
Taxus baccata L.
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Plant toxins

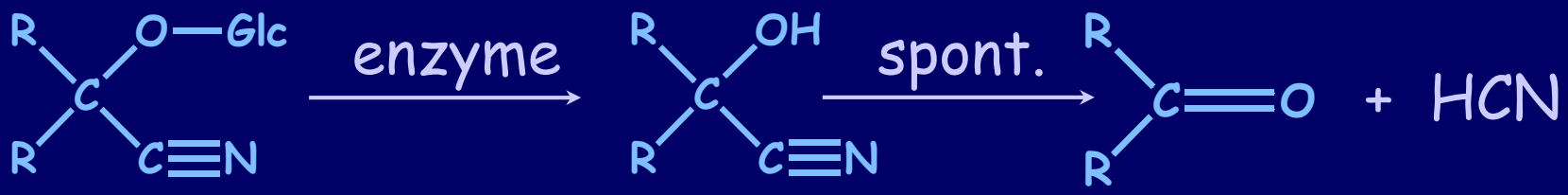
Classification of plant toxins:

- Nitrogen-containing compounds:
  - Cyanogenic glycosides
  - Alkaloids
- Nitrogen-free compounds
  - Terpenic compounds
  - Photolabile compounds

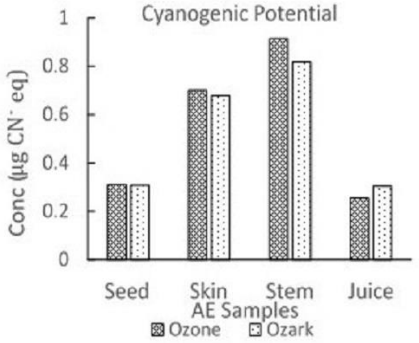
Cyanogenic glycosides

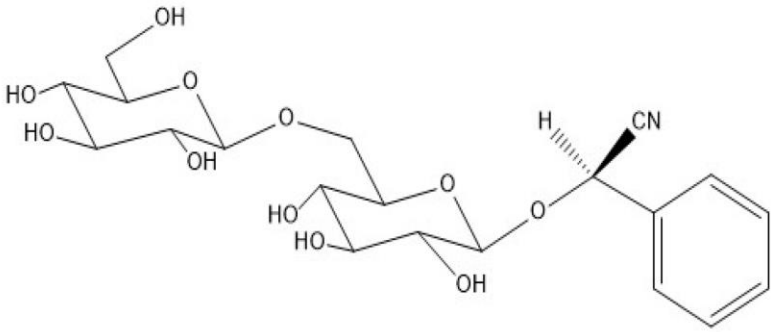
Bitter almonds (Mandloň obecná), clover (jetel), lotus

Sheeps, cattle and some snails are immune

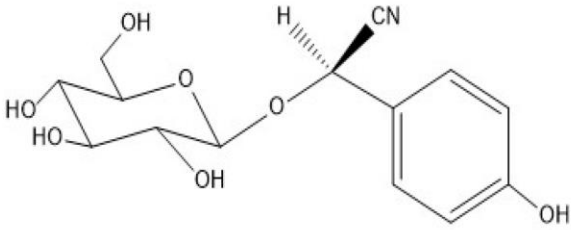


American Elderberry

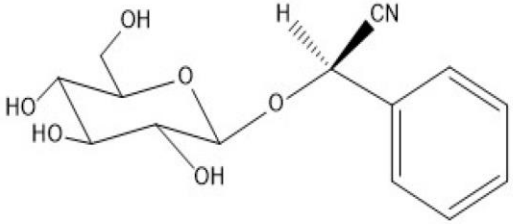




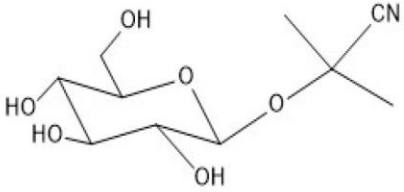
Amygdalin



Dhurrin



Prunasin

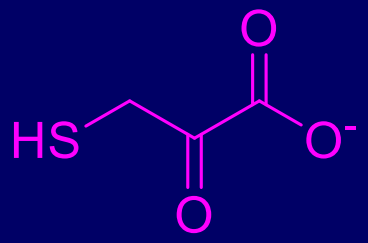


Linamarin

10.3390/molecules26051384

Principle of detoxification:

$$CN^- + S \longrightarrow CNS^-$$

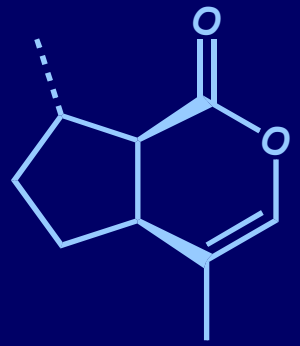


The sulfur originates from mercaptopyruvate from which is released by action of enzyme (3-mercaptopyruvate surfuryltransferase)

The same mechanism is used for clinical treatment of cyanide poisoning

$$CN^- + Na_2S_2O_3 \longrightarrow CNS^- + Na_2SO_3$$

Nepeta Cataria



Nepetalactone

Catnip (catmint, šanta kočičí)

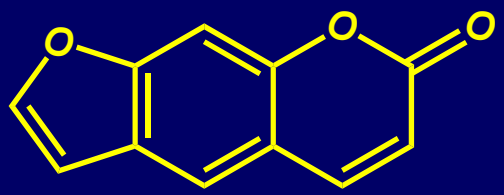
Repellent and toxic effect toward some insect and birds

For other sort of insect attractant

Fotolabile compounds:

Psoralen Garden parsley (Petržel)

Petroselinum hortense



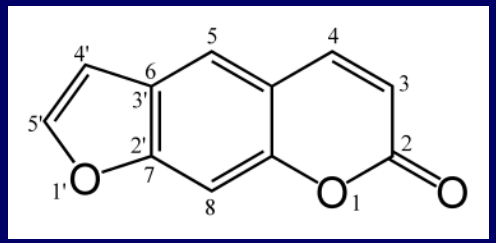
Furocumarins

Also in bergamot essential oil, and *Heracleum mantegazzianum*

- Decomposed by the action of UV light, exposure results in skin damage by binding of product to pyrimidine bases

Fotolabile compounds

phototoxic plant. Its sap can cause phytophotodermatitis



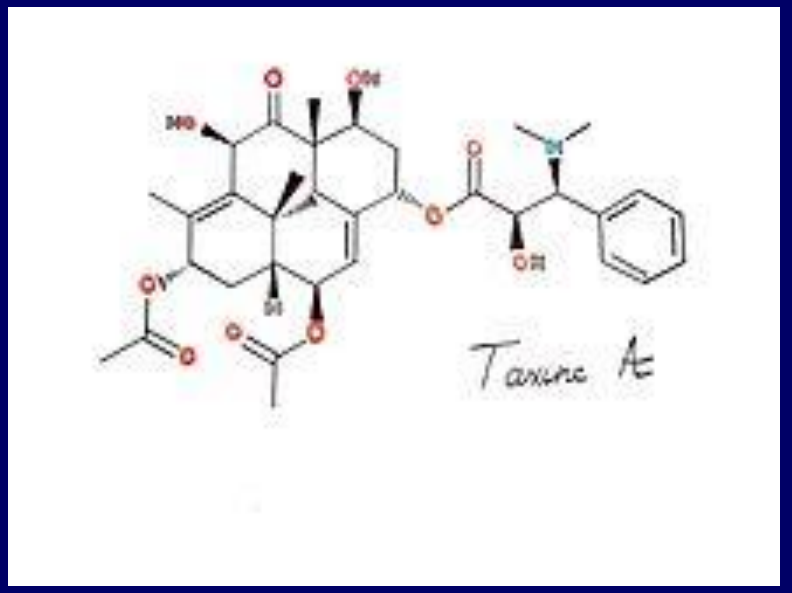
furanocoumarin

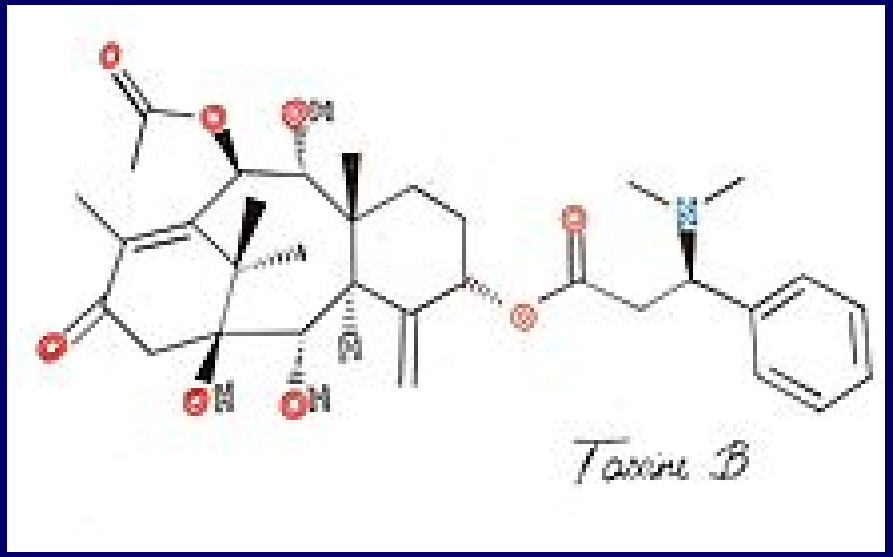
Heracleum mantegazzianum **giant hogweed** (Bolševník velkolepý)

Diterpenes:

Taxus Baccata

Yew tree (Tis červený)





Whole plant toxic except of fruit

(taxins)

Diterpenes:

Taxus Brevifolia

Paclitaxel (Taxol®)

Pacific yew

- used to treat different cancers including ovarian, breast and lungs cancer

Water dropwort (water fennel)

Oenanthotoxin (překrvení sliznic, kolikové bolesti)

Oenanthe aquatica (Halucha vodní)

Urushiol

R = $(CH_2)_{14}CH_3$ or
R = $(CH_2)_7CH{=}CH(CH_2)_5CH_3$ or
R = $(CH_2)_7CH{=}CHCH_2CH{=}CH(CH_2)_2CH_3$ or
R = $(CH_2)_7CH{=}CHCH_2CH{=}CHCH{=}CHCH_3$ or
R = $(CH_2)_7CH{=}CHCH_2CH{=}CHCH_2CH{=}CH_2$ and others

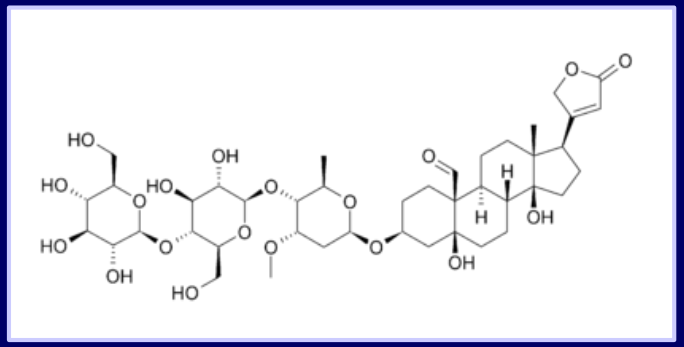
Toxicodendron radicans

Poison Ivy (Jedovatec kořenující)

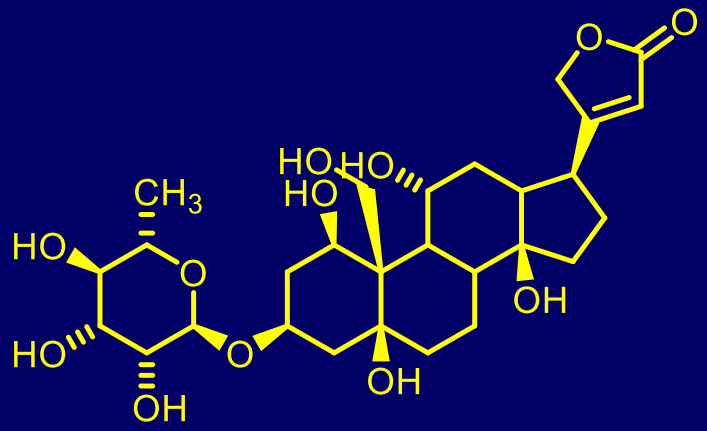
Steroid glycosides

Poison arrow plant

Acokanthera oblongifolia



k-strophantin



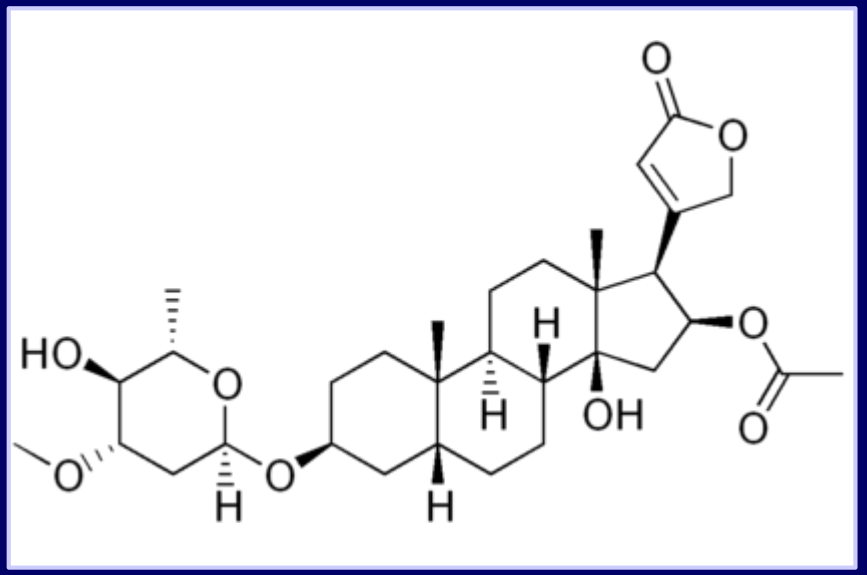
Ouabain

cardiac glycoside that acts by inhibiting the Na⁺/K⁺-ATPase sodium-potassium ion pump (but it is not selective)

Steroid glycosides

Nerium oleander

Oleander



Oleandrin

Alkaloids

- Definition: the term “alkaloid” (alkali-like) is commonly used to designate basic heterocyclic nitrogenous compounds of plant origin that are biologically active.

Classification of alkaloids

- **True (Typical) alkaloids** that are derived from amino acids and have nitrogen in a heterocyclic ring. e.g. Atropine
- **Protoalkaloids** that are derived from amino acids and do not have nitrogen in a heterocyclic ring. e.g. Ephedrine
- **Pseudo alkaloids** that are not derived from amino acids but have nitrogen in a heterocyclic ring. e.g. Caffeine

Alkaloids

New Definition: Alkaloids are cyclic organic compounds containing nitrogen in a negative state of oxidation with limited distribution among living organisms.

Alkaloids

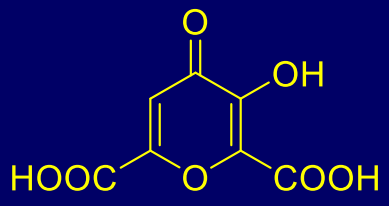
Distribution and occurrence:

- Rare in lower plants.
- Dicots are more rich in alkaloids than monocots.
- Families rich in Alkaloids: Apocynaceae (Toještovité), Rubiaceae (Mořenovité), Solanaceae (Lilkovité) and Papaveracea (Makovité).
- Families free from Alkaloids: Rosaceae (Růžovité), Labiatae (Hluchavkovité).

Distribution in Plant:

- All Parts e.g. Datura (Durman).
- Barks e.g. Cinchona (Chinovník)
- Seeds e.g. Nux vomica (Kulčiba)
- Roots e.g. Aconite (Oměj)
- Fruits e.g. Black pepper
- Leaves e.g. Tobacco
- Latex e.g. Opium

Forms of Alkaloids:



meconic acid

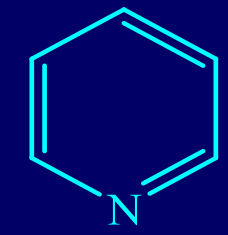
quinic acid

- Free bases
- Salts with Organic acids e.g. **Oxalic, acetic acids**
- Salts with inorganic acids e.g. **HCl, H_2SO_4.**
- Salts with special acids:
  e.g. **Meconic acid** in Opium
  Quinic acid in *Cinchona*
- Glycosidal form e.g. Solanine in *Solanum*.

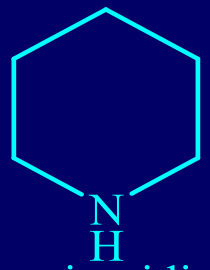
Function in Plants

- They may act as **protective** against insects and herbivores due to their bitterness and toxicity.
- They are, in certain cases, the final **products of detoxification** (**waste products)**.
- **Source of nitrogen** in case of nitrogen deficiency.
- They, sometimes, act as **growth regulators** in certain metabolic systems.
- They may be utilized as a **source of energy** in case of deficiency in carbon dioxide assimilation.

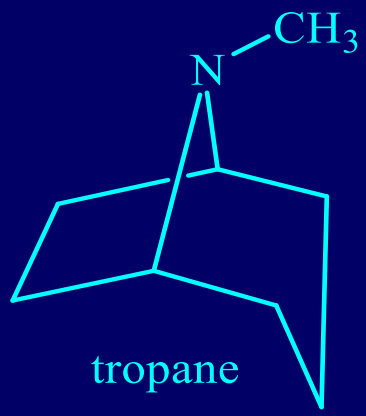
Classification of alkaloids



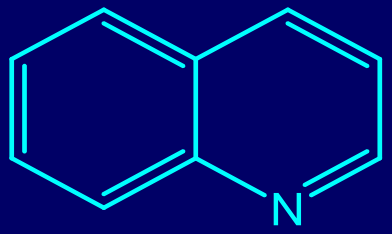
pyridine



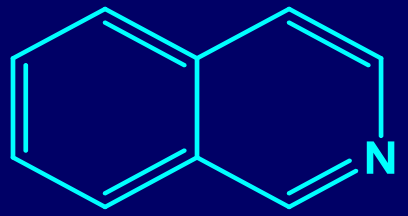
piperidine



tropane

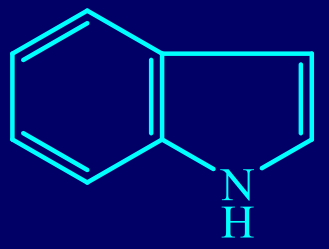


quinoline

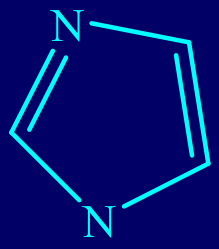


isoquinoline

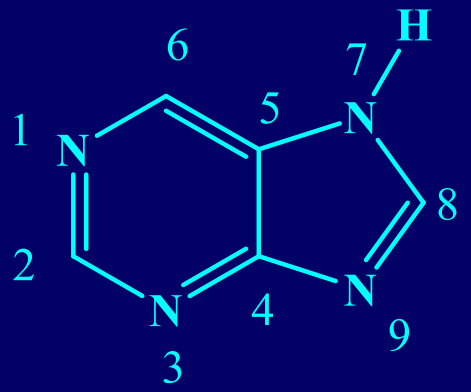
Classification of alkaloids



indole

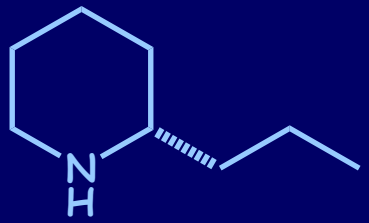


imidazole



purine

Connium maculatum



Coniine

Poison hemlock

(Bolehlav plamatý)

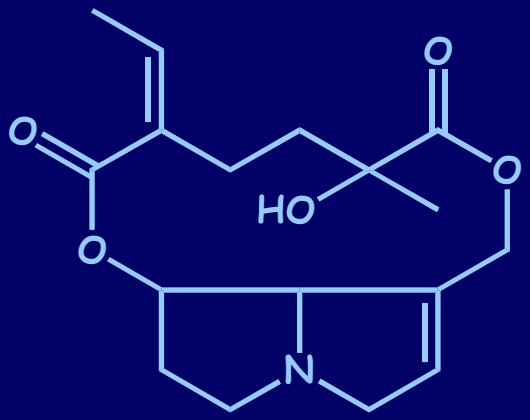
Sarracenia flava

One of the first alkaloids isolated (1827) and first one syntesized in the lab (1886, Ladenburg)

less than 0.2g is fatal to humans (LD_{50} 4 mg/kg – cow, neuromuscular receptors-paralysis)

Alkaloids:

Senecio vulgaris



Senecionin

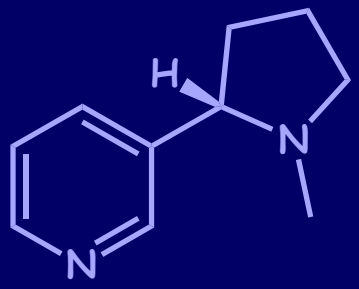
Common groundsel

(Starček obecný)

Toxin causes liver failure

Secondary poisoning from cow milk drinking were described

Nicotiana tabacum



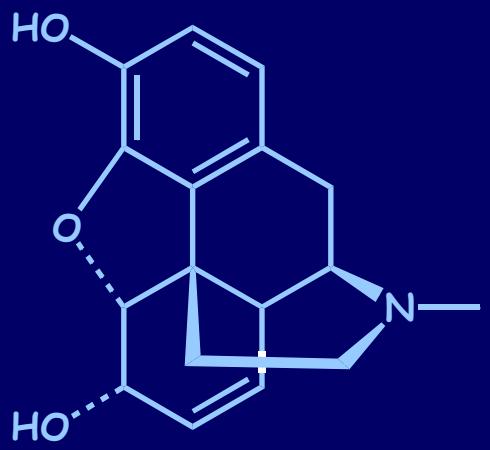
Nicotine

Virginia tobacco

- Highly toxic - LD_{50} about 3 mg/kg (mice)
- Extracts might be used as insecticide
- isolation 1828

  synthesis 1904

Papaver somniferra



Morphine

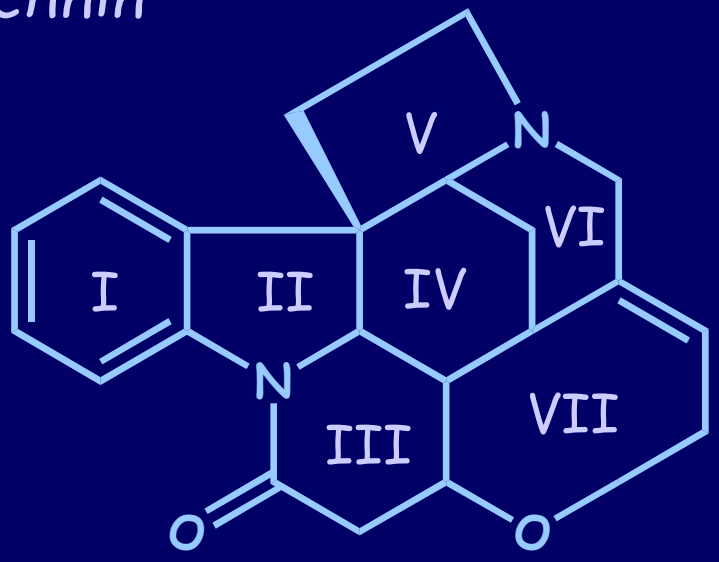
Opium poppy

- Main component of opium (9 - 14%)
- opium – dried latex from unripe seedpods (contains also codeine a thebaine)
- Isolation 1820
- synthesis 1944

Strychnine:

- Tree native to east India, strychnine tree , *strychnos nux-vomica* (*Kulčiba dávivá*)
- Only fruit is toxic
- One of the first alkaloids isolated - Pierre-Joseph Pelletier in 1818
- LD50 = 0.16 mg/kg in rats, 1–2 mg/kg orally in humans, glycine receptor inhibitor
- (barbiturates antidotum)

Strychnin



isolation	1818 (Pelletier)
structure	1946 (Robinson)
synthesis	1954 (Woodward)
stereoselective synthesis	1992 (Overman)

Colchicum speciosum
(Ocún)
autumn crocus or
„naked lady"

Colchicine

Treatment of gout

Clasification of alkaloids

Phenylethylamine a. :

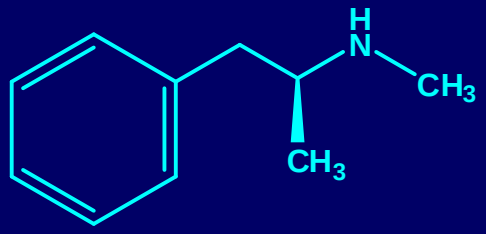
Ephedrine

Ephedra fam.

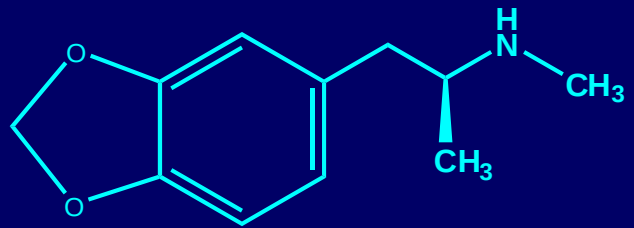
Lophophora williamsii)

mescaline

Metamphetamine and MDMA



Pervitin
(metamphetamine)



Extasy (MDMA)

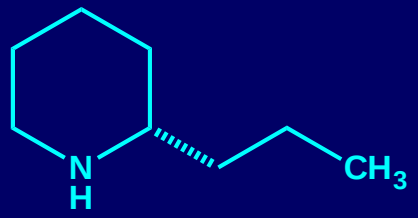
Purine alkaloids

Theobromine

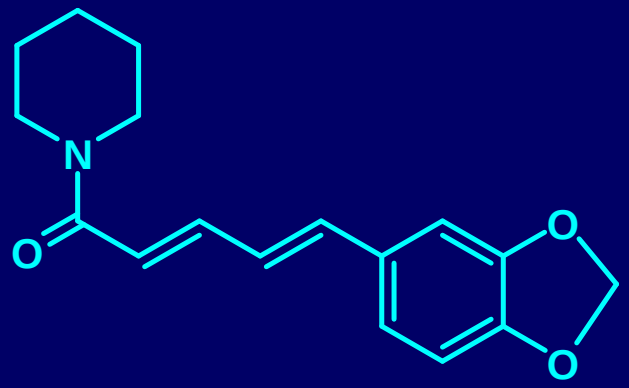
Caffeine

Theophylline

Pyridine and piperidine a.



coniine



piperine

Pyridinové a pyrolidinové a.

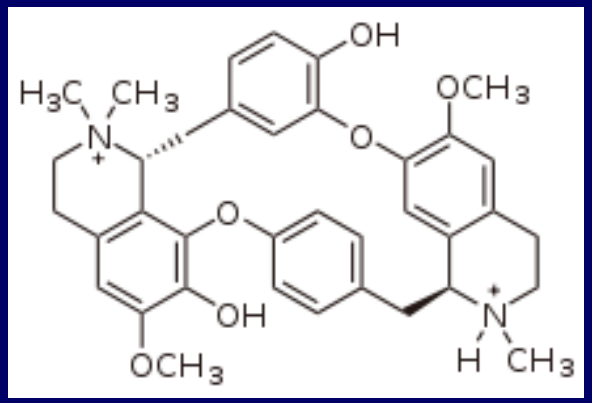
nicotine

cotinine

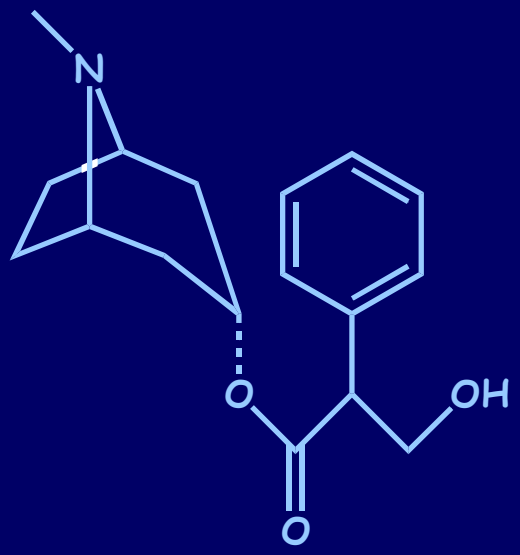
Pyridine and piperidine a.

Strychnos toxifera

(kulčiba jednodárná)



Tubocurarine chloride
inhibitor of nicotinic acetylcholine receptors



Atropine

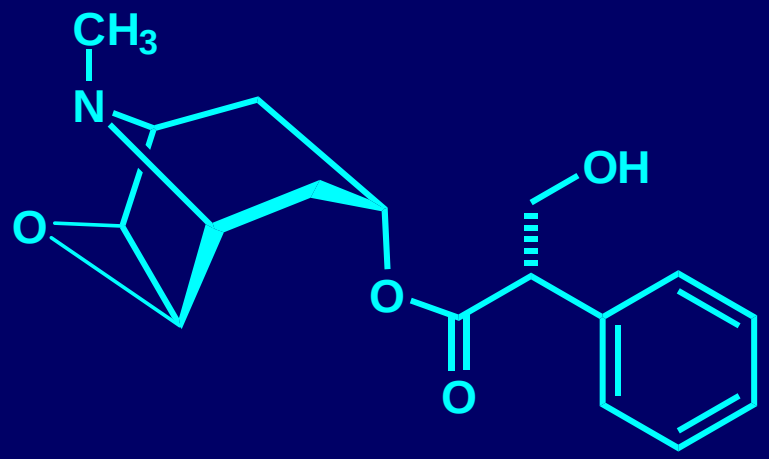
Atropa belladona

Deadly nightshade

Atropine in the small doses supports CNS, used in ophtalmology as mydriatics

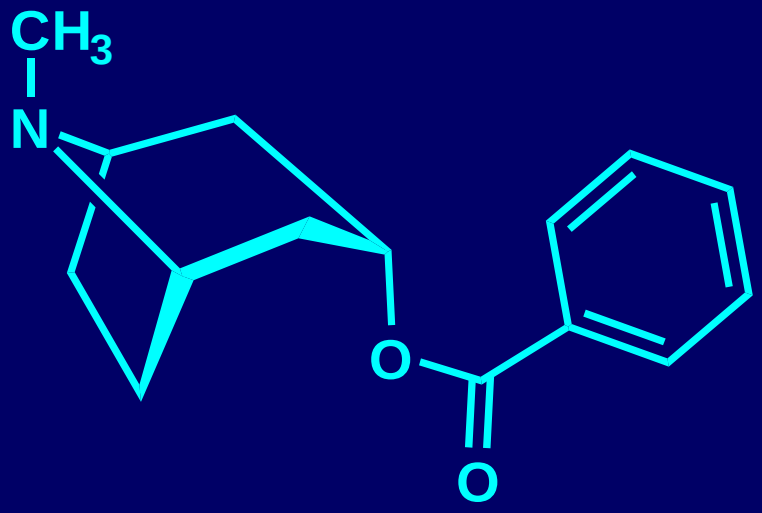
- used also for treatent of Parkinson´s disease

Tropane alkaloids.



scopolamine

Cocaine

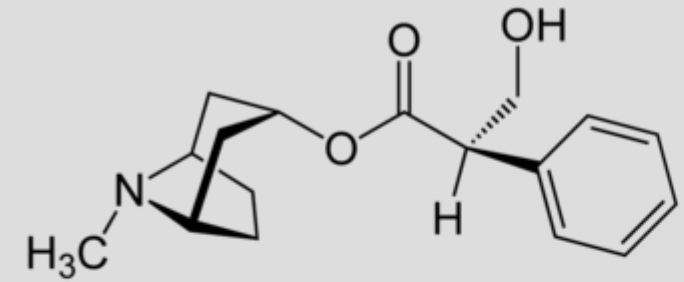


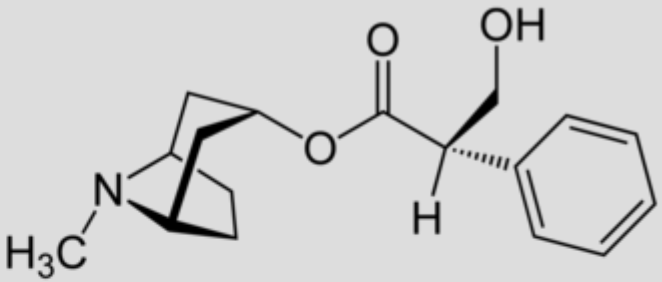
Erythroxylum coca

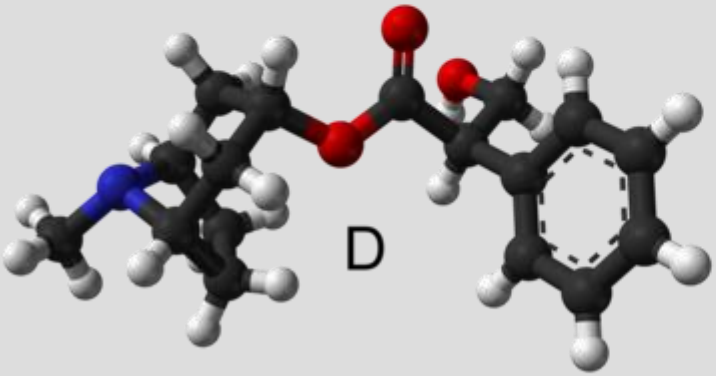
(Rudodřev koka)

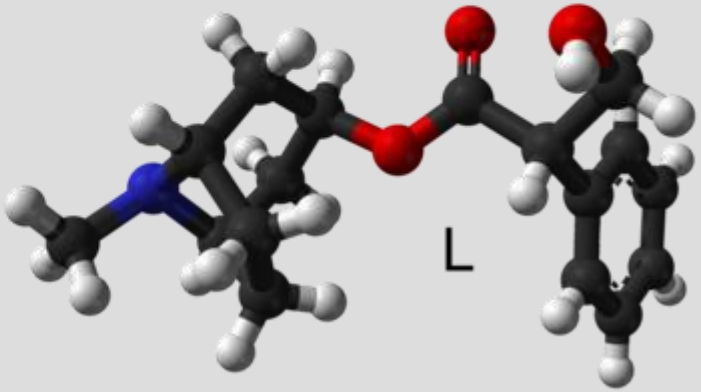
Inhibits reuptake of serotonin, norepinephrine and dopamine.

Atropine a hyoscyamin

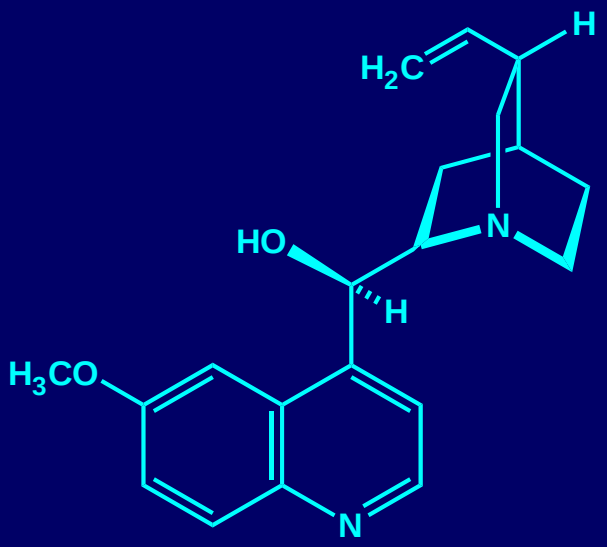








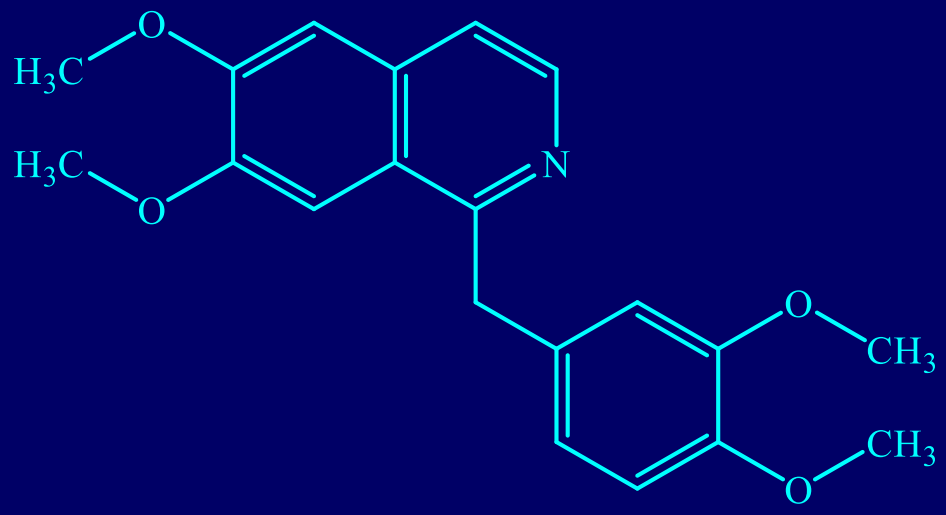
Quinoline alkaloids



quinine

Cinchona calisaya

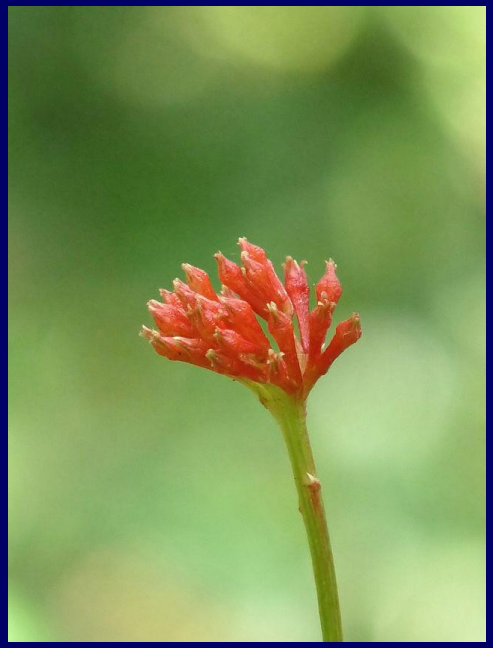
Isoquinoline alkaloids



papaverine

(Léčba spasmů)

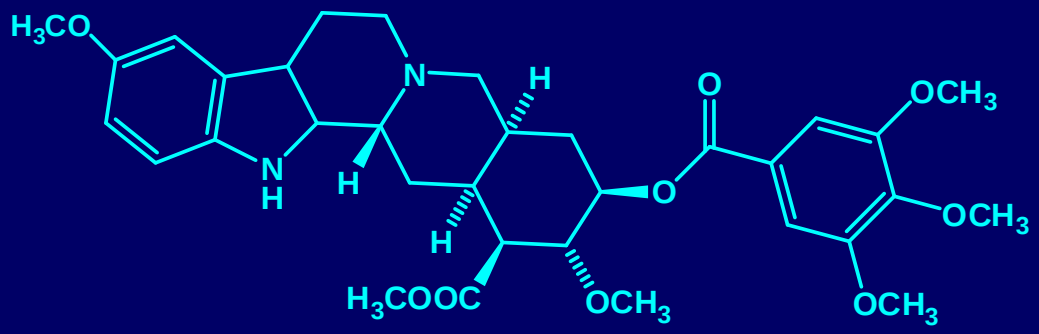
Indole alkaloids



Rauwolfia serpentina

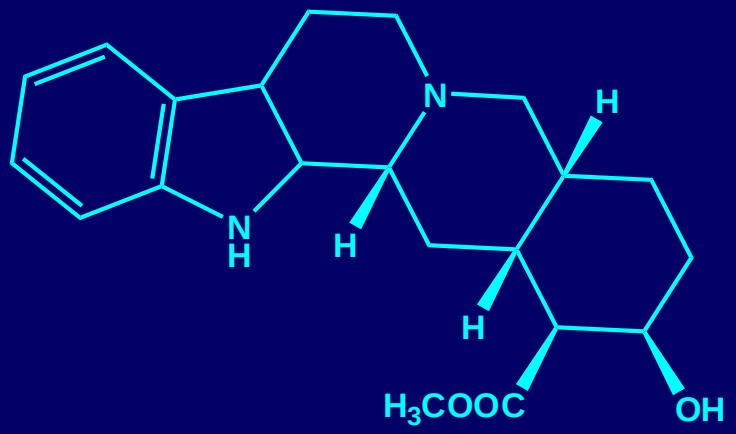
Indian snakeroot

(Zmijovice hadová)



Reserpine
(Léčba hypertenze, trancquilizer)

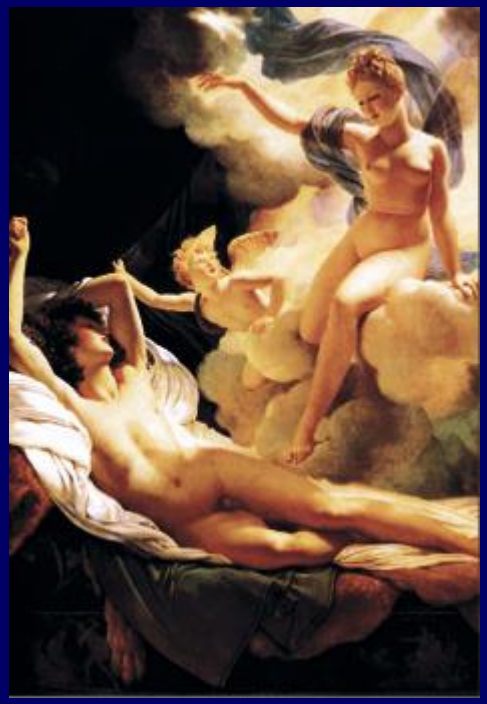
Indole alkaloids



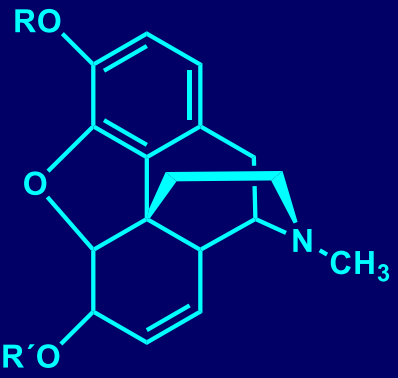
yohimbine

Pausinystalia yohimbe

Phenantrene alkaloids



morphine



heroin (R = R´ = CH_3CO-)

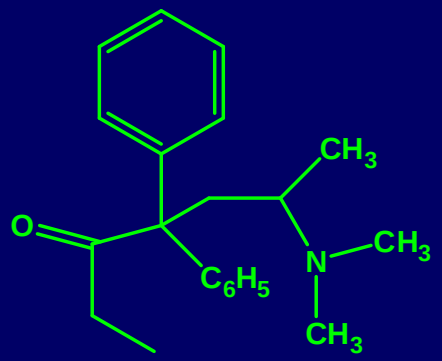
codeine (R = CH_3, R´ = H)

Morphine rule:

Structural requirements:

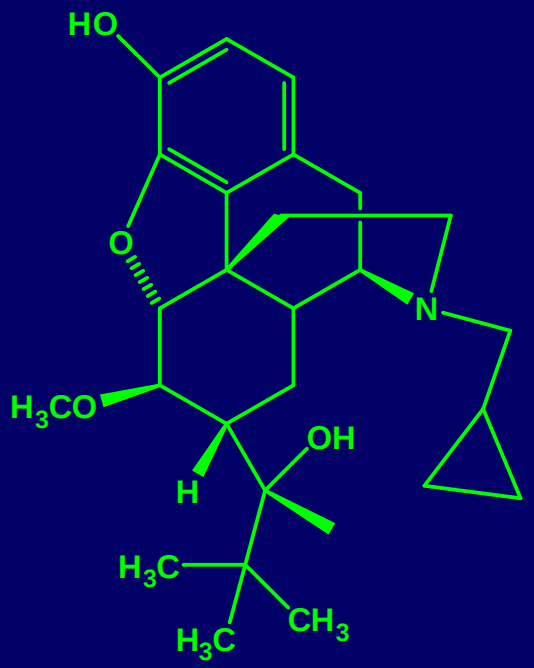
1. Tertiary amine substituted with small alkyl.
2. Quarternary carbon atom.
3. Phenyl group (or its isosteric equivalent)directly attached to quartenary carbon.
4. 2 C spacer between quarternary carbon and tertiary amine

Morphine rule



Methadon

Meperidin



Buprenorphine (Subutex)