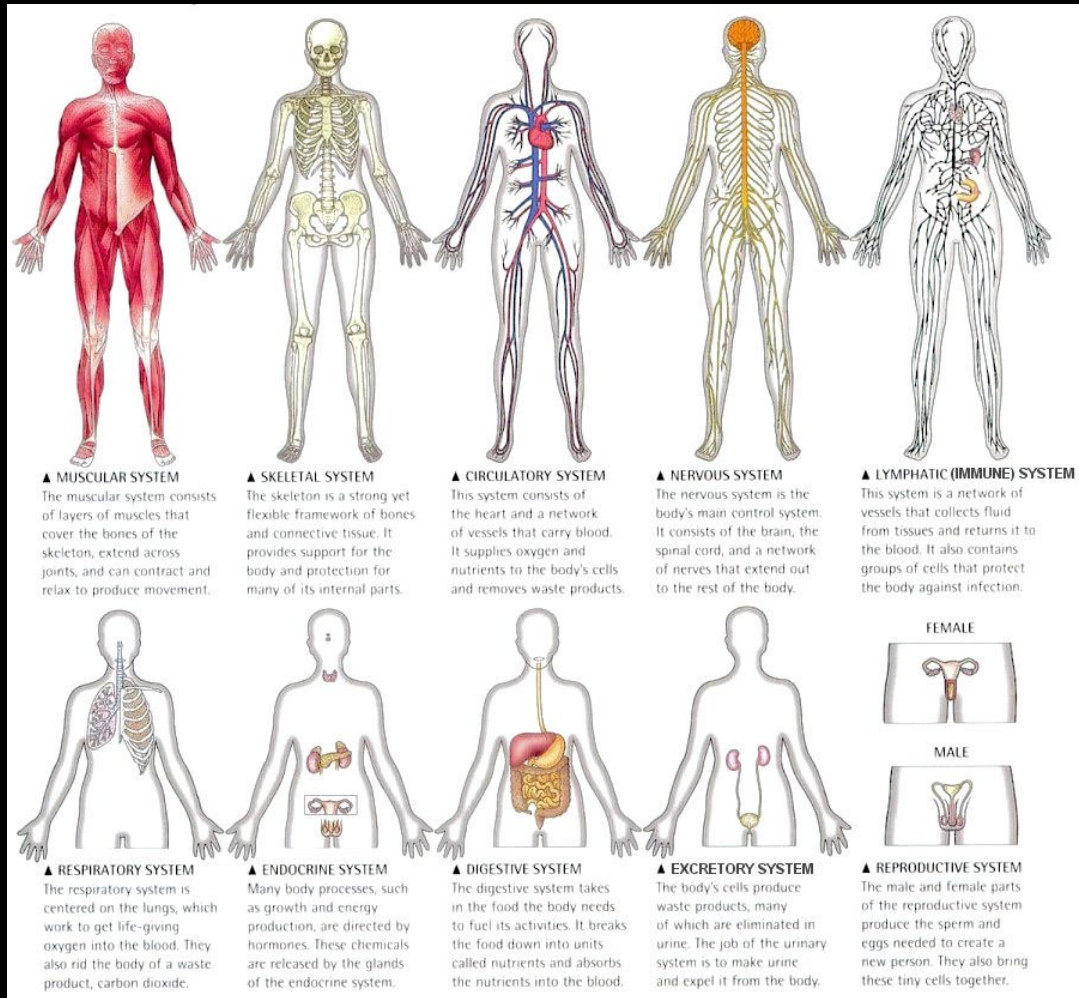
- Chemical compounds are often organized into classes based on their **molecular structure** and **solubility properties**
- Common classes of potentially toxic chemical compounds include: **alkaloids, amino acids, coumarins/furocoumarins, essential oils, cardioactive glycosides, cyanogenic glycosides, glucosinolates, phenols, plant acids, polyynes, proteins/peptides, saponins, tannins, and terpenes**



Molecular structure of strychnine, an alkaloid produced by plants in the genus *Strychnos* in the Loganiaceae (logania family)



# How do phytotoxins affect us?

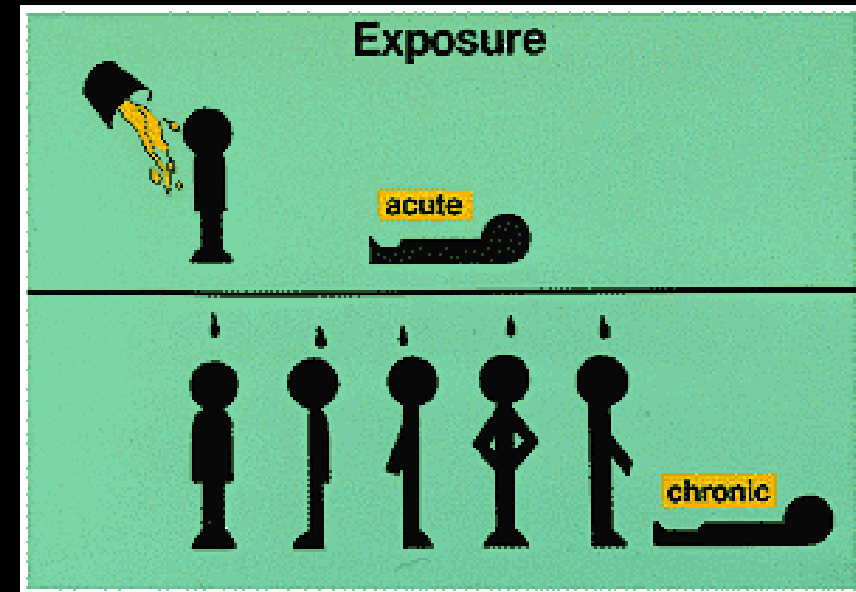


- Some toxic chemical compounds **target specific organ systems** (skin, muscular, skeletal, cardiovascular, respiratory, brain/nervous, digestive, endocrine, excretory, reproductive)
- Other toxic compounds directly affect cellular processes, resulting in **cell damage or cell death**, and may lead to cancer or birth defects

# How do phytotoxins affect us?

## Poisoning may be acute or chronic

- **Acute**-a single exposure with rapid absorption of the toxicant, often leading to sudden and severe symptoms, which are sometimes reversible
- **Chronic**-repeated exposure over days, months, or years; symptoms may not be immediately apparent, but may ultimately be severe and often irreversible



# How do we determine if a plant is toxic?



- 1) Consistent **field syndrome** (multiple cases with similar symptoms upon exposure to a particular plant)
- 2) Experimental **confirmation** with lab animals
- 3) **Isolation of a known toxin(s)** through chemical or pharmacological analysis

This process of documentation can help us to limit future exposure and helps medical and veterinary personnel respond to poisoning cases with appropriate measures

# Gardeners are especially vulnerable to plant-associated dermatitis (skin inflammation)



- **Irritant contact dermatitis (ICD)** – reaction on the skin after contacting the plant, which affects many people
  - **mechanical** (nettles, cacti, other plants with thorns/spines or sharp-edged leaves)
  - **chemical** (saps of agave, spurges, members of the elephant ear/peace lily family, chili peppers, and many bulbs)
- **Phytophotodermatitis (PPD)** – secondary sun-enhanced reaction after contact with the plant (ficus sap, citrus fruit juice, carrot/parsley family)
- **Allergic contact dermatitis (ACD)** – an immune-mediated response, which occurs only in susceptible individuals (poison ivy/mango/sumac family and aster family)



# How to avoid exposure to phytotoxins?



- NEVER eat a plant if you are not 100% certain of what it is
- When foraging, be alert to lookalikes (eg., American nightshade growing amongst wild blueberries or rain lilies growing amongst wild onions)
- Remember that plants may absorb toxins (insecticides, heavy metals, petrochemicals) from the environment

# How to avoid exposure to phytotoxins?

- Learn to recognize the plants most commonly associated with skin irritation, and remove them from high-traffic areas of your landscape
- Avoid skin contact with plant sap/latex
- Wear gloves when weeding and pruning
- Always wash thoroughly with soap and water after gardening
- If you are sensitive to poison ivy and encounter it frequently, you may want to purchase a product especially formulated to remove the oily toxin urushiol that causes the allergic reaction



# How to avoid exposure to phytotoxins?



- If you have pets, learn the houseplants and landscape plants most commonly associated with poisoning
- Remove plants associated with acute pet poisoning, move them to an inaccessible location, or restrict pet access with fencing
- Remember, puppies are especially susceptible to plant poisoning because they have a small body mass and chew on everything!

# In the event of exposure...

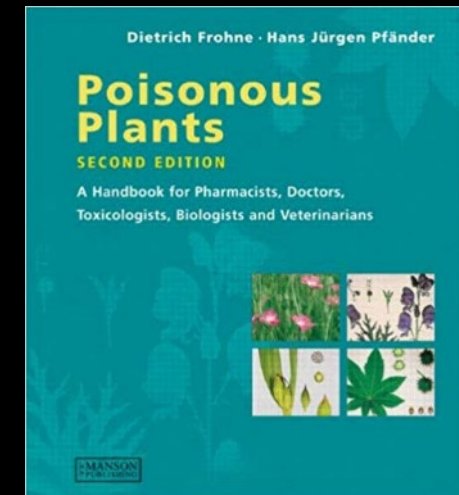
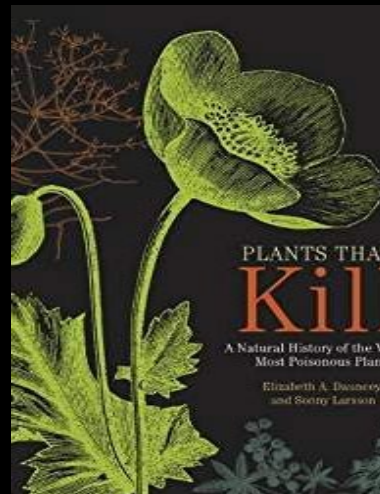
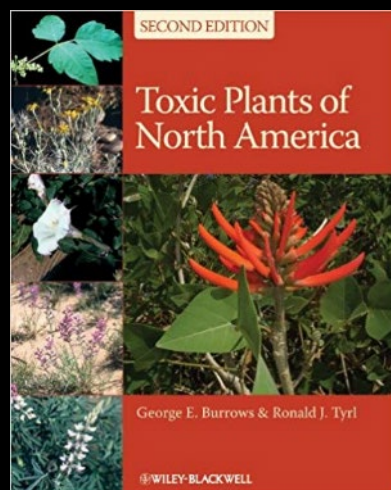
- Call your physician, veterinarian, or Florida Poison control
- Be prepared to tell them
  - What **plant** was eaten?
  - What **part** of the plant was eaten?
  - **How much** was consumed?
  - What are the **symptoms**?
- If you are unsure of the plant ID, be sure to take a physical sample or photos of the plant to the emergency room





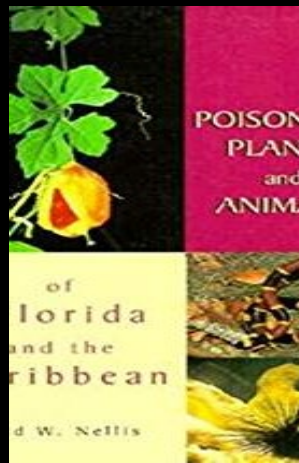
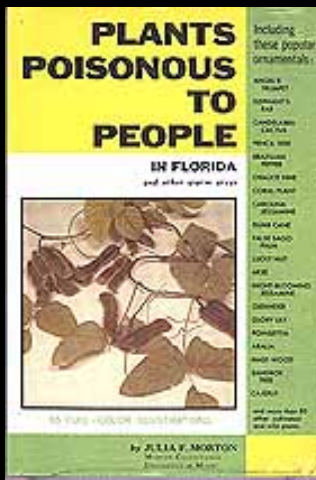
# For more information: academic resources

- Burrows, G.E. and R.J. Tyrl. 2013. *Toxic Plants of North America*, 2<sup>nd</sup> edition. John Wiley & Sons, Inc., Hoboken, New Jersey. 1390 p.
- Dauncy, E.A. and S. Larson. 2018. *Plants That Kill: a Natural History of the World's Most Poisonous Plants*. Princeton University Press, Princeton, New Jersey. 224 p.
- Frohne, D. and H. J. Pfänder. 2005 *Poisonous Plants: A Handbook for Doctors, Pharmacists, Toxicologists, Biologists, and Veterinarians*, 2<sup>nd</sup> edition. Timber Press, Portland, Oregon. 469 p.



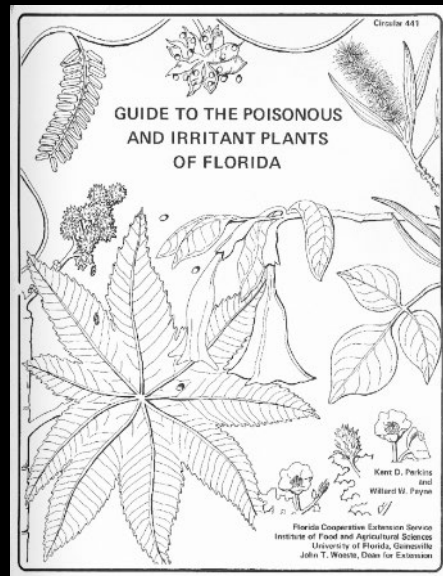
# For more information: field guides and Florida-specific information

- Morton, J.F. 1995. *Plants Poisonous to People in Florida and Other Warm Areas*, 3<sup>rd</sup> edition. Hallmark Press, Miami, Florida. 176 p.
- Nellis, D.W. 1997. *Poisonous Plants and Animals of Florida and the Caribbean*. Pineapple Press, Sarasota, Florida. 315 p.
- Nelson, L.S., R.D. Shih, and M.J. Balick. *Handbook of Poisonous and Injurious Plants*, 2<sup>nd</sup> edition. Springer, New York. 340 p.



# For more information: Florida-specific information

- Perkins, K.D. and W.W. Payne. 1981 (reprint with addendum). *Guide to the Poisonous and Irritant Plants of Florida*. Circular 441. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida. 91 p. Available online at <http://ufdc.ufl.edu/UF00000155/00001>



# Questions?

