UF/IFAS Extension

The Journey to Sustainability Begins with Education

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UF UNIVERSITY of FLORIDA
IFAS Extension

UF/IFAS EXTENSION SARASOTA COUNTY

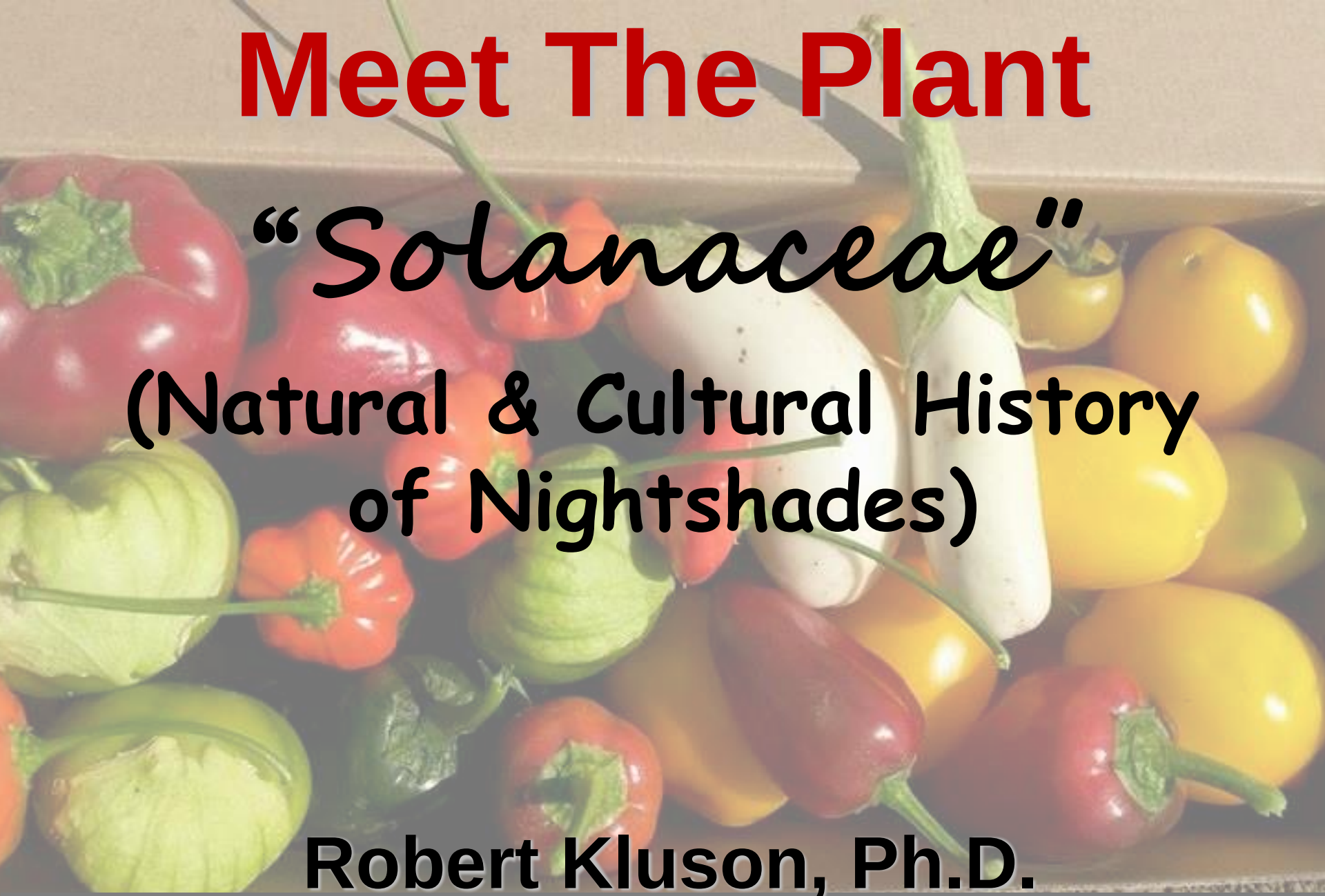
- A partnership between **Sarasota County**, the **University of Florida**, and the **USDA**.
- Our Mission is to translate research into community initiatives, classes, and volunteer opportunities related to five core areas:
    - Agriculture;
    - Lawn and Garden;
    - Natural Resources and Sustainability;
    - Nutrition and Healthy Living; and
    - Youth Development -- 4-H

What is Sarasota Extension?

Meet The Plant

"Solanaceae"

(Natural & Cultural History of Nightshades)



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Ag/NR Ext. Agent, UF/IFAS Extension Sarasota Co.

OUTLINE

- Overview of “Meet The Plant” Series
- Introduction to Solanaceae Family
  - What’s In A Name?
- Natural History
  - Center of origin
  - Botany
  - Phytochemistry
- Cultural History
  - Food and other uses

Approach of Talks on "Meet The Plant"

- Today my talk at this workshop is part of a series of presentations intended to expand the awareness and familiarity of the general public with different worldwide and Florida crops.
- It's not focused on crop production.
- Provide background information from the sciences of the natural and cultural history of crops from different plant families.

“Meet The Plant” Series Titles

- Brassicaceae ← Jan 16th
- Cannabaceae ← Jan 23rd
- Leguminaceae ← Feb 26th
- Solanaceae ← Today !
- Cucurbitaceae ← May 3rd

What's In A Name?

❖ Solanaceae

➢ Etymology:

- The name Solanaceae derives from the genus Solanum, "the nightshade plant".
- The origin of the Latin word is unclear. The name may come from a perceived resemblance of certain solanaceous flowers to the sun and its rays. At least one species of Solanum is known as the "sunberry".
- Alternatively, the name could originate from the Latin verb solare, meaning "to soothe", presumably referring to the soothing pharmacological properties of some of the psychoactive species of the family.

Solanaceae “Sun” Flower Shapes

Potato

Tomato

Petunia

Pepper

What's In A Name?

- Nightshade

➢Etymology:

• Old English nihtscada, literally "shade of night," perhaps in allusion to the poisonous berries. A common Germanic compound, cognates: Dutch nachtschade, German Nachtschatten.

Deadly Nightshade (Atropa Belladonna)

This plant goes by many names, including Belladonna, Devil's Berries, and Death Cherries. Both the leaves and the berries are extremely toxic, and children have been known to die from eating just two berries.

One of the most toxic plants in the Western Hemisphere, consumption of Deadly Nightshade leads to delirium, hallucinations, dilated pupils, sensitivity to light, blurred vision, tachycardia, loss of balance, staggering, headache, rash, dry mouth and throat, slurred speech, urinary retention, constipation, confusion, hallucinations, delirium, and convulsions. Without receiving the antidote, sufferers will eventually die due to the plant's disruption of their body's involuntary activities such as sweating, breathing, and heart rate

What's In A Name?

❖ Potato

➢ Etymology:

- 1560s, from Spanish patata, from a Carib language of Haiti batata "sweet potato.", a crop not in the Solanaceae farmily. Sweet potatoes were first to be introduced to Europe; in cultivation in Spain by mid-16c.; in Virginia by 1648. Early 16c. In Africa to India and Java by Portuguese traders.

- The name later (1590s) was extended to the common white potato, from Peru, which was at first (mistakenly) called "Virginia potato", or, "bastard potato" (due to initial minor importance compared to sweet potato).

What's In A Name?

- Potato (continued)

  - Etymology:
    - German kartoffel (17c.) is a dissimilation from tartoffel, ultimately from Italian tartufolo (Vulgar Latin *territuberem), originally "truffle." Frederick II forced its cultivation on Prussian peasants in 1743. The French is pomme de terre, literally "earth-apple;" a Swedish dialectal word for "potato" is jordpäron, literally "earth-pear."

What's In A Name?

- Pepper
  - Etymology:
    - Old English pipor, from an early West Germanic borrowing of Latin piper "pepper," from Greek piperi, probably (via Persian) from Middle Indic pippari, from Sanskrit pippali "long pepper." The Latin word is the source of German Pfeffer, Italian pepe, French poivre, Old Church Slavonic pipru, Lithuanian pipiras, Old Irish piobhar, Welsh pybyr, etc.
    - Application to fruits of the capsicum family (unrelated, originally native of tropical America) when Columbus tasted the small red berries he found on his voyage, he believed he had reached India and called them red pepper.

What's In A Name?

❖ Eggplant

➢ Etymology:

- also egg-plant, 1763, from egg (n.) + plant (n.). Originally of the white variety.
- "aubergine" = "fruit of the eggplant" (*Solanum esculentum*), 1794, from French aubergine, from Catalan "alberginera", from Arabic "al-badinjan" (source also of Spanish "alberengena", 15c.), from Persian "badin-gan", from Sanskrit "vatigagama". The plant, native to Southeast Asia, was unknown to the ancient Mediterranean world until introduced by the Arabs.

What's In A Name?

❖ Tobacco

- ➢ Etymology
  - 1580s, from Spanish "tabaco", in part from an Arawakan language of the Caribbean (probably Taino), said to mean "a roll of tobacco leaves" (according to Las Casas, 1552) or "a kind of pipe for smoking tobacco" (according to Oviedo, 1535). Scholars of Caribbean languages lean toward Las Casas' explanation. The West Indian island of Tobago was said to have been named by Columbus in 1498 from Haitian "tambaku" (pipe), in reference to the native custom of smoking dried tobacco leaves.

What's In A Name?

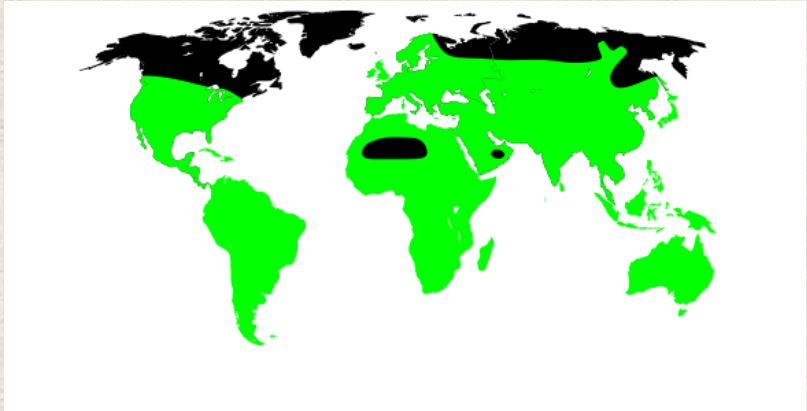
❖ Tobacco (continued)

- Etymology
  - Cultivation in France began 1556; introduced in Spain 1558. Early German and Portuguese accounts of Brazil also record another name for tobacco, bittin or betum, evidently a native word in South America, which made its way into 17c. Spanish, French, and English as petun, petumin, etc., and which is preserved in petunia and butun, the Breton word for "tobacco."
  - "Tobacco Road" as a mythical place representative of rural Southern U.S. poverty is from the title of Erskine Caldwell's 1932 novel.

Solanaceae
Natural History

Natural History

- The Solanaceae family is also known as the nightshade or potato family.
- It comprises some 3,000 species distributed worldwide, almost half of these in the mega-diverse genus Solanum.
- The most diverse part of the world is South America, but Solanaceae have radiated in other areas as well. Species can occupy a variety of habitats, from deserts to tropical rainforests.



Map showing Solanaceae worldwide distribution (light green areas)

Natural History

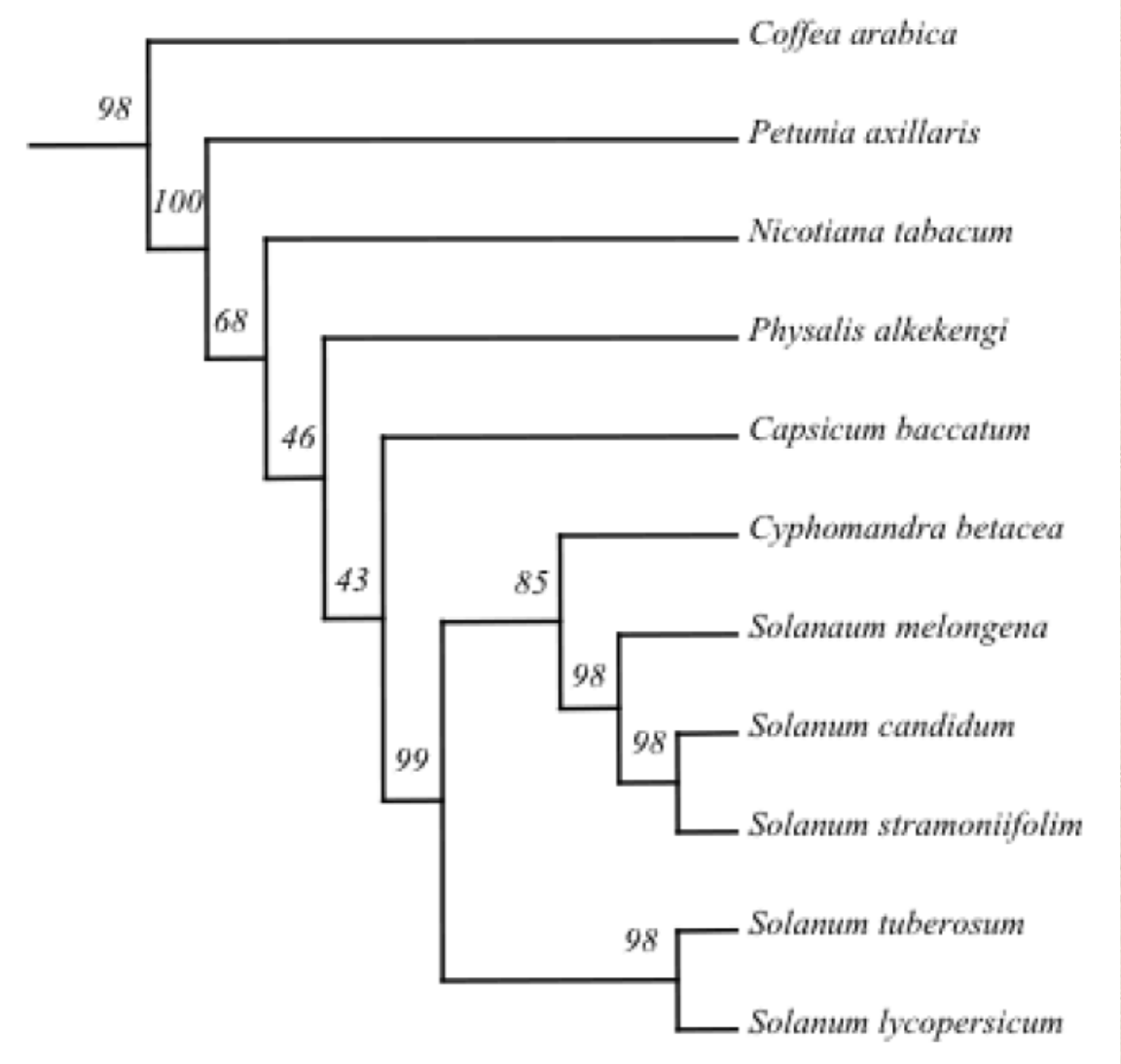
- The Solanaceae are a medium-sized family of flowering plants belonging to the Asterids “clade” (in the sense of the Angiosperm Phylogeny Group (APG) treatment of the major groups of flowering plants.
- Botanists today recognise and give names to “clades”, or monophyletic groups, containing all the descendents of a common ancestor, based on molecular genetics rather than to groups of similar looking plants. This has meant that some traditional groupings are no longer recognised, & that some surprising evolutionary relationships have been revealed. Asterids, including the Solanaceae, however, are one group that has stood the test of time.

Natural History

- Coffee trees (Rubiaceae) and tomato (Solanaceae) belong to the Asterid clade, while grapevine (Vitaceae) belongs to the Rosid clade.
- Coffee and tomato separated from grapevine 125 million years ago, while coffee and tomato diverged 83-89 million years ago.
- In 2017, scientists reported on their discovery and analysis of a fossil tomatillo found in the Patagonian region of Argentina, dated to 52 million years B.P. As tomatillos likely developed later than other nightshades, this may mean that the Solanaceae may have first developed during the Mesozoic Era (252 to 66 million years ago).

Natural History

Solanaceae Phylogenetic Tree



Major Genera in Solanaceae *

Atropa (belladona)
Browallia (bush violet)
Brugmansia (angel's trumpets)
Calibrachoa (million bells)
Capsicum (pepper)
Datura (jimson weed)
Hyoscyamus (henbane)
Lycium (wolfberry)
Lycopersicon (tomato)
Mandragora (mandrake)
Nicotiana (tobacco)
Petunia (petunia)
Physalis (tomatillo)
Salpiglossis (painted tongue)
Schizanthus (butterfly flower)
Solanum (potato)

* Example crop listed in red

Major Genera in Solanaceae

❖ Comparative Number of Species Across Genera

The eight largest genera and their approximate number of species

Genus	Approximate number of species
Estimated total number in all of Solanaceae	3000-4000
Solanum	1000-2000
Cestrum	ca. 250
Lycianthes	ca. 250
Nolana	ca. 80
Physalis	ca. 75
Lycium	ca. 75
Nicotiana	ca. 70
Brunfelsia	ca. 45

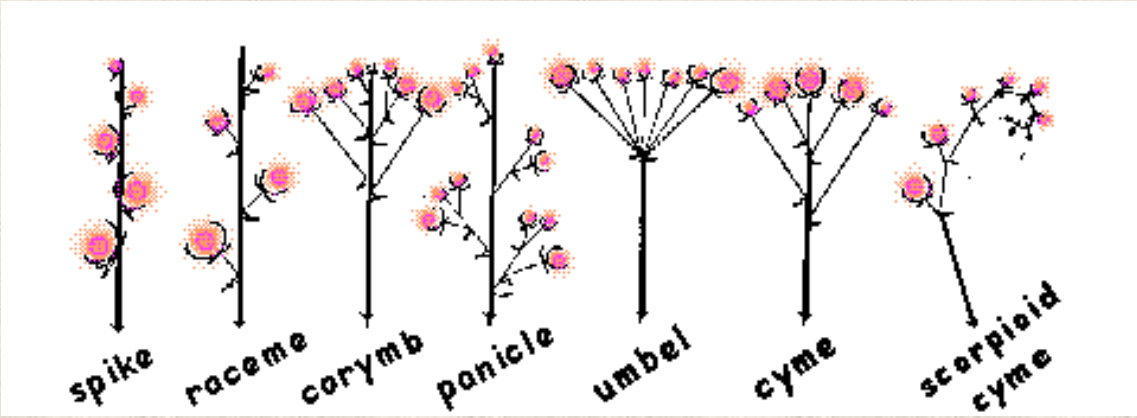
Characteristics of the Solanaceae

- **Flower**: small to large & showy, regular, perfect
- **Fruit**: capsule or berry with many seeds. Often colorful and animal dispersed
- **Pollination**: self- or insect-pollinated
- Commonly contain **alkaloids**, of which tropane alkaloids are particularly poisonous (belladonna)

Flower Botany of Solanaceae

Inflorescences:

Solitary or cymose *



Flowers:

* *

Bisexual

Usually actinomorphic (characterized by radial symmetry, such as a starfish or the flower of a daisy)

Superior ovary

Axile placentation

Usually have 5 petals, 5 sepals,
5 stamens, 2 carpels, 2 locules

Petals and sepals are often united

Flower Botany of Solanaceae

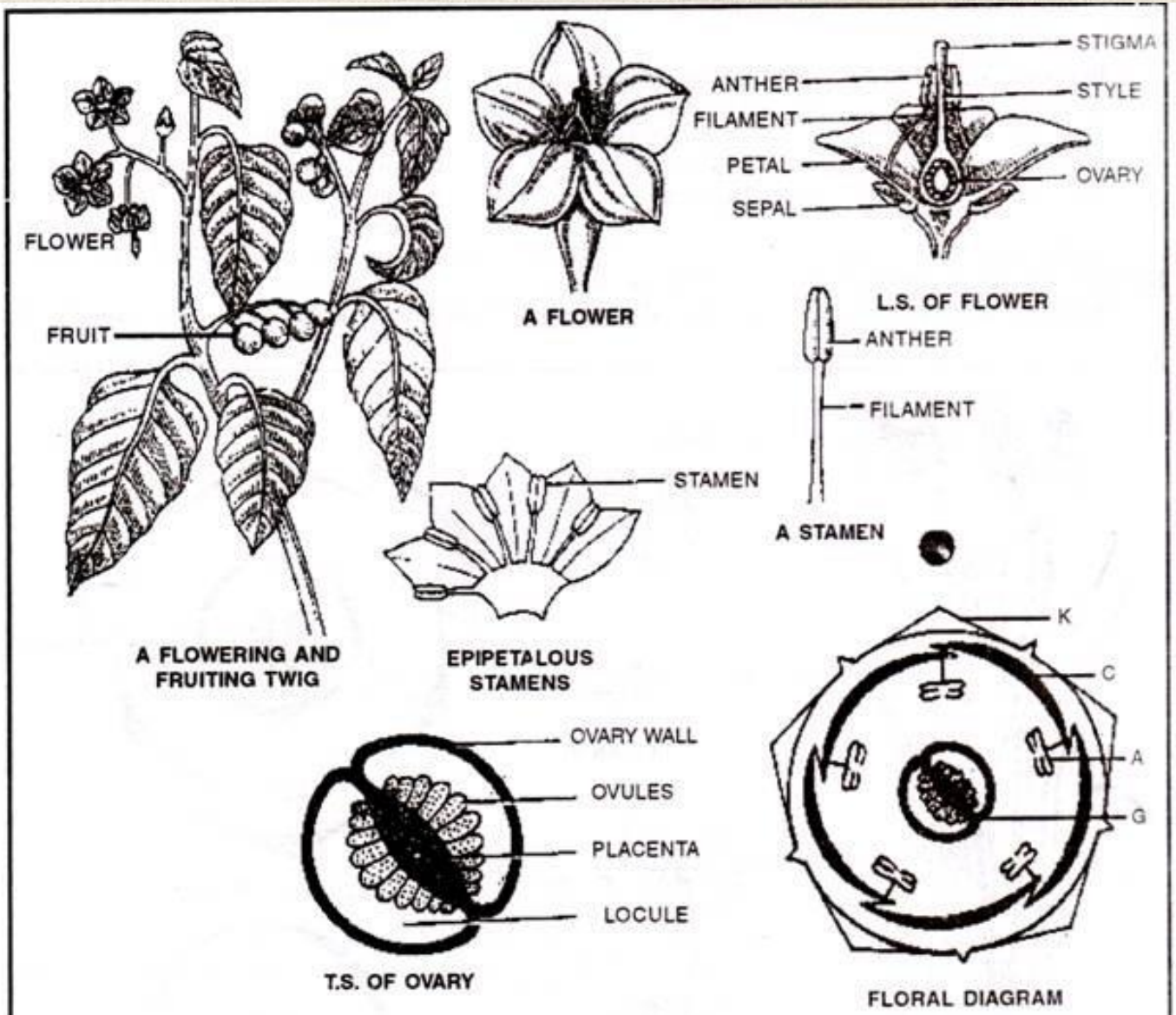


Figure 11.9. Floral structure and floral diagram of a typical plant (*Solanum nigrum*) of family Solanaceae.

Fruit Botany of Solanaceae

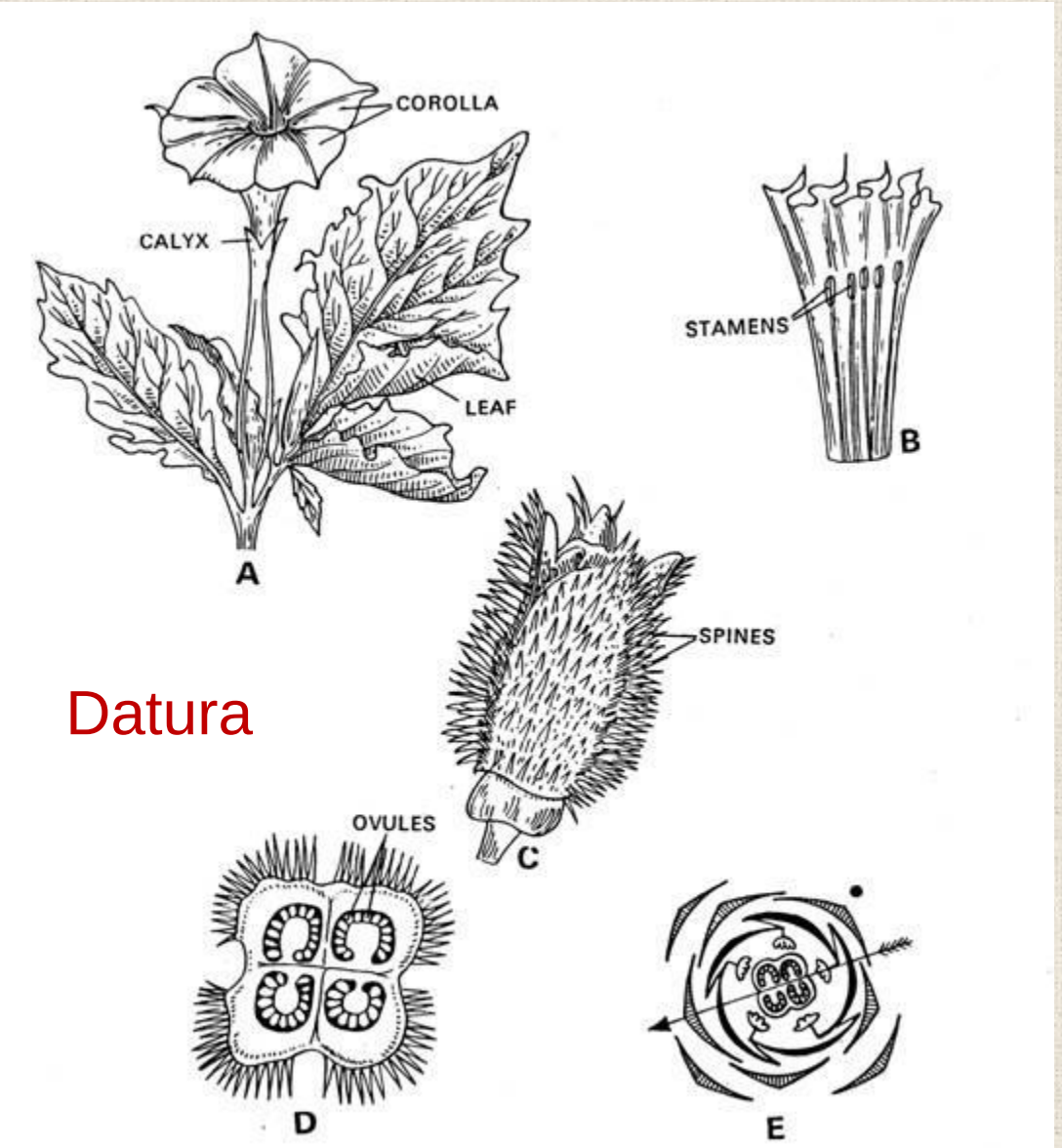
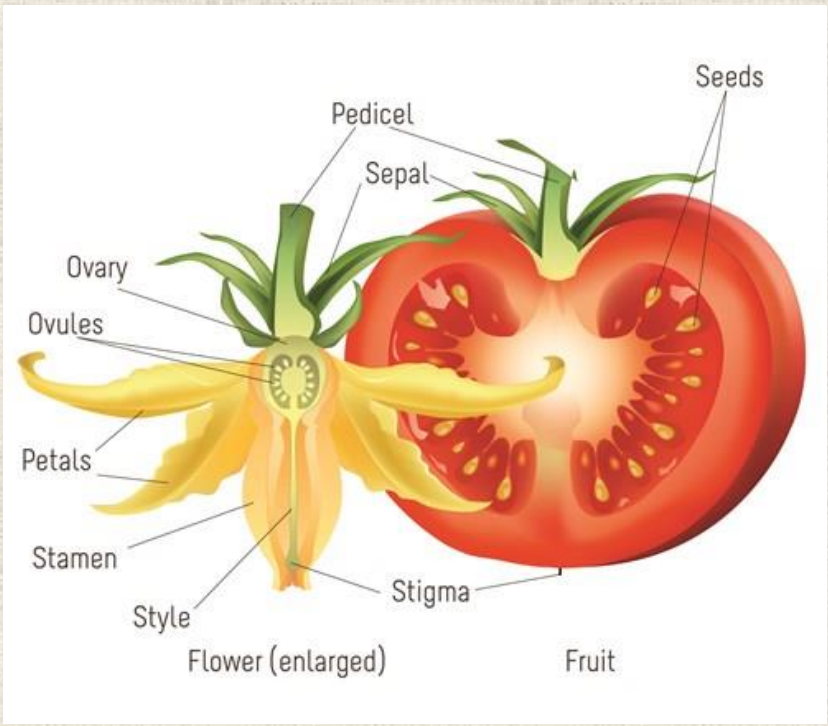


Fig. 26.1. Solanaceae. *Datura stramonium* (Verna–**Dhatura**); A, a flowering twig; B, corolla spread out with epipetalous stamens; C, opening fruit (capsule); D, cross-section of capsule; E, floral diagram.

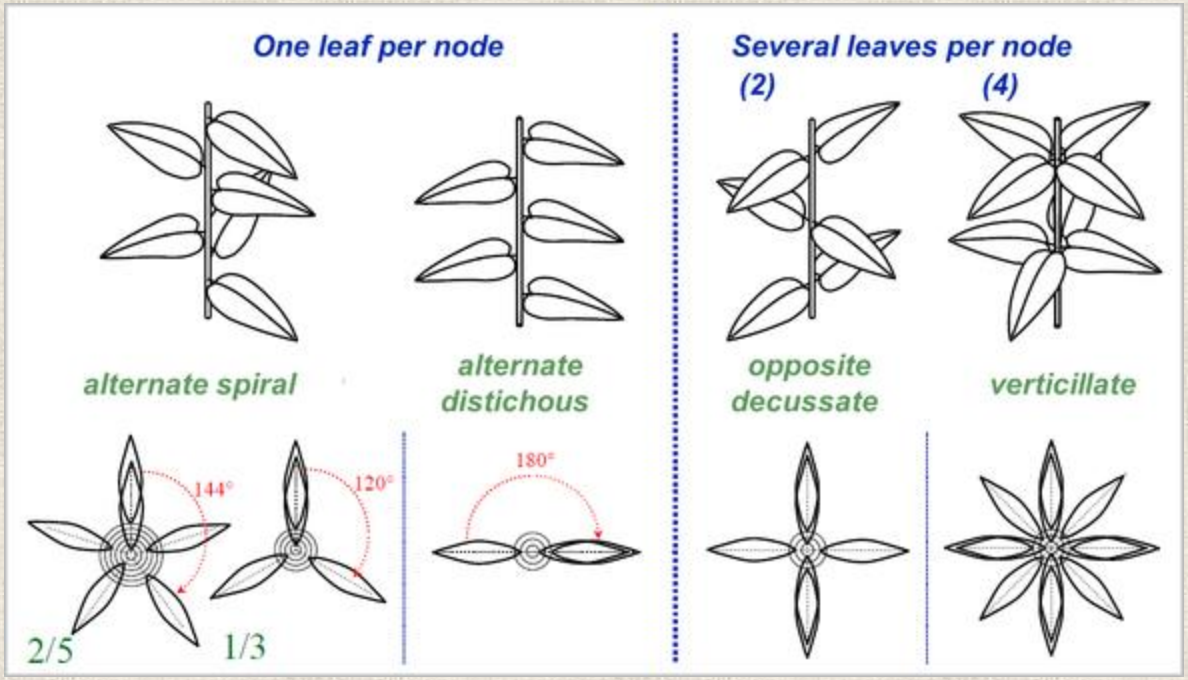
Datura



Tomato

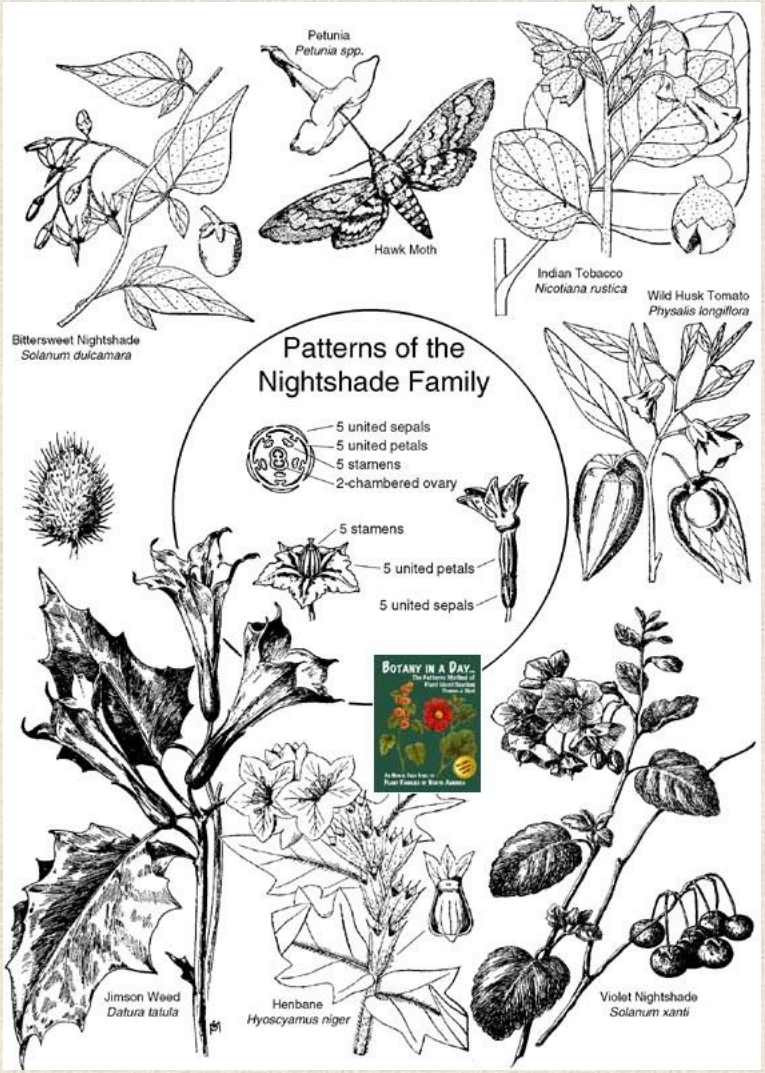
Natural History: Solanum Example

- *Solanum* species can assume a bewildering array of growth forms, from annual herbs to shrubs, trees, or woody vines.
- Leaves of all *Solanum* species are alternate, but their phyllotaxis can be altered by complex growth patterns so that they may appear to be opposite or paired; this arrangement is commonly called 'geminate'.



Natural History: Solanum Example

- Leaf blades can be simple, lobed, or compound, with leaf bases ranging from tapering to truncate or cordate.
- Species can be glabrous or pubescent, and pubescence can take many forms, with hairs simple (unbranched) or branched depending on the species. Hair and spine morphology are diagnostic for many species and groups within Solanum and are very important characters in taxonomy.



Natural History: Pollination

- The pollination requirements for Solanaceae vary according to whether they are self-fertile or self-sterile

- The poricidally dehiscent anthers of nearly all Solanum species make this genus an example of the “buzz pollination syndrome”. In these flowers, nectar is absent and pollen is the sole floral reward.
- However, at least one group, *Solanum* section Pachyphylla, exhibits the male euglossine syndrome in which floral osmophores secrete scents that are gathered by male "orchid" bees.

Natural History: Pollination

Many native bees "buzz" pollinate—sonicating flowers improves pollination of crops like blueberry & tomato

- **Nightshade family & blueberry flowers**

pollen is only released when sonicated, like sound is released from a tuning fork

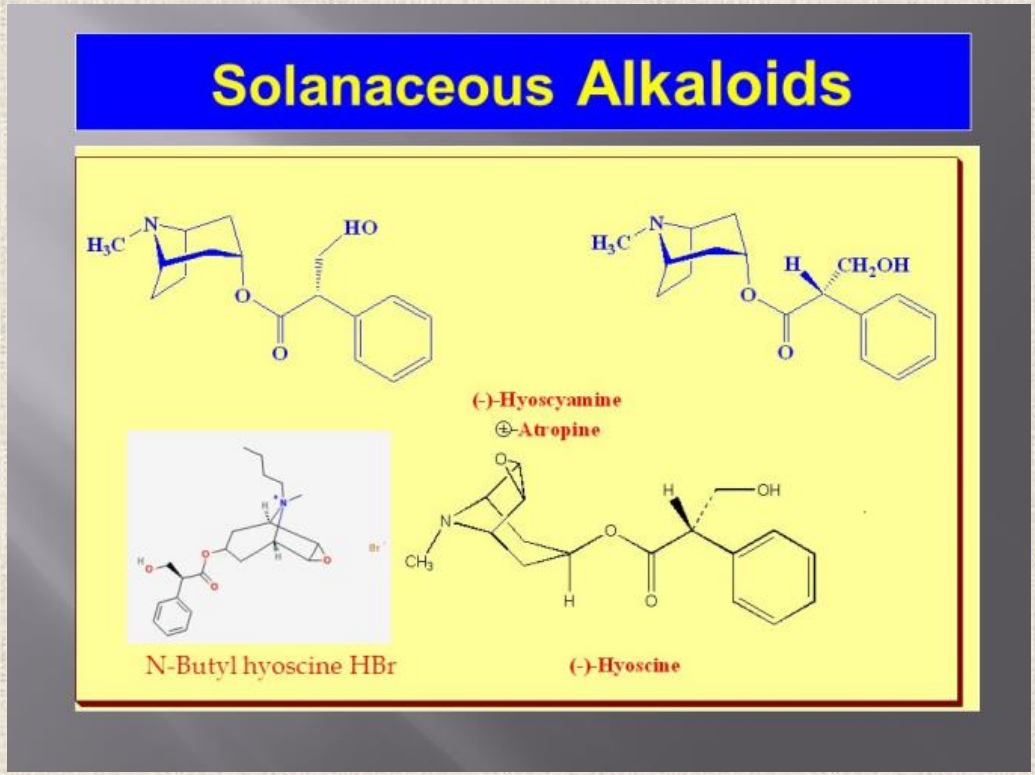
Natural History

- Biologically active phytochemicals are found in Solanaceae plants.
- They are produced by plant “secondary” metabolism that produces compounds such as alkaloids, flavonoids, anthocyanidins, terpenes and phenolics.
- Secondary phytochemicals are organic compounds that are not directly involved in the normal growth, development, or reproduction of an organism. Secondary metabolites often play an important role in plant chemical-based ecological interactions with their biotic and non-biotic environment.

Natural History

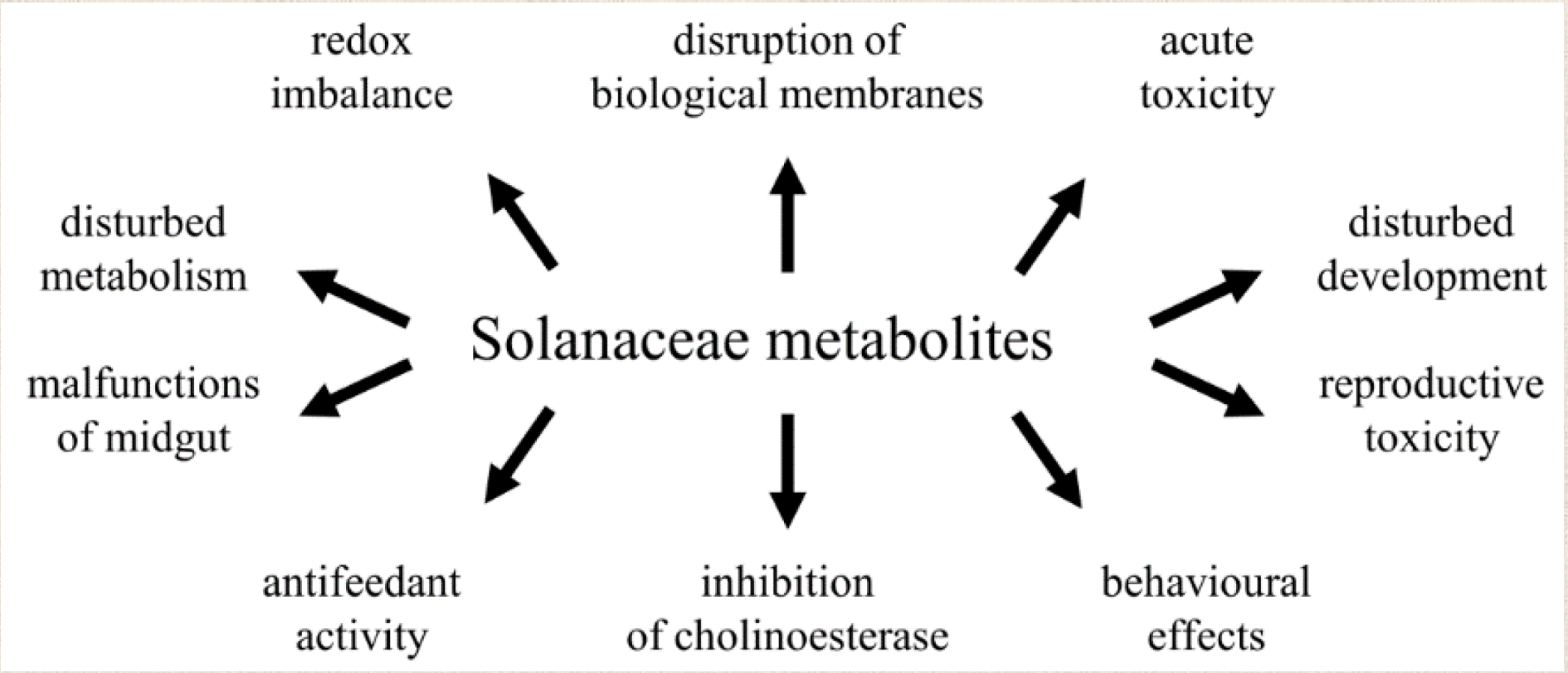
- Chemical protection via secondary phytochemicals plays a decisive role in the resistance of plants against pathogens and herbivores.

- Solanaceae are known for having a diverse range of alkaloids.

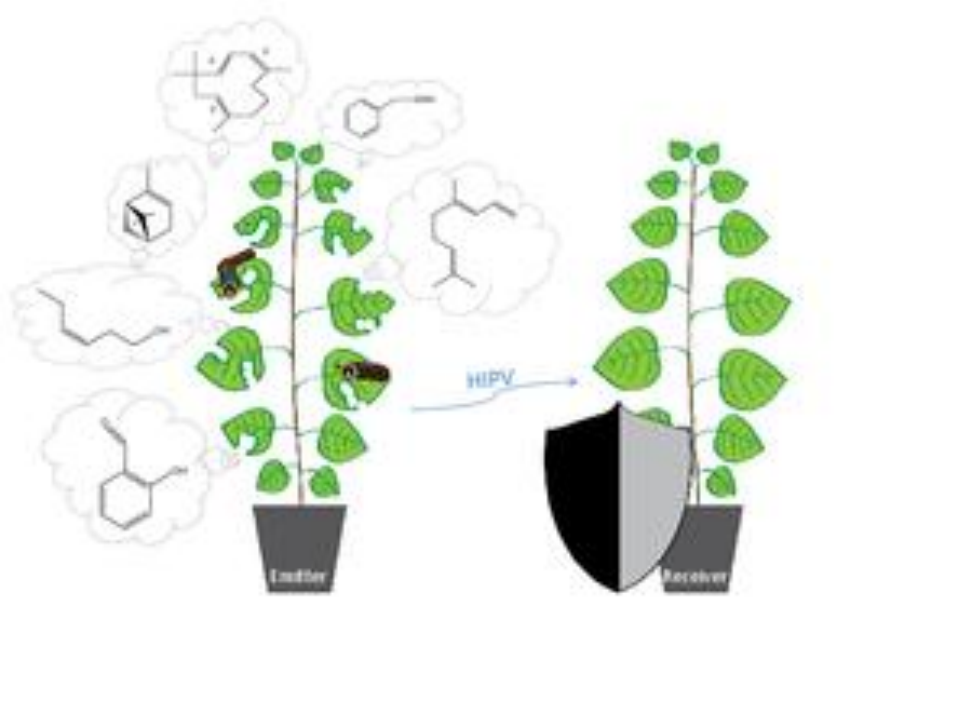


Natural History

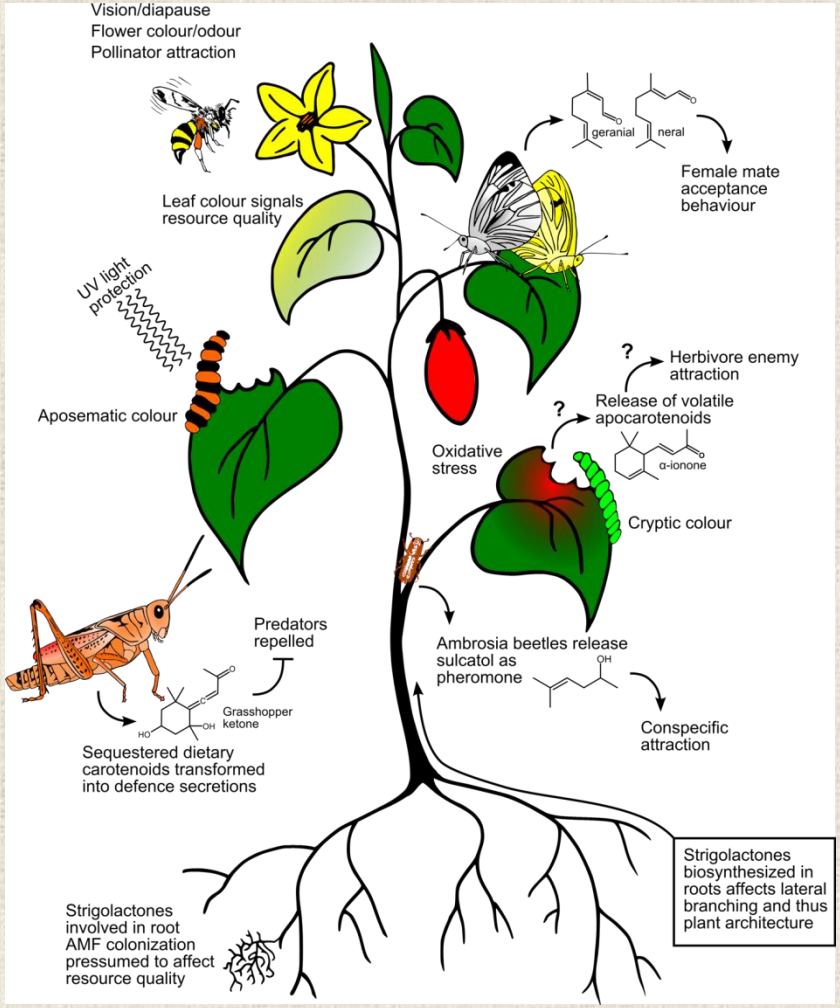
- Solanaceae Alkaloids
  - Types of biological activity



Natural History



Plant chemical defense example



Plant phytochemical research includes multiple ecological processes

Natural History

❖ Solanaceae Alkaloids Examples

➢ Nicotine

- A pyrrolidine alkaloid produced in large quantities in the tobacco plant (*Nicotiana tabacum*).
- Nicotine's function in a plant is to act as a defense against herbivores, as it is a very effective neurotoxin, in particular against insects. In fact, nicotine has been used for many years as an insecticide in agriculture.

Natural History

❖ Solanaceae Alkaloids Examples

➢ Capsaicin

- ➢ An active alkaloid component of chili peppers, which are plants belonging to the genus *Capsicum*.
- ➢ Capsaicin and several related compounds are called capsaicinoids and are produced as secondary metabolites by chili peppers. They are present in large quantities in the placental tissue (which holds the seeds) of the pepper fruit.
- ➢ Research on the capsaicinoids has demonstrated an ecological role for seed dispersal. For example, the seeds of Capsicum plants are dispersed predominantly by birds. In birds there is no biological activity to capsaicin in contrast to mammals.

Natural History

❖ Solanaceae Alkaloids Examples

➢ Capsaicin Research (cont.)

- This is advantageous to the plant, as chili pepper seeds consumed by birds pass through the digestive tract and can germinate later, whereas mammals have molar teeth which destroy such seeds and prevent them from germinating. Thus, natural selection may have led to increasing capsaicin production because it makes the plant less likely to be eaten by animals that do not help it disperse.
- There is also evidence that capsaicin may have evolved as an anti-fungal agent. The fungal pathogen *Fusarium*, which is known to infect wild chilies and thereby reduce seed viability, is deterred by capsaicin, which thus limits this form of predispersal seed mortality.

Natural History

- As is the situation with all defense systems of plants and animals, a few specialized pathogens have evolved in plants and have overcome the chemical defense barrier.
- Furthermore, they are often attracted by a given plant phytochemical toxin.
- For example, ithomiine butterfly larvae are specialist herbivores on Solanaceae. Ithomiines are unpalatable to predators because their adults seek out and sequester pyrrolizidine alkaloids from plants that they visit.

Tomato Horn Worm (*Manduca quinquemaculata*

Solanaceae
Cultural History

Cultural History

- The Solanaceae are the third most important plant taxon economically and the most valuable in terms of vegetable crops.
- They are the most variable of crops species in terms of agricultural utility. They provide many products used by human beings for food, drugs and enjoyment.
  - Edible species such as the tuber-bearing potato, a number of fruitbearing vegetables (tomato, eggplant, peppers), plants with edible leaves (*Solanum aethiopicum*, *S. macrocarpon*) and a host of minor fruit crops.

Cultural History

❖ Solanaceae Agriculture (cont.)

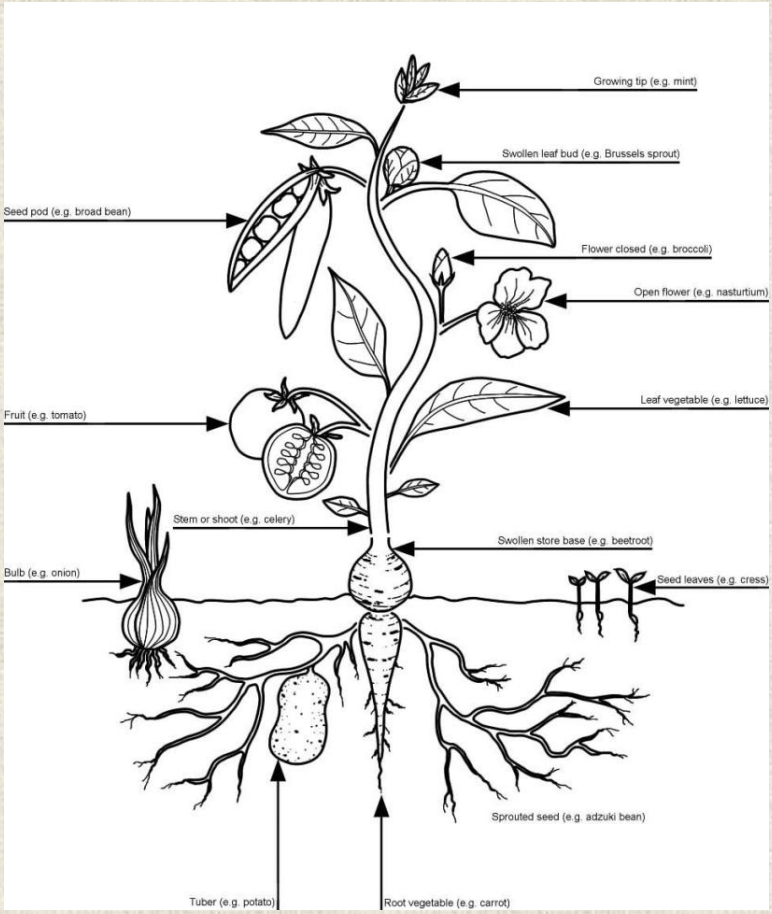
- Medicinal plants such as deadly nightshade, jimson weed, tobacco, and henbane are the sources of drugs such as atropine, hyoscine, nicotine and other alkaloids.
- Horticultural plants such as petunia, floripondio, velvet tongue, and butterfly flower.
- Species such as tomato, potato, tobacco, and petunia are important experimental organisms in genetics and molecular biology.

Cultural History

- The nightshade family Solanaceae is a paradox – some of its members are laden with deadly poisons like the mandrake and the deadly nightshade, while others, like the potato, help feed the world, and still others, like the petunia, beautify our gardens in summer.
- No other flowering plant family can boast such a range of human use; nightshades epitomise the power of human domestication to manage and exploit the diversity of plant life.

Solanaceae Crop Diversity

- Plant parts as vegetables
  - Leaf
  - Stem
  - Root and tuber
  - Seed
- Herbs (culinary)
- Fruits
- Medicinal
- Flowers (horticulture)



Solanaceae Crop Diversity

- It is estimated that humans have been growing and eating Solanaceae food crops for thousands of years. Historical dates of example crops include;
  - Pepper: 7,500 BCE
  - Eggplant: 300 BCE
  - Potato: 10,000 BCE
  - Tomato: 500 BCE (Mexico)
  - Tobacco: 2,000 BCE
- Although the exact number might be unknown, one can estimate that there are hundreds of varieties of Solanaceae crops, including many local varieties that are not exported or grown worldwide.

Common NIGHTSHADE VEGETABLES

Solanaceae Crop Diversity

- How Did Solanaceae Crops & Cultivars Originate?
  - Crop domestication = human-induced plant adaptation
  - *Centers of Origin* have wild relatives of the crop.
  - Hybridization and polyploid formation are important driving forces in crop evolution
  - In each *Center of Origin* numerous crops were domesticated
  - Genetic diversity can be measured at the molecular level

Solanaceae Crop Diversity: Centers of Origin *

Tomato

- Native to western South America. Wild form of *Lycopersicon esculentum* var. *cerasiforme*, found in Mexico, Central America and other parts of South America.
- The exact date of domestication is unknown: by 500 BC, it was already being cultivated in southern Mexico and probably other areas.
- Mexican origin of cultivated tomatoes transported to Old World. Native versions were small, like cherry tomatoes.
- Most likely the first variety to reach Europe was yellow in color, since in Spain and Italy they were known as pomi d'oro, meaning yellow apples. Italy was the first to embrace and cultivate the tomato outside South America.

Tomato

- French botanist Tournefort provided the Latin botanical name, *Lycopersicon esculentum,* to the tomato. It translates to *"wolfpeach"* -- peach because it was round and luscious because it was erroneously considered poisonous (although leaves are poisonous. The botanist mistakenly took the tomato for the wolfpeach referred to by Galen in his third century writings, ie., poison in a palatable package which was used to destroy wolves.

- The English word tomato comes from the Spanish word, tomate, derived Nahuatl (Aztec language) word, tomatl. It first appeared in print in 1595.

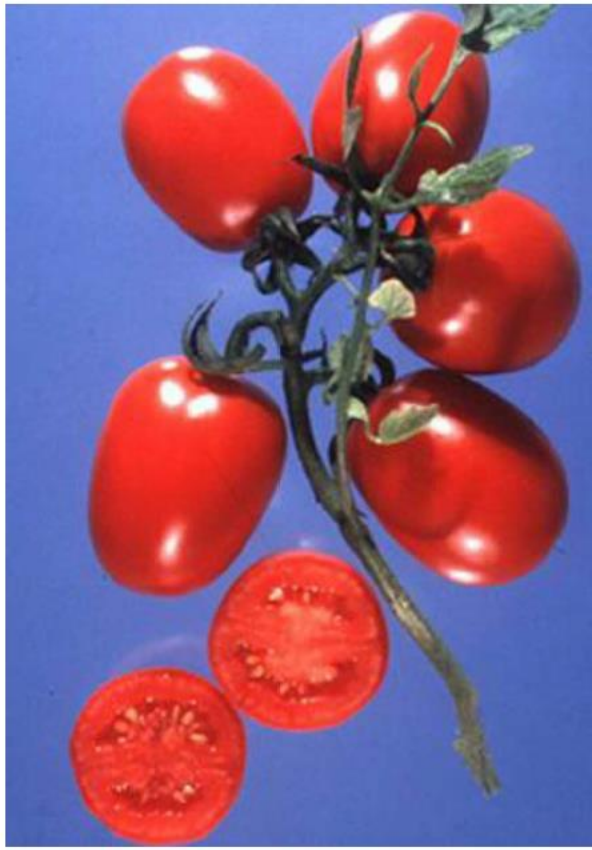
Tomato

- In the late 1700s, a large percentage of Europeans feared the tomato.
- A nickname for the fruit was the “poison apple” because it was thought that aristocrats got sick and died after eating them, but the truth of the matter was that wealthy Europeans used pewter plates, which were high in lead content. Because tomatoes are so high in acidity, when placed on this particular tableware, the fruit would leach lead from the plate, resulting in many deaths from lead poisoning. No one made this connection between plate and poison at the time; the tomato was picked as the culprit.
- Around 1880, with the invention of the pizza in Naples, the tomato grew widespread in popularity in Europe.

Evolution of tomato

Lycopersicon *esculentum*
var. *cerasiforme*

Lycopersicum *esculentum*

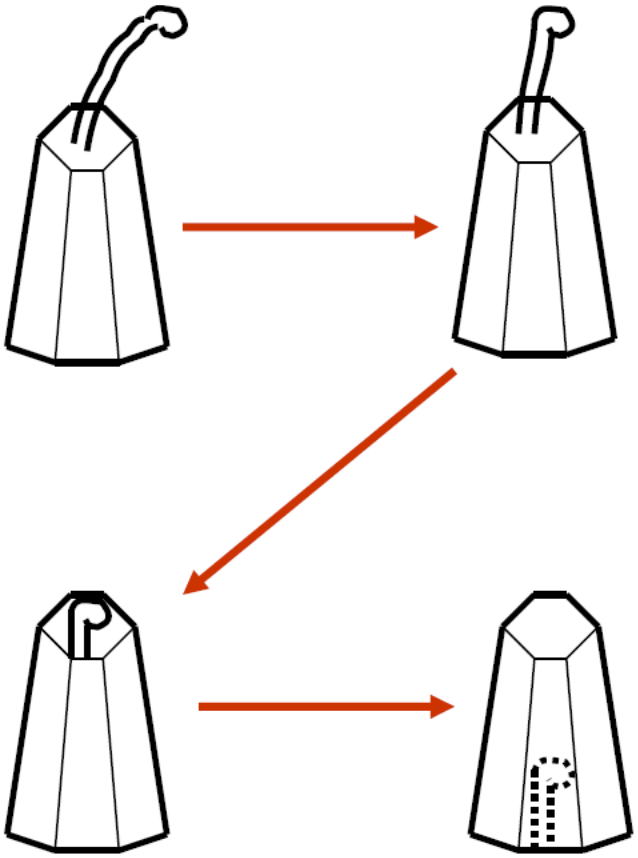


Cytogenetics of tomato

- For all species: 2n = 2x = 24
- L. *esculentum* and its near relatives are self-fertile.
- Other species display different mating systems from strict autogamy to strict allogamy in self-incompatible taxa.
- L. *esculentum* can be hybridized with all other species of Lycopersicon and certain tomato-lik Solanum spp

Morphological evolution

Ancestral self-incompatible species

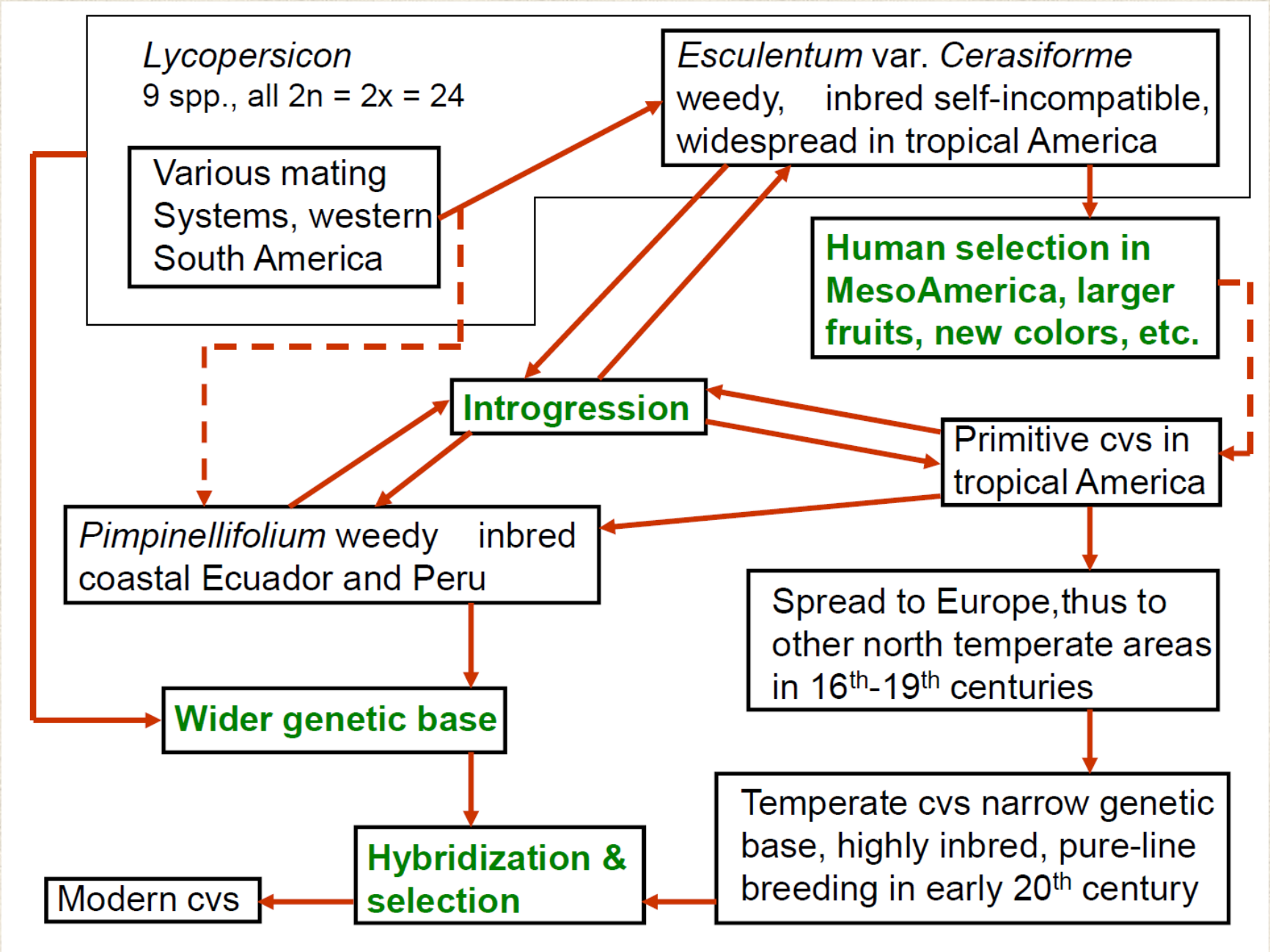


Var. cerasiforme Latin American cultivars

Older European & N. American cultivars

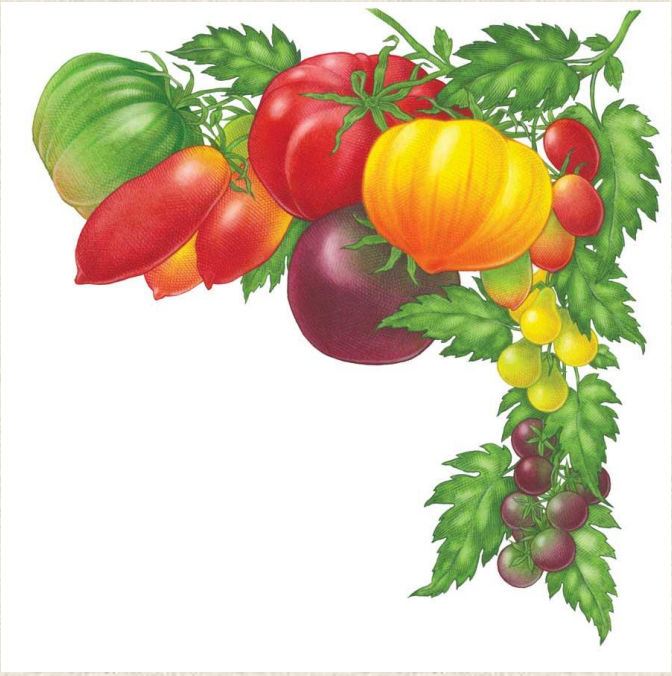
Modern Californian cultivars

Evolutionary Relationships of Tomato



Solanaceae Crops

Harvesting Tips of Tomatoes



- Generally, a tomato is fully ripe when it releases easily from the stem. If you misjudge a bit it's no tragedy, because tomatoes will ripen somewhat after picking. But they develop the fullest sweet flavor if they ripen in the sun on the vine.

- There is a huge range of tomato varieties. Many kinds are red when ripe, but some are orange, yellow, striped or even green. So learn what to expect from your variety and monitor the plant closely as its due date nears.

Tomato Quality Standard Examples

Stage 1 *Green*: The tomato surface is completely green. The shade of green may vary from very light to dark. This is the ideal stage for preparing Fried Green Tomatoes, a southern favorite that involves coating seasoned, sliced tomatoes with corn meal, and shallow or pan frying. Tomatoes in this stage must be specified when ordering.

Stage 2 *Breakers*: There is a definite break of color from green to yellow, pink or red on 10% or less of the tomato surface. Tomatoes are typically shipped at this or the following stage.

Stage 3 *Turning*: Yellow, pink and/or red color shows on over 10%, but no more than 30% of the tomato surface.

Depending on your purveyor, you may receive fresh, field-grown tomatoes at any of the following stages. With proper handling (never falling below 55° F) and timely usage, you will maximize flavor in every use.

Stage 4 *Pink*: Pink or red color shows on over 30%, but no more than 60% of the tomato surface. When receiving tomatoes at this stage, hold in dry storage, away from onions, and monitor daily.

Stage 5 *Light Red*: Pinkish-red or red color shows on over 60%, but red color does not cover more than 90% of the tomato surface. Hold in dry storage, away from onions, and sort to pull out any tomatoes in stage 6. To speed ripening, trap ethylene gas released by tomatoes (see next section). Perfect for QSR tomato slicers.

Stage 6 *Red*: Red color shows on over 90% of the tomato surface. Perfect for slices and wedges, and ready to serve.

Tomato Variety Guide

Anna Russia
Mildy sweet and savory

Antique Roman
Beefy consistency and savory flavor

Better Boy
A disease tolerant plant that produces uniform, flavorful fruit until the frost

Black Cherry
Beautiful black, grape-like tomatoes with a rich flavor

Black Prince
Greenish brown tennis ball-size fruits that are very juicy

Brandywine
A classic tomato variety with plump, pink fruit

Cherokee Purple
Winey and sweet

Dixie Gold Giant
Sweet and mouth-watering

Green Giant
Newer to the public, this is a vigorous and healthy variety

Green Zebra
A rich and sweet tasting fruit

Kelloggs Breakfast
Deep golden-orange fruits with a sweet-tangy flavor

Lemon Boy
A sunny, yellow hued hybrid

Orange Strawberry
Thrives in a moderate summer climate and offers a rich, meaty consistency

Peppermint
Productive and flavorful

Roma
A very common, easy-to-grow tomato

Rutgers
An heirloom tomato that dates very far back

Sara Black
A flavorful and productive variety

Sioux
Tolerant to heat, pests, and disease

Stupice
A cold-tolerant variety

Sun Gold
Fruity and sweet flavor

Supersweet 100
Disease resistant and flavorful

Tigerella
Small red fruits with stripes of yellow and orange

Verna Orange
Appearing similar to a mango this is a productive variety

White Wonder
Some feel the flavor is bland, but is a nice contrast to darker varieties

Yellow Brandywine
A nectarine like consistency with an intense sweetness

Tomato Crop Diversity

Solanaceae Crop Diversity

- Picture from India shows the amazing genetic variation of eggplant where eggplant (or brinjal, as it is called on the Subcontinent) is known as the "king of vegetables."

Solanaceae Crop Diversity

❖ Eggplant

- Native to a wide area stretching from India to Southeast Asia and into southern China.
- The first documented writing about it comes from India as early as 300 B.C.E., where it was probably cultivated for both food and as a medicinal plant.
- The Chinese were also early adopters of the fruit as a source of both food and medicine - eggplant is discussed in a Chinese plant atlas from the 2nd century C.E.
- Eggplant quickly spread to Japan and Korea, and then to the Persian Empire. The Muslim expansion in the 8th and 9th centuries brought eggplant to the Mediterranean, where it has become firmly entrenched in the culinary culture of Spain, Italy, Southern France & the Middle East.

Solanaceae Crop Diversity

❖ Eggplant (cont.)

- The fruit finally made its way across the globe to the Americas during Spain's expansion in the 15th century.
- Eggplants were originally termed "mad apples" in Europe, in keeping with the European propensity to name every vegetable some variation of "apple" (e.g., tomato = "love apple," potato = "Devil's apple,“ etc.).
- The term apple once meant any kind of fruit or fruit in general; coming from Old English “æppel”," from the Teutonic “applen” and the Proto-Germanic “ap(a)laz”.

Solanaceae Crop Diversity

❖ Eggplant (cont.)

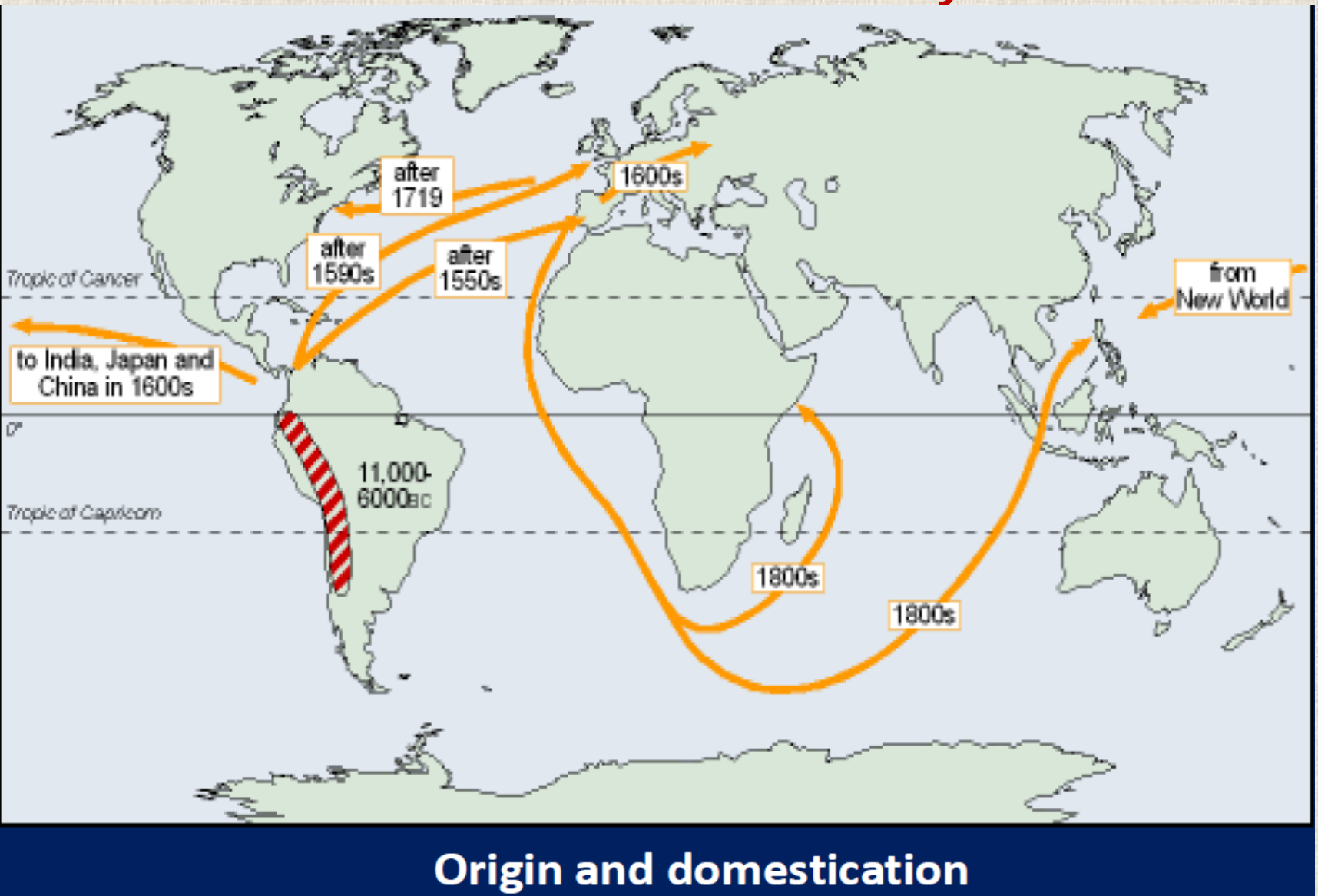
- Early eggplant consumption was viewed with much ambiguity, as eggplant-adopting cultures frequently ascribed all sorts of health problems to eggplant in their culinary and medicinal writings. The Chinese thought eggplant caused uterus injury, the Persians blamed it for everything from pimples to leprosy and the medieval Europeans ascribed the fruit to "melancholy" and anger.
- It was thought that many of these eggplant-induced troubles could be mitigated through liberal salting and rinsing prior to cooking, a culinary technique that is still in existence today

Solanaceae Crop Diversity

- Potato
  - Today the potato is the 5th most important crop worldwide, after wheat, corn, rice and sugar cane.
  - Genetic testing of the wide variety of cultivars and wild species proved a single origin for potatoes in the area of present-day southern Peru and extreme Northwestern Bolivia (from a species in the *Solanum brevicaule* complex), where they were domesticated approximately 7,000–10,000 years ago.

Solanaceae Crop Diversity

- Potato Domestication History



Solanaceae Crop Diversity

❖ Potato Domestication History

- The potato produced in the Andeas today and before European contact is cultivated w/ different varieties at different altitudes. Most people in a village planted a few basic types, but most everyone also planted others to have a variety of tastes.

Solanaceae Crop Diversity

❖ Potato Domestication History

- Wild potatoes are laced with toxic alkaloids, solanine and tomatine. Cooking often breaks down such chemical defenses, but solanine and tomatine are unaffected by heat.

- Andean mountain peoples learned to dunk wild potatoes in a "gravy" made of clay and water. The toxins are adsorbed to the fine clay particles in their stomachs, passing through the digestive system without harm.

- Eventually they bred less-toxic potatoes, though some of the old, poisonous varieties remain, favored for their resistance to frost. Clay dust is still sold in Peruvian and Bolivian markets to accompany them.

Solanaceae Crop Diversity

❖ Potato Domestication History (cont.)

- The most common worldwide is the *S. tuberosum ssp. tuberosum*. This subspecies (a long day plant) was introduced in Europe in the mid-1800s from Chile when a fungus disease almost completely destroyed *S. tuberosum ssp. andigena*, the original subspecies (a short day plant) imported by the Spanish directly from the equatorial Andes in the 1500s.

POTATO SPECIES CLASSIFICATION

Solanum tuberosum	Solanum andigena
1)It was originated from the coastal regions of south chile	1)It was originated from the Andean region
2)It has thick and short stem	2)It has thin and long stem
3)Larger and wider leaflets are present	3)Small and narrow leaflets are present
4)Adapted to longer days	4)Adapted to shorter days
5)Grown in large scale	5)Not grown in large scale
6)Pedicel is thickened above	6)Pedicel is not thickened at the apex
7)Yield potential is high	7)Yield potential is low
8)Species of tuberosum has characters of early potato	8)Species of andigena are having characters of late potato

Solanaceae Crop Diversity

❖ Potato Domestication History (cont.)

- The most common worldwide is the *S. tuberosum ssp. Tuberosum*. This species was introduced in Europe in the mid-1800s from Chile when a fungus disease almost completely destroyed *S. tuberosum ssp. andigena*, the original species imported by the Spanish directly from the Andes in the 1500s.

Solanaceae Crop Diversity

❖ Potato Domestication History (cont.)

- Hunger was a familiar presence in 17th- and 18th-century Europe. Cities were provisioned reasonably well in most years, their granaries carefully monitored, but country people teetered on a precipice.
- While initial acceptance was slow due to incorrect information given to farmers and consumers, many researchers believe that the potato's arrival in northern Europe spelled an end to famine there.
- Antoine-Augustin Parmentier was the potato's Johnny Appleseed who successfully promoted potato consumption during the Flour War of 1775 in France.

Solanaceae Crop Diversity

❖ Potato Domestication History (cont.)

- By the end of the 18th century, potatoes had become in much of Europe what they were in the Andes—a staple. Roughly 40 percent of the Irish ate no solid food other than potatoes; the figure was between 10 percent and 30 percent in the Netherlands, Belgium, Prussia and perhaps Poland.
- Routine famine almost disappeared in potato country, a 2,000-mile band that stretched from Ireland in the west to Russia's Ural Mountains in the east. At long last, the continent could produce its own dinner.

Solanaceae Crop Diversity

❖ Potato Domestication History

- In exalting the potato, proponents unwittingly changed it. By urging potato cultivation on a massive scale from cuttings of a few initial tubers, promoters were unknowingly promoting the notion of planting huge areas with clones—a true monoculture.
- The name *Phytophthora infestans* means, more or less, "vexing plant destroyer." *P. infestans* preys on species in the nightshade family, especially potatoes and tomatoes, and causes a deadly disease called "late blight" which destroys both the leaves and the edible tubers of the potato plant.

Solanaceae Crop Diversity

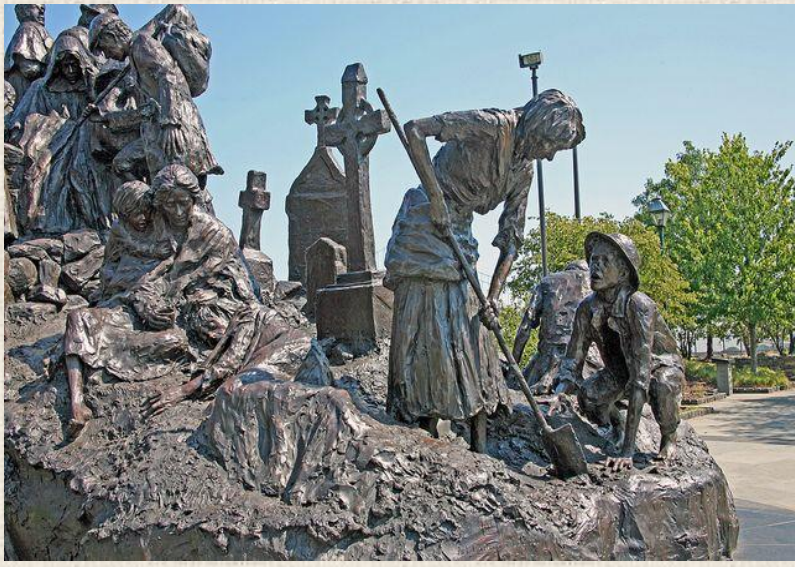
❖ Potato Domestication History (cont.)

- Scientists believe that the late blight disease of Europe originated in Peru. Large-scale traffic between Peru and northern Europe began with the importation of guano fertilizer which probably carried the disease.
- *P. infestans* first broke out in early summer 1845, in the West Flanders, six miles from the French border. The blight hopscotched to Paris by that August. Weeks later, it was destroying potatoes in the Netherlands, Germany, Denmark and England. It was reported in Ireland on September 13, 1845. Governments panicked.

Solanaceae Crop Diversity

❖ Potato Domestication History (cont.)

- The potato blight did not wind down until 1852. A million or more Irish people died—one of the deadliest famines in history, in the percentage of population lost. Within a decade 2 million more had fled Ireland as immigrants, mostly to America.



- Excluding Ireland, the death toll from the crisis is estimated to be in the region of 100,000 people. Belgium and Prussia account for most of the deaths: 40,000–50,000 (Belgium) 42,000 (Prussia) and 10,000 (France).

- The potato did indeed change the course of history!

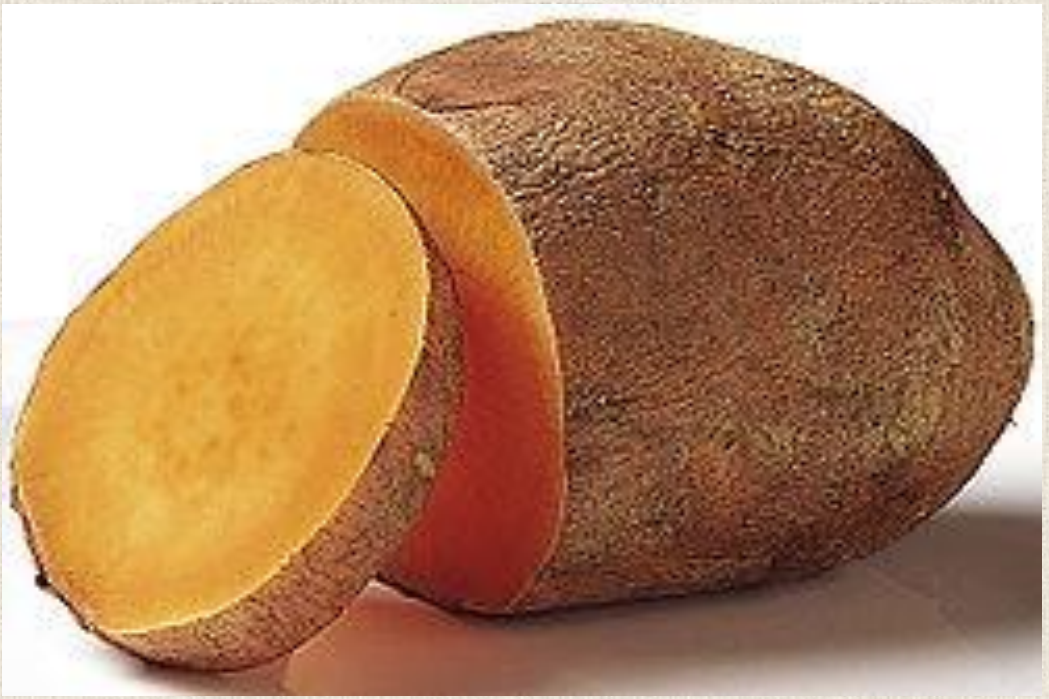
Potato Variety Diversity

Potato Variety Diversity

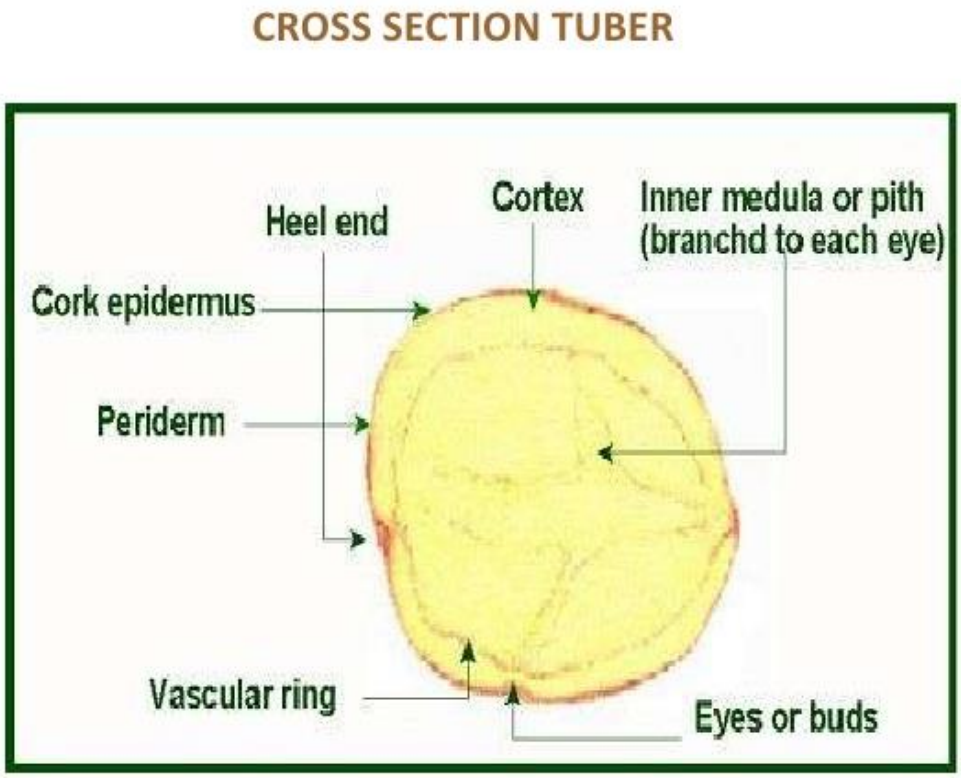
- Over 4,000 varieties in Peru alone!

Potato Crop Biology

- Is it a potato?
- No! Its internal anatomy shows that it's a root (i.e., a sweet potato)



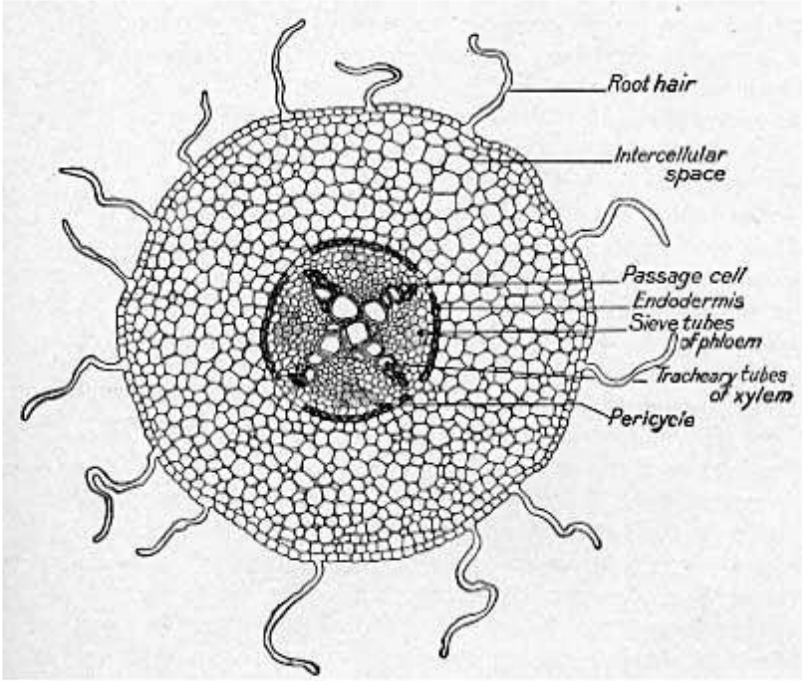
Potato Crop Biology



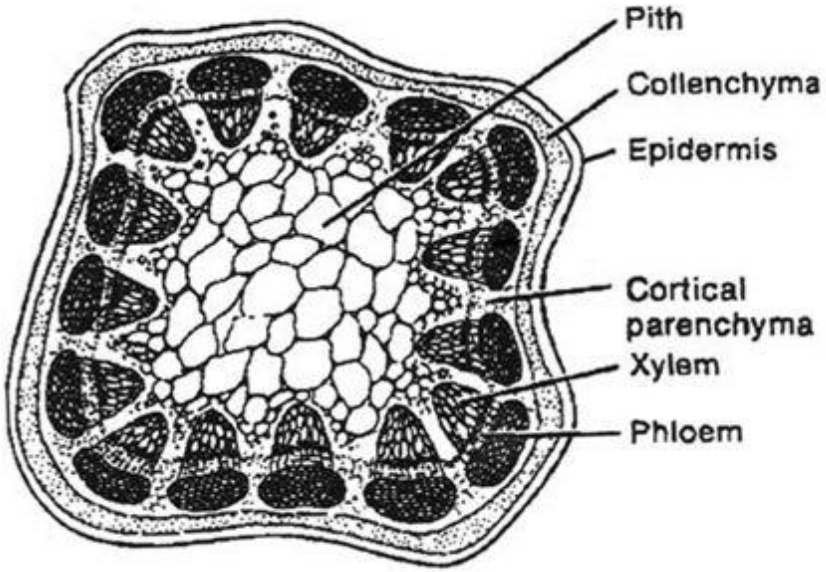
- The potato tuber is a swollen stem tissue with internal anatomy of an aboveground stem.

Potato Crop Biology

Root vs Stem



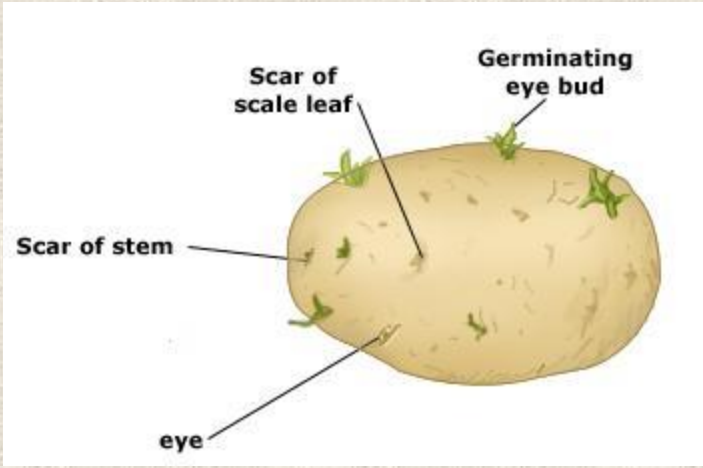
Root cross section



Stem cross section

Potato Propagation Tips

- If you have ever grown potatoes before, you are familiar with the process of planting “seed potatoes” which actually is a misnomer because it is actually a tuber and not a seed.
- Potatoes do produce seeds in small green fruits (berries) about the size of a cherry tomato.
- The fruit, however, should never be eaten. It contains toxic solanine, which can cause headaches, diarrhea, cramps, and in some cases, coma and death.



Potato Management Tips

- "Chitting" means sprouting the tuber – putting it, most eyes upright, in a light, cool but frost-free place at about 50F (10C).

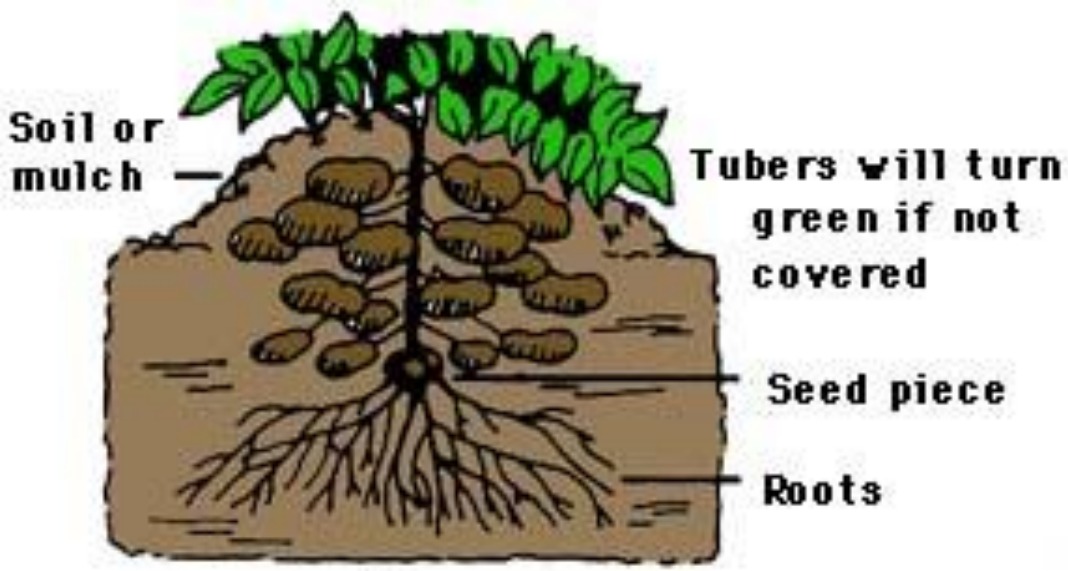


Figure 6

- The green color is from chlorophyll, and is itself harmless. However, it is an indication that increased level of solanine may be present.

- Potatoes are ready to harvest when the tops begin to die and the skin becomes firm on the potato. The skin is set when it does not scrape easily when rubbed with the thumb. Skin set can be speeded by cutting back the tops to the plants.

Solanaceae Crops

Pepper

- An annual herbaceous plant in the genus *Capsicum* cultivated in regions of temperate and warm climate and valued for its characteristic pungency, aroma, & color appeal.
- Its species are native to the Americas, where they have been cultivated for thousands of years and were spread worldwide following European colonization and trade.
- Capsicum consists of 20–27 species, five of which are domesticated: *C. annuum, C. baccatum, C. chinense, C. frutescens, and C. pubescens*

C. baccatum

C. chinese

C. frutescens

C. pubescens

Capsicum annuum

The species includes a wide variety of shapes and sizes of peppers ranging from bell pepper to chili pepper

- Some varieties;
  - bell pepper
  - Cascabel
  - Anaheim
  - Alma paprika
  - Bird's eye
  - Italian sweet pepper
  - Cherry
  - Fresno
  - Hungarian wax
  - Pablano
  - Piquin
  - Pepperoncicni

Capsicum annuum

Solanaceae Crops

❖ Pepper (cont.)

- The fruit has a variety of names depending on place and type.
  - The spicy varieties are commonly called “chili peppers”, or simply "chilis".
  - The large, mild form is called "red (bell) pepper", "green (bell) pepper", or just "bell pepper" (depending on color) in North America and United Kingdom and typically "capsicum" in New Zealand, Australia, South Africa, Singapore and India.

Solanaceae Crops

- Pepper (cont.)
  - The one attribute most typical of chilis is pungency and must be considered one of its most important traits.
  - Pungency is produced by the capsaicinoids, alkaloid compounds, that are found only in the plant genus, *Capsicum*.
  - Capsaicin is a powerful and stable alkaloid that can be detected by human taste buds in solutions of ten parts per million. Capsaicin's composition ($C_{18}H_{27}NO_3$) is similar to peperin ($C_{17}H_{19}NO_3$) that gives black pepper its bite.

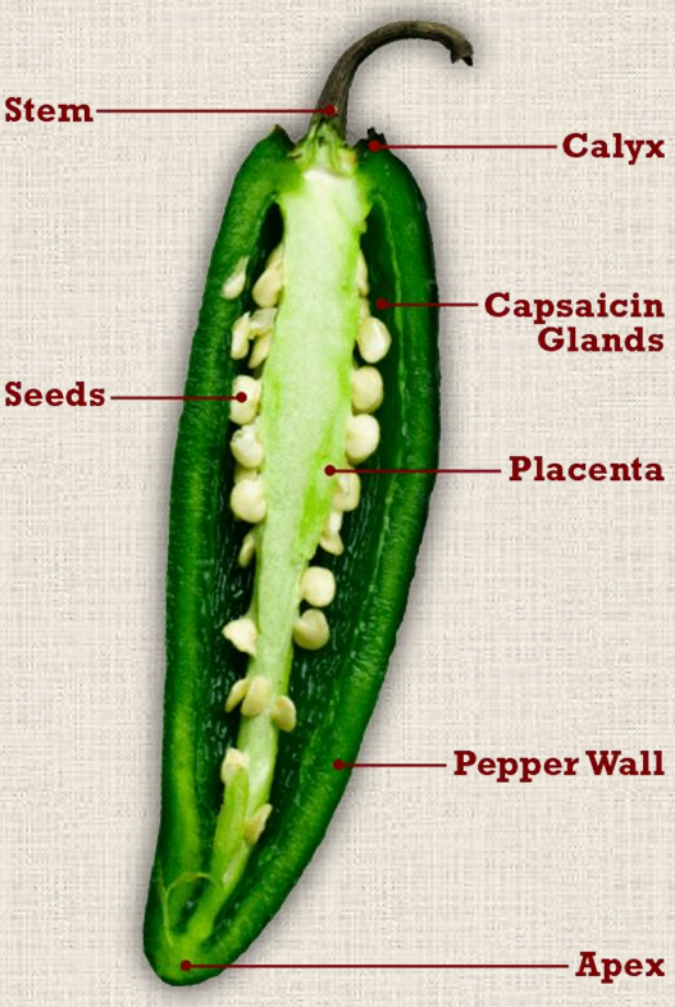
Solanaceae Crops

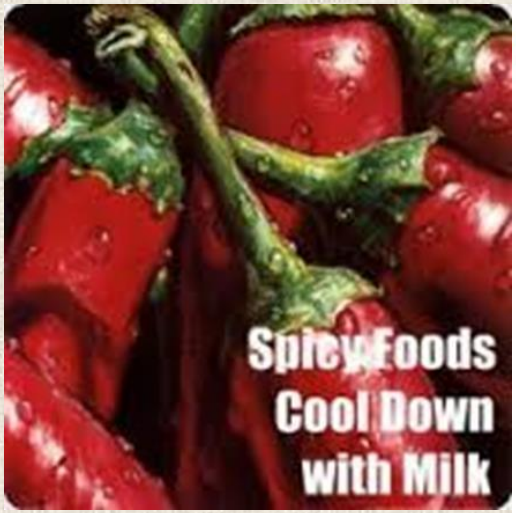
❖ Pepper (cont.)

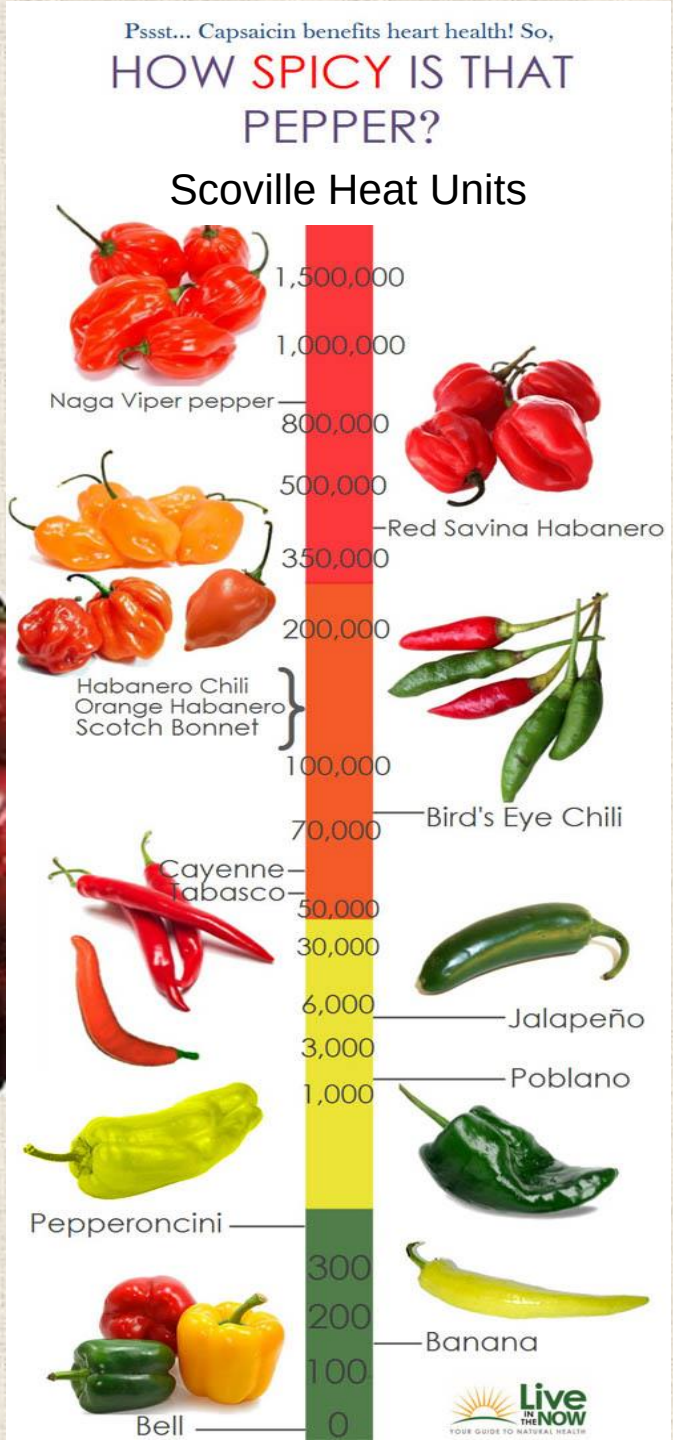
- The capsaicinoids are produced in glands on the placenta of the fruit. While seeds are not the source of pungency, they occasionally absorb capsaicin because of their proximity to the placenta. No other plant part produces capsaicinoids.
- The capsaicinoid content is affected by the genetic make-up of the cultivar, weather conditions, growing conditions, and fruit age. Pungency is increased with increased environmental stress.
- Chili pungency is expressed in Scoville Heat Units based on the Scoville Organoleptic Test by a panel of five human representatives, who tasted a chili sample and then recorded the heat level.

Solanaceae Crops

Chili Peppers







What's Your Favorite Pepper?

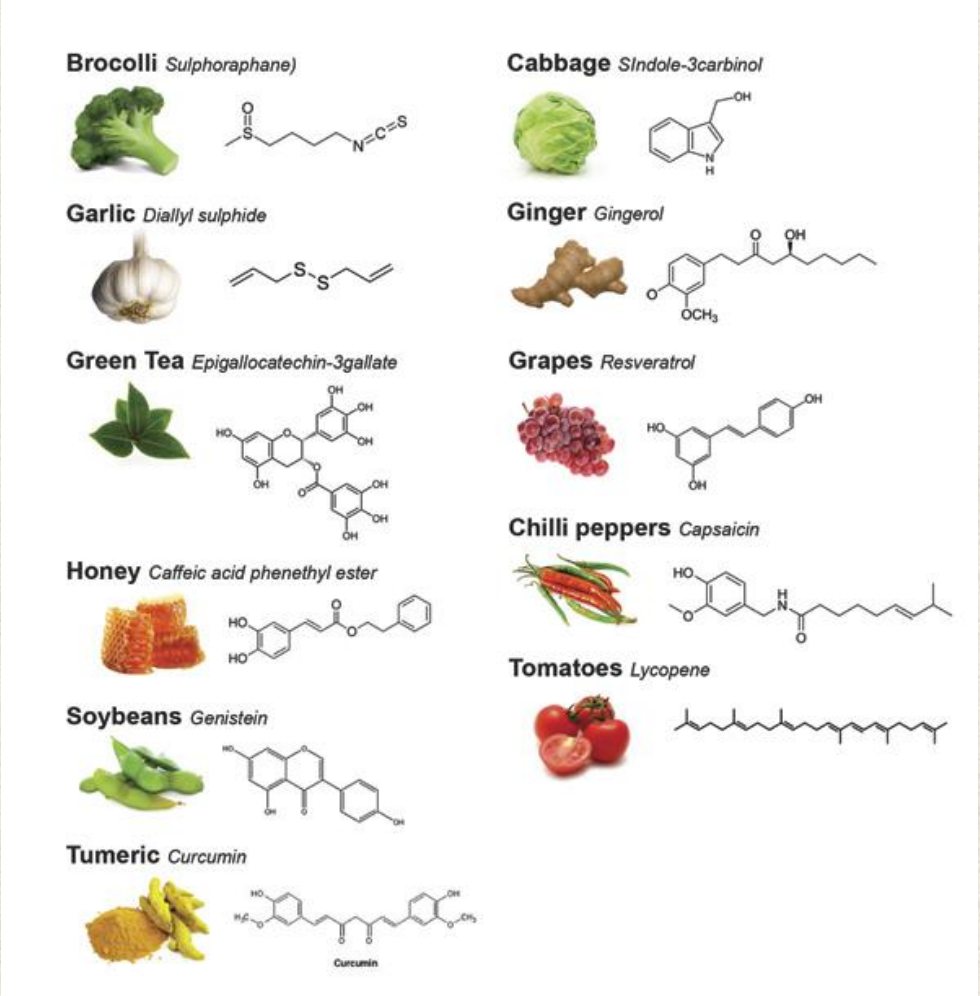
Solanaceae Crops

Harvesting Tips of Peppers

- You can eat peppers when they are mature yet still green (green peppers), although the flavor and the vitamin content of peppers improve as they ripen to red, yellow or orange.
- Use pruning shears to snip ripe peppers from the plant, leaving a small stub of stem attached.

Cultural History

- Solonaceae crop breeding history included both selection for & removal of natural phytochemicals found in wild types in centers of origin.
- For example, the medicinal use of phytochemicals from different plant families has a long history with human populations, a.k.a. “food as medicine”



- Picture shows examples of crops bred from wild plants with medicinal phytochemicals.

Cultural History

❖ Solanaceae Alkaloids

- To humans, these alkaloids can be desirable, toxic, or both.

- Tropane
  - The most well-known of the alkaloids found in the Solanaceae. The plants that contain these substances have been used for centuries as poisons. However, despite being recognized as poisons, many of these substances have invaluable pharmaceutical properties
  - The term "tropane" comes from a genus in which they are found, Atropa (the belladonna genus). Atropa is named after the Greek Fate, Atropos, who cut the thread of life.

Cultural History

❖ Solanaceae Alkaloids

➢ Tropane (cont.)

- Despite the extreme toxicity of the tropanes, they are useful drugs when administered in extremely small dosages.
- Pharmacologically, they are the most powerful known anticholinergics in existence, meaning they inhibit the neurological signals transmitted by the endogenous neurotransmitter, acetylcholine. More commonly, they can halt many types of allergic reactions.
- These alkaloids include, among others, atropine, cocaine, scopolamine, and hyoscyamine. They are found in various species, such as mandrake, black henbane, the stramonium and Brugmansia species, as well as many others in the Solanaceae family.

Cultural History

❖ Solanaceae Alkaloids

➢ Nicotine

- Edible Solanaceae such as eggplants, tomatoes, potatoes, and peppers also contain nicotine, but at concentrations ~100,000–1,000,000 times less than tobacco.

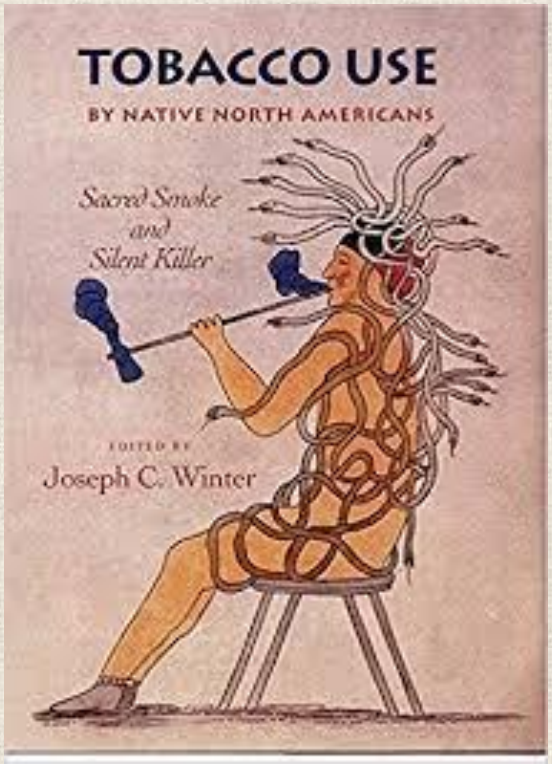
- At low concentrations, nicotine acts as a stimulant in mammals, which causes the dependency in smokers. Like the tropanes, it acts on cholinergic neurons, but with the opposite effect (it is an agonist as opposed to an antagonist). It has a higher specificity for nicotinic acetylcholine receptors than other ACh proteins.[95]

Cultural History

❖ Solanaceae Alkaloids

➢ Nicotine

- History of tobacco use
  - Used by native peoples of North and South Americas since 3000 BCE
  - Smoked in one form or another since 2000 BCE
  - Used by native Americans for:
    - ✓Ceremonial purpose
    - ✓Medicinal purpose

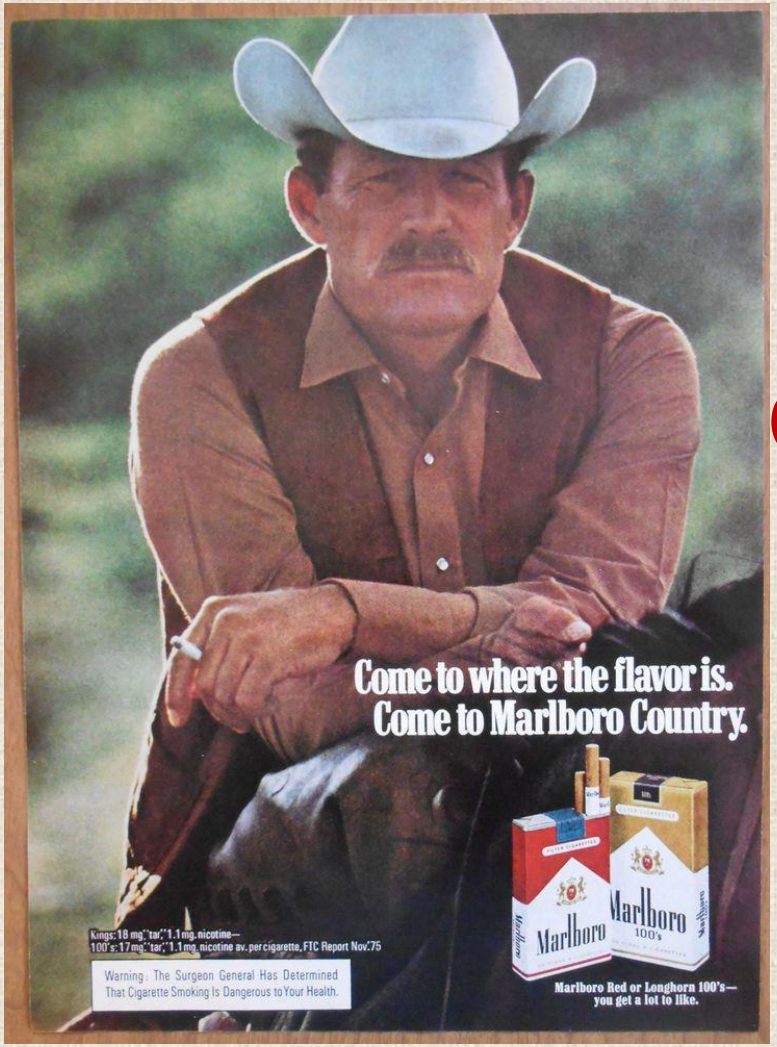


Cultural History

- Nicotine (cont.)

Cultural History

- Nicotine (cont.)



Tobacco Corporate Industry

Today

- Tobacco is the major public health issue
- Smoking & smokeless tobacco may lead to -
  - Mouth cancer
  - Lung cancer
  - Lung diseases
  - Heart disease
  - Premature birth of baby
  - Poor reproductive health in females
  - Fetal defects (child is born with defects)
  - Premature Death of person

(Risk is both to smokers & non-smokers)

Cultural History

❖ Solanaceae Alkaloids

➢ Solanine:

- A toxic glycoalkaloid with a bitter taste, it is formed by the alkaloid solanidine. It is found in leaves, fruit, and tubers of various Solanaceae such as the potato and tomato.
- Substance intoxication from solanine is characterized by gastrointestinal disorders (diarrhoea, vomiting, abdominal pain) & neurological disorders (hallucinations & headache).
- The amount of these glycoalkaloids in potatoes, for example, varies significantly depending of environmental conditions during their cultivation, the length of storage, and the variety. Solanine has occasionally been responsible for poisonings in people who ate berries from species such as *Solanum nigrum* or *Solanum dulcamara*, or green potatoes

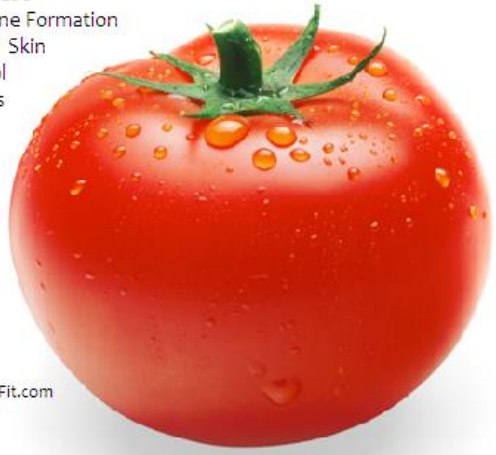
Solanaceae Crops

- Medicinal Foods
  - The current trend to a healthier food and the continuing quest for new drugs explain the attention given to Solanaceous crops as a source of bioactive compounds that can serve as candidates for medicianal foods and/or pharmacological drugs.
  - For example, researches have demonstrated antioxidant, anticancer, anti-inflammatory, and antiulcer properties of pepper extracts. A pepper-rich diet is supposed to be helpful against obesity and promises other health benefits.

10 Health Benefits of...

Tomatoes

1. Reduce Heart Disease
2. Lowers Risk of Stone Formation
3. Promotes Healthy Skin
4. Lowers Cholesterol
5. Reduces Migraines
6. Anti-Inflammatory
7. Improves Bones
8. Boosts Immunity
9. Prevents Cancer
10. Purifies Blood



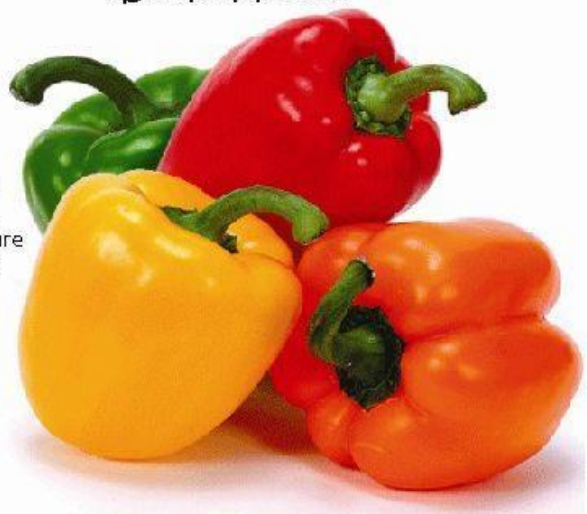
EatHealthyLiveFit.com

10 Health Benefits of...

Capsicums

(Bellpeppers)

1. Good for Eyes
2. Burns Calories
3. Anti-Cancer
4. Healthy Heart
5. Cures Anaemia
6. Boost Immune System
7. Lower Bad Cholesterol
8. Regulates Blood Pressure
9. Prevents Hypertension
10. Anti-Inflammatory



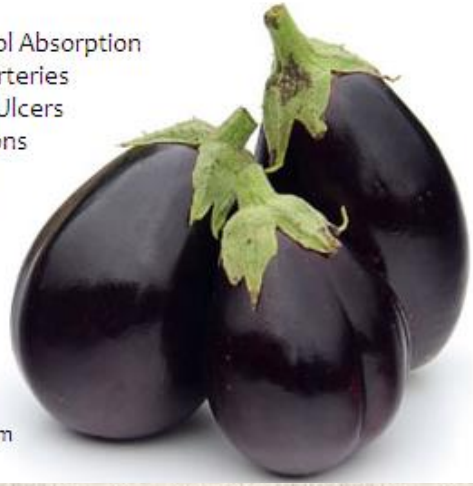
EatHealthyLiveFit.com

10 Health Benefits of...

Eggplant

(Aubergine)

1. Lower Bad Cholesterol Absorption
2. Protects Heart and Arteries
3. Assist with Stomach Ulcers
4. Assist Nerve Conditions
5. Prevents Infections
6. High Fibre Content
7. Prevent Cancer
8. Low in Calories
9. Protects Brain
10. Cleans Blood



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10 Health Benefits of...

Potatoes

1. Rich in Vit C, B6, Copper & Manganese
2. Helps Control Blood Sugar Levels
3. Best Energy Producing Veggie
4. Resists Stroke & Heart Attack
5. Reduces Inflammation
6. Liver Cleansing
7. High in Fibre
8. Low in Sodium
9. High in Vitamin A
10. Prevent Kidney Stones

EatHealthyLiveFit.com

Solanaceae Crops

❖ Medicinal Foods

- ➢ Lycopene
  - a naturally occurring red carotenoid pigment (not an alkaloid) found in tomatoes, pink grapefruit, watermelon, papaya, guava, and other fruits, has been extensively studied for health benefits for more than 70 years.
  - In the 2000s, lycopene-containing foods (primarily tomato products) and lycopene supplements have been reported for benefits to diseases ranging from cancer to heart disease to asthma.

Solanaceae Crops

❖ Medicinal Foods (cont.)

- ➢ Lycopene (cont.)
  - 2013 Research Update
    - ✓ Discrepancies between animal data, which are generally positive, and human data, which are less clear, may be due to differences in carotenoid absorption and metabolism in humans relative to other species as well as inter-individual differences in humans.
    - ✓ it is unclear whether apparent reductions in disease risk observed in epidemiological and short-term prospective studies result from the whole tomato or from lycopene alone

Now a Gallery of Solanaceae Art...

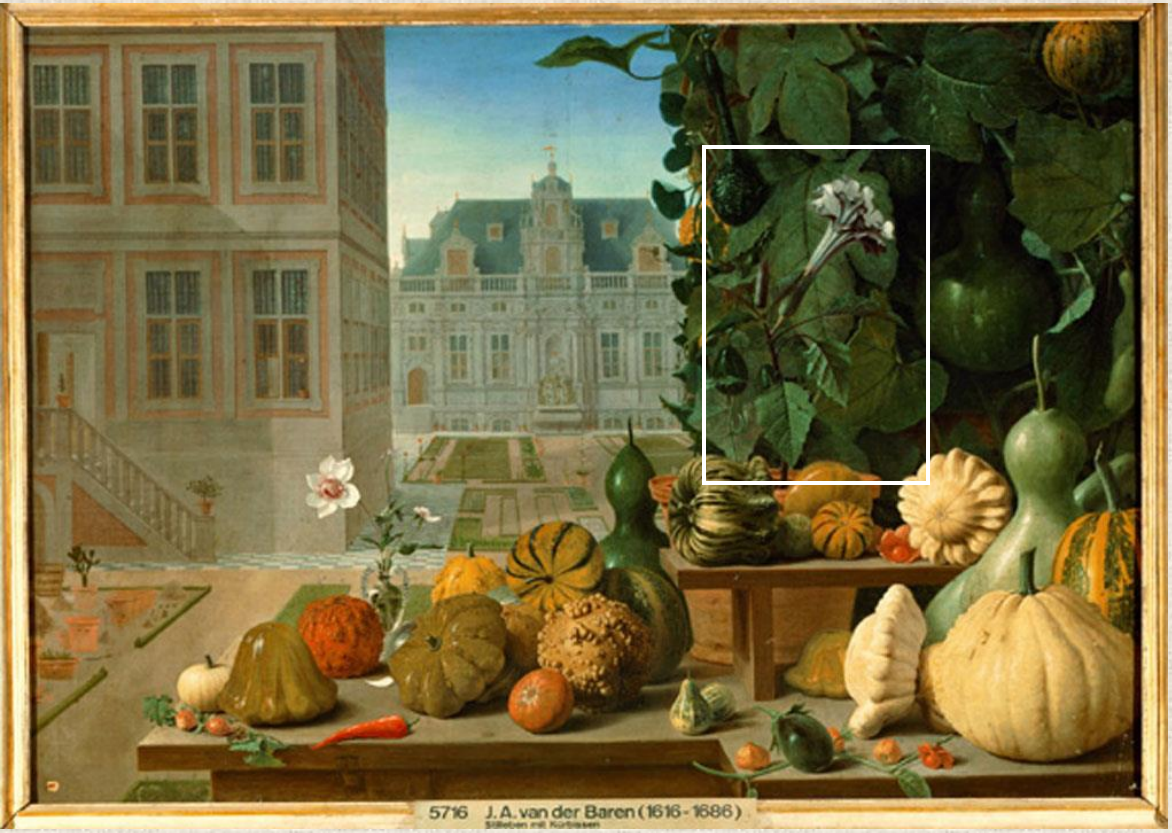
Archimboldo
Autumn 1573

Eggplant

Pisa Cathedral 1601

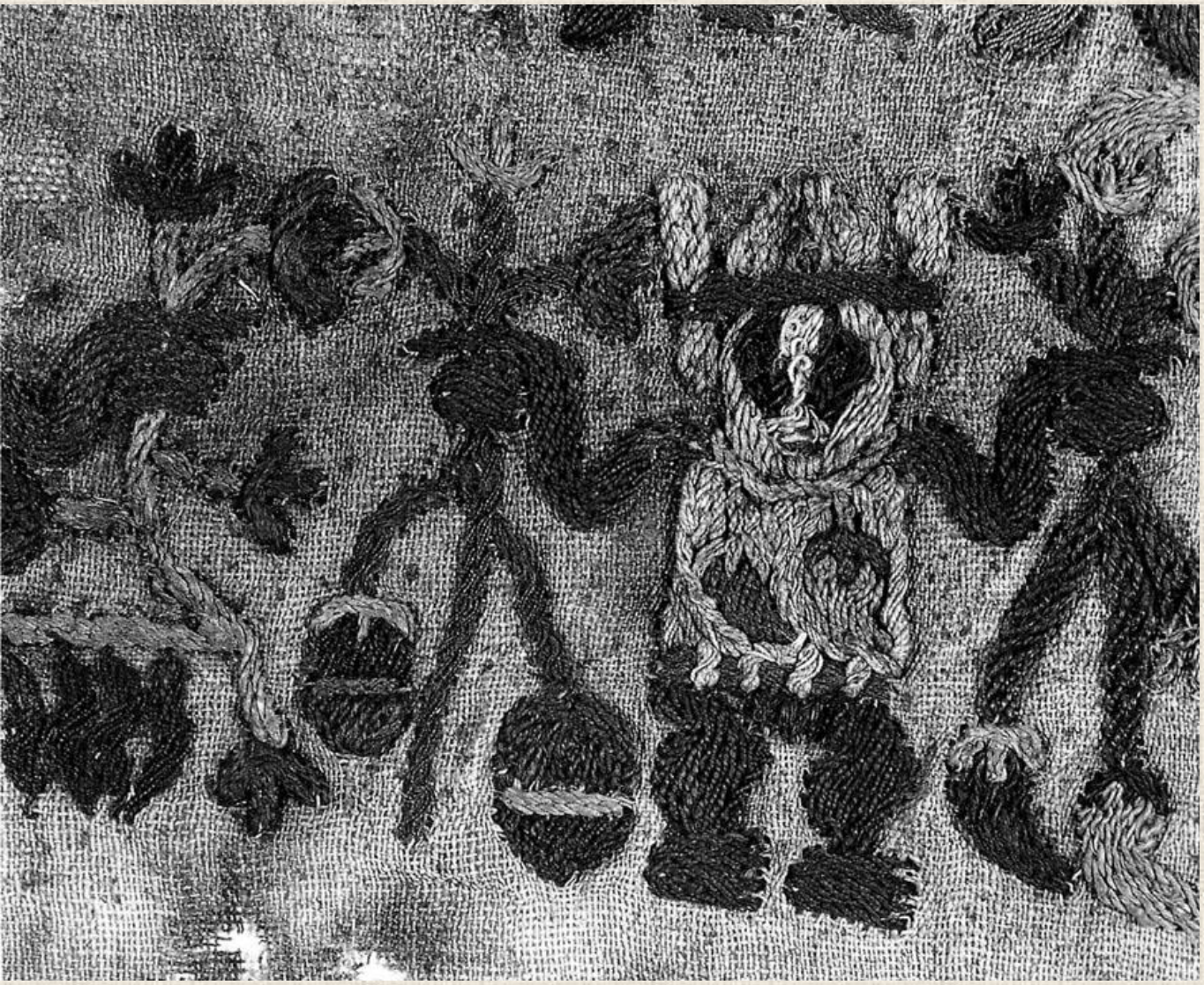
Eggplant

Datura



Still Leben mit Kurbissen ca. 1650

Capsicum Pepper



Peru 400–500 CE

Mexico
500–1500 CE

Pisa Cathedral 1601

Tomato

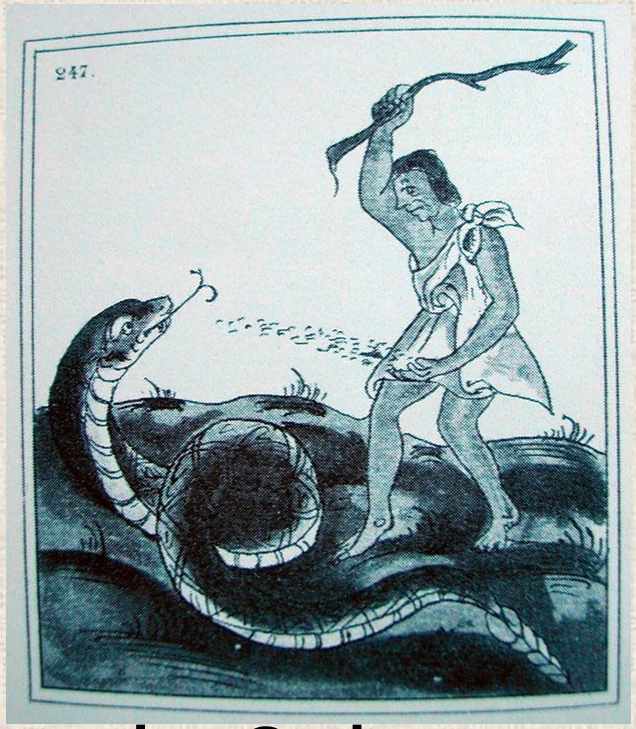
Potato

Proto-Chimu period pre-columbian, 200 CE

Chimu period pre-columbian, 90

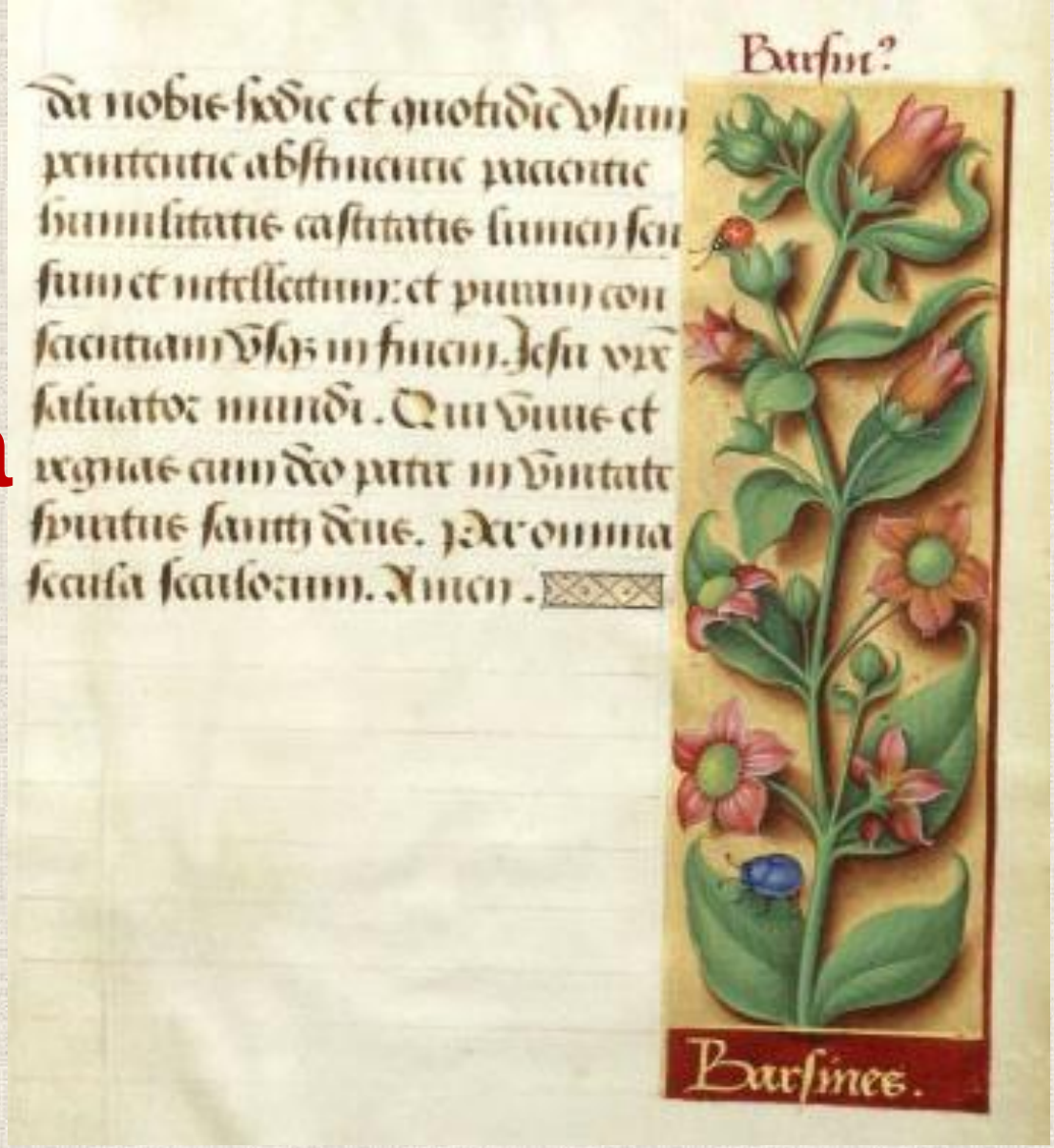
Tobacco

Badianus manuscript,
Aztec Herbal, 1552



Florentine Codex
1540–1585, Mexico

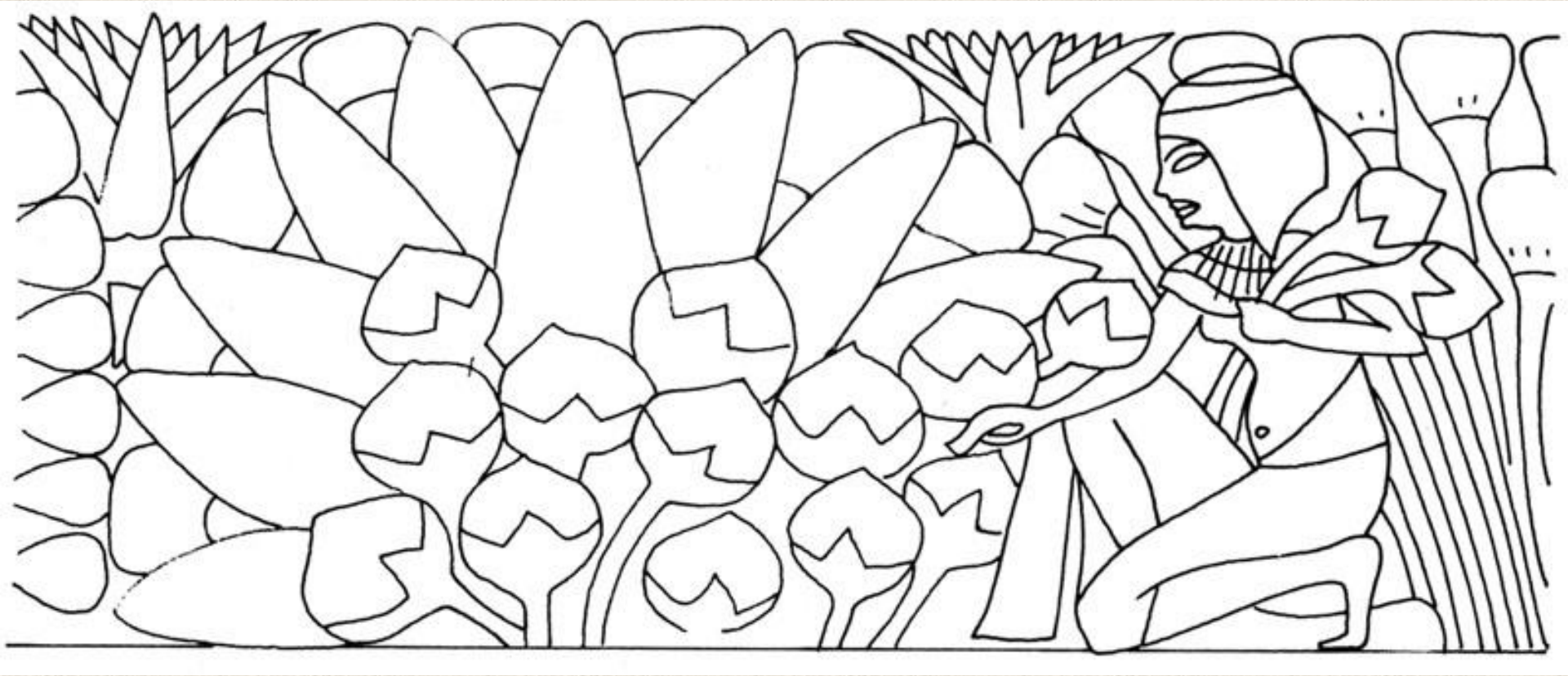
Belladonna



Horae ad usum romanum
1503–1508

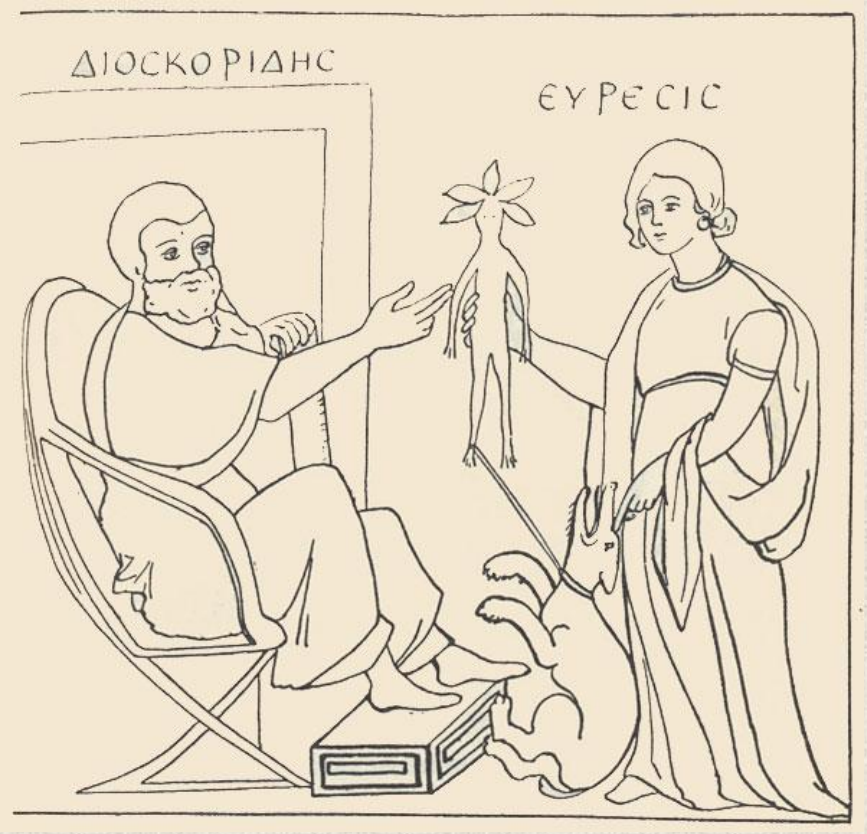
Mandrake

Harvesting fruits from ivory casket of Tutankhamun 1327 BCE



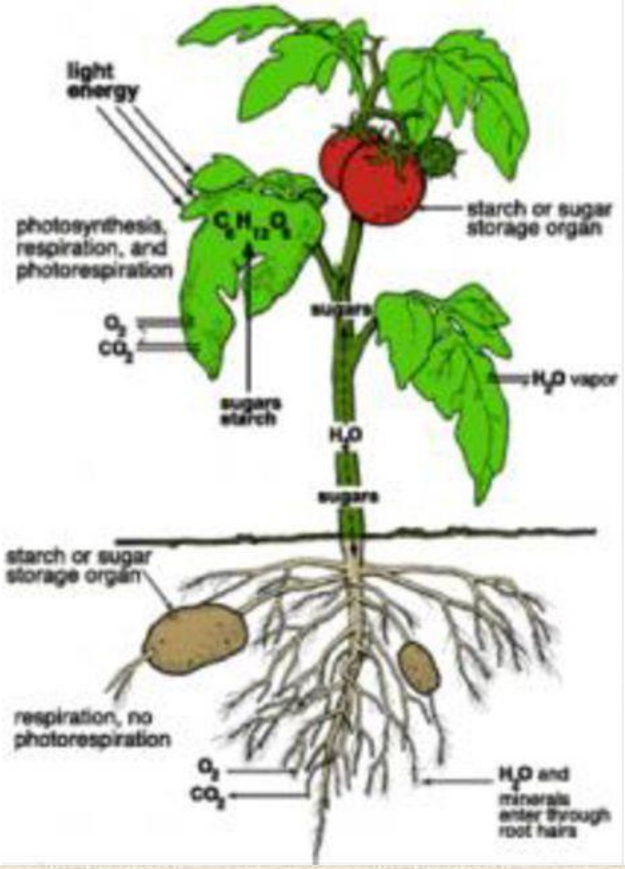
Dioscorides ca. 512, Aniciae Julianae Codex

Dioscorides receiving mandrake from the nymph Epinoia (Discovery) for Krateuas to paint.



Thank You !

Solanaceae – other approaches (pomato)



References and Resources

- Asnin, L. and S.W. Park. Isolation and Analysis of Bioactive Compounds in Capsicum Peppers – see https://www.researchgate.net/publication/262976950_Isolation_and_Analysis_of_Bioactive_Compounds_in_Capsicum_Peppers
- Bosland, P.W. Capsicums – see https://hort.purdue.edu/newcrop/proceedings1996/V3-479.html
- Carr, G. Solanaceae – see http://www.botany.hawaii.edu/faculty/carr/solan.htm
- Dauney, M.C., J. Janick, and H. Laterrot. Iconography of Solanaceae: Antiquity to the 17th Century – see https://www.hort.purdue.edu/newcrop/actahort745.pdf
- Darrigues, A. 2003. Evolution of Crops – see http://www.cropwildrelatives.org/fileadmin/templates/cropwildrelatives.org/upload/Presentations/Evolution%20of%20crops%20-%20D.Tay-2.pdf
- Fillipone, P.T. Tomato History - The history of tomatoes as food – see https://www.thespruce.com/history-of-tomatoes-as-food-1807678

References and Resources

- FL Museum of Natural History. Mimicry Diversity, Evolution and Ecology of Ithomiine Communities – see https://www.floridamuseum.ufl.edu/mcguire/research/ecology/
- Grant, A. What Is True Potato Seed: Learn About Potato Seed Growing – see https://www.gardeningknowhow.com/edible/vegetables/potato/true-potato-seed-growing.htm
- Guyat, R., et. al., Ancestral synteny shared between distantly-related plant species from the asterid (*Coffea canephora* and *Solanum* Sp.) and rosid (*Vitis vinifera*) clades. – see https://bmcgenomics.biomedcentral.com/articles/10.1186/1471-2164-13-103
- Jacobs, J. 1995. The Eaten Word: the language of food, the food in our language. - see https://www.brotherhoodbooks.org.au/books/the-eaten-word-9781559722858/
- Khoury, C., et.al., Origins of food crops connect countries worldwide – see http://rspb.royalsocietypublishing.org/content/royprsb/283/1832/20160792.full.pdf

References and Resources

- Kirasur, N. Genetic Resources of Potato – see https://www.slideshare.net/ningappas/genetic-resources-of-potato
- Maestri, M. 2017. Potato History - Archaeological Evidence for Domesticating Potatoes – see https://www.thoughtco.com/potato-history-archaeological-evidence-172097
- Mann, C.C. 2011. How the Potato Changed the World – see https://www.smithsonianmag.com/history/how-the-potato-changed-the-world-108470605/
- Mother Earth News. A Crop By Crop Guide – see http://www.motherearthnews.com/crop-guide-growing-organic-vegetables-fruits-zl0z1211zsto.aspx#axzz3KnoGP3v7
- Online Etymology Dictionary. – see https://www.etymonline.com/
- Raven, S. 2010. How to grow: chitting and forcing potatoes – see https://www.telegraph.co.uk/gardening/howtogrow/fruitandvegetables/7053223/How-to-grow-chitting-and-forcing-potatoes.html
- Saynisch, M. 2017. Real Food Right Now and How to Cook It: Eggplant – see http://www.gracelinks.org/blog/1280/real-food-right-now-and-how-to-cook-it-eggplant

References and Resources

- Smith, K.A. Why the Tomato Was Feared in Europe for More Than 200 Years – see https://www.smithsonianmag.com/arts-culture/why-the-tomato-was-feared-in-europe-for-more-than-200-years-863735/
- Solanaceae Source – see http://solanaceaesource.org/
- Solgenomics Network. About the Solanaceae – see https://solgenomics.net/about/about_solanaceae.pl
- Story, E.N, et. al., An Update on the Health Effects of Tomato Lycopene – see https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3850026/
- The Plant List. Solanaceae – see http://www.theplantlist.org/browse/A/Solanaceae/
- Wikipedia. Solanaceae – see https://en.wikipedia.org/wiki/Solanaceae
- Youtube Video
  a) Domestication of Potato – see https://www.youtube.com/watch?v=VULg41VjU74
  b) Solanaceae – see https://www.youtube.com/watch?v=PIpk2ALCKJs